Town of Queensbury Stormwater Identification Project

Prepared by the

Warren County Soil and Water Conservation District

For the Town of Queensbury under the Lake George Park Commission Community Stormwater Grant Program

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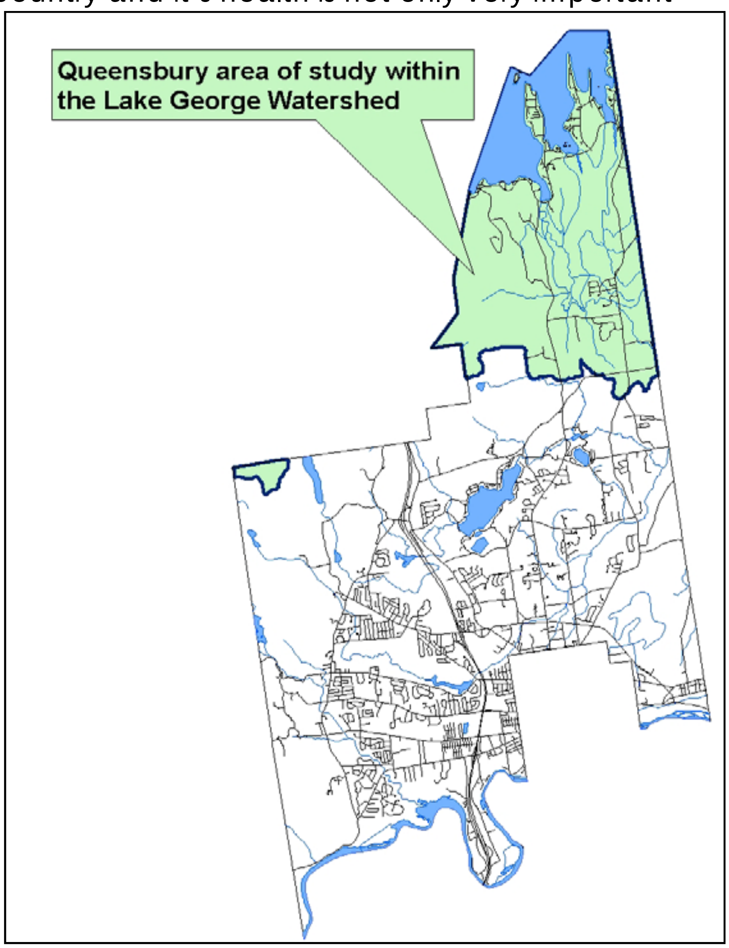
Introduction and Background

The Town of Queensbury is very active in the field of stormwater management and are advancing their water quality improvements within the watershed through the Lake George Park Commission's stormwater grant program. This project has allowed the town to examine their roadway networks in relation to stormwater runoff issues and their impacts to Lake George. Highly developed areas of Queensbury including Assembly Point, Rockhurst, and Cleverdale are located within the Lake George Watershed and border the lake, making these locations areas of concern when it comes to stormwater runoff impacting the lake. This project's scope was to identify areas of concern from the roadways that may impact water quality, and assign recommendations to the highest priority areas that could have potential solutions.

The Town of Queensbury worked with the Warren County Soil and Water Conservation District, who has extensive experience in stormwater runoff assessments and retrofitting techniques. The project consisted of a review of the stormwater runoff and conveyance system from the town, county and state roads within the Lake George Watershed. This assessment resulted in the determination of stormwater retrofit projects and opportunities in locations of high priority in terms of stormwater runoff volume reaching the lake. This project allowed the town to prioritize their stormwater issues with the most cost effective solutions to improve the water quality in Lake George. Lake George is one of the most pristine lakes in the country and it's health is not only very important from an ecological point of view, but also from an economical point of view for the Town. The heavily populated communities around Lake George depend on water quality for drinking water and economic value, making stormwater runoff and its impacts to the lake a priority to understand and correct, and maintain a high water quality.



Location

The Town of Queensbury is located in the southeast corner of Warren County. This location also happens to be the southeast corner of the Lake George Watershed. Queensbury's northwest town line borders the Town of Lake George and southern town line borders Saratoga County. Assembly Point, Rockhurst, and Cleverdale are the most northern points of the Town of Queensbury that extend into Lake George as small peninsulas.

Stormwater Runoff

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

Stormwater outfall entering trout stream during a rainfall event

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, 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 the lake, 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 waterbodies, 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 the largest water quality impact in the Lake George Watershed. This report will provide the Town of Queensbury the ability to identify opportunities to address stormwater issues and their impacts within the Lake George watershed.

Soils

A group of soils having the same runoff potential under similar storms and cover conditions are considered to be a *Hydrologic soil group*. Hydrologic soil groups are used in equations that estimate runoff from rainfall. The soil properties that influence runoff potential are those that cause a minimum rate of infiltration for an unfrozen bare soil after prolonged wetting. The soils of the U.S. are placed into four groups, A, B, C, D. Definitions of the classes are as follows:

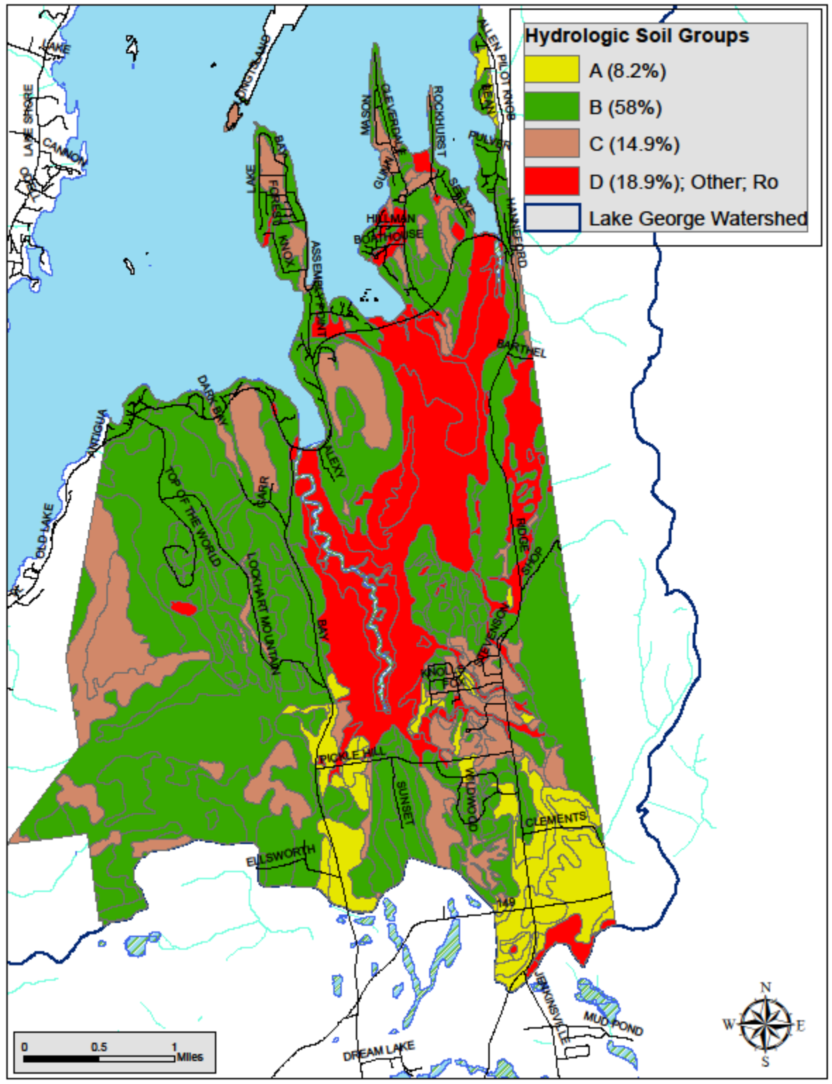
A- Soils with low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well drained to excessively well-drained sands or gravels.
B - Soils having moderate infiltration rates even when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures.
C- Soils having slow infiltration rates even when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures.
D - Soils with high runoff potential. Soils having very slow infiltration rates even when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.
(*From www.nesoil.com*)

