



open drainage ditch system is in fair condition with the exception of a few locations where piles of leaves and grass clippings have been placed. This ditch has minimal slope and was observed to have standing water for extended periods of time during periods of a rain event (see Existing Conditions **Drawing CI-06**, Appendix A).

Flows from the rear yard ditch are directed to Shawnee Road (west ditch) and are collected in a roadside piped storm drainage system that crosses under Moyer Road with an outlet to Tributary SEB. The ability of Tributary SEB to drain is directly related to the water surface elevations of Bull Creek. Water filled 50 percent of the ditch capacity for the majority of the year.

Corrective Measures identified to help improve the drainage conditions are as follows:

- The storm pipe crossing Moyer and Shawnee Roads is reverse pitched and holding flows back from a portion of the rear yard ditch system. The recommended corrective measure is to install a new 12-inch pipe adjacent to the existing pipe at proper grade, or re-align the 24-inch pipe crossing Shawnee Road.
- Construct a French drain system under the center of the open ditch as a means to store sitting water below grade. This alternative would consist of installing a 4-inch perforated pipe bedded with 1-inch clean stone.
- With respect to the residents that abut the open buffer to the wetland area, the recommended course of action would be to construct two shallow swales (approximately 75 feet in total length) from the upland buffer area to the ACOE wetland area.

4.10.2 Conclusions

Topography is flat with minimal opportunity to relieve surface water runoff quickly from the Moyer Road and neighboring area. Extended periods of standing water within this area are to be expected in response to the downstream conditions of Loveland Road and Bull Creek.

Opportunities for improving the drainage system include a combination of adjusting the storm sewer along Shawnee Road, constructing a French drain and constructing swales to the ACOE wetland.

5. Recommendations

Recommendations have been separated into non-structural, maintenance, and capital improvement type projects. The non-structural recommendations include updates to the Town code and policies for future planning purposes. The maintenance type improvements are for inclusion in annual budgets, while the capital improvements are mainly one-time projects to correct or alleviate flooding problems. This section also includes recommendations for additional confirmatory investigations and future studies to further evaluate select alternatives and conceptual improvements.

5.1 Non-Structural Recommendations

During the course of this study, GHD identified potential updates to the Town Code and stormwater management policies to assist in managing potential drainage impacts of future planning and development. These suggested modifications include:



- Update the basis for design criteria associated with land development activities involving commercial and major residential subdivision projects. Recommended stormwater management design practices should include:
- Model the off-site areas within the watershed when determining storage required to safely pass the 10-, 25-, 100-year storm event peak flows. The analysis should be completed to demonstrate that storage provided for a proposed site development is appropriate when combined with upstream and downstream flows. As an example, detention at a site may in some instances exacerbate flooding problems within a watershed.
- Complete a downstream analysis. The analysis should include an evaluation of hydrologic and hydraulic effects of all culverts and/or obstructions within the downstream channel. Assess water surface elevations to determine impact if the results indicate an increase in elevation on downstream structures.
- Update Town standards to include a provision for construction of control valves on retention/detention pond outlets. The inclusion of valves at Town maintained stormwater facilities will provide additional control to manage the system and potentially reduce downstream flooding.
- Utilize precipitation data from an extreme rainfall analysis that was completed as a joint collaboration between the Northeast Regional Climate Center (NRCC) and the Natural Resources Conservation Service (NRCS). A link to the web-based application can be found at <http://precip.eas.cornell.edu>.
- Establish stormwater management zones (see Figure 8).

Zone A: Zone A can generally be defined as the drainage area north of Niagara Road within the upper watershed of the Town. Suggested criteria for development within this zone include:

1. Design retention and increased detention time to attenuate peak flows to:
 - a. Capture and manage 100 percent of the site rainfall runoff for up to the 1 year, 24-hour storm event (1.8 inches).
 - b. Attenuate the post development peak flows for a 10-year, 24-hour peak discharge rate to the 5-year predevelopment.
 - c. Attenuate the post development 25-year, 24-hour peak discharge to the 10-year predevelopment.
 - d. 100-year predevelopment to 25-year predevelopment, discharge the post development 25-year to predevelopment 5 year, 100-year post development runoff to 10-year predevelopment.
 - e. Reduce peak flows from off-site areas that are tributary to a project development based upon the downstream capacity analysis.

