TABLE OF CONTENTS

TABLE OF APPENDICES

Executive Summary

The purpose of the Hicks Creek and Abrahams Creek Stormwater Management Study, funded by the Department of Environmental Protection and Luzerne County, was to identify the regional flooding problems that occur in both watersheds, and investigate a variety of potential solutions in order to make comprehensive recommendations in selecting the preferred alternatives. It was not the intent of the study to identify or model local drainage issues or stormwater problems caused by inadequately sized storm sewers or stormwater management facilities.

The complicating issue in the analysis is that Hicks Creek and Abrahams Creek are designated ponding areas (areas inundated by ponding of interior runoff at intervals of ten (10) years) in the Swoyersville-Forty Fort Local Flood Protection Project constructed by the U.S. Army Corps of Engineers in the 1950's. The "Operation and Maintenance Manual (June 1957) indicated that a ponding area along Hicks Creek and Abrahams Creek are required when high river stages cause the discharge gates to remain closed.

The O&M Manual states that the ponding areas are the same as backwater areas frequently flooded under natural conditions. In general, these areas will be flooded less often or to lesser elevations than prior to completion of the project. Due to exorbitant prices demanded by property owners the State and County declined to acquire control of these areas but, instead, gave assurance that whenever encroachment on these areas interferes with their project function, local interests will take appropriate measures to provide substitute facilities. Construction, filling and dumping on these areas should be controlled by the respective boroughs insofar as possible through careful review of plans prior to the issuance of permits.

The flooding problem in the Hicks and Abrahams Creek watersheds is further complicated by the fact that there is a high water table due to the proximity of the watersheds to the Susquehanna River. This means that groundwater seepage into basements, which is exacerbated by intense storm events causing the water table to rise, is a common problem which cannot be mitigated by standard flood damage reduction projects.

The scope of this project was to analyze the existing flooding problems in the Hicks and Abrahams Creeks and determine proposed alternative solutions. This was accomplished by developing hydrologic and hydraulic models for the Hicks Creek and Abrahams Creek watersheds in order to identify the sources of flooding along the watercourses, and to evaluate a range of potential solutions to the problems. The 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour design storms, as well as historic events including the June, 2006 event were modeled to show the effectiveness of the proposed solutions.

A variety of computer models were used to pinpoint the causes of flooding in the Hicks and Abrahams Creek watersheds. The models are utilized by the Department of Environmental Protection (DEP), United States Army Corps of Engineers (USACE), and the Federal Emergency Management Agency (FEMA) for floodplain analysis and are accepted engineering models used in this type of floodplain and stream analysis. The

HEC-HMS hydrologic model was utilized to develop the hydrology, or flows. HEC-RAS and the USACE program, INTerior DRAinage (INT-DRA), were utilized to calculate the flooding and water surface elevations along the Hicks Creek. The use of INT-DRA was not required for the Abrahams Creek as HEC-RAS was sufficient for the hydraulic calculations. The Federal Highway Administration HY8 program was utilized to evaluate headwater conditions at the levee culvert on the Hicks Creek.

Flooding on Hicks Creek occurs from two scenarios. The first flooding scenario occurs when a large magnitude storm (one with a 1, 2, or 4 percent probability of occurrence oftentimes referred to as the 100-, 50-, or 25-year storms, respectively) occurs on the watershed. The other flooding scenario occurs when the Susquehanna River is high and the flap gate closes, thus preventing stormwater from discharging from the Hicks Creek to the River.

Several historic storm events were modeled with the INT-DRA program in order to determine the timing relationship between the Hicks Creek and Susquehanna River hydrographs. The results of the data analysis and modeling concluded that Hicks Creek takes about 17 hours to rise to its peak (7 hour lag time) behind the levee during a 24-hour flood event (per HEC-HMS modeling results), whereas the Susquehanna River takes on an average 30 hours before the river reaches the bottom of the flap gate, 39 hours before it reaches the top of the flap gate, 41 hours before it closes the flap gate, and 48 hours before the River peaks. The numbers for the River times were obtained from an average of the historic events that were modeled using the INT-DRA program. There is some degree of variation associated with these average values due to the different storm characteristics that exist between each of the historic events that were modeled. Of the storms analyzed, the shortest times for the River to reach the bottom of the flap gate, to reach the top of the flap gate, and to close the flap gate were 21 hours, 29.5 hours, and 31 hours, respectively (June, 1972 event). The largest times for the River to reach the bottom of the flap gate, to reach the top of the flap gate, and to close the flap gate were 56 hours, 63 hours, and 62 hours, respectively (June, 2006 event). It can be seen from these results that there is no situation in which a storm originates simultaneously on the Hicks Creek and the Susquehanna River where the River rises above the flap gate before the Hicks Creek peaks (i.e. 17 hours < 21 hours).

