GREEN BROOK FLOOD CONTROL PROJECT:

SAVING BOUND BROOK

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Dedication

This paper is dedicated to my parents:

Arnold and Janet Blackstone,

who taught me the fine art of perseverance and to my children:

Nicholas, Madeline and Teddy,

who have reminded me of the importance of that very same fine art.

Thank you to each of you for your encouragement and belief in me.
A special thank you to each of these people, for your part in building this paper:

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ABSTRACT

THE GREEN BROOK FLOOD CONTROL PROJECT:
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Charles E. Defendorf, PE

Bound Brook, New Jersey sits between Middle Brook, Green Brook and a bend on the Raritan River in the Triassic Basin of New Jersey. Like many cities and towns all over the world, it was originally situated on the river to take advantage of fresh water for drinking, transportation and trade. As transportation networks have become centered around motor vehicles, the importance of river transportation and trade has become less important. However, communities continue to live within flood zones begging the questions: Why do towns continue to thrive on the river’s edge? Are river towns viable? Should they be encouraged and saved through the use of taxpayer dollars?

Faced with these questions, the communities in the area surrounding Bound Brook spent many years convincing the national, regional and local authorities that saving Bound Brook was important and cost effective. The Army Corps of Engineers embarked on the Green Brook Flood Control Project, one of the most comprehensive and ambitious projects undertaken anywhere. The solution involved residential buyouts, wetlands mitigation, bridge reconstruction, railroad realignment, installation of large pumping stations, upgrading regional storm-water collection, flood-proofing, channel modifications, and levee and flood wall construction. The Bound Brook portion of the Green Brook Flood Control Project was to take a total of 12 years and cost more than $111 million¹ to be shared by federal, state and local interests. As the project nears completion in 2012, I will review the history of Bound Brook, the Green Brook Flood Control Project, and the effectiveness of each remedial element of the flood control project.

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1.0 INTRODUCTION

A story of heartbreak, determination and resilience, Bound Brook, New Jersey is in the epicenter of the chronic Raritan River flooding events. Bound Brook has documented countless flooding events as a result of its low elevation, location amongst the convergence of multiple river systems into the Raritan River (Middle Brook, Green Brook and Ambrose Brook most immediately and Millstone and Stony Brook further upstream), proximity to the Watchung Mountains, overdevelopment within its own borders as well as those upstream, and even development downstream. Yet Bound Brook, because of its location on the Raritan River, has also benefited from its flows as a transportation hub, and a core of commerce and recreation. Since 1966, the Raritan River has exceeded flood stage 32 times\(^2\) and warranted 12 Presidential Disaster declarations and seven other declared emergencies\(^3\).

The Green Brook Flood Control Project (GBFCP) evolved out of ongoing devastation, bringing together citizens and the government to mitigate the problem to the best of their ability. The GBFCP is a combination of federal, state and local interests including the citizens of Bound Brook. In the pages to follow, I will review and analyze the history of river flooding in Bound Brook and the mitigation techniques employed on behalf of the citizens of Bound Brook for the largest river flood protection effort on the East Coast. The GBFCP began in 2000 with the reconstruction of the Lincoln Bridge located on the border of Bound Brook and Middlesex crossing Green Brook. The Bound Brook portion of the GBFCP included buyouts, flood-proofing, levees, floodwalls, closure gates, wetlands mitigation, bridge raising, bridge

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demolition, and pumping stations. Presently the project is in its final year of build out with the last Bound Brook element being completed this fall.

2.0 BOUND BROOK, AN OVERVIEW

In 2009, Bound Brook, New Jersey had a population of 10,433 and a population density of 6,117 people per square mile. It is a borough that sits on 1.71 square miles and is 48 feet above sea level. Bound Brook’s proximity to New York City makes it a very desirable place to live. With a train station in Bound Brook, commuting into the city takes about 20 minutes. Additionally Bound Brook residents have immediate access to U.S. Interstate 287 and U.S. Route 22 for easy connections throughout the state and tri-state area. Economically it is very much a working class area with a January 2011 cost of living index of 124.2. Ethnically this community consists of a Hispanic population of almost 46.4% where 42.7% speak Spanish at home. The most commonly held jobs of residents are in the building and grounds cleaning and maintenance occupations. The most common industries in Bound Brook are Accommodation, Food Services, and Waste Management services.4

2.1 Geology

The Raritan River watershed drains the central portion of New Jersey into the Atlantic Ocean at Raritan Bay just south of New York City. Its presence in the Garden State is crucial to the region for many reasons including ground water, drinking water, transportation, recreation, and ecology. The Raritan River is also very sensitive as a result of being embedded in one of the region’s most industrial areas making it vulnerable to pollution and overdevelopment. This over-development, in particular, is the focus of this report as it relates to flooding in the Bound Brook

region: its history, its solutions, and its future. Bound Brook rests at the “top” of the lower reach of the Raritan River watershed.\(^5\)

Figure 1 shows Bound Brook in relation to the remainder of the Raritan River watershed. The map also shows some of the key transportation routes and infrastructure highlights. Yet arguably the larger part of the story lies in the topography and elevations of the region which make this area truly unique and subject to devastating flooding.

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The Raritan River headwaters begin at an elevation of 1,400 feet in Budd Lake, New Jersey. Bound Brook rests at the upper edge of the Lower Raritan reach of the watershed where the topography changes from steep to flat. Bound Brook along with Raritan Borough and Branchburg are located in a geologically transitional area within a watershed. The bedrock types include different sedimentary rocks including conglomerates, sandstones, shales, and argillites and the Triassic Newark Group diabase. The elevation on the northernmost portions is about 60 feet above sea level and it slopes down to about 40 feet above sea level on the southern portion of town. Immediately to the north of Bound Brook the elevation rises sharply to 400 feet above sea level in only about a half mile. Bound Brook along with Raritan Borough and Branchburg as a result of their proximity to the mountains, are all in what is known as a geologically transitional area within a watershed. This type of soil drains quickly as the elevation levels out after several miles of rapid elevation descent.

Walking and driving this area one sees the stark contrast between the mountain roads and the flatter once fertile farmlands that make up the region’s diverse landscape. The mountain roads are loaded with large boulders and beautiful woods. While the soils in this area are now classified as urban they are underlain by shale which is typically slow to absorb water. Bob Schopp, surface water specialist from the US Geological Survey, identifies the Raritan River basin as having the highest runoff rates in the state due to the topography and the paved surfaces and buildings. The surface waters emanating from the looming Watchung Mountains seem to

---

**Figure 2** Geology map of New Jersey with interaction of Watchung Mountains and the Raritan River highlighted


rush and roar down the mountainside and pool at the compacted shale mountain base causing flash flooding. Prior to reaching Bound Brook, the Raritan River travels at a good clip on its flatland route at the base of a series of three bands of mountains which make up the Watchung Mountain range. The Watchung Mountains are organized in a very distinctive and unusual pattern. They were formed as a result of a series of volcanic eruptions which left “basaltic lava sheets”\textsuperscript{10}. Resultantly, instead of running at a diagonal parallel to the Atlantic Ocean like the Appalachian Mountains, the Watchung Mountains hook to the northwest creating a horseshoe or “U” shaped element on the terrain map. The Watchung Mountains were further exposed by continental rifting which also created the Newark Basin at about the same time in the late Triassic and early Jurassic periods. This series of events was soon followed by a fissure eruption which created the First Watchung Mountain. Six hundred feet of silts, sands, and muds were pushed over the tops of the original basaltic lava sheets magnifying the shape on the landscape. This was followed by a second set of basaltic eruptions to form the second Watchung Mountain. This resulted in approximately 1500 feet of Newark Basin material. The third and final eruption built the third Watchung Mountain which created the western leg of the “U”.\textsuperscript{11} Finally, about 13 million years ago, just after the Miocene Period there was a gradual uplift of the regions north of Somerset County. This uplift intensified the slopes of the Watchung Mountains which in turn eroded the terrain more quickly leaving more chiseled profiles in their wake. As a result, Bound Brook itself is underlain by the Brunswick foundation characterized by shale bedrock. The river systems and more recent geological activity have brought silts of all types including clay silts, soft silts, and gravel.\textsuperscript{12}

\textsuperscript{11} Tobiassen, p. 4-5.
\textsuperscript{12} Kupper, p. 3.
The Raritan River runs along the base of this steep “U” collecting water from the western and southern legs of the mountain range’s “U” shape. Because of the shape of the mountain range the volume of water entering into the area of confluence often comes more quickly and with less opportunity to be absorbed into the uplands terrain. Adding to the Raritan River just prior to entering the Bound Brook area is the Millstone River. The Millstone River realizes its headwaters in the more traditionally oriented Sourland Mountains. It is the confluence of these two rivers that sets the stage for the events that will occur only a few feet further downstream.

