CASPIAN LAKE FEEDER STREAM STUDY

(1)
BACKGROUND

Over the years a great deal of study and effort has been undertaken to preserve the water quality and natural beauty of Caspian Lake. This investment has reaped rich rewards; Caspian remains one of Vermont's cleanest and most scenic lakes. (See Appendix 15, ANR's Caspian Lake scorecard.)

However, over that same period of time very little coordinated study has been conducted to evaluate the health of Caspian's arteries: the small brooks and streams which feed into the lake. If these streams were to substantially degrade, the lake itself would be placed at risk.

Sensing this void, the Greensboro Land Trust formed a committee in the late fall of 2012 to study the health and ecology of the streams which feed into Caspian Lake, and to determine what action, if any, might be appropriate for the Land Trust or others to take regarding these streams. The committee, which consisted of Rick Yeiser, Lee Wright, Linda Shatney, Clive Gray and Andy Dales met a number of times over the winter, spring and summer of 2013, and consulted with several private and public sources to gather information. These included:

Lydia Menendez, Assistant Director of the Vermont River Conservancy, who talked to the committee about various strategies for maintaining and improving stream quality.

Len Gerardi and Jud Kratzer, Regional Fisheries Biologists for the Vermont Agency of Natural Resources, who addressed the importance of the feeder streams to the Caspian Lake fishery, and who provided USGS based maps of the various components of the Caspian Watershed.

Susan Warren, Section Chief, Lakes and Ponds Management and Protection Program for the Vermont Agency of Natural Resources, who provided copies of various studies of the feeder streams conduced in the late 1990's, including one she prepared while working as an aquatic biologist with ANR.

Jim Ryan, Regional Watershed Coordinator for the Vermont Agency of Natural Resources, who met with the group to discuss watershed management, and who later led a larger group on an inspection tour of many of the feeder streams.

Andy Dales, who for years has been the lay monitor for Caspian Lake, and who provided the committee with copies of every known study of the feeder streams.

In addition, members of the committee conducted interviews and studied historical records to try to get a sense of the historic role of the feeder streams.

The committee is very grateful for the time and effort contributed by the individuals noted above. Without their input this study would not have been possible.

(2)
OVERVIEW

The entire Caspian watershed is approximately seven square miles. Within the watershed there are five year-round streams which feed into the lake, and which are the primary water sources for the lake. In addition, there are numerous intermittent or spate streams scattered around the lake.

The three largest feeder streams are Porter Brook, Tate Brook, and Cemetery Brook, all of which are important habitat for fish reproduction. Bachelor Brook and Baker Hill Brook are also year-round streams, but are smaller than the other three.

Although the discharge rates from the three major streams were calculated in a 1999-2000 Sterling College report, the conclusions were at odds with visual and mapping evidence and therefore should be recalculated.

The lake level was lower prior to the construction of the Hardwick Electric dam at the south end of the lake in 1926. From 1926 through the late forties the lake was subject to dramatic drawdowns by Hardwick Electric each fall. After that, the lake has more or less maintained its present levels. There is no known correlation between feeder stream health and size and the historic changes in the water level of the lake.

The streams received very little attention until the late 1990's when erosion, sedimentation and expanding deltas in the lake became a major concern. Part of the explanation for the escalating sedimentation can be traced to two 100-year storms and to increased maintenance on the dirt roads which surround the lake. Another problem lies with questionable land use practices in the various riparian zones and with gradually increased development, including driveways, which has tended to concentrate storm runoff.

The concerns about erosion, sedimentation and aggrading deltas led to several studies and/or formal observations which were undertaken to identify and rectify the problem. They include:

* A 1997-1998 inspection report and recommendations by Susan Warren, then an aquatic biologist for ANR. See Appendix 4.

* A 1999 study by Lori Barg, consulting geologist, prepared for Christine Cano and Cynthia Meyers. See Appendix 5.

* A 1999 study by a group of Sterling College students, prepared for the Greensboro Association. See Appendix 6.

(3)
THE FEEDER STREAMS IN MORE DETAIL

(Many of the conclusions about the current conditions of the major feeder streams come from Jim Ryan's May, 2013, site visit report. That report is catalogued as Appendix 3. See Appendix 1 for maps of the Porter, Tate and Cemetery Brook watersheds.)

Porter Brook is located at the northeastern corner of the lake. Its watershed is approximately 2.3 square miles and its linear length is approximately 2.3 miles, making it by far the largest of the feeder streams.

