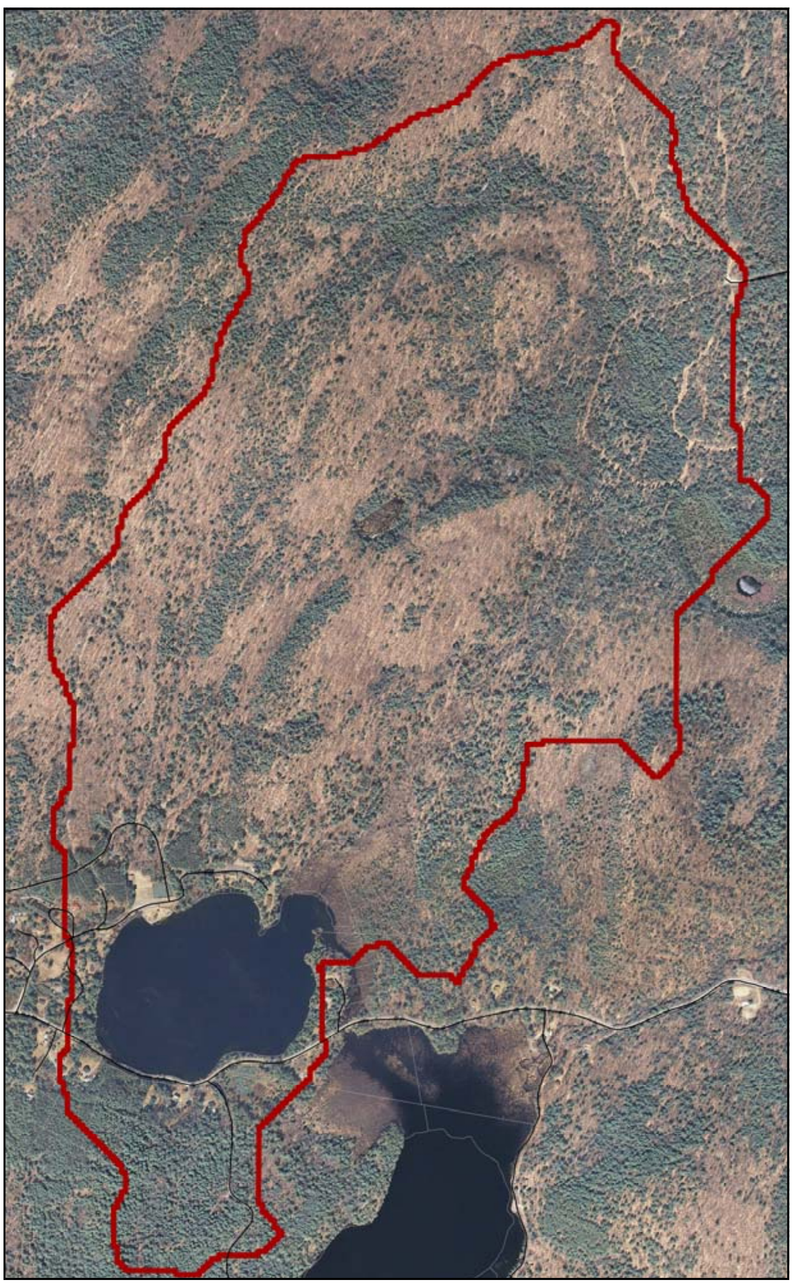
Crystal Lake Watershed Stormwater Assessment

Prepared by the
Warren County Soil & Water
Conservation District

For the Crystal Lake Homeowners Association
November 2013



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Introduction and Background

The Warren County Soil and Water Conservation District (District) has undertaken the review of the stormwater conveyance system within the Crystal Lake Watershed. This report identifies areas of high priority in terms of stormwater runoff reaching Crystal Lake. The Lake's surface is 49 acres and its watershed is approximately 800 acres.

Assessment Methodology

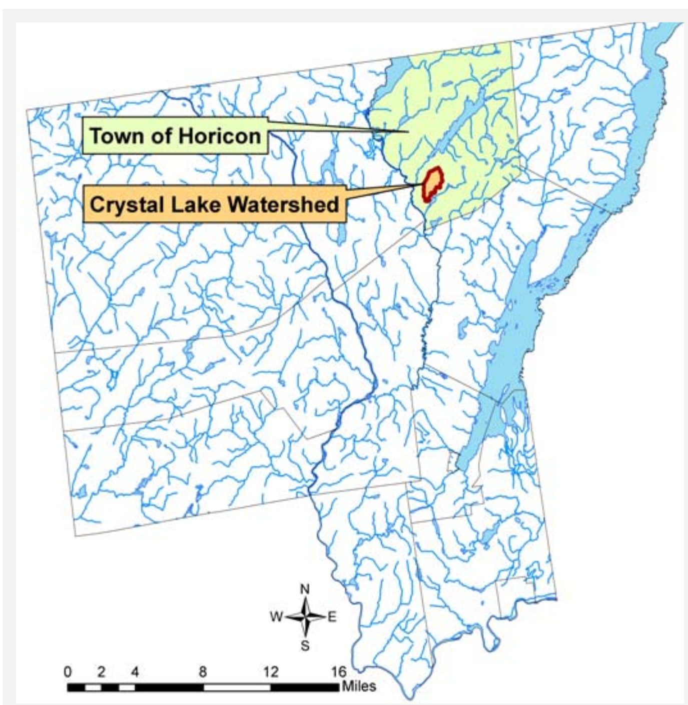
This report is a comprehensive stormwater examination of the Crystal Lake Watershed in the Town of Horicon. This consisted of a review of the stormwater runoff from the conveyance system along all roads within the Crystal Lake Watershed as well as detail cost effective recommendations that will reduce stormwater pollutants and sediment input to the lakes or streams.