Figure 3

Terrain map with Finderne Farms Mitigation site on left and Bound Brook on the right highlighted

As the Raritan River comes into Bound Brook it immediately is joined by the Middle Brook. The Middle Brook also has headwaters in the highest peaks of the Watchung Mountains initially diving, and then flowing down from the bottom leg of the Watchung “U” into Bound Brook just inside and along the western edge of the town’s borders joining the Raritan River.

On the eastern edge of Bound Brook the Green Brook roughly parallels the Middle Brook except that the Green Brook’s headwaters are now coming from the eastern side of the Watchung Mountain “U” shaped skeleton. The importance of the shape and position of this mountain chain should not be minimized, for its shape dictates a heavy channeling effect right at the gates of the town of Bound Brook. Add to this the effects of New Jersey’s booming suburban development, and stormwater runoff and the resultant volume of water, Bound Brook becomes a virtual plunge pool in times of heavy rain and snow melt.

2.2 Development in the Central New Jersey Area

While the population base in Bound Brook itself has remained flat, the surrounding region has experienced aggressive and continuous growth over the past 50 years. This increased development has resulted in a loss of wetlands, less point source infiltration, more channelization of stormwater into the watershed and overall negative effects for towns like Bound Brook downstream of the heaviest suburban development. In fact, this area is inundated with suburban runoff from a booming housing market and side effects of urban sprawl. Unfortunately Bound Brook, like many other cities of its time arose on the banks of a viable transportation network that offered colonists fertile land and a steady river system that would eventually become a major source of commerce for the region to include the Delaware Raritan Canal system for easy transportation and exchange of goods between Philadelphia and New York City. But similarly, like other thriving cities born on the edges of dynamic river systems, too little attention was paid to the impact of the contributing ecologies. Wetlands were filled in, edge conditions eliminated, and soils disturbed as development exploded. Increased housing, roads, shopping malls, factories, and parking lots, removed the pervious surfaces. Housing developments created accelerated channelization of runoff waters and snow melt to overwhelm an already flood prone area on the river’s bend at Bound Brook.
At an average of only 48 feet above sea level pre-colonial Bound Brook sat in a natural floodplain prone to devastating periodic flooding events. Since urbanization, more and more significant flooding events have occurred.

2.3 Land Use and Development

While the Bound Brook region is prone to flooding events as a result of the geological factors, there are other exacerbating anthropological issues that dramatically affected the intensity of the flooding situation. These come in the form of overdevelopment within the greater New Jersey region. The Somerset County region in particular, as a result of its proximity to New York City and Philadelphia, has long been recognized as a desirable place to live and work. Major industries in the Central New Jersey region include pharmaceuticals, chemical development, telecommunications, food processing, electric equipment and printing and publishing. Each of these industries relies heavily upon the sophisticated and established transportation network to move goods to and from the region in addition to providing adequate transport for people via commuter rail, bus and auto. Bound Brook in particular is a transportation “through zone” for freight and commuter rail, Interstate 287 and Routes 22 and 28. It is also very near Interstates 78 and 95 and US highway 1. It also abuts the Delaware and Raritan Canal system which promoted industrial era commerce and trade. Residential neighborhoods have risen within that industry and transport network supporting it with a very skilled and educated labor force. The Raritan River Basin experienced massive population growth which resulted in the loss of agricultural land, forests, and wetlands described in the following quotation.

“Many municipalities within the Basin experienced the majority of their housing development after 1980. Between 1986 and 1995 almost 57 square miles of land coverage was converted to urban land use. Almost 42 square miles of agricultural land
were lost, as well as over 8 square miles of forested land and 6.6 square miles of wetlands between 1986 and 1995.\textsuperscript{14}

Predictably with the residential neighborhoods came the shopping centers and other supporting infrastructure that makes any area viable in today’s world. This development has had significant impact on flooding with its increased coverage of pervious surfaces.

Figure 4 illustrates the percentage of non-absorbent surfaces in Bound Brook and surrounding towns as consistently over 30\%.\textsuperscript{16} The Raritan River watershed is made up of 136 subwatersheds. This includes the three subwatersheds that traverse through or are wholly contained within Bound Brook. Of these 13 communities that make up the Green Brook subwatershed, all have contiguous impervious surface coverage of greater than 25\% in and

\begin{itemize}
  \item[14]{Raritan Basin Watershed Management Project, \textit{Raritan Basin, Portrait of a Watershed}, August, 2002, p. 8.}
\end{itemize}
around the Bound Brook region! Of course the impervious surfaces bring with them many issues including runoff of storm waters with resultant increased stream velocities, less point source absorption, more erosion, and degeneration of stream and streambank habitat. In addition to erosion, aquatic systems are also harmed by the increased fertilizers, pesticides, road salts and other chemical runoff associated with industry and urbanization. This further minimizes the ability of the plants and trees to cleanse and absorb water making the waters polluted as well.17

Wetlands in the Raritan River Watershed were lost at a staggering rate over time. Because of its elevation, Bound Brook would naturally have been a vast portion of these wetlands. Between 1986 and 1995 the lower Raritan River watershed lost 20 acres of wetlands to agriculture, 56 to barren lands, 4 to forest, 2,982 to urban development and 133 to water; this totals 3,195 acres of converted wetlands which are the most absorbent and ecologically sensitive and valuable lands to the health of a watershed.18 Due to overdevelopment in recent years about 1/3 of these highly valuable ecological areas have been lost to agricultural or urban land uses by 199519. In the case of Bound Brook most of its city limits rest inside the natural floodplain which may qualify as wetland.

3.0 HISTORIC FLOODING

Bound Brook was the first settlement in Somerset County20 and flooding has been a documented part of its history since its formal incorporation in 1869. The USGS stream gauge data for the Raritan River below Calco Dam at Bound Brook provides a measured record of the flood stage of 28 feet being exceeded multiple times since 1966 as shown in Figure 5, a table of historical crests.

### Most Historic Flood Stage Recordings

<table>
<thead>
<tr>
<th>Date</th>
<th>Level of Raritan River at Calco Dam</th>
<th>Number of ft Above Flood Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/17/1999</td>
<td>42.13 ft</td>
<td>14.13 ft</td>
</tr>
<tr>
<td>08/28/2011</td>
<td>41.90 ft</td>
<td>13.9 ft</td>
</tr>
<tr>
<td>04/16/2007</td>
<td>38.38 ft</td>
<td>10.38 ft</td>
</tr>
<tr>
<td>08/28/1971</td>
<td>37.47 ft</td>
<td>9.47 ft</td>
</tr>
<tr>
<td>03/14/2010</td>
<td>36.04 ft</td>
<td>8.04 ft</td>
</tr>
<tr>
<td>10/20/1996</td>
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<tr>
<td>09/09/2011</td>
<td>33.14 ft</td>
<td>5.14 ft</td>
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<td>07/07/1984</td>
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<tr>
<td>04/16/1984</td>
<td>31.84 ft</td>
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<tr>
<td>12/21/1973</td>
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</tr>
<tr>
<td>04/03/1970</td>
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</tr>
<tr>
<td>04/05/1984</td>
<td>30.94 ft</td>
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</tr>
<tr>
<td>04/03/2005</td>
<td>30.54 ft</td>
<td>2.54 ft</td>
</tr>
<tr>
<td>02/01/1973</td>
<td>30.47 ft</td>
<td>2.47 ft</td>
</tr>
<tr>
<td>07/14/1975</td>
<td>30.27 ft</td>
<td>2.27 ft</td>
</tr>
<tr>
<td>09/21/1989</td>
<td>30.22 ft</td>
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</tr>
<tr>
<td>06/23/1972</td>
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<td>04/05/1987</td>
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</tr>
<tr>
<td>03/11/2011</td>
<td>28.49 ft</td>
<td>0.49 ft</td>
</tr>
</tbody>
</table>
But before stream gauge records like this were kept, the Raritan River’s cresting tendencies were recounted through newspaper records and personal accounts. The history is one of heartbreak, determination and resilience.

Even in the earliest years of Bound Brook’s incorporation, one can find an article talking about the “freshets” that frequented the area. Townspeople were very aware of the flooding conditions in this immediate area and neighboring communities wondered publicly why the community didn’t re-establish to higher ground as shown here in an editorial from the Elizabeth Journal Editor as printed in the Bound Brook Chronicle:

“Four such freshets—none so large as the last, however—have swept through this main street in thirty-one years, one in 1865, one in 1873, one in 1882, and one in 1886, and each one did a great deal of damage.

What seems strange is this: Within a single block of Main street on the north is a parallel street which is never reached or even approached by high water. It is much better located for the principal street of the town. It is safe, it is high, it is dry, and it could be made easily accessible. But notwithstanding the floods and the damage and annoyance and after effects of the overflow, Main street is not vacated, and the people do not move their stores and offices to the street that is safe and easy of access.”