To identify hydrologic soil types in the Lake George Watershed portion of Queensbury, the watershed boundary was superimposed onto a Geographic Information System soils layer developed from the United States Department of Agriculture Soil Survey created in 1986. The majority of soils (approx. 58%) within the watershed are Hydrologic Soil Group B.

Hydrologic Soils Group	Watershed %	Within 1/4 mile of the shoreline by %
A	8.2	1.5
B	58	65.1
C	14.9	18.4
D	18.9	15.1

A significant amount of development is found within ¼ mile of the Lake George shoreline. If you evaluate the soils within this area, you will find that "B" soils represent 65.1% and "C" soils make up 18.4% of the remaining land area. Development can alter soils in many ways: soil compaction, loss of topsoil, increase of impervious areas and altered drainage patterns are but a few of the ways that soil can be affected. All of these can certainly cause water quality issues and can result in negative impacts to the environment. It is only careful planning that erosion and sedimentation may be avoided.

All soil types can cause water quality concerns, erosion and sediment issues if treated and used improperly. However, B and C soils can be very beneficial in development (road construction, house sighting and septic systems) and natural resources (farming, forestry improvement). These soils types are more flexible in their uses than the "A" or "D" soils, which can be highly erodible and can cause issues when utilized for a septic infiltration bed. Having slightly more than 83% of the soils within ¼ mile of the shoreline being a B or C, means that one can focus on the remaining 16.6% of land to look at and prioritize any potential areas of concern.



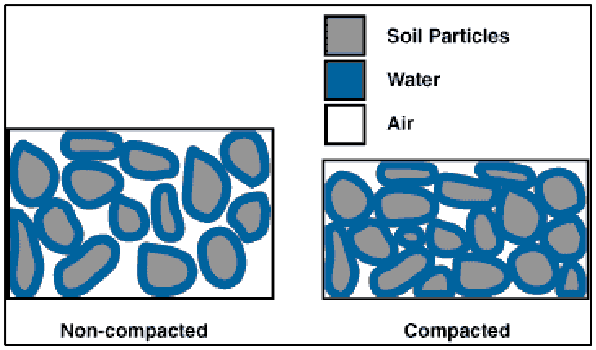
Research suggests that the predominate soils (sands and sandy loams) from this section of Queensbury are less impacted and are more successfully remediated from compaction than soils with silt as a major component (Source: University of Minnesota, http://purl.umn.edu/5607). However it appears that most remediation involves deep tillage techniques, which may work in and around developments, but not necessarily along roadsides, due to the narrowness of road shoulders.

The topographic characteristics of the Lake George watershed along with the native soils are what created the lake as it is today. Direct precipitation accounts for approximately a quarter of the water in the lake, another 18% comes through ground water infiltration and a little over half is contributed by it's tributaries (Shuster, E.L. 1994 Ph.D Thesis, Rensselaer). Thus, over three quarters of the water in Lake George either passes over or through the native soils on its way to the lake. Approximately 1.5% of the Lake George watershed is now paved roads and estimates of developed land (high and low impact development) vary widely from as low as 5% to newer numbers approaching 25%. It is critical that soils be understood to reduce the likelihood of failure from improper uses. It is very easy to lose this vital resource, and even easier to develop negative impacts from the improper use of the site specific soil.

Another item of importance is soil productivity. All soils have some nutrient levels of the elements that are required for plant growth. However levels can vary dramatically based on soil type, prior use and current land use. In order to determine what levels of nutrients are in the soil, a soils test should be performed in locations that will be acting as a buffer for stormwater. Generally an analysis will include Phosphorus, Potassium, Nitrogen and macronutrients necessary for plant growth and survival.

If you are interested in detailed soil information, you may obtain it at your county Soil and Water Conservation District office or on line at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

Soil Compaction



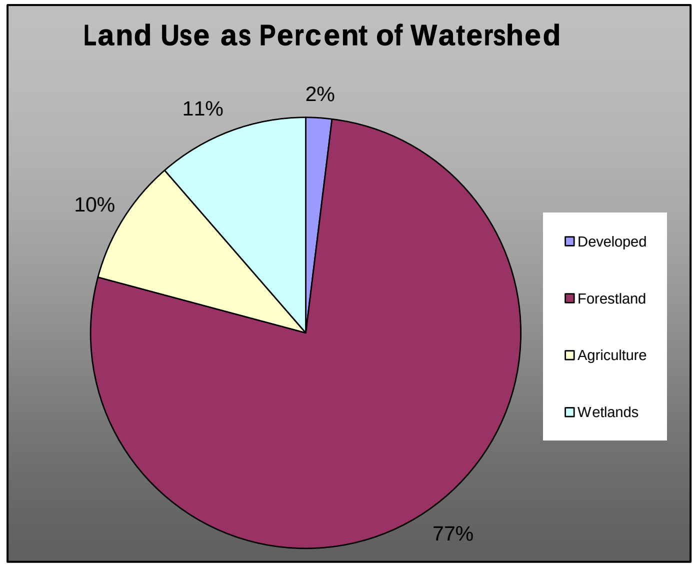
Simply stated, soil compaction "*occurs when soil particles are pressed together, reducing pore space between them. Heavily compacted soils contain few large pores and have a reduced rate of both water infiltration and drainage from the compacted layer. This occurs because large pores are the most effective in moving water through the soil when it is saturated. In addition, the exchange of gases slows down in compacted soils, causing an increase in the likelihood of aeration-related problems.*" (Source: University on Minnesota, Extension, www.extension.umn.edu/distribution/cropsystems/components/3115s01.html#section1).