District staff used Geographic Information System ArcView 9.3 (GIS) to assist with mapping of the roads from existing data. These maps were referenced throughout the project as a guide and layout for final stormwater identification mapping. Each of the roads were driven, documenting the stormwater network, outfalls and storm drain inlets along with any point and non-point source pollution within the watershed. Data was collected using a Global Positioning System (GPS) Trimble Juno SB. Data was logged and photographed to document the physical conditions of stormwater runoff from the conveyance system. The information collected was processed in the office and the GPS data was differentially corrected and exported as shapefiles for utilization in GIS maps.

Each area of concern identified as a contributor to erosion or stormwater pollution was reviewed for potential solutions. The recommendations identified in this report involve areas of direct discharge to a water body, inlets that receive significant amounts of stormwater runoff from the roadway network and roadside ditch erosion to the conveyance system.

Location

Crystal Lake is a small, clear water lake in the south east portion of the Town of Horicon. Crystal Lake is part of the Hudson River Basin Watershed in the northeastern section of Warren County. The outflow of Crystal Lake drains south to Burnt Pond. The main road running by the lake is Hayesburg Road which runs west to east along the southern boarder of the lake.

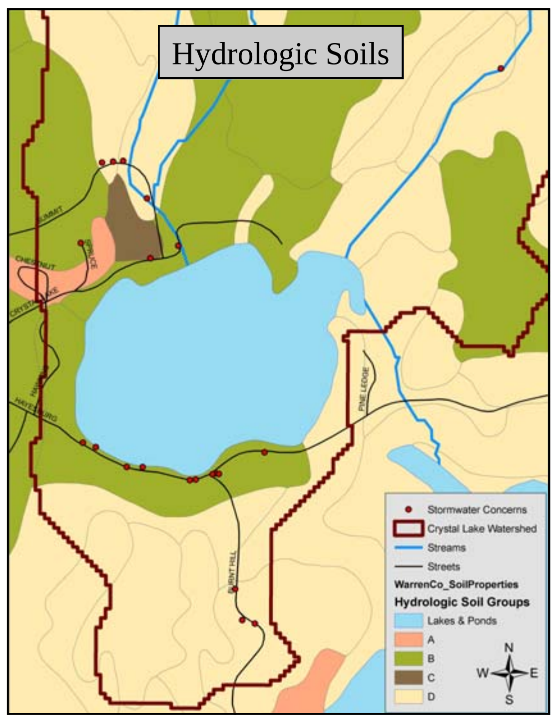


Hydrology

The waters that formed Crystal Lake are a product of it's watershed. Rainfall and snowmelt within the watershed flow to the small streams which empty directly to the lake. Precipitation within the watershed that does not directly flow into one of these three small streams is absorbed into the soils; these waters form your groundwater table. Groundwater, contributes to lakes in two ways, it emerges as bottom springs within lakes and by recharging streams which allows for flow even during the driest periods. Within the watershed there are two unnamed mapped tributaries that flow into the lake. Tributary 1 for purposes of this report will be known as the Crystal Lake Road Tributary. The watershed for the Crystal Lake Road Tributary is about 200 acres and covers the south end of Fox Hill.

Tributary 2 will be known as the Jim Younes Road Tributary. The watershed for this tributary consist of the northern and eastern side of Fox Hill Road and western side of Amasa Mountain. This section of the Crystal Lake Watershed is approximately 500 acres. There is an additional small unnamed tributary flowing into the lake near the Burnt Hill and Hayesburg Road intersection which only contributes approximately 6% of the tributary waters and drains in the area of 35 acres.

Soils in the Watershed



Soils within a watershed and along a shoreline lay the framework that all land uses are based upon. They have a direct correlation to the type of land uses that may be suited for a particular location. Very sandy soils may pose serious issues with setting a septic system for a house, whereas soils with high clay content cause issues with infiltration. This section briefly evaluates the soils within the near shore area of Crystal Lake to summarize some of the potential concerns with land use and water quality within the lake. Please note that this is only a brief summary of the soil conditions, and much more detailed information and maps are available in the Warren County Soil Survey available through the Warren County Soils & Water Conservation District.

The soils along the Crystal Lake shoreline are 75% hydrologic soil group "B" and 25% hydrologic soil group "D". Group B soils have moderately low runoff potential and water transmission through soil is unimpeded. Group D soils have high runoff potential due to high groundwater causing restricted to very restricted water movement and infiltration. Hydrologic soil group properties and physical characteristics are very important when is comes to septic systems. Soil groups B and C work well for septic as opposed to soil groups A and D characteristics which are not ideal (Part 630 National Engineering Handbook).

Stormwater Runoff

A significant concern in any developed area is the impact of stormwater runoff on the nearby water bodies. Along roadways, driveways, rooftops and parking areas, runoff is often channeled into drains and pipes, which frequently outlet into a stream or a lake. Impervious surfaces such as concrete, asphalt or compacted soils do not allow water from precipitation or snowmelt to infiltrate into the ground. As the water courses across these surfaces, it can collect sediment, phosphorus, de-icing materials (sand and salt), petrochemicals and other pollutants.

Sediment deposition in Crystal Lake from Burnt Hill Road stormwater runoff

Roadside ditches also contribute to stormwater runoff issues when improperly installed or poorly maintained. A poor roadside ditch can contribute to increased stormwater runoff velocity leading to increased erosion and sedimentation. During warmer months, this runoff can also be significantly warmer than the stream's water, causing thermal pollution affecting the stream's aquatic communities.