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Bound Brook in 1896 was reportedly almost six feet under water (see Figure 6). The ground was snow covered when a heavy rainstorm came through. Unable to infiltrate the frozen ground the waters swiftly flowed down the mountainsides. The Raritan River flooded within hours and Main Street in Bound Brook succumbed to the reported six feet of water. Merchants carried goods to the second floor and waited for the waters to recede. In the meantime a fire broke out where lime met with water causing an exothermic reaction that then was fed by the highly combustible surrounding materials\(^\text{24}\) in the L. D. Cook lumber yard. Fire soon spread to the nearby Presbyterian Church, an historic landmark at that time in Bound Brook\(^\text{25}\) (see Figure 7).

Figure 7 Before and after: Presbyterian Church following flood and fire of February 6, 1896.\textsuperscript{26,27}

Record floods were also recorded once in 1908 and twice in 1938, in July (see Figure 9) and September. Although these floods were nowhere near as epic as the one in 1896, “the Raritan River rose 13 ½ feet above normal”\textsuperscript{28}. Main Street merchants reported one foot of water on their ground floor entrances and recorded the goods and machinery in their basements as total losses.\textsuperscript{29}

Another flood resulting from seasonal precipitation happened in 1914. While this flood was not as large as the one from 1896, it still left an impression on the town as shown in Figure 8.\textsuperscript{30}

\textsuperscript{26}“Anniversary of Big Flood”, Bound Brook Chronicle, February 5, 1926. p. 9.
\textsuperscript{27}“The Illustrated American” p. 251.
\textsuperscript{29}“Floods Hit Boro Again”, Bound Brook Chronicle, September 23, 1938. p. 1.
Figure 8  Intersection of East Main Street and Hamilton Street during flood in 1914\textsuperscript{31}

Figure 9  South end of Main Street near underpass to South Bound Brook at the peak of the July Flood, 1938\textsuperscript{32}


\textsuperscript{32} “At the Peak of the Great Flood”, Bound Brook Chronicle, July 29, 1938. p. 1.
“While flooding from hurricanes continued to punish the area year after year, heavy flooding wasn’t recorded again until Hurricane Diane August 17, 1955. This picture (see Figure 10) was captioned as follows: Slightly Damp—the scene above was one of those that greeted Bound Brook area shoppers Friday evening when they tried to enter Main street from Hamilton to do their regular Friday evening shopping. The view above shows the flood waters at their height, looking east on East Main street toward Bolmer’s garage. Rising Raritan River waters swelled by heavy rains upstate, surged over the outlets of the borough’s storm sewers and backed water up into the borough’s business section. Cellars all along Main street were flooded and merchants worked feverishly with piles of sand, trying to block the water from the entrances to their places of business. By Saturday morning the waters had subsided, but cellars were still being pumped out on Monday. Photo by Ed Bubeck.”

By now Bound Brook had clearly become accustomed to flooding…in fact so much so that while residents continued to struggle with “seasonal flooding”, it no longer attracted media attention until 1971. This is according to accounts from residents who describe seasonal flooding instances that routinely inundated their basements and ground floors.

In 1971 Hurricane Doria affected Bound Brook (see Figure 11). This hurricane would rival the power of Diane in 1955 and leave in its wake even greater damage and human tragedy. Hurricane Doria came through on August 27, 1971 depositing over 10 inches of rain and gale

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35 Personal Interview with Resident: 645 Hanken Road, Bound Brook, March 11, 2012, 12:30 pm.
force winds of 40 to 74 mph on the Garden State. The Raritan River crested at 37.5\textsuperscript{36} feet which is about 9.5 feet above flood stage. Authorities realized that they would need to begin evacuating, but before they could get to that an even greater tragedy emerged. A dam operated by the Bound Brook Water Company located uphill and upstream from Bound Brook in the Chimney Rock portion of Bridgewater burst. The Bound Brook Chronicle reported the situation as follows:

“As tons of water crashed down from the reservoir, brown waves with white caps lapped at houses and carefully tended homes were ruined in a matter of minutes. Witnesses observed that the waves were a couple of feet high and the current was so strong that bystanders had to hang on to signposts so they wouldn’t be dragged under.

…When John Mizerek, director of Bound Brook’s Civil Defense, was awakened by the police alerting him to the disaster, there was so much water surrounding the exits from his street that he didn’t think he could get out. But when he tried to call back the police, he discovered that the phones were disconnected. Determined to make his way, he drove his car through four feet of water.”\textsuperscript{37}

Unsuspecting residents were terrified of the unexpected event. Local resident William Springer of Hankin Road describes the situation and suggests that improvements in the form of river dredging and sewer cleanout would help the local infrastructure greatly:

“His strongest recollection is of ‘a big wave coming through my front window’, and of six inches of water covering the first floor of his home after his basement had been flooded.

‘The water force was so hard,’ he remembered, ‘that from the time I saw it at the corner of Tea Street to the time it hit my house was about four seconds, We lost the carport and the top portion of the house;’ His wife remembers seeing three cars lifted and piled atop one another.”\textsuperscript{38}

\textsuperscript{37} Risch, A-2.
\textsuperscript{38} “Concerned Residents Await Lawsuit Action”, Bound Brook Chronicle, Thursday, August 26, 1976, p. 2.
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Springer further notes that while the local infrastructure improvements were important, Bound Brook also needed cooperation from towns up the mountain from Bound Brook “since the water only goes one way—down\(^{39}\).”

Over 500 people were left homeless as a result of Hurricane Doria. The local high school served as a refugee camp for several days until displaced residents could be relocated. Amongst those were residents from “an old people’s home” on Main Street. The director of this home describes the experience this way:

“Finally, Mrs. Tornow hailed some men in boats traveling down Main Street. As the craft pulled up to where the porch used to be, the one man tied the boat to the railing and then stepped off into water over his head.

Mrs. Tornow rushed back into the kitchen for the medication for the old people, and said later that the water was waist high and felt “warm and prickly.” Then I realized that the 220 current was giving me shocks,” she said.

“I was all right until I got into the boat. We’re trained to handle emergencies, she said. “But then I began to cry. I lost everything. A new drier and living room set down in the basement, the TV, all my clothes. This is the third time.”\(^{40}\)

Clearly Mrs. Tornow’s account brings with it added concern about electricity and other utilities. As is clear from this response, Bound Brook by now had learned to cope with flooding emergencies.

\(^{39}\) “Concerned Residents Await Lawsuit Action”, p. 2.
Figure 11 Scenes from 1971 flood as a result of Hurricane Doria. Note the cars falling into the hole as the earth beneath gives way.\textsuperscript{41}

The next heavily reported flood occurred in 1973 as a result of seasonal flooding (see Figure 12). This storm had no name and was reportedly a very local event. This flood took the lives of 6 people. Residents remember the storm as a deluge of “sheets of water pouring down from the sky”. These sheets resulted in flash flooding that left residents with only seconds to jump to safety.\textsuperscript{42}

\textsuperscript{41}“Picking up the Pieces”, Bound Brook Chronicle, September 9, 1971, p. 13.
\textsuperscript{42}“Flooding leaves memories”, The Bound Brook Chronicle, Saturday April 17, 2004.
On October 18, 1996 the region experienced another massive rainstorm. This one brought 6 inches of rain and the waters of the Raritan River rose again above flood stage. But the biggest was yet to come.

On September 16, 1999 a near Category 5 Hurricane Floyd came off the coast of Africa, swept up the east coast and entered New Jersey. This storm came in following two months of wet weather that left the groundwater uncharacteristically high for this time of year. The result was that there was much less capacity to absorb additional waters from the hurricane of this magnitude. Although Hurricane Floyd had diminished to a tropical storm before it reached New Jersey, it still brought high rainfall totals and heavy winds. Figure 13 shows Bound Brook in the middle of the zone receiving 12-16” of rain. This soaking coupled with the rushing waters coming from upstream communities overwhelmed Bound Brook once again (see Figure 14).
Floyd set a record river crest at 42 feet, 14 feet above flood stage reaching up to a story and a half and inundating many one-story homes entirely.

Figure 13  **Hurricane Floyd at its peak in 1999**

Billed as a 100-year event nationally, images from Floyd are sobering. Locally Floyd was considered a greater than 500 year event for river flow. As a result of the flooding gas lines were broken and fire erupted highlighting once again the tragic irony of a fire amongst the flooding (see Figure 15). For with no way of reaching the fire, fires cannot be controlled and thus the fires consume the buildings involved.

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Figure 14  Corner of Vosseller Ave and Main Street following Hurricane Floyd\(^47\)

Figure 15  Fire at the Harley-Davidson building on Main Street following Hurricane Floyd\(^48\)

\(^{47}\) Auletta, Ben Jr. via Mary Nelson, Adult Services Librarian, Somerset County Library System, Bound Brook Memorial Library Branch.