Traditionally when land has been developed, the impact on soils has not been a major factor in the decision making process. This is a critical oversight as stormwater runoff may be increased from a construction site due to compacted soils and can have significant impacts that will require retrofitting activities in the future. The best option to prevent soil compaction and subsequent impacts would be proper planning and the development of a construction sequencing of a work site that includes identified areas in which machinery should be restricted and remedial plans for addressing the impacted areas.

Queensbury/LG Watershed Shoreline
Courtesy of Google Earth 2013

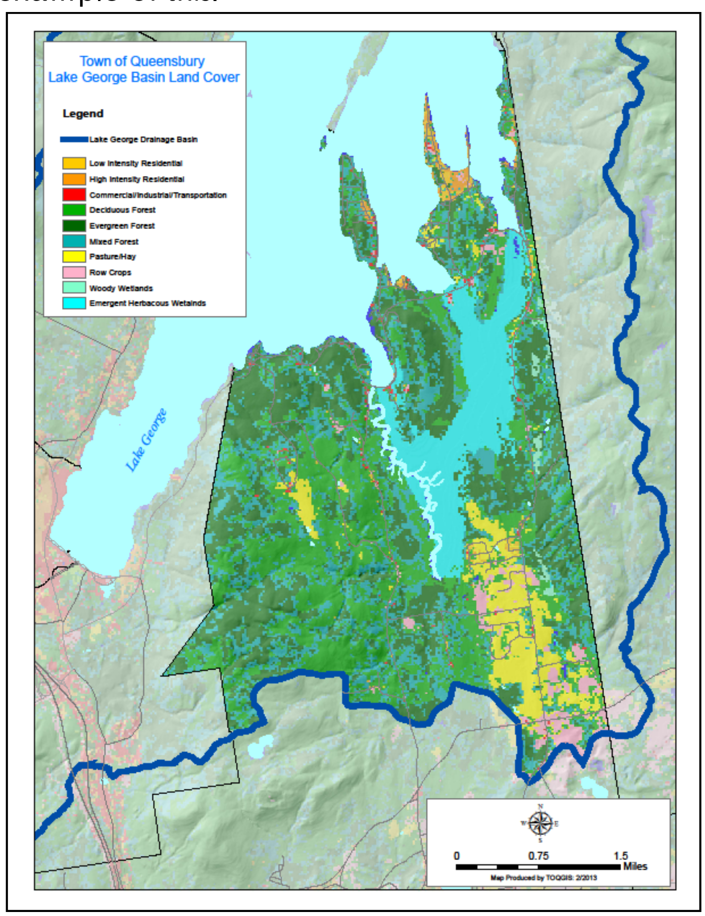
Land Use and Development

In all watersheds, land use plays a tremendous role in the quality of water which runs off into a waterbody. In undeveloped watersheds where no human activity is present, waterbodies are not exposed to stormwater runoff from development activities, fertilizers from homes and golf courses, or sediment from construction or logging operations. These undisturbed lakes and streams tend to be pristine and high quality, generally with excellent clarity.



While this would seem to be the ideal condition for our lakes and streams, it is not a realistic or even a practical condition for most lakes with privately held land ownership surrounding the shores. We all live, work, and recreate in a watershed and rates of development around lakes and ponds often exceeds other locations. Land development activities can have a significant effect on the quality of water which flows into nearby waterbodies. However, even with this development, there are many lakes which maintain excellent water quality and a well rounded ecosystem. Schroon Lake, with its moderate levels of development and history of good stewardship, is a very good example of this.

To understand the land use within the approximately 8,700 acre watershed, 2001 land cover satellite imagery and data was utilized (most recent available). This data was developed by the US Geological Survey. Although this land use/land cover data is from 2001, it is still felt to be representative of current conditions within the watershed.
The predominant land cover within the Queensbury's Lake George Watershed is forest land at seventy seven percent. Having a vast majority of the land being undeveloped forest is a benefit to the water quality. Forests allow for increased infiltration of water, low levels of erosion, recycle nutrients efficiently, and help to reduce temperatures to streams that feed lakes and ponds. Unlike developed and impervious areas, the rate of water runoff from forest land is extremely low, which reduces the impact of stormwater runoff. In this watershed, there are large sections of both deciduous forest (maple, beech, birch, etc), and evergreen forests (pine, hemlock, balsam fir, etc).



Map and data interpolation courtesy of Town of Queensbury GIS

Eleven percent of the land is considered wetland. Wetlands are commonly recognized for their benefits that include: pollutant reduction, flood mitigation and habitat for many fish and wildlife species. Ten percent of the land is classified as agriculture and comprises mainly open fields (open land habitat), the remaining two percent is classified as developed. This includes residential, commercial and industrial development, plus transportation corridors such as roads and highways. While the overall development rates in the watershed are very low, the percentage of shoreline development in the area is another story. An analysis of the land cover data reveals that almost 73% of the development within the watershed is found within a quarter mile of the lakeshore which is 36 times greater than the overall watershed development rate. This is critical to understand when dealing with nonpoint source pollution.

This concentration of development around the lake itself is no surprise, as lakes are a natural draw for both residential and tourist-related development activities. This type of development often poses inherent stresses on lakes, due to increased concentrations of urbanized stormwater runoff, pesticides, herbicides, road de-icing materials, pet wastes, and other pollutants. Compounding this issue is that when most of the development took place, there were few standards for stormwater runoff or erosion control. As such, much of the runoff from these properties discharges to a road drainage network which outlets into the lake or stream.

Given this trend, the need for appropriate development practices around Lake George is exceedingly important. The role of the Queensbury planning and zoning boards is vital to the long-term quality of Lake George. While residential and commercial development activities are a mainstay of economic growth in the region, these activities should be held to a high standard in the review process regarding their long-term potential impact to the lake. As our population and economy grows, land development within our watersheds will inevitably increase as well. We must take heed of how our actions can affect our surrounding environment, and work to minimize those impacts. With diligence and regard for environmental considerations at both the individual and municipal levels, we can continue to have responsible land development and economic growth while greatly reducing the harm done to the natural resources we so heavily rely upon.