Similar to the Hicks Creek, the Abrahams Creek discharges to the Susquehanna River, however, the culvert system through the levee is more complex. Twelve (12) 54.9 inch Ultraflo pipes carry stormwater through the levee, and gates on the ends of the pipes can be manually closed to prevent the River from backing up into the watershed. To date, the backing up of stormwater due to the gates being closed has not caused flooding in the developed portions of the Abrahams Creek watershed, and other sources of flooding were therefore investigated.

A brief explanation of the alternatives and the results of the modeling are presented here.

Hicks Creek Alternatives

Alternative 1 – Additional Levee Culvert:

This alternative is successful in reducing the 100-year water surface elevation by ~6 feet between the railroad and the levee; however, the reduction upstream of the railroad is minimal. Initial runs were made by doubling the size of the culvert to see what impact it would have. A final design will yield the ultimate size required for the most beneficial result.

Alternative 2 – Eliminate Railroad Culvert:

Eliminating the railroad culvert with a culvert is successful in reducing the 100-year water surface elevation by ~4 feet immediately upstream of the railroad. The water surface elevation downstream of the railroad increases due to increased flow through the railroad culvert. This indicates that this alternative cannot be successful without modifying the levee culvert as well (see Alternative 4).

Alternative 3 – Utilize Golf Course as Storage Area:

This alternative results in a reduction of flow due to storage, thus decreasing the 100-year water surface elevation by ~4 feet immediately upstream of the railroad. There is only a minimal reduction downstream of railroad. Although this alternative reduces flow, it is achieving these flows by detaining water. The detaining of water in fact may be detrimental to the situation because it is desirable to remove as much water from the system as possible in order to open up more available storage for when the flap gate closes. In addition, this storage of water will cause groundwater recharge and may infiltrate into basements.

Alternative 4 – Combine Alternatives 1 and 2:

By removing the railroad culvert and adding additional levee culverts the 100-year water surface elevation is reduced by ~6 feet between the levee and the railroad, and is reduced by 7 to 8 feet immediately upstream of the railroad. The reduction of surface water elevation dissipates slowly between the railroad and Packard Ave, and returns to normal surface elevations in the vicinity of Slocum Street. The reduction in water surface elevation results from reducing the backwater effect from the railroad and levee culverts. This alternative also achieves moving more water out of the system to allow for additional storage volume when the flap gate closes.

Alternative 5 – Combine Alternatives 1, 2, and 3:

This alternative is capable of reducing the 100-year water surface elevation by one-half foot more than Alternative 4. However, it is preferable to discharge stormwater from the Hicks Creek as quickly as possible in order to create more available storage volume before the flap gate closes. The flow attenuation that occurs through the golf course storage area would actually present the problems identified in Alternative 3.

Alternative 6 – Pump Station:

A detailed analysis of a pump station was beyond the scope of this study; however, the general concept of how a pump station could reduce flooding was determined

through the modeling effort. The purpose of a pump station would be to pump water out of the Hicks Creek in situations where the flap gate is closed. In the existing conditions, if the flap gate closes, a 4-year 24-hour storm will cause flooding on the Hicks Creek during peak flow conditions. A pump station could be designed to discharge stormwater to the river in both small and large events by installing multiple pumps with different capacities. A more detailed analysis will need to be performed to determine the exact capacities and the actual effect pumping will have on upstream flooding. Initial concerns, based on a working knowledge of hydraulics, are that there may not be enough storage volume available (specifically between the levee and Exeter Avenue) for a large scale pump station; that the hydraulic capacity of the upstream reaches may not be adequate to convey storm water to a pump station; and that the pump station will not be capable of reducing water surface elevations to prevent basement flooding.

Alternative 7 – Pump Station and Replace Railroad Culvert:

To gain an understanding of what would happen if the railroad culvert is removed and a pump station is installed, a theoretical low starting water elevation was used as the downstream boundary condition to mimic the effects that a pump station would have. The results are identical to Alternative 4, in which the water surface elevation is reduced between the levee and the railroad, as well as upstream of the railroad to Packard Ave, returning to normal surface elevations in the vicinity of Slocum Street. The difference is that a pump station can mitigate flooding in the lower reaches of the basin, in situations where the flap gate is closed and a 4-year storm or greater develops on the Hicks Creek. However, this situation only arises a small percentage of time (~1%).

Alternative 8 – Upstream Storage Area:

This alternative measured the impacts that a storage facility constructed in the upstream portion of the Hicks Creek has on minimizing the downstream flooding. The results were such that the downstream flows were not reduced enough to minimize the flooding. Because it is desirable to discharge as much water as possible as quickly as possible, the attenuation that occurs with this option actually counteracts the benefits of the other alternatives.