Stormwater discharges are a major contributor to stream sedimentation and delta formation in lakes, and can also have significant negative impacts on aquatic communities. Calcium from road salt can create improved conditions at the mouths of streams suitable for the colonization of zebra mussels. Phosphorus transportation by sediments create multiple problems including the eutrophication of water bodies, increased habitat for invasive aquatic plants and animals and cause a general reduction in water quality.

This runoff directly affects the stream systems long-term stability. As land gets developed, typically more water runs off the land into nearby streams, often very quickly following a precipitation event. This large volume of water entering a stream in a short period of time can cause an over widening of the stream channel in order to accommodate the increased volume of water. These channel widening processes occur through accelerated stream bank erosion, and ultimately more downstream deposition (deltas).

Stormwater runoff is considered to be one of the largest water quality impact in the Crystal Lake Watershed. This report will provide the Crystal Lake Homeowners Association with the ability to identify opportunities to address stormwater issues and their impacts within the Crystal Lake Watershed.

Stormwater Mapping and Retrofit Recommendations

Burnt Hill Road

Location 1: Burnt Hill Road is an unpaved road at the southern end of the watershed. Burnt Hill is a well maintained road with ditching and turnouts along the entire road. The three most southern mapped points of concern on Burnt Hill are on steep slopes and have some ditch and bank erosion. With the larger and more frequent rain storms we have been experiencing in the northeast, it is important to protect roadside ditching to keep sediment and stormwater pollutants from migrating to a water body. Properly established roadside ditching will also stabilize the road by preventing erosion.


Location 1: Burnt Hill Road ditch erosion

Recommendation:
Establishing protected ditching on steep slopes in heavily forested areas will require rock lined ditches. Fractured rock is used to line ditches due to its ability to lock together preventing it from migrating during larger storm events. The fractured rock will also slow stormwater velocity preventing erosion, increasing infiltration and allow for suspended solids to settle out. It is also recommended that check dams be installed to assist in slowing stormwater velocity and adding to ease of maintenance when cleaning the ditches. The stormwater turnouts along Burnt Hill road also need protection. The outlets should be rock protected and also maintained when they fill with sediment. When installing rock lined ditching and rock protected outlets, a layer of filter fabric under the rock as a base will prevent the rock from sinking into the sandy soils and will be additional stabilization adding to the longevity of the road and ditching.


Location 2: Burnt Hill Road ditch before intersection with Hayesburg Road

Location 2: One hundred feet south of the intersection with Hayesburg Road, Burnt Hill Road has a steep section that allows for increased stormwater velocity and erosion which outfalls into the lake through a culvert.

The runoff from the last 100' of the unpaved Burnt Hill Road flows over the intersection of Hayesburg Road and eventually to the lake. The Burnt Hill runoff that does not flow to the east or west ditching flows across the Road and builds up sediment on the lakeside bank and shoreline creating a small delta. There are multiple site limitations in this location. The ditching on the east and west of Burnt Hill Road drains to the lake, the steep slopes of the unpaved road, the close proximity to the lake and maintenance needed in this location to maintain and limit the sediment migration towards the lake.

Recommendation:

Due to all of the limitations in this location, the following recommendations would need further research before a project is implemented. Depending on groundwater elevation in this area, a drywell at the intersection may be feasible but would need yearly maintenance due to the large amount of sediment that would be flowing into it from Burnt Hill Road. It is recommended that the maintenance to clean out the behind the check dams and the ditching in this location take place every year in spring or early summer to prevent sediment from draining to the lake and to encourage vegetated growth.

Location 2 recommendation: Burnt Hill Road runoff across Hayesburg Road to lake

A second recommendation to assist in remediating the Burnt Hill Road runoff is the retrofit and maintenance of the ditching on the west side of Burnt Hill Road that flows onto Hayesburg Road. This ditching flows to a small stream, which drains to the lake. The image on the right shows the ditch with sediment that flows into the stream and lake. To improve this ditching, it is recommended that fractured rock check dams be installed as well as yearly maintenance to clean out the sediment build up from behind the check dams and within the ditch. This section of Hayesburg Road has saturated soils and may be a regulated wetland. Further investigation and a site visit from the Adirondack Park Agency (APA) and U.S. Army Corps of Engineers will be necessary. Maintenance should be performed in spring or early summer to encourage vegetated growth in the ditching and the banks should be left to grow freely for additional stabilization.

Stabilizing the ditch and turnouts south along Burnt Hill Road within the Crystal Lake Watershed will greatly reduce migrating sediment north to these more sensitive areas that outfall to the lake. Breaking up stormwater in multiple areas is much more effective than trying to fix and capture everything at the problem location. Multiple retrofits throughout a drainage area will prevent a failure during a large storm event due to the ability to capture the stormwater in multiple locations.

Hayesburg Road

Burnt Hill Road Intersection

A 12" corrugated metal culvert (cmp) located at the intersection of Hayesburg and Burnt Hill Road outfalls directly to Crystal Lake. The ditching leading to the culvert on the east side of the road is in need of maintenance and stabilization. The ditch currently has a significant amount of sediment covering the majority of the rock lining.

Recommendation:

The recommended retrofit for this last 100' stretch of road is to clean and reestablish the stone lined ditching. It is also recommended that the straw bale is removed from the ditch and proper check dams installed according to the New York State Standards and Specifications for Erosion and Sediment Control guide, known as the *Blue Book* -http://www.dec.ny.gov/chemical/29066.html.

The check dams and rock lined ditches on the east side of Burnt Hill Road will assist in reducing stormwater pollutants from draining to the lake by capturing the sediments and suspended solids behind the check dams. Lining the ditch with filter fabric before armoring the ditch with fractured rock will stabilize the ditch and prevent the rock from sinking into the fine sandy loam soils in this location.