Road De-icing Practices

Stormwater runoff in the Lake George Watershed is one of the highest priorities due to the pollutants stormwater carries to the waterbodies. Road de-icing practices (salt and sand) are a necessity for transportation safety, but also affect water quality when carried to a waterbody through stormwater conveyance. Within the Lake George Watershed portion of the Town of Queensbury, there are 42.9 lane miles of road that require de-icing practices during winter storm events. These de-icing practices vary between town, county, and state roads. The Town of Queensbury uses 50% salt and 50% sand mixture on the 29 miles of town roads. Warren County and NYS Department of Transportation (DOT) use salt only. Warren County maintains 3.4 lane miles and NYS DOT maintains 10.5 lane miles within the Lake George Watershed portion of Queensbury. Another factor of road de-icing is temperature during the storm event. A 15° to 23° storm event requires a higher application rate of de-icing materials as opposed to a

23° to 32° storm event. For example a 32° snow storm may require only 125 Lbs of de-icing materials per lane mile, and a 15° snow storm may require 325 Lbs of de-icing materials per lane mile. The chart below represents an average of sand and salt application rates.

Average Deicing Material in the Lake George Watershed Portion of the Town of Queensbury				
Roads	**Lane Miles**	**Pounds salt/sandper lane mile**	**Total Lbs of Salt**	**Total Lbs of Sand**
Town Roads	29	100/100	2900	2900
Warren Co. Roads	3.4	200/0	680	0
NYS Roads	10.5	195/0	2047.5	0
Total Per Storm	42.9		5627.5	2900
	Total Average De-icing Materials Per Storm 8,527.5 Lbs			

Advancements and awareness in road de-icing practices and stormwater treatment are becoming a major part of municipal duties. Treated salts are available now that de-ice faster at colder temperatures allowing for a lower application rate on roads. A lower salt application rate directly results in lower stormwater contamination from road runoff. Both Warren County and the NYS DOT have used treated salt, but their state contract controls whether or not the county and state are able to purchase the treated salt. Another advancement is the DICKEY-john snowplow sander controller. The Town of Queensbury trucks have be equipped with DICKEY-johns allowing the operator to program a set application rate of de-icing materials. Once programmed, the flow of de-icing material automatically adjusts depending on ground speed, allowing the applications rates to remain uniform at all speeds. Queensbury recycles the sand cleaned from their sediment basins, drywells, and street sweepers, preventing additional sediments from entering stormwater and eventually a waterbody. Additional stormwater retrofit systems resulting from this report and the Town of Queensbury will continue to assist in preventing sands used in de-icing materials from entering waterbodies within the Lake George Watershed, but do not effectively address the salts used. Salts dissolve in stormwater causing increases in stream and lake salinity.

Assessment Methodology

This report is a comprehensive stormwater examination of the roadway network in the Town of Queensbury. This consisted of a review of the stormwater runoff from the conveyance system along all town roads within the Lake George Watershed as well as detail cost effective recommendations that will reduce stormwater pollutants and sediment input to Lake George.

District staff used Geographic Information System ArcView 9.3 (GIS) to assist with mapping of the town 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 in the Town within the Lake George 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 waterbody, inlets that receive significant amounts of stormwater runoff from the roadway network and roadside ditch erosion to the conveyance system.

Stormwater Mapping and Retrofit Recommendations

Southern Watershed

Pickle Hill Roadside Drainage

Approximately 400 feet of Pickle Hill Road drains to an unnamed tributary of the Lake George Watershed. This location drains from west to east causing stormwater to collect and deposit sediments at the stream crossing due to the low point in the topography. Pickle Hill Road crowns in the center draining roughly 4000 square feet of roadside drainage to the stream.

Pickle Hill Road

Recommendations:

Depending on depth to bedrock, depth to water table and soil types, a 4'x8' drywell will catch and infiltrate the first flush of stormwater (containing the highest concentration of pollutants) and allow sediments to settle out before running off into the stream. A drywell in this location will also assist in reducing the amount of thermal pollution in the stream resulting from super heated stormwater running off the asphalt road during the summer months. One drywell could certainly handle a 1/2" storm for this section of road. Runoff from a 1/2" storm on this section of Pickle Hill Road would be 1,247 gallons and a 4'x8' drywell has the volume capacity of 1,503 gallons. A 1" storm can be captured with a double stack drywell or two drywells side by side, if site location constraints allow. An infiltration system able to handle a 1" storm in Warren County will capture 90% of stormwater pollutants and events. If bedrock is a limiting factor, a vegetative swale with check dams may serve as the best alternative. Benefits of vegetated swales are, cost effective, allows for stormwater infiltration, removal of roadside pollutants, and reduces stormwater velocity.

Bay Road

Just north of Pickle Hill Road on Bay Road is a culvert that conveys a significant amount of water to an unnamed tributary of Lake George. At this location, Bay Road is constructed to drain to the west side of the road and stormwater is conveyed to the lowest point, being the stream flowing through the culvert under Bay Road. Paved swales along the west side of Bay Road increase stormwater volume and velocity outletting directly to the stream at the culvert location.

Recommendations:
The best way to deal with stormwater in a watershed is to break it up by retrofitting sections to prevent runoff into a waterbody through infiltration. The recommendation for this location is two 4'x8' drywells north and south of the culvert on the west side of Bay Road. The drywells will collect sediments, and infiltrate stormwater minimizing stormwater pollutants from entering the stream and eventually flowing to Lake George. Also, with further planning in this location, vegetated swales may be another possibility to reduce stormwater pollutants and velocity during conveyance.

Bay Road

Bay and Lockhart Mountain Road

The intersection of Bay and Lockhart Mountain Road receives a significant amount of stormwater from both roads. As seen in this photo, stormwater settles in this location and drops a significant amount of sediment. During a large storm event, the deposited sediment will continue to flow approximately 600 feet south to the tributary crossing at the Bay road culvert discussed in the previous section. The stormwater conveyance south of the intersection of Bay and Lockhart Mountain Road to the tributary is constructed of vegetated swales with no issue, and paved swales that increase stormwater velocity and sediment transportation. Paved swales increase stormwater velocity due to the impervious surface preventing infiltration, and the channelized flow prevents sheet flow which also concentrates stormwater runoff.

Bay and Lockhart Mountain Road

Recommendations:
An infiltration system (dry well) in this location will break up the stormwater runoff and the collection of sediments and pollutants from entering the tributary to the south on Bay Road. By replacing the paved swale with vegetation, a significant improvement in stormwater conveyance will be achieved through decreased velocity and increased infiltration. Another benefit of increased infiltration aside from a cleaner, healthier watershed, is groundwater recharge. It is important to replenish groundwater because like all reservoirs, if they are not recharged, water is used and depleted, leading to a drop in the water table. Ground water is also an important water supply for our streams, lakes, rivers, and wetlands.