Alternative 9 – Upstream Diversion to Abrahams Creek:

The modeling of Abrahams Creek revealed that the Abrahams Creek channel is at full capacity at the same time the Hicks Creek is at its peak discharge. This prevents any diversion from being feasible because it would cause additional flooding along the Abrahams Creek.

An eight (8) inch pump serves to pump water out of the Hicks Creek and into the Abrahams Creek near 5th Street. The pump is used to dewater the ponding that takes place after a storm takes place. Under the assumption that the pump operates less than 20 feet of total head (TDH), this pump has a capacity of 1,300 gallons per minute (gpm). To show how such a pump is inadequate for flood prevention

measures, the peak flow during the June, 2006 event (four approximately 4- to 5-year events over 4 days) was approximately 390 cfs which equates to 175,070 gpm. In essence, if the pump were to be used during peak flow conditions, it would only have been capable of pumping <1% of the peak flow rate during the June, 2006 event. This further illustrates the magnitude of a pump station that would need to be constructed to divert flows to the Abrahams Creek, which is infeasible in the upstream portion of the Hicks Creek.

It was found that the railroad and the levee culvert are the constrictions to flow, and that they back water up throughout Hicks Creek. If these two restrictions were removed, it would first, prevent the backwater from flooding the residents, and secondly, allow a large volume of water to exit into the river, thus allowing a greater storage volume to be available for floodwater storage when the flap gate closes. A pump station would reduce the flood levels, in localized areas, in the event that a storm of flood magnitude occurs in Hicks Creek (interior storm) when the river has closed the flap gate, however, the probability that an interior storm of flood magnitude occurs when the flap gate is closed is less than a flooding event caused by a backwater from the railroad culvert. Therefore, it is more cost beneficial to replace the railroad culvert regardless of the ultimate solution, and perform detailed feasibility analyses for replacing the levee culvert and constructing a pump station.

Based on the results of the study, the following approach is recommended to address the flooding problems along Hicks Creek.

1. The Pocono Northeast Railroad has been contacted and negotiations are underway to remove the existing railroad culvert. A consultant should be engaged to prepare the demolition plans.

2. Engage a consultant to complete the design for the replacement culvert through the levee.

3. Engage a consultant to complete necessary studies and design a pump station sized to minimize flooding problems along Hicks Creek.

Abrahams Creek

Based on observations and historic accounts of flooding in the Abrahams Creek watershed, it was determined that the majority of the problems exist near 6th Street in West Wyoming. This a low point between the two watersheds, and overflow from both watersheds meet at this location to cause ponding. Therefore, the alternatives investigated sought to minimize flooding at this location.

Abrahams Creek Alternatives

Alternative 1 – Restore Lower Trapezoidal Channel to Original Constructed Dimensions:

This alternative is successful in reducing the 100-year water surface elevation by approximately one-half foot just around the West 8th Street Bridge. There are minimal changes to the water surface profile upstream of the bridge throughout the concrete portion of the channel.

Alternative 2 – Enlarge Upper 8th Street Bridge:

The smallest obstruction on the concrete portion of the Abrahams Creek is the upper 8th Street Bridge (14' wide by 6' high), and it was determined that the existing conditions flows overtop the channel due to the backwater caused by this obstruction for the 25-year event and higher. By enlarging the bridge opening to 25' by 7', the 25-year through 100-year flows are contained in the channel as a 2.5 foot reduction in the water surface elevation is achieved (100-year event), and overtopping of the bridge is eliminated.

Alternative 3 – Enlarge Erie-Lackawanna Railroad Culvert:

Through the modeling of the existing conditions, it was determined that the main cause of the flooding near the 6th Street area arises from the backwater condition at the Erie-Lackawanna Railroad culvert, which forces water out of the channel upstream of this crossing for the 25-year flows and higher. By increasing the clearance by 1.5 feet and widening the opening to 25', the 100-year flows are contained within the channel, and no overtopping of the railroad culvert occurs.

Alternative 4 – Combine Alternatives 2 and 3:

This is the initial recommended alternative. By enlarging both the Erie-Lackawanna Railroad culvert and the upper 8th Street Bridge, flows are contained in the concrete portion of the Abrahams Creek channel throughout its entirety.

Alternative 5 – Combine Alternatives 1, 2, and 3:

While a further reduction in the water surface elevation throughout the Abrahams Creek is achieved by this alternative, the additional benefits of restoring the lower portion of the channel in conjunction with enlarging the 8th Street Bridge and the railroad culvert are minimal.