Zone B: Zone B can generally be defined as the drainage area south of Niagara Road within the lower watershed areas of the Town. Suggested criteria for development within this zone include:



1. Design stormwater systems to capture and manage 100 percent of the rainfall runoff on-site for storms up to the 1 year 120-minute event (1.0 inches).
2. Attenuate the post development peak discharge rates (10-, 25-, 100-year, 24-hour) to predevelopment conditions. Increase in detention may be required based upon results of the downstream analysis.
3. Conduct downstream analyses to include backwater effects (elevated stream conditions) for proposed developments that discharge to tributaries of Tonawanda Creek, Bull Creek, Sawyer Creek, and Southern Drainage.

5.2 Maintenance Recommendations

This study identified several maintenance activities that the Town should incorporate into their routine maintenance program to help alleviate flooding and restrictions in the Town.

5.2.1 Ditch/Creek Maintenance Program

GHD recommends the Town develop a 5-year ditching program to prioritize annual maintenance improvements. Permitting and access easements could be planned in advance of the annual projects. In general, the following minor and major stream corridors should be considered for inclusion in the initial 5-year ditch/creek maintenance program:

- Private ditch network behind Walck Drive properties and outlet to Bergholz Creek.
- Sawyer Creek West behind Cayuga Drive Extension from Walmore Road upstream to Niagara Falls Boulevard.
- Tributary BEB (Bergholz Creek) upstream from Ward Road to Eagle Chase.
- The man-made ditch behind Rose Court properties south toward Niagara Falls Boulevard.
- Black Creek Outlet from River Road upstream to Liberty Drive.
- Overflow ditch from the detention pond behind Mourning Dove Lane east to the railroad tracks.
- Tributary CAA-1 (Cayuga Creek) from Walmore Road upstream east of Inducon Park.
- Sawyer Creek West from confluence of Bergholz Creek east to Walmore Road.
- Bull Creek downstream of Hill Road. Coordination with the Town of Pendleton is required.

5.2.2 Maintenance for Major and Minor Tributaries

The following creek sections and roadway crossing culverts have been identified as having significant silt accumulation and vegetation along the alignment, and maintenance activities should be performed to alleviate these restrictions:

- 36-inch CMP storm crossing at Walmore Road (90 percent plugged).
- Tributary CAA-1 beginning at Walmore Road and east 4,000 linear feet.
- 5,500 linear feet tributary BEB from Nash Road to Ward Road.



- Roadside ditch (500 feet) located along Lockport Road from roadway culvert crossing east to Eagle Chase outlet (30-inch).
- Tributary BUB: Townline Road 30-inch by 24-inch CMPA (partially plugged at outlet). Remove sediment and vegetation beginning at the existing ditch outlet at Townline Road to a point downstream approximately 400 linear feet past the residential properties.
- Tributary BEA-1: Spot check channel and remove sediment and trees, as required, to improve stream capacity and flow. Based upon a review of the aerials, there appears to be a piped crossing on private property that may be restricting flow.
- Sawyer Creek (SWA): Remove sediment and vegetation as needed to allow for equal distribution of flow to be directed north toward Cayuga Drive Extension.
- Sawyer Creek (SWA) at Walmore Road (culvert crossing is 50 percent blocked). Removal of sediment buildup upstream and downstream is needed.
- Niagara Falls Boulevard (near Mavis Drive intersection): Broken 18-inch flap gate broken on end of pipe requires repair (see **Exhibit C**).
- Tributary SEB-1: Clean and regrade/establish ditch alignment from Stieg Road upstream to Nash Road.
- Two 24-inch RCP located behind the properties on Deborah Lane (80 percent blocked under the railroad).
- Black Creek (BLA): Liberty Drive culvert crossings: 43-inch by 27-inch CMPA (crushed end sections and 80 percent plugged).
- Colvin Blvd Culvert crossing west of Williams Road: 30-inch CMP crossing (80 percent plugged); drainage system is tied to a wetland area that does not drain.
- Black Creek (BLA): The creek alignment from Liberty Drive to River Road. Spot inspections to identify and remove debris and sediment accumulation.
- Nash Road: 24-inch CMP (pipe outlet partially collapsed and plugged).
- Nash Road: 44-inch by 22-inch CMPA at south boundary with City of North Tonawanda (pipe outlet partially collapsed and plugged); clean and regrade downstream ditch to Graydon Drive.
- Witmer Road at Stenzel Avenue: 18-inch pipe crossing (partially plugged).
- Remove vegetation between Errick Road and Ward Road.