Lockhart Mountain Road

A quarter mile north of the Bay and Lockhart Mountain Road intersection on Lockhart Mountain Road is an 18" corrugated metal culvert that drains to an unnamed tributary of the Lake George Watershed. Approximately 700 feet of roadside drainage flows to this tributary. The majority of the this stormwater conveyance consists of vegetated swales.


Lockhart Mountain Road

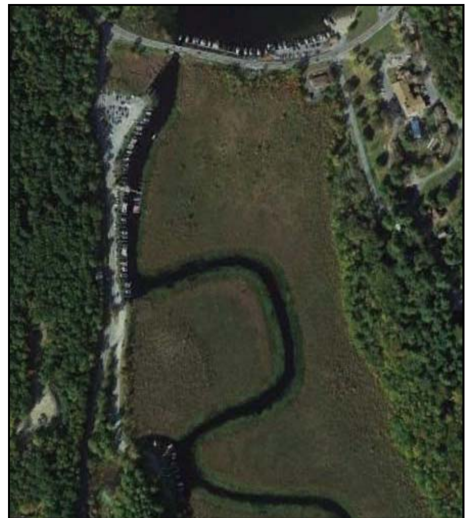
Recommendations:
Vegetated swales are ideal conditions except the steep topography in the area creates high velocity runoff enabling transportation of sediments through the vegetation. Check dams installed in the vegetated swales are an economical fix that will slow stormwater velocity allowing the sediments to settle out behind the dams which also allows for ease of maintenance. A careful analysis of this drainage and road elevation would be needed as to not cause road flooding during extreme rainstorm or snowmelt events. Also, depending on soil types, a drywell placed north of the culvert will capture large amounts of sediments including the first flush of stormwater containing high amounts of pollutants including de-icing materials and petrochemicals.


Intersection of Bay and Woodchuck Hill

Bay and Woodchuck Hill Road
Approximately 50 feet south of the Bay and Woodchuck Hill Road intersection is a culvert stream crossing under Bay Road. A 1,000 foot section of Woodchuck Hill Road drains to this intersection. While GPS mapping and collecting data, the sediment built up from roadside drainage was clearly visible as an area of concern (photo on left). The sediment build up results from a slowdown and disbursement of stormwater allowing sediment to settle out on the level topography of Bay Road in this location. During larger storm events, stormwater is able to build up high velocities flowing south on Woodchuck Hill, enabling it to carry sediments and other pollutants to the unnamed tributary of Lake George running under Bay Road. This unnamed tributary, similar to the majority of the Lake George Watershed tributaries, is a NYS Department of Environmental Conservation classified AA-S stream. One of the best usages for a classified AA-S stream is drinking water and must be held to the highest standards when is comes to overall stream health.

Recommendations:
The ideal retrofit for this location would include the installation of a 4'x8' drywell north of the stream and on the west side of Bay Road. Barring construction location constraints, it should be located at the confluence of stormwater from Woodchuck Hill and Bay Road. To pinpoint this location, there would need to be further research and

a survey of the area. If all factors work in favor of infiltration, the retrofit would maximize the amount of stormwater captured, resulting in a healthier stream/ Lake George Watershed.



Dunham's Bay Marina Parking Lot
Courtesy of Google Earth 2013

Dunham's Bay Marina Parking Lot

The Dunham's Bay Marina parking lot is located at the intersection of Bay and 9L (Ridge Road). The parking lot has a large wetland and tributary to Lake George located on the east side and spanning the entire length of the lot. Due to the high water table in this location, stormwater infiltration would not be feasible because of the lack of treatment.

Recommendation:

The recommended retrofit would be to break up the stormwater runoff around this area or direct conveyance away from the stream and wetland. Vegetated swales built to capture and convey roadside drainage along with vegetated buffers between the parking lot and edge of stream would assist in reducing stormwater runoff into the wetland and stream. Since this is a private business, the landowner would need to be contacted and an agreement reached prior to any type of design draft development.

Lockhart Mountain Road (southeast of 9L)

Lockhart Mountain Road
(Southeast of 9L)

The intersection of Lockhart Mountain Road and 9L receives a significant amount of stormwater and de-icing material. Lockhart Mountain road drains 800' of road north through vegetated ditching to 9L. This section of Lockhart Mountain Road has very steep slopes requiring large amounts of de-icing materials, to keep the road safe for travel, and are deposited west on 9L ditching.

Recommendation:

The ditching on the west side of the intersection of 9L and Lockhart Mountain Road is in need of maintenance due to the significant amounts of material deposited in this location by stormwater. The installation of check dams in the ditch intersection will slow stormwater allowing sediments to be deposited adding to ease of maintenance. Areas behind the check dams collect the sediments and need to be cleaned out as opposed to the entire ditch needing maintenance.

Dunham's Bay Road Outlet

The Dunham's Bay Road outlet is located a quarter mile east from the intersection of Bay Road and 9L. The outlet collects stormwater from 9L and Dunham Bay Road where it discharges directly to the lake. Because there are several drainage areas that combine in a relatively small area, we split up the sections into two: Dunham's Bay Road and 9L. The 9L section of this drainage is not a top priority because it is conveyed through vegetated swales along 9L, but it is still may be an area of concern due to the direct discharge to Lake George and the fact that it is a state route.

Intersection of 9L and Dunham's Bay Road

Dunham's Bay Road drains to a drop inlet at the bottom of the road slope that discharges directly to Lake George. During this report, the Town of Queensbury was planning on repaving this road and asked for any potential water quality improvement projects. The town installed a stone lined trench along the roadway, where feasible to reduce stormwater velocities and allow sediment to drop out of suspension. Infiltration may not be ideal as there is bedrock in this area. 9L drains 315' of road south through mostly paved ditching to Dunham's Bay Road. In this location, the entire 20' width of 9L is paved to drain to the west side of the road which receives 3,927 gallons of stormwater during a 1" storm.

<u>Recommendation:</u>
The use of a rock lined infiltration trench is probably the most feasible retrofit that would assist in reduction of sediments to Lake George and ease of maintenance. Ideally, a drywell to capture and infiltrate stormwater would be the best recommendation in this location (Qsby. Highway Dept. installed trench in 2012).

Assembly Point

The majority of Assembly Point's stormwater conveyance system is constructed of outdated and under designed structures. This is primarily due to depth to bedrock. Test pits and additional research and surveying would be necessary to determine the feasibility of another type of retrofit solution.