Burnt Hill Road intersection: ditch to stream & lake

Hayesburg Road West Side

On the western side of the watershed on Hayesburg Road, there is a small head cut that is starting to erode towards the lake. The head cut if forming due to stormwater drainage flowing east down Hayesburg Road combine with driveway runoff. If head cuts are not addressed, they will continue to grow by continually eroding away soil especially with the heavy rains we have received this summer. Preventing head cuts from forming requires breaking up any concentrated stormwater flow.

Hayesburg Road west side: head cut towards lake

Recommendation:

To assist in reducing the volume of stormwater runoff to the head cut, it is recommended that a vegetated turnout with a protected outlet be installed west of the head cut on the north side of Hayesburg Road. A turnout will give the stormwater a place to settle out and infiltrate, reducing runoff volume. Since this is not an established ditch and the turnout would be going towards private property, the property owner would have to be contacted and worked with on this project. The recommended project area west of the head cut on Hayesburg Road is currently heavily forested and is down slope from any houses. Prior to this project, the wells in this location will have to be identified to establish proper buffers and retrofit locations. The turnout will have a protected inlet from Hayesburg Road and a protected outlet. The outlet will mainly serve as an overflow point for the vegetated turnout.

Hayesburg Road East Outfall

An outfall directly to Crystal Lake is located on the east side of the watershed on Hayesburg Road. This outfall currently has a damaged 10" cmp in an unpaved ditch. The ditch in this location is full of sediment from the sandy loam soils in this area and roadside runoff from deicing materials. The culvert is located in a low point in the topography and has a sediment build up that flows to the lake during storm events.

Hayesburg Road east outfall

Recommendation:

Preventing stormwater pollutants from reaching the lake is one of the main goals of this assessment. This outfall is not the top priority area of stormwater pollution but it is an area of concern and does outfall directly to the lake. The sediment in the ditches and in front of the culvert needs to be removed. It is recommended that rock check dams be installed to capture sediment before it enters the culvert and flows to the lake. This adds to easier maintenance by capturing sediment and other debris behind the dams. It was noted that this culvert is beginning to deteriorate and is partially crushed. A maintenance schedule should be established to clean out the sediment build up in the ditch and behind the rock check dams.

Spruce Drive

Spruce Drive is a very steep, narrow unpaved road on the north west side of the lake. Spruce drains south towards the lake and is showing signs of erosion. This is a difficult location to retrofit and the only solutions may be water bars with protected turnouts into a wooded area and/or the establishment of a ditch lined with fractured rock and check dams, if feasible. Depending on the side of the road chosen for ditching, the driveways would need culverts if ditching were to be installed. The limitations of a steep, narrow, unpaved road with houses will need additional research and planning to determine a solution that will work best in this location.

Spruce Drive

Crystal Lake Road Tributary

A tributary flowing to Crystal Lake crossed Crystal Lake Road located at the Lake Association beach and tennis courts. The stream crosses through a 24" corrugated HDPE culvert under the unpaved road. Above the culvert's head wall is a turnout from the road that drains stormwater directly to the stream. Crystal Lake Road drains from east to west with a portion of the stormwater flowing to the stream.

Recommendation:

The turnout from the road to the tributary needs regrading and vegetation. Both sides of the tributary are already vegetated and will benefit from connecting the vegetation on both sides of the tributary. With the vegetated area by the tributary graded to distribute the stormwater away from the stream, the stormwater will be able to splay out and infiltrate in the larger grassed area to the west.

Crystal Lake Road tributary

Crystal Lake Road Erosion

The western most mapped point on Crystal Lake Road is an area of the road that has some erosion. This section of the road does not have established ditching and is on a steep section of unpaved road. The erosion is located where Crystal Lake Road takes a turn towards Summit Road and the stormwater forms a concentrated flow to the center of the road, causing the migration of road material down slope towards the lake and tributaries.

Crystal Lake Road erosion

Recommendation:

A turnout on the east side of the road will infiltrate the stormwater in a forested area and prevent concentrated flow from forming erosion issues on the road as shown in the photo on the right. The turnout will need a rock protected outlet and will need to be installed in a location where concentrated flow will not form and create a head cut. The turnout needs to flow to an area that will allow for the stormwater to spread out, drop suspended solids and infiltrate into the ground.

Summit Road Stream Crossings

Summit Road is an unpaved road and has two stream crossings. Both of the stream crossings have turnouts that drain stormwater and road material from Summit Road to the streams. The sediments and other road material are transported downstream to Crystal Lake leading to sedimentation of the lake and eventually delta formation, if the issues are not resolved.

Recommendation:

The turnouts on Summit Road need to be established up slope of the streams to cut off the stormwater before it reaches the streams. An additional recommended retrofit would be rock lining the ditch to the turnout and the outlet. The rock will assist in stabilizing the ditch line. When establishing the ditches, filter fabric should be installed under the rock to prevent sediments from migrating through the rock and to allow stormwater to infiltrate.

Jim Younes Road Tributary

Bridge Washout

The main inlet to Crystal Lake is a tributary that flows in on the north eastern end of the lake. Approximately 1,700' north of Crystal Lake on the tributary is a bridge that has been washed out. Currently the bridge has collapsed into the stream and is clogging a section causing scouring in this area. The bridge appears to have been used to connect recreational trails through out this area.

Bridge washout: tributary to Crystal Lake

Recommendation:

The bridge debris should be removed to prevent anymore scouring of the stream and stream banks. Once the debris is removed, the stream should reform to a stabilized section. Any soils disturbed during debris removal should be seeded and mulched for stabilization.

Other Recommendations

To determine future trends in your lake's water quality and aquatic plant population it is important to set baseline data in order to track changes, by using previously collected data and comparing it to more recent findings, changes or trends that can be identified.