5.3 Capital Improvement Recommendations

As part of this study, capital improvement projects were identified to address poor conditions and capacity restrictions, as well as focus on specific areas of concern in the Town.

5.3.1 Culvert Replacement

Culverts that have been identified for replacement are presented in Table 8, along with the estimated construction cost and replacement priority (A being the highest priority, C being the lowest priority).



Table 8 Recommended Culverts to be Replaced

Culverts	Present Culvert Dimensions	Recommended Culvert Dimensions	Estimated Construction Cost	Replacement Priority
Sawyer Creek East Tributary SEB at Lemke Drive	Two 48" CMP	12'W x 7'H or 95" x 67" CMPA	220,000	A
Sawyer Creek East Tributary SEB at Errick Road	14'W x 7'H CMP Arch	14'W x 6'H or 117" x 79" CMPA	220,000	A
Cayuga Creek at Walmore Road	Two 48" RCP One 48" CMP	15'W x 5'H	200,000	B
Cayuga Creek at Cory Road	Three 40" RCP	15'W x 5'H	200,000	B
Bergholz Creek Tributary BEA-1 at Walmore Road	12'W x 4'H Bridge	15'W x 4'H	135,000	B
Bull Creek Tributary BUB at Lockport Road	24" RCP	ADD -4'W x 2'H	90,000	C
Bergholz Creek BEA at Hunt Street crossing	Bridge 37'W x 6'H (County)	Remove / or replace with 45'W x 7'H	County	C
Sawyer Creek West at Niagara Falls Boulevard	8'W x 5'H (NYSDOT)	10'W x 6'H	NYSDOT	C

5.3.2 Specific Areas of Concern

Improvement recommendations for the six areas of concern evaluated as part of this study are presented in the following subsections.

5.3.2.1 Walck Drive Area

Conceptual drainage improvements for the Walck Drive area are shown on **Drawing CI-08** (Appendix A). The recommended improvements by order of priority for the Walck Drive area are as follows:

Priority A (Highest)

- Replace 15-inch with 30-inch (private property)
- Clean/regrade ditch along rear lots of Walck Drive
- Construct a berm along the end of the paper street section of Walck Drive
- Construct a new 18-inch storm system at the intersection of Ward and Pearce Roads



Priority B

- Replace 18-inch on Pearce Road with 24-inch
- Replace 12-inch Pearce Road crossing with 24-inch
- Clean existing ditch from outlet of 30-inch pipe on Ward Road to Bergholz Creek

5.3.2.2 Thornwoods Drive Area

Conceptual drainage improvements are shown on **Drawing CI-08** (Appendix A). The recommended improvements by order of priority for the Thornwoods Drive area are as follows:

Priority A

- Remove 10-inch riser in Thornwoods catch basin
- Clean basin outlet and remove sediment accumulation
- Remove sediment accumulated upstream and downstream of Thornwoods Drive entrance culvert
- Confirm all storm flap gates for subdivision are in working condition

Priority B

- Berm east top of bank of existing dry pond approximately 18 inches to elevation 581

5.3.2.3 Eagle Chase Area

Conceptual drainage improvements for the Eagle Chase area are shown on **Drawing CI-07** (Appendix A). The recommended improvements by order of priority for the Eagle Chase area are as follows:

Priority A

- Clean and regrade the Lockport ditch from the outlet at Eagle Chase to the box culvert crossing Lockport Road (300 linear feet)
- Lockport Road drainage system (15-inch) – Remove sediment accumulation, debris and vegetation at driveway culvert crossings
- Clean and regrade the ditch from Eagle Chase pond outlet to Lockport Road

Priority B

- Construct a 12-inch berm from the inlet pipe along the easterly residential property to Lockport Road. Additional improvements to include a secondary road crossing should also be considered as a secondary priority.