\(^{48}\) Auletta, Ben Jr.
In April of 2007, a nor’easter struck the east coast bringing with it yet another catastrophic flooding event (see Figure 17 and Figure 18). Five inches of rain fell on the area destroying homes and businesses alike. A state of emergency was called and evacuations began. In addition to the flooding damage, despite the fact that electricity was cut to the area as a precaution, three houses caught fire on East Street destroying all three. Residents watched the burning houses from the hillside next to the Public Library, but firefighters could not reach the homes to save them because of the flood waters. The Raritan River crested and held at 38 feet which is 10 feet above flood stage. While Floyd was technically a bigger event, with up to 7 feet of water covering Main Street, the April “monster storm” unfortunately did just as much damage financially.\(^4^9\) At that point the GBFCP was only 50% complete and therefore not providing the necessary complete flood relief. Federal funding had slowed with another $30-40 million dollars needed to complete the protection for Bound Brook. Although not an official guess, authorities predicted that this single storm could be estimated close to the $80 million in property damages that Hurricane Floyd had cost.\(^5^0,5^1\) Damages throughout the state ran in the range of $180 million according to then Governor Codey.\(^5^2\)

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\(^5^2\) “6 counties declared disaster areas”, Star-Ledger, Thursday, April 26, 2007.
Hurricane Irene was the most recent storm to affect Bound Brook. It occurred in August of 2011 and resulted in a 500-year event for discharge on the Raritan River at Bound Brook.

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With the flooding protection now 90% complete, the Town of Bound Brook was left anxious. Would the levees hold? Would they be overtopped? The levees did hold throughout the night and into the next morning. But sometime in the mid-morning hours of Sunday, August 28th, the waters came up and through the last portion of Bound Brook’s levee/wall system and brought with it two to three feet of water on Main Street (see Figure 18). By this time the river had crested at 41.90 feet. Some sections of town though that would have previously been wet were actually dry! Charley Defendorf, NJDEP’s Project Manager was delighted with this, and in his words, “without the facilities in place, Bound Brook would have been just devastated.”

Despite the overtopping, the Army Corps of Engineers was encouraged by the length of time that the levees, walls and flood gates held the water back as it validated their work. The key factor is that while water did eventually enter the town by way of the one incomplete section, the depth of that water was much less than it would have been without the protection especially when one considers that this was a 500-year event and not the 150-year flood event for which the levees were designed.

Paul Kara, lead engineer with the U.S. Army Corps of Engineers, is optimistic that at the end of the year 2012 when the entire system is complete, Bound Brook will be secure for a 150-year flood event.

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57 Defendorf, Charley, Project Manager, New Jersey Department of Environmental Protection, personal interview: April 19, 2012.
58 Personal interview, Paul Kara, Army Corps of Engineers, February 28, 2011.
Figure 18  Circle at the end of Main Street in Bound Brook near the Lincoln Bridge and the Queen’s Bridge just after the waters have overtopped the railroad breach. Note the water here is only about two feet deep, a vast improvement over the Hurricane Floyd event.\(^{59}\)

For those residents outside of the system walls the future remains predictable. A resident from 323 East Street acknowledges that another flooding event is likely to consume his home again\(^{60}\), yet he had turned down an opportunity for a buyout. His home is the first home outside of the flood gates on East Street (see Figure 19).

Figure 19  325 East Street on the uphill and unprotected side of the closure gate. What is not seen in this image is the lack of water on the other side of the gate just inches to the left of this shot.\(^{61}\)

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\(^{59}\) Photo Credit: Paul Kara, August 29, 2011.

\(^{60}\) Personal interview with resident at 325 East Street, Bound Brook, March 11, 2012.

\(^{61}\) Photo Credit: Paul Kara, August 28, 2011, 4:22 pm.
Figure 20 **Current view of 325 East Street. Note that the house on the left was dry during the Hurricane Irene event**  

The home at 325 East Street shown in Figure 20 is just outside the flood-gate. While the homes to the south of the flood gate received only four feet of basement flooding, the homes to the north and before the ground begins to rise experienced about four to five feet of flooding at their first floor level demonstrating the effectiveness of the flood control project. But again, it is important to note that without the levees, in the aftermath of Floyd, a lesser storm event, this same home experienced flooding up to the middle of their first floor...a six foot difference! Homes on the other side of town were completely dry throughout the event.

Bound Brook’s flooding has been unrelenting forcing a response on many levels. With repeated insurance payouts, and an obvious need to respond on a humanitarian front, something clearly needed to be done to address the issue. The physical region is integral to New Jersey and the people’s voices were eventually heard through the formation of the Green Brook Flood

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63 Personal Interview with resident from 322 East Street, Bound Brook, March 11, 2012
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Control Commission and its creation of the GBFCP. Next we will learn about the Commission and its work on behalf of the people of Central New Jersey.

4.0 THE GREEN BROOK FLOOD CONTROL COMMISSION

In answer to the devastating floods, the Green Brook Flood Control Project (GBFCP) was born following the tragedies of the floods of 1971 and 1973. With regular flooding and the dam burst emanating from the reservoir above, Bound Brook had reached its limit. Residents by now were appealing to the federal and local authorities for relief and multiple studies were undertaken to address the larger issue. Recognizing that this was an issue much larger than a single town, a local group started looking at the broader contributing river systems. Indeed this issue was less about Bound Brook and more about the communities that dumped waters into it. This was a community problem, a watershed problem from which Bound Brook suffered. Local residents eventually came together to establish the Green Brook Flood Control Commission authorized by the State of New Jersey to work with and amongst the communities most affected by the persistent floods.64 A Final Environmental Impact Statement was issued in August of 1980 which led to federal legislation in the form of formal authorization by Congress in the Water Resources Development Act of 1986.65 The GBFCP is authorized to provide “basin wide flood protection with a 150-year level of protection in the lower portion of the basin and a 150-year level of protection in the upper and Stony Brook portions of the basin.”66 Upon the completion of the initial studies and subsequent legislative endorsement, strategy sessions were conducted to review the research, develop alternative mitigation techniques, and ultimately come up with the combination of efforts that would solve some flooding problems. This required local, regional,

state and federal buy in. These strategy sessions resulted in a Project Cooperation Agreement between the Army Corps of Engineers who is the Federal Sponsor of the project and the State of New Jersey who is the non-Federal sponsor on June 24, 1999. The State of New Jersey has subsequently partnered with the involved counties for their share of the project. Somerset County pays for 53% of the State’s 25% share and Middlesex County pays for 47% of the 25% of the State’s share. This formula is laid out in a State Aid Agreement between the NJDEP and the two counties dated February 13, 2002.

Figure 21  GBFCP recommended plan layout with each segment A-U identified

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68 Defendorf, Charley. NJDEP, April 26, 2012.

69 Army Corps of Engineers, Environmental Assessment of the Demolition of Conrail Bridge and Embankment Middlesex Borough, Middlesex County and south Bound Brook, Somerset County, New Jersey for the Green Brook Flood Control Project, February, 2007.
The concept behind this project was to save Bound Brook and twelve other affected communities from the impact of flooding. The epicenter of the project presently sits at the Bound Brook Flood Works on the Raritan River in Bound Brook but includes to greater or lesser extents the entire watershed (see Figure 21). This project’s projected cost was more than 400 million dollars. It was billed as an “environmentally friendly” project with a myriad of sub-projects designed to mitigate the flooding issues at hand. No one element could or would solve the problem, but in concert with one another the elements could facilitate the movement of floodwaters most effectively with the least amount of environmental impact. The project aimed to promote the ecology to the extent possible and balance the needs and concerns of all local interests. Ultimately the project has resulted in massive infrastructure upgrades for the community as well as multiple quality of life improvements. The Bound Brook portion of the project included mitigation of wetlands as addressed at the Finderne Farms site in near-by Bridgewater,70 removal of an abandoned Conrail Bridge just downstream from the confluence of Bound Brook with the Raritan River; reconstruction and raising of the Lincoln Boulevard and Talmage Avenue bridges; installation of levees, flood walls, flood gates, and pump stations; property buy outs; passive use recreational construction; re-channelization; flood-proofing; and most importantly the building of the spirit of a community, first locally, then regionally and ultimately federally. Ultimately the project was to include 65 square miles, two counties and thirteen (13) impacted communities71 and would take twelve years to complete just the lower portion of the project and an undefined number of years to complete the remainder. The cost breakdown for the project is as follows:

“Local interests will provide lands, easements, rights-of-way, and relocations, pay 25 percent of total project costs (of which at least 5 percent is cash), and bear all costs of

71 Defendorf, Charley. Personal Interview: December 1, 2011.
While Bound Brook was to benefit the most, other communities would contribute to the project’s success as well as benefit from it on a lesser scale. The lower portion of the basin drainage area which includes Bound Brook encompasses 65.2 square miles and would receive 150-year recurrence level of protection following all of the construction (see Figure 22). Construction would include 66,540 feet of levees with an average height of 11 feet. There would be 11,220 feet of floodwalls averaging 13 feet in height. There would be 8 closure structures of which three would be in Bound Brook. There would be 10 bridge replacements of which two would be in Bound Brook. There would be 3,300 feet of Channel relocation, 8,900 feet of Riprap Channel Stabilization, 162 flood-proofings and 12 buyouts. In the end, the Operation and Maintenance of the project upon completion would be turned over to local interests, specifically Somerset County through the NJDEP. The State would contribute to 75% of this Operation and Maintenance cost and the county would contribute 25%.