A common tool used for determining water quality in a lake or to determine a general lake health is the Trophic State Index (TSI). The TSI is a combined set of data that is a sum of three standard water measurements.

1. Seechi Disk Depth: The disk is used to measure the transparency of the water. An 8" circular disk attached to a measured line is lowered into the water until it disappears from view, that depth is recorded; the disk is then raised until it can be once again seen and that depth is then recorded. The seechi reading is the mean of the two recorded depths.

2. Total Phosphorus (TP): Phosphorus is generally the limiting nutrient in the freshwater system. The higher a TP reading is in a lake system the greater the number of Macrophytes (rooted plants), phytoplankton and algae found in the lake.

3. Chlorophyll A: A chlorophyll a measurement in a lake will give you an estimate of the phytoplankton production occurring in your system.

The combination of all three constituents will give you your TSI number; The three main trophic classifications are: Oligatrophic (<30 to 40) – low nutrient, high visibility, low primary production, high oxygen content waters. Mesotrophic (40 to 50)- Meso meaning middle or intermediate, these lakes generally have clear water, a healthy population of rooted plants and a good oxygen levels. They also have a well established and mixed fish population. Eutrophic (50 to 70) - high nutrient, lower visibility, abundant plant-life both rooted and algae, the abundance of decaying plant material will cause a loss of oxygen in the lower depths of the water body.

By contacting the New York State Dept. of Environmental Conservation (Scott Kishbaugh 518.402.8286) your lake association can be come a member of the New York State Federation of Lake Association (NYSFOLA) and join the Citizens Statewide Lake Assessment Program (CSLAP).

Aquatic Vegetation and Invasive Species

If an aquatic plant survey of Crystal Lake has not been conducted recently, it should be considered. A comprehensive list of the wetland and aquatic plant populations allows you to track the introduction of invasive species to the lake and its associated wetlands.

Species such as Fanwort, Water Chestnut, Curly Leaf Pondweed and Eurasian Water Milfoil are all found in northern New York, and recently Hydrilla has been identified in two lakes in the southern tier of New York. Wetland and terrestrial species such as Purple Loosestrife, Common Reed (Phragmites) and Japanese Knotweed are commonly found in our area. Two additional aquatic invertebrate invasive species have recently been in the local news, the Asian Clam and the Spiny Waterflea both which can be transported from lake to lake by boats, fishing tackle or bait buckets.
A resource locally for aquatic plant and Invertebrate surveys and water chemistry analysis is the Darrin Freshwater Institute in Bolton Landing, NY. Larry Eichler at 518.644.3541 is the contact person for information on water chemistries and biological surveys of your lake.

Another source for invasive species information is the Adirondack Park Invasive Plant Program based in Keene Valley NY, their phone number is 518.576.2082.

Conclusions

By following the well established best management practices outlined in this report for existing development within the watershed the effects of stormwater runoff can be greatly diminished. Containing runoff on developed property and maintaining the existing roadside ditches will contribute greatly to the preservation of Crystal Lake. The overall design and layout of the Crystal Lake community within the watershed is well put together. Runoff from impervious surfaces on lakeshore properties are major contributors of stormwater runoff; roofs, sidewalks, patios and driveways make up some of these impervious surfaces. Lawns may add additional pollutants with the use of pesticides, herbicides and fertilizers; inadequate septic systems may also contribute to the nutrient loading of the lake. Having the majority of the houses in the southern half of the watershed on the opposite side of the roads away from the lake makes for less pollutants and stormwater runoff into the lake. Some of the driveways on the southern end of the lake are steep and flow directly towards the lake. The impervious surface of these driveways allows for increased stormwater velocity which flows across Hayesburg Road and to the lake. The development on the northern shore of Crystal Lake for the most part has excellent setbacks and well vegetated buffers at the shoreline.

The road system along the northern stretch of Crystal Lake is primarily unpaved; an excellent website for information on best management practices for unpaved road from the state of Massachusetts will be included at the end of the report.

Landowners can help by capturing and using on-site stormwater runoff. The use of rainbarrels, rain gardens and permeable paver for driveways, sidewalks and patio will also reduce the flow of stormwater to the lake.