Intersection of Sunset Lane and Assembly Point Road

Assembly Point Road and Sunset Lane

There are two drop inlets located at the intersection of Sunset Lane and Assembly Point Road that receive 150' of roadside runoff from Sunset Lane. Stormwater draining to these drop inlets continues to flow east and is conveyed through a 12" corrugated metal pipe directly to Lake George. The entire 24' wide road is capture by the two drop inlets that receive

2,244 gallons of stormwater during a 1" storm. Sunset Lane also receives heavier amounts of de-icing materials necessary to keep travel safe due to the steep slope of the road.

Recommendation:
A drywell retrofit on the north side of the intersection of Sunset Lane and Assembly Point Road would prevent a significant amount of stormwater from draining to Lake George. An infiltration system in this location would capture roadside pollutants (salts, sands, petrochemicals) and also assist with groundwater recharge. The feasibility of this project depends on site constraints such as, depth to bedrock and groundwater near the intersection.

Intersection of Knox Road and Assembly Point Road

Knox Road and Assembly Point Road
Another outfall to Lake George is located at the intersection of Knox Road and Assembly Point Road. This intersection receives approximately a 150' of stormwater runoff from Knox Road and is conveyed through a 12" corrugated metal pipe east across Assembly Point Road to an outfall at the lakes edge.

Recommendation:
Depending on site constraints in this location, Knox Road has a good location for a drywell and infiltration chambers shown on the right hand side of the photo on the right. This intersection has the space for an infiltration system but a test pit is needed to check the soils and groundwater.

Mason Road location

Cleverdale, Rockhurst & Pilot Knob

Mason Road
Mason Road located off Cleverdale Road currently has a drop inlet that conveys stormwater from roadside drainage to a 12" shallow corrugated metal culvert leading directly to Lake George. From the drop inlet on Mason Road, the pipe runs 100' under the road where it flows into the pipe of concern that discharges it directly to the lake.

Recommendation:
By replacing the corrugated metal pipe with a corrugated perforated pipe, it will allow storm-

water to infiltrate out reducing the input into the lake and recharging groundwater. Another possible retrofit would be a shallow vegetated swale with check dams to slow the velocity of stormwater and allow sediments to settle out behind the dams. The DEC recognizes that successfully developing a vegetative cover will reduce sediment inputs by up to 90%. A general seed mix that works successfully in the Lake George Watershed is comprised of creeping red fescue, Kentucky bluegrass, chewing's fescue, and perennial ryegrass. It is also advisable to add annual ryegrass, which will germinate quickly for short term vegetated cover, die and decompose supplying a higher organic load to the area.

Pilot Knob Road

A culvert located on Pilot Knob Road outlets to the west side of Pilot Knob Road, down to Pulver Road. The water flows under Pulver Road and into a riparian area of the lake.


Pilot Knob Drainage
Across Pulver Road

Recommendation:

There is really no ability to mitigate stormwater on Pilot Knob Road, however between Pilot Knob Road and Pulver Road a detention basin may be installed to allow sediment to drop out of suspension, prior to the water draining to the lake. This appears to be on private property and would need landowner approval. There may not be much infiltration available at this location due to the high water table, so a practice that captures or settles sediment may be the only option.

Allen Road

A drop inlet located northeast of Kattskill Bay on Allen Road, has a direct outfall to Lake George. The drop inlet conveys stormwater through a 15" HDPE pipe to the lake. Allen Roads drains 200' of road from the south and 300' of road from the north to the drop inlet. The entire 18' width of the road flows to the east side vegetated ditching draining 5,610 gallons of stormwater during a 1" storm.


Allen Road

Recommendation:

The recommended retrofit for this location would be a rock lined ditch on the east side of the road or an application of porous pavement. A rock lined ditch would slow the stormwater flow allowing for suspended solids to drop out and infiltration. Porous pavement would have a similar results, however there will likely be more maintenance needed in the spring and fall. Porous pavement this section will need to be vacuumed to remove fine material that has become embedded in the pavement.

Other recommendations:

The Assembly Point, Cleverdale, Rockhurst and Pilot Knob Road areas are of particular concern due to proximity of the development to the lake. The Queensbury Highway Department has been active in attempting to remediate stormwater runoff and erosion controls when the site allows. However as noted in the specific recommendation sections, these areas are limited by existing development, narrow town right of ways, soil depth, and the high amounts of impervious areas in relation to the land mass.

Landowners should be made aware that they will play a critical role in reducing water quality impacts to the lake. Many of the properties in these areas drain to a road network which adds to an unmanageable situation for the town with the land constraints. Encouraging property owners to consider on-site stormwater management will be one of the most important options available for reducing stormwater runoff and non-point source pollutants. This will be dependant on the existing site conditions including depth to bedrock, water table, location of septic systems, vegetation and setback requirements. As the Town continues to do improvements to the infrastructure, it would be a benefit to utilize existing and newer technologies for stormwater management if feasible, rather than just getting the water off the road as soon as possible.

The Town of Queensbury should encourage anyone redeveloping in these areas to look at green infrastructure techniques or infiltration when feasible. The Fund for Lake George has a "*Do-It Yourself Water Quality Guide*" and the Lake George Association has a booklet "*A Homeowner's Guide to Lake Friendly Living"* that are for landowners and include many simple techniques for reducing impacts to Lake George. They are available at various municipal office or at the Fund and LGA.

It is important to note that even though there are identified prioritized work areas, there are numerous outfalls and stormwater structures that transport stormwater into the lake that have been identified in this report. There are in some instances, culverts that flow from wetlands and wet areas to the lake as well. If a culvert is flowing from a wetland, unless an analysis of the outflow is conducted, it is impossible to say whether the wetland is acting as a nutrient sink or sump. In order to collect this data the Town of Queensbury should work with the landowners or lake groups to develop an access agreement.

At a minimum, in order to address all stormwater runoff from these roads: complete road topographic surveys, test pits for potential infiltration locations, a road safety analysis and an analysis of all residential stormwater inputs would need to be done. Is this a feasible action at this time? Most likely the answer is no, which is why site specific areas of concern that have the potential for being corrected are identified. Management of existing stormwater and nonpoint source pollution in Lake George is a remedial effort due to the fact that many laws or ordinances were not in place for many of the structures that were built along the shoreline. This will be a continuing process of adjustment as development continues and our weather patterns change. We will see impacts to the watershed that will influence our management and development strategies.