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Presently the upper portions of the project have been put on hold pending further discussions with the communities involved.

4.1 The Project Preparations

The project was broken down into many segments. For organization, project segments were alphabetized from Segment A through Segment U. Each project segment was treated individually and subcontracted out as a separate project. But a project of this magnitude can never be conducted in a vacuum. Communities like river systems are dynamic. As a result,

\[\text{Figure 22} \quad \text{US Army Corps delineation of the project breakdown into three portions}\]^{74}

\[^{74} \text{US Army Corps of Engineers. Green Brook Flood Damage Reduction Project, June 2009. p. 2.}\]
there were things that Bound Brook and the State of New Jersey needed to do to be prepared to accept this project…in essence, get their “house in order”. Specifically, at the crux of the project on the Raritan River there was a Superfund site that needed to be completed; there was a landfill that needed to be officially closed at the confluence of the Green Brook and Raritan Rivers; and there was a retail development project change on the western edge of the community that would result in the need for additional modifications. Fortunately for the latter of the three projects this project had already addressed the capping of yet another landfill closure underneath its structure. But this particular historic landfill might have additional impacts later in the process. While all of these projects and their funding were outside the scope of the GBFCP, they still needed to be completed before construction could begin elsewhere.

Figure 23  Map showing projects underway prior to the Flood Control Project beginning. These projects needed to be completed before the Flood Control Project could begin.
4.1.1 Superfund Site

Located at 100 West Main Street in Bound Brook (see Figure 23, lower portion) is an industrial park which was home to several companies who were cited for pollution violations in the early 1970’s. Three companies, Blue Spruce Chemical, Jame Fine and National Metals Finishing Company, occupied the 4.5-acre site 500 feet from the edge of the Raritan River. This location increased the probability of chemicals leaching into the soils and subsequently being conveyed downstream. Key pollutants identified by the EPA included pesticides (specifically Agent Orange as well as other banned chemicals), volatile and semi-volatile organic compounds, metals and other organics. Later in 1980 the NJDEP did inspections and cited Blue Spruce for elevated levels of pesticides in the spill and runoff areas of the site and Jame Fine for illegal discharge of cooling water into the Raritan River. In 1985, the United States Air Force accepted partial responsibility for the storage of Agent Orange and contributed to the cost of the cleanup. These critical clean-ups and remediation of soils needed to be completed prior to any laying down of flood protection for the Bound Brook community.  

4.1.2 Landfill Closure

Located on the corner of East Street and Lincoln Avenue in Bound Brook and surrounded on the other two sides by the Green Brook and the Raritan River was the East Gate Park Landfill (see Figure 23, upper right). It operated between 1940 and 1970. GBFCP documents estimate the contents to be comprised of 62% municipal waste, 28% bulky waste, 9% vegetative waste and 1% dry sewage and between three (3) and seventeen (17) feet deep. Two Sanitary Landfill Disruption Approvals were issued by the DEP/Division of Solid Waste Management for this site. The first was in 1992 to construct a recreational park inclusive of ball fields, passive recreational

areas and parking. This first issuance also included a methane venting system. The second approval was granted in 2001 for the construction of the pumping station, the re-channelization of the Vosseller Brook and the building up of Segment T of the levee system. This approval also involved the reconstruction of the trunk sewer.

4.1.3 Retail Development

As with any long-range, large-scale project, plans must evolve with changing conditions. Such was the case with the levee system that was planned for segment U on the northwest side of town. The original plan called for a levee here, but in the lengthy process of the project’s build out, a retail developer proposed and applied for approvals to place a shopping center on the site. (See Figure 23, upper left.) As it turned out, this too was a former landfill dating back to an even earlier time. With the approval of the Bound Brook Zoning Department ShopRite’s construction began in 197777. Located on eight acres of land on the northwest corner at the intersection of Tea Street and NJ Route 28, the landfill was “detected in April 1996” during the construction of the shopping center. Initial operation of the landfill is unknown, but soil investigations bear out depths of between two (2) and seven (7) feet of metal debris, ash and rubble. The landfill use was discontinued sometime in the early 1940’s.78 The shopping center construction led to the capping of this site and subsequently the earliest plans for the Flood Control Project needed to be modified to replace the originally planned levee with a floodwall.

This potentially becomes significant today as six flooding events, including the most recent Hurricane Irene, have scoured the edges of the Middle Brook along earth that abuts the flood wall edge. While there is still roughly ten feet left of bank before the floodwall, the area is clearly in jeopardy if left to nature’s course. As shown in Figure 24, the scouring images reveal

77 Personal interview Resident of 47 years, 645 Hanken Road, Bound Brook. March 11, 2012.
loose rubble (a conglomeration of large crushed rock, a 2’ layer of tumbled 2-inch river stones, sand, and silty earth) pushing against the floodwall. Figure 25 shows the natural edge on the opposite side (although slightly north of the floodwall) of the brook indicating the sedimentary shale formation typical of the area. This indicates that the geology underpinning the floodwall is similar having been cut through by the brook. Charley Defendorf says that the floodwall is built much lower than these images suggest, further indicating that the floodwall has actually been installed on firm bedrock far below. He goes on to say that while it needs to be fixed, it certainly looks much worse than it actually is.\textsuperscript{79} The original reason for placing the earth here is to give one more level of protection and leave a natural edge. The Army Corps of Engineers, however, will replace the natural edge stream bank with a hardened edge riprap which will be much less likely to be moved.\textsuperscript{80}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure24.png}
\caption{Present day view of Middle Brook behind the ShopRite of Bound Brook. Note the bottom most section of scouring has broken stone, the next layer is the tumbled river stone with earth above and floodwall above that\textsuperscript{81}}
\end{figure}

\textsuperscript{79} Defendorf, Charley: April 19, 2012.
\textsuperscript{81}Robin Valinski, March 10, 2012.
The other consideration is that because Middle Brook has been straightened over the years to accommodate urban development, it is now simply returning to its original state and migrating as would be the normal tendency of any brook over time. This natural tendency is for Middle Brook to migrate to the east therefore existing scouring is likely to continue towards the floodwall. Unfortunately, 600 linear feet of surrounding and supporting landscape needs to be restored in front of the floodwall. The Army Corps anticipates that they will need to rebuild approximately 1,200 linear feet of bank leading up to the floodwall…300 feet on either side of the original scouring to properly sustain the area for the future. The Army Corps has begun the process of surveying to correct this. Because this segment of the project has been financially “closed out” there are questions as to who will be responsible for the repair and replacement of

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82 Robin Valinski, March 10, 2012.
the stream bank. Messaros, says “there is no clear formula: it is a cooperative thing” but most likely it would be the federal government picking up the tab as a result of the state’s financial condition at this time.

Returning to our Commission’s beginnings, with all changes and adaptations accounted for, the project could begin.

4.2 The Green Brook Flood Control Project in Bound Brook

The Bound Brook portion of the GBFCP was to commence as soon as funds became available. The Bound Brook portion would include all of the construction elements inside the borders of Bound Brook itself and also include the removal of the Conrail Bridge just downstream from Bound Brook and the Finderne Wetlands site just to the upstream side of Bound Brook. While all other elements of the project are equally important and interesting, they are beyond the scope of this paper. Figure 21 shows each of the segment projects from A to U. The ones that are pertinent to Bound Brook are: Segments U, R, and T (see Figure 26).
4.2.1 East Main Street Bridge
The first element of the project was part of Segment T and involved the removal and replacement of the East Main Street/ Lincoln Bridge over the Green Brook (see Figure 27). This began in 2001 and was completed in 2004. The new bridge was constructed with a center pier to allow water flow on either side. The new bridge is a two-lane 214-linear foot long structure. As part of the project there were twenty-two buildings that were demolished on East Street and East Main Street, Bound Brook, and Prospect Place in the Borough of Middlesex. The project cost for this Segment was $4,960,318.00.85

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There were some homeowners who were offered a buyout, but refused. Included in this offer were two homes on East Street that will be discussed later in the “Aftermath” section.

4.2.2 Removal of the Conrail Bridge

Shortly after the GBFCP began a project change was recommended in the form of the removal of the abandoned Conrail Bridge which crossed the Raritan River downstream from Bound Brook connecting the neighboring communities of Middlesex and South Bound Brook (see Figure 28). The benefit of removing this bridge was to “improve water (hydraulic)
conveyance” specifically during the build out years of the project. The scope of the proposed change was as follows:

“...The proposed demolition would involve removal of the bridge deck and piers, the northern shore abutment, the railroad embankment between River Road and the Raritan River, the remaining bridge structure over River Road and its two abutments.”