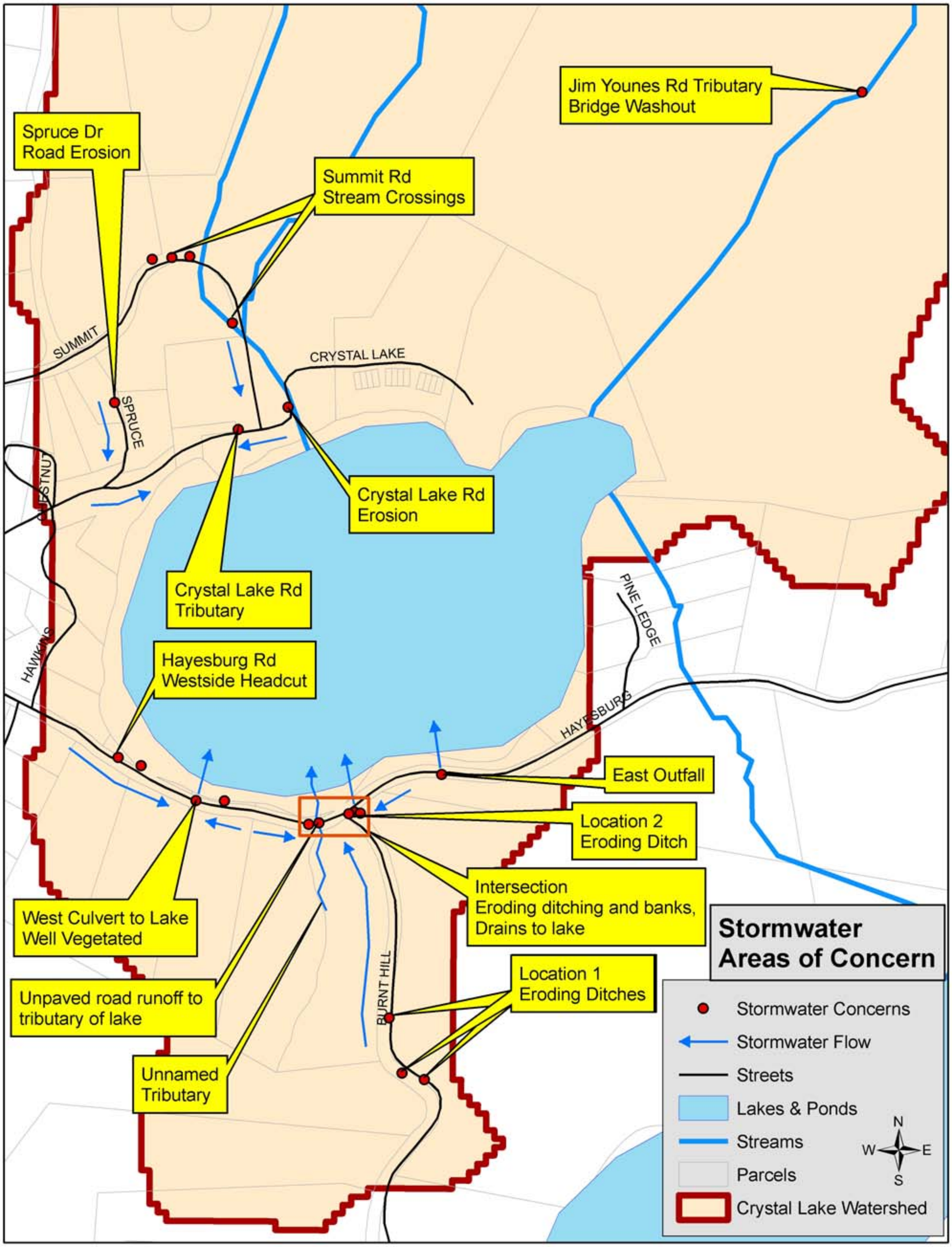
It is imperative to understand that the best way to address nonpoint source pollution issues will be for landowners and The Town of Horicon to work together and be willing to understand and accept concerns from each other, as well as understand the limitations that all of the groups may have.

Appendix

Stormwater Resource Websites

- DEC Division of Water Stormwater Webpage:
  http://www.dec.ny.gov/chemical/8468.html
  - New York State Standards and Specification for Erosion and Sediment Control ("Blue Book") Current Version: August 2005
  - New York Stormwater Management Design Manual
    Current Version: August 2005
- Lake George Park Commission:
  http://www.lgpc.state.ny.us/
- Warren County Soil & Water Conservation District:
  http://www.warrenswcd.org/
- The Lake George Association:
  http://www.lakegeorgeassociation.org/
- The Fund For Lake George:
  http://www.fundforlakegeorge.org/
- Soil & Water Conservation Society - Empire State Chapter:
  http://www.swcsnewyork.org/
- SUNY-ESF Continuing Education - Stormwater Management Program:
  http://www.esf.edu/outreach/stormwater/
- Center For Watershed Protection:
  http://www.cwp.org/
- EPA Stormwater Homepage:
  http://cfpub.epa.gov/npdes/home.cfm?program_id=6

Map 1: Stormwater Areas of Concern



STANDARD AND SPECIFICATIONS FOR VEGETATING WATERWAYS

Definition

Waterways are a natural or constructed outlet, shaped or graded. They are vegetated as needed for safe transport of runoff water.

Purpose

To provide for the safe transport of excess surface water from construction sites and urban areas without damage from erosion.

Conditions Where Practice Applies

This standard applies to vegetating waterways and similar water carrying structures.

Supplemental measures may be required with this practice. These may include: subsurface drainage to permit the growth of suitable vegetation and to eliminate wet spots; a section stabilized with asphalt, stone, or other suitable means; or additional storm drains to handle snowmelt or storm runoff.

Retardance factors for determining waterway dimensions are shown in Table 5B.1 and "Maximum Permissible Velocities for Selected Grass and Legume Mixtures," are shown in Table 3.6.

Design Criteria

Waterways or outlets shall be protected against erosion by vegetative means as soon after construction as practical. Vegetation must be well established before diversions or other channels are outletted into them. Consideration should be given to the use of synthetic products, jute or excelsior matting, other rolled erosion control products, or sodding of channels to provide erosion protection as soon after construction as possible. It is strongly recommended that the center line of the waterway be protected with one of the above materials to avoid center gullies.

1. Liming, fertilizing, and seedbed preparation.
   A. Lime to pH 6.5.
   B. **The soil should be tested to determine the amounts of amendments needed.** If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 1.0 lbs/1,000 sq. ft. of N, P_2O_5, and K_2O.
   C. Lime and fertilizer shall be mixed thoroughly into the seedbed during preparation.
   D. Channels, except for paved section, shall have at least 4 inches of topsoil.
   E. Remove stones and other obstructions that will hinder maintenance.
2. Timing of Seeding.
   A. Early spring and late August are best.
   B. Temporary cover to protect from erosion is recommended during periods when seedings may fail.
3. Seed Mixtures:

Mixtures	Rate per Acre (lbs)	Rate per 1,000 sq. ft. (lbs)
A. Birdsfoot trefoil or ladino clover[1]	8	0.20
Tall fescue or smooth bromegrass	20	0.45
Redtop[2]	2	0.05
	30	0.70
OR		
B. Kentucky bluegrass[3]	25	0.60
Creeping red fescue	20	0.50
Perennial ryegrass	10	0.20
	55	1.30

[1] Inoculate with appropriate inoculum immediately prior to seeding. Ladino or common white clover may be substituted for birdsfoot trefoil and seeded at the same rate.