5.3.2.4 Moyer Road / Briars Subdivision Area

The recommended improvements by order of priority for the Moyer Road / Briars Subdivision area are as follows:

Priority A (Highest Priority)

- Improve existing drainage system that crosses Moyer Road. Install a new 12-inch pipe adjacent to the existing pipe at proper grade; alternate plan is to re-install the 24-inch crossing Shawnee Road to provide positive slope.
- Remove grass and leaf piles within the existing rear yard ditch.
- Construct one or two shallow swales from the buffer area to the ACOE wetland area.

Priority B

- Construct a French drain system under the center of the open ditch. This alternative would consist of installing a 4-inch perforated pipe bedded with 1-inch clean stone.

5.3.2.5 Willow Lake Outlet

The addition of the flap gate on the outlet of Willow Lake has reduced the storm system vulnerability to flooding due to backwater/surcharging within the downstream ditch. The recommended course of action is to continue monitoring existing conditions during storm and periods of snow melt. If street flooding continues to occur, then additional investigation into constructing additional wetland storage should be considered.

5.3.2.6 Southern Drainage / Black Creek Area

Conceptual drainage improvements are shown on **Drawing CI-11** (Appendix A). The recommended improvements by order of priority for the Southern Drainage / Black Creek area are as follows:

Priority A:

- Lower the existing primary control outlet to elevation 569.0, modify the rock overflow structure, add a flap gate to the upstream subdivision pond outlet, and regrade 1,200 linear feet of ditch at 0.08 percent south to the first set of culverts downstream.

Priority B:

- Clean the existing ditch from overflow structure at the detention pond behind Mourning Dove Lane easterly to railroad tracks. Also, lower the detention pond overflow elevation from 573.4 to 572.0.

5.4 Additional Investigations and Studies

As part of this study, several additional investigations and studies were identified as necessary to further evaluate existing conditions and develop and/or refine the conceptual improvements. The following confirmatory investigations are recommended to confirm existing conditions:



- Sawyer Creek (SWA) downstream of Walmore Road (Private Property): Confirm creek condition and potential pipe restrictions.
- Monitor flow conditions of Bergholz Creek between Hunt Street and Cayuga Creek Extension to confirm restriction points and culvert replacements (see **Findings Section 4.3.1**).
- Tributary SWA-1 outlet at Niagara Falls Boulevard: Additional investigation and survey is required to further develop alternatives to reduce flooding. Potential solutions could include constructing a piped or open channel system that diverts flow prior to Sawyer Creek before the 24-inch single pipe.
- The split in Sawyer Creek West (SWA) downstream of the railroad tracks represents a critical flow control point and can be used to manage flows that are directed toward Bergholz Creek. Downstream conditions should be inspected and cleaned as required.

GHD also recommends that the Town conduct the following studies to further evaluate select alternatives and conceptual improvements.

- Bergholz Creek flood protection measures: Conduct a study and evaluation to determine the feasibility of incorporating additional flood protection measures that could include construction of earth berms and additional flood storage.
- Potential overbank flows from Bergholz Creek into the headwaters of Tributary SEB (Sawyer Creek West) could be mitigated with a combination of berms and construction of a flow control structure at Ward Road. An additional investigation to confirm overflow occurrence and a topographic survey of the south embankment of Bergholz Creek is recommended.
- Walmore Road at Airbase: Evaluate alternatives to improve downstream capacity
- The drainage system under Stieg Road is a control point resulting in backwater/surcharging and localized flooding. Reducing peak flows before they reach Stieg Road will minimize impacts to residents. An alternate solution that should be further evaluated would be the construction of a secondary drainage system to bypass a portion of flows at Stieg Road, which would also reduce the risk of flooding and downstream impacts at Lemke Drive.
- Tributary CAA-1 (Cayuga Creek at Airbase): The Town should further evaluate the construction of a regional stormwater storage pond along the alignment to reduce downstream peak flows at Walmore Road and potentially reduce runoff volumes and peak flows associated with Bergholz Creek.