This project was essential to insure that all flood event elevations were not increased in any upstream communities, such as Manville. Construction began following completion of an extensive Environmental Assessment (EA) in 2007. The EA for this sub-project considered the following affected environments:

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89 US Army Corp of Engineers EA. P. 2.
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- Wildlife and Fisheries
- Water Quality
- Air Quality
- Environmental Contamination
- Cultural Resources
- Landscape Aesthetics
- Socioeconomic Environment

The EA further considered impacts on each of these plus the noise and traffic implications. While the removal of this bridge was done to alleviate the construction impacts as a result segments T, U, R-1 and R-2 levees in Bound Brook shown in Figure 29, the bridge removal also enhanced all involved communities as it eliminated a future risk of blockage should the bridge have collapsed during a storm event.

Figure 29
US Army Corps marketing piece prepared for the public to present to Bound Brook residents during construction

90 US Army Corps of Engineers, EA, p. 3.
With the bridge demolition complete the levee construction inside Bound Brook could begin.

### 4.2.3 Segment T

Segment T construction began in 2002 shortly after the Sanitary Landfill Disruption Approval was granted by the DEP/Division of Solid Waste Management. Segment T surrounds the newly created Billian Legion Park which was built as part of the Flood Control Project on top of the East Gate Park Landfill. Included in the construction of Segment T was a pump station with two pumps (see Figure 30), an “L” shaped levee (see Figure 31), a realignment of the sewer line running the length of the site, and a realignment of Vosseller Brook and a foot bridge over the top of it. There are several small check valves along this stretch of levee as well.

![East Street Pump station on inside of the levee showing sluice gates](image)

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Figure 30 shows the pump station which was constructed at an elevation that would not block views of the river. There are two pumps on the upper level and three inlets on the lower level to control the flow of water. Figure 31 shows the levee rising about six feet above the park below. Each of the levees throughout the Bound Brook area provides the community with a walking path for residents to use. The walking paths are open to the community. The levee shown on the left of Figure 30 is covered with grass and formed of imported earthen material. A typical levee cross-section is shown in Figure 32.

Figure 31  The earthen levee with methane stacks shown on the inside of the levee

Figure 32  Section drawing of levee construction

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The methane vent pipes from the closed landfill run in an array down the east side of the park (see Figure 31). Figure 33 shows a check valve coming into Vosseller Brook which was dry when the photo was taken. While at one time this brook was a viable brook, urban alterations have brought its viability into question. Paul Kara of the Army Corps of Engineers notes that this brook handles the residential storm water and back flow from the Green Brook making it more of a swale and retention basin than an actual brook. The foot bridge over Vosseller Brook connects the top of the levee with a parking area emanating from Route 28. Costs for Segment T ran at $10,652,358.52.
4.2.4 Flood-proofing of 500 East Union Street

On the north side of Segment T’s levee system is an apartment complex. A ringwall was built around the complex to prevent flooding. Also included in this project was a pump station, interior drainage facilities, landscaping, paving and curbs to channel water appropriately. The cost of this project was $1,619,142.34$<sup>96</sup>. The contract for construction was awarded in 2004 and completed in 2005. Figure 34 shows the apartment complex the day after Hurricane Irene with standing floodwaters. Figure 35 shows the apartment complex during a dry period in March of 2012. As far as the flood-proofing for this apartment complex, the facility is protected up to a 100-year event (not the 150-year event for which the remainder of Bound Brook is), but Hurricane Irene was a 500-year event. As the Raritan River backwater backed up Green Brook and Vosseller Brook, the ringwall was overtopped according to Roy Messaros, Hydrologist for the Army Corps of Engineers.<sup>97</sup> As a result, the area filled up like a bathtub. Because the 500 East Union Street property building is positioned inside the ringwall, it was overcome with water. This project was done as a “one time fix” which means that once the initial project was complete, the responsibility of the Operation and Maintenance became the complex owner’s. Any costs associated with redoing or fixing following any storm event in the future are not shared.<sup>98</sup>

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<sup>96</sup> US Army Corps of Engineers. GBFCP – Segment T Levee, Contract Number DACW51-02-C-0004, October 15, 2010, p. 1


<sup>98</sup>Defendorf, Charley, April 27, 2012
Neighboring residents say that the ground floor has been abandoned due to structural issues. The Army Corps of Engineers reports that these are in fact foundation issues, but falls short of explaining its potential causes. Logically one might return to the history of the property and remember that parts of this area and the land abutting it, is underlain by the old East Street Landfill. Charley Defendorf of the NJDEP reports that the bank which is to the east of the

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99 Kara, Paul, US Army Corps of Engineers August 28, 4:19 pm.
100 Valinski, Nicholas, March 10, 2012.
apartment complex has been abandoned due to noxious odors within the structure.\textsuperscript{101} The yellow caution tape at each of the resident doors validates this. Roy Messaros of the US Army Corps of Engineers says that while the government holds no responsibility for this and is under no obligation, the Army Corps of Engineers will pay for a new pump and generator. The cost of the foundation repairs and all other associated expenses will fall on the building’s owner.\textsuperscript{102}

4.2.5 Segment U

Segment U is a combination levee and floodwall that runs along the eastern edge of Middle Brook and the western border of Bound Brook from Route 28 north to Route 22. It was begun in 2004 and completed in 2010. It is paved on top to create a firm walkway for residents and access for maintenance (Figure 37). Construction underneath is made up of clay earthen material. Pin Oaks (Quercus palustris) were planted along the edge of the levee at the treed edge of Middle Brook in several places. The contract cost was $4,775,210.65 and resulted from “uncontrollable changes due to unforeseen site conditions when constructing one flood wall and retaining walls 1 and 2.”\textsuperscript{103} The section of land had originally been designated as an area for a levee, but in the time from when the GBFCP began its planning to when it became executed, a developer came in, obtained the proper zoning and built a ShopRite on the property along with several other retail stores.\textsuperscript{104} This property was built on an old landfill that was capped to accommodate the shopping complex as noted earlier. All necessary permitting was obtained to develop this property.\textsuperscript{105} Once the plaza was in place, the US Army Corps of Engineers revised its original plans and built a floodwall because there was not enough room for a levee. A typical section diagram of a floodwall is shown in Figure 36.

\textsuperscript{101} Defendorf, Charley, April 27, 2012
\textsuperscript{102} Messaros, Roy, April 2, 2012.
\textsuperscript{104} Resident, 645 Hanken Road, Bound Brook Personal interview: March 11, 2012.
\textsuperscript{105} Kupper Associates. Closure Plan for a Borough of Bound Brook Landfill, December, 1996.
The floodwall was erected on the western edge of the ShopRite parking lot adjacent to Middle Brook. With the most recent flood event, Hurricane Irene, a 500 to 600 foot section of Middle Brook’s bank was scoured resulting in erosion on the left overbank (east side). Scouring and erosion removed several feet of streambank revealing a stratified layer of rubble. The erosion occurs for the entire length of this floodwall plus a few feet in either direction north and south of its beginning and end. Clearly this area will need to be stabilized to protect the wall. The US Army Corps of Engineers is presently evaluating this situation. Surveyors were on the site on February 28, 2012.

4.2.6 Segment R-1

Segment R-1 runs along the left bank (eastern edge) of Middle Brook from Route 28 to the Talmage Avenue Bridge (Figure 29). This segment cost $4,134,652.32 and was begun in 2004 and completed in 2010. On the east side there are several homes, most of which are built on slabs. This levee has a paved walkway/access path on top of it. Prior to the flood control

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106 US Army Corps of Engineers, EA. p. 3.
project, these homes had pretty vistas of Middle Brook. Flood protection meant losing some of their backyard along with their access to Middle Brook.

Figure 37  Image of the Little League fields protected by the levee on Segment U. Note that this levee has paved walkway.\textsuperscript{107}

One resident at 645 Hanken Road, which backs up to this levee, reminisced about the project and the accommodations that the Army Corps of Engineers and Flood Commission had made for their section of the relief. The original plans called for each of these residents along this stretch to lose their entire backyard up to 10 feet from their back porches. When residents questioned this and tied string from tree to tree at the proposed height of the levee along the stretch, the Commission and the Army Corps of Engineers agreed to reassess their plans and move the levee further out toward Middle Brook. The end result was that residents, working in concert with the build out team, retained about 30 feet of their backyards demonstrating the level of cooperation between the government, the local sponsor and the community. Each of the residents had their swing sets, gardens, sheds and other out buildings relocated on their property. Several trees were removed and construction began. The resident at 645 Hanken Road

\textsuperscript{107}Valinski, Nicholas. March 11, 2012.
remembers the construction process and talks about the experience. He is ambivalent about the new levee system. He recognizes that it needed to be done, and is grateful to have not had any water in his house immediately following Hurricane Irene. Prior to the levee he would have had about a foot of water in his family room on the ground floor destroying carpets and wallboard. This resident noted that the ball fields just a few houses down had been realigned to accommodate the levees, but that they hadn’t lost any of them due to the construction. Several residents from other parts of town walk the area regularly making it a nice addition to Bound Brook’s recreational park system. He spoke about the sacrifice of some privacy with the new walking path created by the levee as there was an occasional passerby who lingers just a little too long “examining his dinner as he eats it on the porch”. Overall though, this resident seemed pleased with the project.108

The newly reconstructed park is lined with pin oaks on the left overbank (eastern edge) of Middle Brook as shown Figure 38, has a fenced retention basin at the corner of Middle Brook’s eastern edge and Talmage Avenue and newly graded and drained ball fields.