[2] Perennial ryegrass may be substituted for the redtop but increase seeding rate to 5 lbs/acre (0.1 lb/1,000 sq. ft).

[3] Use this mixture in areas which are mowed frequently. Common white clover may be added if desired and seeded at 8 lbs/acre (0.2 lb/1,000 sq. ft.)

STANDARD AND SPECIFICATIONS FOR PERMANENT CRITICAL AREA PLANTINGS

Definition

Establishing grasses with other forbs and/or shrubs to provide perennial vegetative cover on disturbed, denuded, slopes subject to erosion.

Purpose

To reduce erosion and sediment transport.

Conditions Where Practice Applies

This practice applies to all disturbed areas void of, or having insufficient, cover to prevent erosion and sediment transport. See additional standards for special situations such as sand dunes and sand and gravel pits.

Criteria

All water control measures will be installed as needed prior to final grading and seedbed preparation. Any severely compacted sections will require chiseling or disking to provide an adequate rooting zone, to a minimum depth of 12". The seedbed must be prepared to allow good soil to seed contact, with the soil not too soft and not too compact. Adequate soil moisture must be present to accomplish this. If surface is powder dry or sticky wet, postpone operations until moisture changes to a favorable condition. If seeding is accomplished within 24 hours of final grading, additional scarification is generally not needed, especially on ditch or stream banks. Remove all stones and other debris from the surface that are greater than 4 inches, or that will interfere with future mowing or maintenance.

Soil amendments should be incorporated into the upper 2 inches of soil when feasible. **The soil should be tested to determine the amounts of amendments needed.** Apply ground agricultural limestone to attain a pH of 6.0 in the upper 2 inches of soil. If soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 600 lbs. per acre of 5-10-10 or equivalent. If manure is used, apply a quantity to meet the nutrients of the above fertilizer. This requires an appropriate manure analysis prior to applying to the site. Do not use manure on sites to be planted with birdsfoot trefoil or in the path of concentrated water flow.

Seed mixtures may vary depending on location within the state and time of seeding. Generally, warm season grasses should only be seeded during early spring, April to May. These grasses are primarily used for vegetating excessively drained sands and gravels. See Standard and Specification for Sand and Gravel Mine Reclamation. Other grasses may be seeded any time of the year when the soil is not frozen and is workable. When legumes such as birdsfoot trefoil are included, spring seedings are preferred. See Table 3.1 "Permanent Critical Area Planting Mixture Recommendations" for additional seed mixtures.

General Seed Mix:
[1] add inoculant immediately prior to seeding

	Variety	lbs./acre	lbs/1000 sq. ft.
Birdsfoot trefoil[1] OR	Empire/Pardee	8[2]	0.20
Common white clover[1]	Common	8	0.20
PLUS			
Tall fescue	KY-31/Rebel	20	0.45
PLUS			
Redtop OR	Common	2	0.05
Ryegrass (perennial)	Pennfine/Linn	5	0.10

[2] Mix 4 lbs each of Empire and Pardee OR 4 lbs of Birdsfoot and 4 lbs white clover per acre.

Time of Seeding: The optimum timing for the general seed mixture is early spring. Permanent seedings may be made any time of year if properly mulched and adequate moisture is provided. Late June through early August is not a good time to seed, but may facilitate covering the land without additional disturbance if construction is completed. Portions of the seeding may fail due to drought and heat. These areas may need reseeding in late summer/fall or the following spring.

Method of seeding: Broadcasting, drilling, cultipack type

STANDARD AND SPECIFICATIONS FOR MULCHING

Definition

Applying coarse plant residue or chips, or other suitable materials, to cover the soil surface.

Purpose

The primary purpose is to provide initial erosion control while a seeding or shrub planting is establishing. Mulch will conserve moisture and modify the surface soil temperature and reduce fluctuation of both. Mulch will prevent soil surface crusting and aid in weed control. Mulch is also used alone for temporary stabilization in non-growing months.

Conditions Where Practice Applies

On soils subject to erosion and on new seedings and shrub plantings. Mulch is useful on soils with low infiltration rates by retarding runoff.

Criteria

Site preparation prior to mulching requires the installation of necessary erosion control or water management practices and drainage systems.

Slope, grade and smooth the site to fit needs of selected mulch products.

Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Apply mulch after soil amendments and planting is accomplished or simultaneously if hydroseeding is used.

Select appropriate mulch material and application rate or material needs. Determine local availability.

Select appropriate mulch anchoring material.

NOTE: The best combination for grass/legume establishment is straw (cereal grain) mulch applied at 2 ton/acre (90 lbs./1000sq.ft.) and anchored with wood fiber mulch (hydromulch) at 500 – 750 lbs./acre (11 – 17 lbs./1000 sq. ft.). The wood fiber mulch must be applied through a hydroseeder immediately after mulching.

STANDARD AND SPECIFICATIONS
FOR
CHECK DAM

Definition

Small barriers or dams constructed of stone, bagged sand or gravel, or other durable material across a drainage way.

Purpose

To reduce erosion in a drainage channel by restricting the velocity of flow in the channel.

Condition Where Practice Applies

This practice is used as a temporary or emergency measure to limit erosion by reducing velocities in small open channels that are degrading or subject to erosion and where permanent stabilization is impractical due to short period of usefulness and time constraints of construction.

Design Criteria

Drainage Area: Maximum drainage area above the check dam shall not exceed two (2) acres.

Height: Not greater than 2 feet. Center shall be maintained 9 inches lower than abutments at natural ground elevation.