Conclusions

The Town of Queensbury can further its progress in stormwater management within the Lake George Watershed by following the recommendations within this document. The town may be limited in its abilities to deal with stormwater, so true progress may need to come from the willing hand of a landowner. On the heavily developed peninsula's there is little room for effective retrofits within the roadways due to their proximity to the shoreline and its shallow depth to bedrock. As discussed previously in the report the key to minimizing the impacts of stormwater is to reduce the watershed areas into treatable sizes and utilize multiple techniques instead of always looking at an "end of pipe" solution. It is imperative to understand that the best way to address nonpoint source pollution issues will be for landowners, lake groups, community organizations and municipalities 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.

It is also imperative that these groups present their concerns as a unified front to the NYSDOT regional and central offices and Warren County Department of Public Works and try to develop solutions with them on their roads. This has been attempted in the past, however there has been some reluctance, mainly due to a lack of available funding opportunities. With the installation of Warren County's Beach Road Porous Pavement Project and the NYSDOT's reduction in salt usage (10-15%) there looks to be an opportunity to have frank discussions with them to resolve these resource issues.

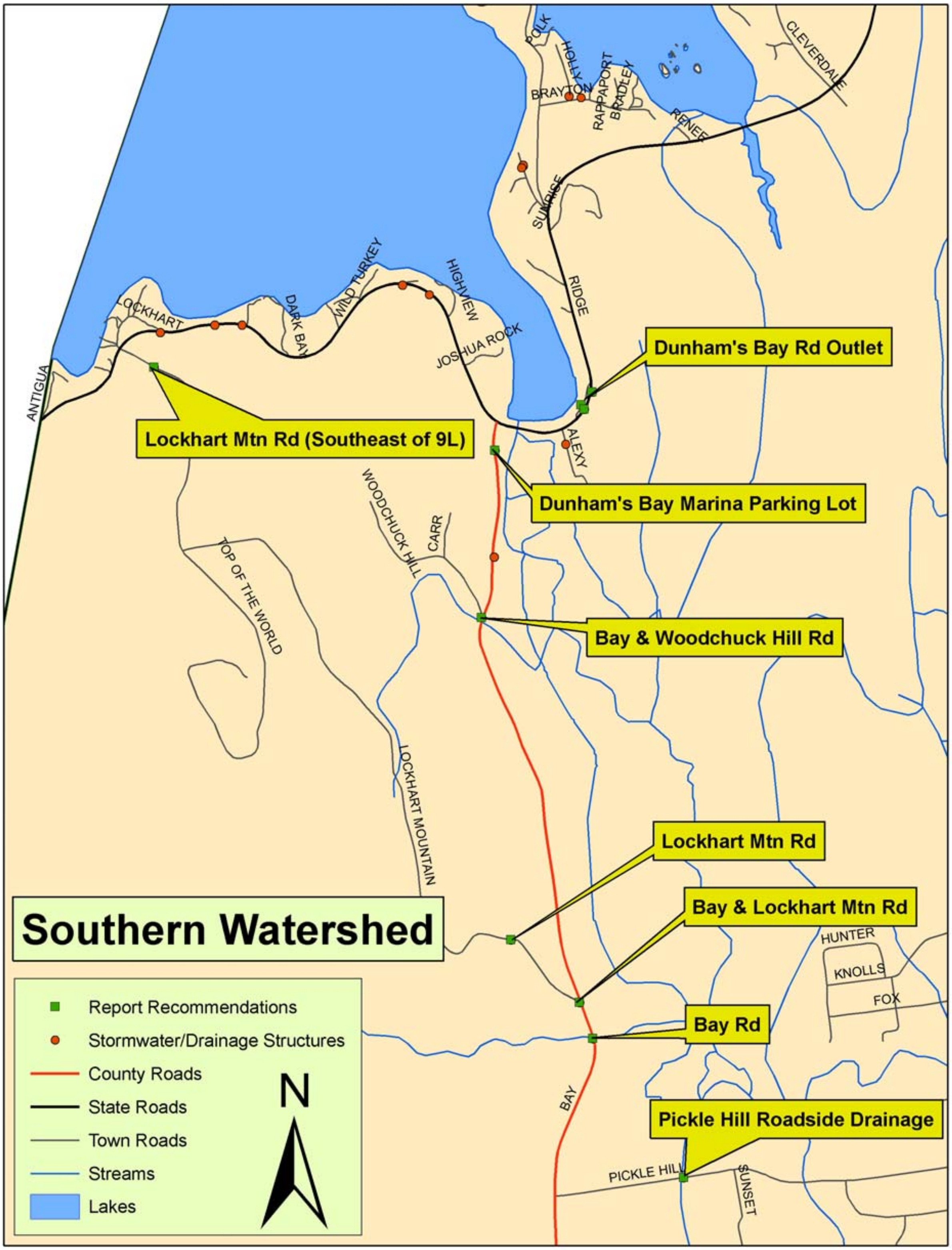
Lake George needs everyone to work together to survive for another 10,000 years.

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 - Southern Watershed

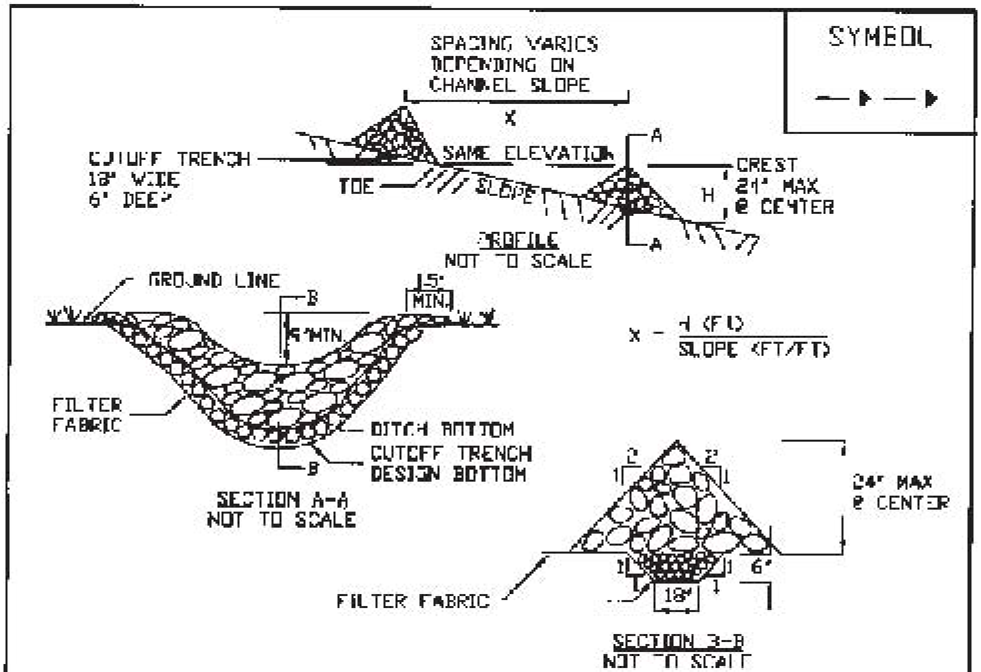


Map 2 - Assembly Point

Map 3 - Cleverdale, Rockhurst & Pilot Knob

Design 1 - Check Dam Specifications: Courtesy of the NYS DEC Standards and Specifications for Erosion and Sediment