108 Resident, 645 Hanken Road, Personal interview, March 11, 2012.
The levee supports multiple duck bill check valves which control water flow during major flooding events (see Figure 39). The check valves along this stretch of levee are consistently sized and manually operated from above.

4.2.7 Talmage Avenue Bridge

The Talmage Bridge reconstruction (see Figure 40) began in the summer of 2007, cost $17,989,433.65 and was completed late in 2010. The project included replacing the old bridge with a new one with a raised crest to reduce the backwater effects. The new bridge has a central pier and new stone fascia at the request of residents and Somerset County. The new bridge is 60’ wide and 136’ long. In addition to the bridge proper, 1820 feet of roadway surrounding the bridge along Talmage, East Main Street, Tea Street and Wheatland Avenue were improved. As part of the project, construction included tie in to existing levees, the construction of a temporary pedestrian bridge and associated drainage structures.

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113 Defendorf, Charley, April 26, 2012.
4.2.8 Segment R-2

Segment R-2 was started in 2008 and will be complete by the end of 2012. This part of the project encompasses 3,836 feet of levees of varying heights from three to twenty feet above the baseline level of existing ground elevation and a 712 linear foot wall that is between 10 and 18 feet high above the base elevation. The levee circles the area south of the Talmage Bridge on the Middle Brook towards the Bound Brook train station. A floodwall is positioned in between the Superfund site on West Main Street and the Raritan River and continues from the pump

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house to the flood gates at the entrance to the Queen’s Bridge. The flood gates close the road
towards South Bound Brook automatically during a flooding event. Lining the entire inside of
the levee is a water conveyance ditch that travels to the pumping station at the central point of
the system. This begins at the Talmage Bridge and winds around a small neighborhood to the
pumping station. The pumping station sits on top of a small hill and houses two pumps and
generators. There is also a diesel storage tank incorporated into the structure. Ancillary
equipment and structures for this segment include manholes, sluice gates and elastomeric check
valves.117

The cost of this portion of the project is projected to be $13,859,428.50.118 One house
was bought out behind the pump house to accommodate a drainage structure. The circle in
Figure 42 shows the former location of this house. The drainage structure where the house used
to be now carries water under the railroad tracks above from the western side of Bound Brook’s
downtown area.

Figure 42  View looking north towards West Main Street where a house once stood from the R-2
levee119

119 Valinski, Nicholas, March 11, 2012.
The pump house (see Figure 43) marks the epicenter of the Bound Brook section of the GBFCP. Because this area is adjacent to the Raritan River, this is the lowest elevation in Bound Brook and therefore the central drainage point for the town. As waters come into this lowlands region the pump house manages its flow into the river. The building itself houses generators (see Figure 44) to keep the pumps running. The diesel tank holds enough fuel to run the pumps for two days should it be impossible to reach the pump station in a flooding event.

Figure 43  Electrical panel inside the R-2 pump station.120

Figure 44  The generator inside the R-2 pump station121

The computer (as seen in Figure 45) gives a summary view of the river level and well levels at any given time.

Figure 45  **Flow meter inside the R-2 pump station**

Outside the pump house there are three sluice gates to control the water coming from the conveyance ditch. Additionally there are multiple duck-ball or elastomeric check valves at strategic points around the inside of the levee. The R-2 segment has the largest of these which comes in from the NJ Transit railroad as shown in Figure 46 (this one is roughly 10 feet tall):

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Other smaller check valves convey storm waters from Tea Street and discharge along this course into Middle Brook. The inside drainage structures for the Segment R-2 levee are considerably more substantial than the ones on Segments T and U. Most of the conveyance drainage structures are five feet in diameter (see Figure 47).
As part of the project a small ball park was enhanced by adding several layers of wetland trees inside the levee which also serves as a walking path for residents (see Figure 48). These will grow to match the only remaining natural area in Bound Brook’s project area which is positioned on the outside of levee at the confluence of Middle Brook and the Raritan River located between the Raritan River and the levee. The Conrail freight line and Interstate 287 run through this natural area.

Figure 48  Plantings inside the R-2 levee wall: red maple (Acer rubrum), pin oak (Quercus palustris), pussy willow (Salix caprea), and red twig dogwood (Cornus sericea) all noted. Picture taken from levee.124

4.2.9  Closure Structures

There are three points in Bound Brook that require the use of closure structures. The first and largest of these is on East Street/South Main Street going over the Queens Bridge into South Bound Brook and is a part of Segment R-2. The structure is 53.5 feet long and 16.5 feet high on a steel roller track tying off the road between the floodwall and the New Jersey Transit railroad embankment (see Figure 50). The total cost of the closure gate was $4,138,481.00. This closure gate is automatically controlled and housed in its own garage. As the Raritan River rises, the road is closed and the gate is rolled across the road.
The second closure gate is located on East Street just south of Route 28. This closure structure is presently manually moved to close off the road. The gate moves across the track on steel wheels. It has a rubber gasket underneath the steel gate to limit water leakage. Figure 51 shows the closure gate during the Hurricane Irene flood event. It is expected to see some seepage beneath the gate, but the waters on the other side of this gate at the time this picture was taken were 1 and ½ feet below the top of the gate itself. Please refer to the images of the home on the other side of this floodgate as seen on page 27.

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The last closure structure is being installed as this paper is being written in May of 2012. It is a railroad closure gate to close off the New Jersey Transit train tracks near the Talmage Bridge. Construction on this portion is on schedule to be complete at the end of 2012. This 75 foot closure structure will use a double leaf swing gate to close off the railroad tracks. Additionally there are four culverts beneath the tracks to move the water efficiently under the bed, reconstruction, landscaping to include sidewalks and municipal elements. The estimated cost on this portion of the project is $8,230,488.00. All piping is done and they are awaiting the arrival of the gates. This will be the last section of the Bound Brook portion of the GBFCP.
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4.2.10 Finderne Farms Wetland Mitigation Project

While outside the city limits of Bound Brook, the Finderne Farms Wetland Mitigation Project is crucial to the success in terms of mitigation credits of Bound Brook’s flooding issues. Specifically, the site served “as an off-site wetland and habitat mitigation acreage for the environmental impacts of the Bound Brook construction elements (Segments A, N, R1, R2 T and U) and a portion of structural project elements proposed in Middlesex County that could not be mitigated on-site.”\textsuperscript{131} The 130-acre project is located upstream of Bound Brook in Bridgewater on the Raritan River before the confluence of the Millstone River and was approved in August of 2005 and completed in 2006 (see Figure 52).

![Finderne Farms Wetland Mitigation project site showing planning elements](image)

The purpose of utilizing this site was to achieve a minimum ratio of 2:1 in-kind mitigation for wetlands impacted by the GBFCP. The plan provided a “minimum of 21 acres of

created forested wetlands to mitigate for anticipated wetlands impacts” and “enhancement of approximately 32 acres of existing wetlands”\textsuperscript{133} with the construction of the segments further downstream. Additionally the project focused on six acres of scrub-shrub wetland, five acres of emergent wetland, preservation of six acres of palustrine emergent wetland, six acres of upland forest, 27 acres of riparian forest and the restoration of 800 linear feet of a small stream.

The forested land was to support 7 to 10 days of inundation beyond 7 to 11 days of soil saturation during the spring, summer and fall seasons. There were 8 planting zones including 15 planting areas covering 62.28 acres in total.\textsuperscript{134} Planted trees and shrubs included are shown in Figure 53.

\textsuperscript{133} US Army Corps of Engineers. Application. P. 16
Figure 53  **Tree planting plan for the Finderne Farms site**\(^{135}\)

This created deciduous floodplain forest was planted along a 100-800 foot wide corridor parallel to the northern bank of the Raritan River. Further adding to the impact of the design is a moderate to dense shrub layer that stabilizes the river banks. Each plant species was planted according to planting compatibility specifications which had a prescribed planting density to assure success of the project. Each carefully chosen plant needed to be native, hardy and suitable

for the fluctuating conditions of a wetlands habitat. To support this there was some grading done to create depressions where appropriate and extend swales where necessary to slowly convey waters towards the Raritan River.136

A small stream running east/west on the Finderne Farms site was restored to help convey waters during flooding events. This process involved decreasing the slope on the banks of the small stream to prevent undue erosion during storm or high flow events, evening out the slope break at the culvert and replacing it as it no longer functioned properly.