Side Slopes: Shall be 2:1 or flatter.

Spacing: The check dams shall be spaced as necessary in the channel so that the crest of the downstream dam is at the elevation of the toe of the upstream dam. This spacing is equal to the height of the check dam divided by the channel slope.

Therefore:

$$S = h/s$$

Where:

S = spacing interval (ft.)
h = height of check dam (ft.)
s = channel slope (ft./ft.)

Example:

For a channel with a 4% slope and 2 ft. high stone check dams, they are spaced as follows:

$$S = \frac{2\text{ ft.}}{.04\text{ ft/ft.}} = 50\text{ ft.}$$

Stone size: Use a well graded stone matrix 2 to 9 inches in size (NYS – DOT Light Stone Fill meets these requirements).

The overflow of the check dams will be stabilized to resist erosion that might be caused by the check dam. See Figure 5A.9 on page 5A.24 for details.

Check dams should be anchored in the channel by a cutoff trench 1.5 ft. wide and 0.5 ft. deep and lined with filter fabric to prevent soil migration.

Maintenance

The check dams should be inspected after each runoff event. Correct all damage immediately. If significant erosion has occurred between structures, a liner of stone or other suitable material should be installed in that portion of the channel.

Remove sediment accumulated behind the dam as needed to allow channel to drain through the stone check dam and prevent large flows from carrying sediment over the dam. Replace stones as needed to maintain the design cross section of the structures.

STANDARD AND SPECIFICATIONS FOR LINED WATERWAY OR OUTLET

Definition

A waterway or outlet with a lining of concrete, stone, or other permanent material. The lined section extends up the side slopes to the designed depth. The earth above the permanent lining may be vegetated or otherwise protected.

Purpose

To provide for the disposal of concentrated runoff without damage from erosion or flooding, where grassed waterways would be inadequate due to high velocities.

Scope

This standard applies to waterways or outlets with linings of cast-in-place concrete, flagstone mortared in place, rock riprap, gabions, or similar permanent linings. It does not apply to irrigation ditch or canal linings, grassed waterways with stone centers or small lined sections that carry prolonged low flows, or to reinforced concrete channels. The maximum capacity of the waterway flowing at design depth shall not exceed 100 cubic feet per second.

Conditions Where Practice Applies

This practice applies where the following or similar conditions exist:

1. Concentrated runoff is such that a lining is required to control erosion.
2. Steep grades, wetness, prolonged base flow, seepage, or piping that would cause erosion.
3. The location is such that damage from use by people or animals precludes use of vegetated waterways or outlets.
4. Soils are highly erosive or other soil and climate conditions preclude using vegetation.
5. High value property or adjacent facilities warrant the extra cost to contain design runoff in a limited space.

Design Criteria

Capacity

1. The minimum capacity shall be adequate to carry the peak rate of runoff from a 10-year, 24-hour storm. Velocity shall be computed using Manning's equation with a coefficient of roughness "n" as follows:

Lined Material	"n"
Concrete (Type):	
Trowel Finish	0.015
Float Finish	0.019
Gunite	0.019
Flagstone	0.022
Riprap	Determine from Figure 5B.11 on page 5B.19
Gabion	0.030

2. Riprap gradation and filter (bedding) are generally designed in accordance with criteria set forth in the National Cooperative Highway Research Program Report 108, available from the University Microfilm International, 300 N. Ree Road, Ann Arbor, Michigan 48016, Publication No. PB-00839; or the Hydraulic Engineering Circular No. 11, prepared by the U.S. Bureau of Public Roads, available from Federal Highway Administration, 400 7th Street, S.W., Washington, D.C. 20590, HNG-31, or the procedure in the USDA-NRCS's Engineering Field Manual, Chapter 16.

Velocity

1. Maximum design velocity shall be as shown below. Except for short transition sections, flow with a channel gradient within the range of 0.7 to 1.3 of this

STANDARD AND SPECIFICATIONS FOR ROCK OUTLET PROTECTION

Definition

A section of rock protection placed at the outlet end of the culverts, conduits, or channels.

Purpose

The purpose of the rock outlet protection is to reduce the depth, velocity, and energy of water, such that the flow will not erode the receiving downstream reach.

Scope

This standard applies to the planning, design, and construction of rock riprap and gabions for protection of downstream areas. It does not apply to rock lining of channels or streams.

Conditions Where Practice Applies

This practice applies where discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This applies to:

1. Culvert outlets of all types.

2. Pipe conduits from all sediment basins, dry storm water ponds, and permanent type ponds.

3. New channels constructed as outlets for culverts and conduits.

Design Criteria

The design of rock outlet protection depends entirely on the location. Pipe outlet at the top of cuts or on slopes steeper than 10 percent, cannot be protected by rock aprons or riprap sections due to re-concentration of flows and high velocities encountered after the flow leaves the apron.

Many counties and state agencies have regulations and design procedures already established for dimensions, type and size of materials, and locations where outlet protection is required. Where these requirements exist, they shall be followed.

Tailwater Depth

The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. If the tailwater depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a Minimum Tailwater Condition; see Figure 5B.12 on page 5B.25 as an example. If the tailwater depth is greater than half the pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a Maximum Tailwater Condition; see Figure 5B.13 on page 5B.26 as an example. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition; see Figure 5B.12 on page 5B.25 as an example.

Apron Size

The apron length and width shall be determined from the curves according to the tailwater conditions:

Minimum Tailwater – Use Figure 5B.12 on page 5B.25
Maximum Tailwater – Use Figure 5B.13 on page 5B.26

If the pipe discharges directly into a well defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank, whichever is less.

The upstream end of the apron, adjacent to the pipe, shall have a width two (2) times the diameter of the outlet pipe, or conform to pipe end section if used.