Based on the results of the study, the following approach is recommended to address the flooding problems along Abrahams Creek.

1. The owner of the railroad should be contacted to obtain permission for the removal/enlarging of the existing railroad culvert.

2. Engage a consultant to complete the design for the replacement railroad culvert.

3. Engage a consultant to complete the design for a replacement culvert of the Upper 8th Street stream crossing.

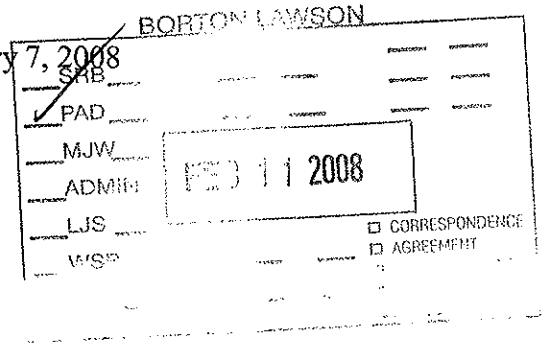
The report was reviewed by the Pennsylvania Department of Environmental Protection, the United States Army Corps of Engineers, Luzerne County Flood Protection Authority, and the Hicks Creek Watershed Association. The majority of the comments were addressed in the preparation of the final report. Some comments had no bearing on the results of the study, and were therefore noted as appropriate in the responses. All comment letters from the above entities are included in Appendix D of this report.

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, U.S. ARMY CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MD 21203-1715

REPLY TO
ATTENTION OF

Engineering Division

February 7, 2008



Paul Debarry
Borton Lawson Engineers
3893 Adler Place, Suite 100
Bethlehem, PA 18017

Dear Mr. Debarry:

The hydrology and hydraulics analysis that your firm performed of flooding along Hicks Creek in Luzerne County, Pennsylvania has been reviewed. Our review found that the analysis utilized appropriate methods and computer models to assess the flooding conditions along Hicks Creek and evaluate alternative measures for reducing the flooding.

If you have any questions on this matter, please contact Mr. Dennis C. Seibel, Supervisory Hydraulic Engineer, at (410) 962-4841.

Sincerely,

Anthony Vidal, P.E.
Chief, Civil Engineering Section

CF:
CENAB-EN-WW (J. Curtin)

Pennsylvania Department of Environmental Protection

Rachel Carson State Office Building
P.O. Box 8460
Harrisburg, PA 17105-8460
January 11, 2008

Bureau of Waterways Engineering Phone: 717-787-3411

James J. Brozena, P.E.
Executive Director
Luzerne County Flood Protection Authority
Luzerne County Courthouse
200 North River Street
Wilkes-Barre, PA 18711-1001

Re: DEP File No. C40:13

Dear Mr. Brozena:

The Pennsylvania Department of Environmental Protection (DEP) has reviewed the written comments submitted by the Hicks Creek Watershed Association (HCWA) pertaining to the draft report on the "Stormwater Management Study for Hicks Creek and Abrahams Creek Watersheds". The findings of the draft report were presented by Borton Lawson Engineering at a public meeting held on September 10, 2007, at the Wyoming Area High School Auditorium in the Borough of Exeter, Luzerne County. The HCWA comments consisted of 11 pages of detailed concerns they had with the study and included three additional pages of comments from local residents. Due to the complexity of the many comments from HCWA, DEP feels that it would be more productive to address these comments in the next phase of the process rather than have a prolonged delay in issuing the final report. It is recommended that the HCWA comments as well as any other written comments received be made part of the final report by including them in an Appendix.

DEP also feels that one of the most important recommendations brought up during the public meeting was the formulation of a technical review committee for the next course of action by DEP and the Luzerne County Flood Protection Authority (LCFPA). A meeting should be scheduled with the Borough shortly after the final report is prepared to discuss the next phase and to recommend or appoint members of the committee. Once the technical review committee is formed their first task would be to develop a "Scope of Work" for the next phase. Funding for the next phase will be provided by DEP and the LCFPA.

DEP is committed to our partnership with the LCFPA in developing a practical approach to reduce flooding in the Borough of Exeter. If you have any questions, please feel free to contact me by e-mail at pmcsparran@state.pa.us or at the number listed above, or contact Joseph G. Capasso by e-mail at jcapasso@state.pa.us or by phone at 717-783-7723, or contact our federal project coordinator Scott A Steigerwald, by e-mail at ssteigerwa@state.pa.us, or by phone at 717-783-7729.

Sincerely,

Patricia A. McSparran,
Director
Bureau of Waterways Engineering

cc: Debra Serbin, Secretary-Treasurer, Exeter Borough