For the past 5 years there has been a monitoring program in place to determine the success of this portion of the project. According to this program, the Finderne Farms Mitigation Project has not met the expectations of the Army Corps of Engineers. The four elements by which they measure the performance are as follows:

1. The goals of the project and its required wetland buffer have been satisfied identifying exact acreage,
2. The site has 85% survival with 85% coverage of mitigation plantings or target hydrophytes native to the area…all plantings must be “healthy and thriving” and “all trees are at least five feet in height.”
3. There must be less than 10% invasive plants or noxious species,
4. The hydrologic regime as specified in the proposal has been satisfied.137

The biggest part of the problem seems to be in the survival of the plantings. Not only did many plantings not survive, but those that did survive failed to reach the anticipated heights. Additionally the monitoring report found that invasive species managed to claim significant portions of the site preventing the plantings from taking hold. Herbicides had little to no effect on their expansion. Some invasive plants of note include those shown in Figure 54.

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### Latin Name: | Common Name: | Image:
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Humulus japonicus | Japanese Hops | ![Image](138)
Phalaris arundinacea | Reed Canary Grass | ![Image](139)
Lythrum salicaria | Purple loosestrife | ![Image](140)
Artemisia vulgaris L. | Common Wormwood, Mugwort | ![Image](141)

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From the hydrological standpoint, the soils within the project area are not “trending towards developing typical wetland soil characteristics”. These issues work together and are of course a sign of one another’s failures. As a result of the poor performance of the vegetation, the Corps has taken the following actions:

- Performed spot ground elevation surveys to supplement previous investigations in 2010,
- Installed piezometers and conducted weekly tests through spring and summer months of 2010 and 2011,
- Conducted on-site flood analysis including duration, inundation and soil conditions in 2012,
- Performed a river hydrology analysis, developing a discharge frequency relationship for the wettest periods in 2010.

The Army Corps of Engineers further suggested in an application dated June 15, 2011 that additional modifications be made so as to achieve the original 2:1 ratio of mitigation. These modifications included a nine point recommendation list. The nine points covered included continued monitoring, improvements of the Hydrologic Engineering Centers River Analysis System (HEC-RAS), further geotechnical analysis below the surfaces within the various areas, creation of individual water budgets for each vegetative area within the project site, evaluation of constructed swales and grading, evaluation of recent stabilization installations,

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revision of the planting plan to identify more suitable plants for the specific areas with consideration to the effects of deer browsing and “rapid flow hydrological conditions”, development of an invasive plant management plan, and an update of the Adaptive Management Plan (AMP) to reflect the findings.\textsuperscript{145}

Clearly the survival of the wetlands as a natural habitat will have an effect on the communities downstream. The viability of the wetlands is crucial as are additional point source absorption containments, zoning restrictions and best building practices in any new development upstream.

5.0 AFTERMATH

Hurricane Irene came one year too early to fairly and completely assess the success of the Bound Brook portion of the entire project but all indications are that the project has been successful. Despite the fact that Hurricane Irene was a 500-year event, Bound Brook held up very well (see Figure 55).

\textsuperscript{145}Finderne Farm 2011 Monitoring Report, p. 5-2.
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Figure 55  Image following Hurricane Irene of Segment T levee. Note that inside is dry protecting the town inside and outside is at capacity soon to overtop\textsuperscript{146}

It was much different than in 1999 with Hurricane Floyd as reported by Mayor Carey Pilato:

"The (Raritan) river level was at or maybe more than Hurricane Floyd. The difference here is because of the flood control project, there are only pockets of places flooding in Bound Brook," Pilato said. In 1999, "we almost instantaneously lost one quarter of the town."\textsuperscript{147}

During Hurricane Irene, all points were dry up until the water overtopped Segment T and inundated the railroad tracks near the Talmage Bridge, the one portion of the project that has not been completed. This one section was the closure structure at the New Jersey transit railroad coming in and out of town near Interstate 287.

\textsuperscript{146} Kara, Paul. August 28, 2:10pm. \textsuperscript{147} Livio, Susan and Eugene Paik. Floodwall Project saved Bound Brook in Saturday’s storm, Star Ledger, September 1, 2011.
The Star Ledger reported comments from officials on the day after the event:

“Even though there was flooding, business owners, residents and government officials agreed yesterday that Irene could have been far more punishing without the newly-installed flood gates and pumping stations. Where Floyd sent floodwaters rising 13 feet or higher, water levels from Irene climbed just one to three feet high — about five feet in limited spots — said Paul McCall, Somerset County’s director of public works.”

With the completion of this closure structure due to be completed by the end of this year, Bound Brook will be totally protected up to a 150-year flood event. In the meantime, the state has contracted with the county government to maintain all of the levees and other protection mechanisms built for Bound Brook at the rates previously noted in Section 4.0. Other maintenance issues will include managing the pump stations and monitoring the condition of the valves, flood gates and other infrastructure. Bound Brook will continue to have an Office of Emergency Management for flood events as they will always have a different understanding of preparedness than other non-riverside communities. But things have greatly improved in Bound Brook. The community is happy. Residents have gained a great deal of infrastructure improvements including their storm drains, their bridges, their parks and their homes.

6.0 SUMMATION

And now with the Bound Brook portion of the GBFCP winding down, it becomes important to review the project: identify its strengths, weaknesses and lessons learned. We know that overdevelopment has its consequences; we are all indeed connected. While the work represented in this paper has deliberately focused on one community, it becomes impossible to adequately tell its story without acknowledging the influence that each community has on its neighbors. Clearly there are ongoing issues for certain portions of this project that need to be monitored by the people, the town, the state and the federal government including the

148 Livio, Susan and Eugene Paik.
stabilization of Middle Brook, repair and rebuilding of the site at 500 East Union Avenue, monitoring the strength and structure of the land underneath and continued strategizing for the success of the Finderne Farms Wetlands Mitigation Site. There will be costs and conversations about who will and can afford to pay for these issues, but without the extraordinary efforts made thus far to address the flooding issues within this region of New Jersey, there would be continued bail outs (both literally and financially) and devastation.

Levees, though, are meant only to reduce the risk of flooding; they will never completely eliminate flooding risk entirely as there will be times like with the recent Hurricane Irene when a flooding event will exceed the capacity of the levee system. It will be important for Somerset County to be vigilant in their upkeep of the levee system, constantly watching for weaknesses and breaches to continue to give the borough optimum protection. The town should also continually be prepared with their Office of Emergency Management and heed warnings for evacuation. Despite the protection, there is no place for complacency when one lives behind a levee. With all of the warnings in place, though, Bound Brook’s future looks very bright. With new infrastructure and a new confidence, they can rebuild with the hope that it won’t be washed away with the next flooding event.

After all, Bound Brook is home to more than 10,000 people who are a vital part of the state’s labor force and critical to the economy of the rest of the state. The people remain here because it is affordable, convenient and “home”. From its earliest days up to the time when this project began, Bound Brook’s downtown area was not a viable economic center due to the probability of flooding. Businesses could not hold inventories necessary to run their business without running the risk of devastating flooding. Within a few months, though, downtown Bound Brook will be certified by the Federal Emergency Management Agency (FEMA) similar
to the homes on Middle Brook who have already received this certification following the completion of Segment U in 2006. The businesses and residents closer to downtown are hoping to gain that same certification once the levee system is complete, making it once again possible for businesses with inventory to thrive. Certification involves the community participating in the National Flood Insurance Program which compels a community to “adopt and enforce floodplain management ordinances” to reduce the risk of flood damage. While FEMA will eventually certify the entire area behind the levee system, businesses and residents will be smart to continue to carry flood insurance independently. Further, the U.S. Army Corps of Engineers is quick to point out that levee certification will never directly affect how safe or unsafe a levee system may or may not be. Ultimately it is up to the community to be vigilant in its maintenance.

Was it all worth it? Bound Brook’s proximity is central to transportation, communication and commerce within the state. Indeed much of the state’s transportation infrastructure passes directly through the town. Furthermore, a significant portion of New Jersey’s labor force lives in Bound Brook. While this project is clearly important to the Borough itself, it is also critical to the greater central New Jersey region. Preserving this town and mitigating the land area supporting the Raritan River and its contributing tributaries can only enhance the entire state’s ecology, inclusive of its human ecology. The Federal Government, State of New Jersey, Counties and local community have much to be proud of for this project was a wonderful example of compromise and collaboration to achieve an environmentally friendly end on behalf of the people of New Jersey.

150 Defendorf, Charley, April 26, 2012.
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Picture Credits:

Auletta, Ben Jr., Bound Brook, New Jersey resident.


Munson, John, Star-Ledger.


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