Figure 5A.9
Check Dam



CONSTRUCTION SPECIFICATIONS

1. STONE WILL BE PLACED ON A FILTER FABRIC FOUNDATION TO THE LINES, GRADES AND LOCATIONS SHOWN IN THE PLAN.
2. SET SPACING OF CHECK DAMS TO ASSUME THAT THE ELEVATIONS OF THE CREST OF THE DOWNSTREAM DAM IS AT THE SAME ELEVATION OF THE TOE OF THE UPSTREAM DAM.
3. EXTEND THE STONE A MINIMUM OF 1.5 FEET BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM.
4. PROTECT THE CHANNEL DOWNSTREAM OF THE LOWEST CHECK DAM FROM SCOUR AND EROSION WITH STONE OR LINER AS APPROPRIATE.
5. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE.

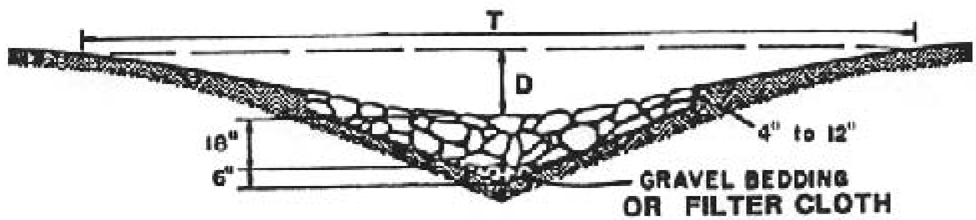
MAXIMUM DRAINAGE AREA 2 ACRES.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE	CHECK DAM

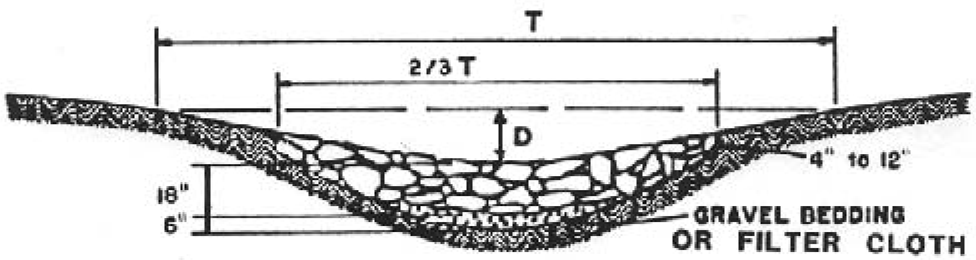
New York Standards and Specifications For Erosion and Sediment Control — Page 5A.24 — August 2005

Design 2 - Grassed Waterway: Courtesy of the NYS DEC Standards and Specifications for Erosion and Sediment

Figure 5B.8
Typical Waterway Cross Sections



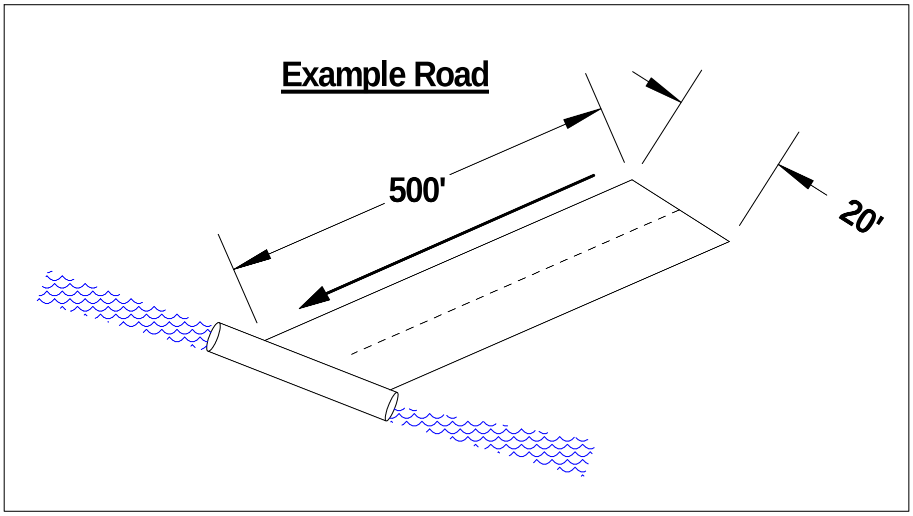
Waterway with stone center drain. "V" section shaped by motor grader.

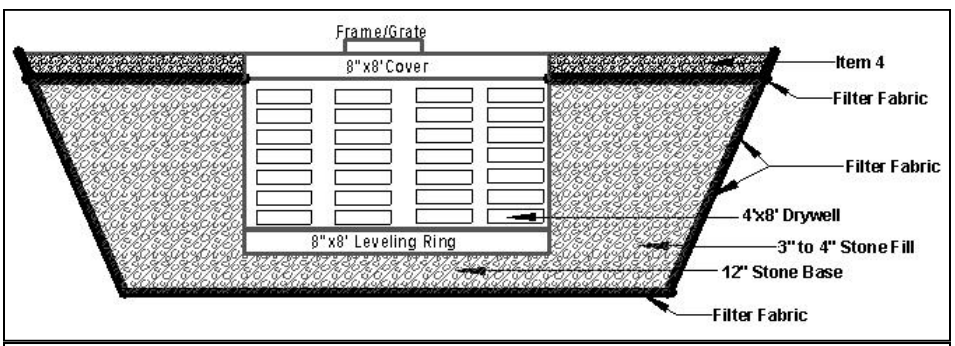


Waterway with stone center drain. Rounded section shaped by bulldozer.

Typical Roadside Treatment Calculation

Example Road drains 500' of length and 20' of width to the low point in the topography. The low point in Example Road is a culvert with a stream flowing under the road. This section of Example Road drains 500' x 20' = 10,000 square feet of road drainage. To calculate volume of stormwater in a 1" storm divide 10,000 sq ft by 12" and you get 833 cubic feet which converts to 6,231 gallons of stormwater draining to the stream.





Cross section of a typical 4' x 8' Drywell