The brook begins in gently sloped agricultural land adjacent to Gebbie Road, and then flows westward toward the lake down a steep wooded hillside. The gradient flattens after Craftsbury Road as the brook meanders toward the lake. Part of the area between Craftsbury Road and the lake is a mapped Class Two wetland. Much of this area is accessible to the public via Highland Lodge's Porter Brook Nature Trail.

There is an open bottomed culvert where the brook crosses underneath Craftsbury Road, which allows for unimpeded passage of aquatic organisms and which is in good condition.

An unnamed brook feeds into Porter Brook from the southeast, just below Craftsbury Road. The brook originates on the western slope of Barr Hill, and flows westward toward Gebbie Road, and then turns southward until it joins with Porter Brook. For purposes of identification, it will be called West Barr Hill Brook.

According to several sources, this brook seems to be adding sediment to Porter Brook.

David Smith, who owns the land around the lower reaches of Porter Brook, has noted significant sedimentation over the past several years, which he attributes to runoff from Gebbie Road via West Barr Hill Brook, and to winter sand being washed from both Gebbie Road and Craftsbury Road. David has observed that the streambed of Porter Brook seems to be filling in in some areas; places which once had a rock and gravel bottom have now become soft silt.

In her 1997 report, Susan Warren noted significant erosion along West Barr Hill Brook. Jim Ryan also noted erosion in this area during his 2013 observations.

There is a significant delta where Porter Brook enters the lake. Photographic and anecdotal evidence suggests that the delta has grown in recent years. See Appendix 8L for photographic evidence of a recent sedimentation deposit on the delta.

That said, Porter Brook is in very good health, in no small part due to the extensive protections provided by the Porter Brook Natural Area.

Porter Brook is a vital cog in the Caspian Lake fishery, particularly for the lake's rainbow and brown trout populations. Rainbows migrate far up the brook to spawn in the early spring; browns spawn in the fall, when they will take advantage of a spate, move upstream, spawn, and leave quickly before the water level falls. It is likely that smelt and suckers also spawn in the brook in the spring. Fish and Wildlife personnel electrofished Porter Brook in 2007, and noted abundant juvenile trout populations, including small brook trout, most of which probably do not migrate to the lake.

Tate Brook is located on the middle of the north shore. The brook is the combination of Tate and Wright Brooks, which join approximately .25 miles north of the lake. Its watershed is approximately .5 square miles; its linear length (which includes Wright Brook) is approximately 1.5 miles. The area between North Shore Road and the lake was once far more wooded and boggy, but was "reclaimed" approximately 50 years ago by the Watson family.

Both Wright and Tate Brooks form in higher elevations above Caspian Lake. After their confluence, the unified brook meanders slowly along flatter ground through beaver ponds and a wooded area until it crosses under North Shore Road through a culvert. There is no development in this area.

Part of the area north of North Shore Road is a mapped Class Two wetland.

The culvert under North Shore Road is tilted above stream level on the downstream end, which compromises the passage of aquatic organisms, particularly during normal and low water flows. Directly below the culvert is a deep pool which is an important spawning area for smelt, which usually congregate in the pool to spawn just after ice-out, often at night.

Below the culvert, the stream appears to be channelized, perhaps as the result of the Watson reclamation project. There is inadequate riparian buffering along this stretch.

Where the brook enters the lake there is a noticeable delta, which expanded dramatically in 1999 after a 100-year storm (See Appendix 7.). Photographic and anecdotal evidence suggests that this delta was quite large many years ago and was known as the "Watson Sand Bar" (see Appendix 8A). The bar was eliminated as part of the Watson reclamation project.

Fish and Wildlife personnel electrofished Tate Brook in 2007, and noted a modest juvenile trout population, some above the culvert.

Some of the existing studies suggest that Tate Brook is the least healthy of the three major feeder streams. However, most of these studies were conducted in the late 1990's when some very aggressive logging near the brook combined with two serious storms to produce an unusual amount of sedimentation. Although there is still sedimentation, it is less dramatic than it was in the late 1990's.

Cemetery Brook is located at the northwestern corner of the lake. Its watershed is approximately one square mile; its linear length is approximately one mile. The brook originates

west of Lake Shore Road, above the Greensboro cemetery. It crosses under the road through a culvert, and then proceeds toward the lake down a gentle and diminishing grade. It appears to have been channelized in its upper reaches below Lake Shore Road because it is very straight for a stream of its type.

Several field drains feed directly into the brook in this area, which increases erosion and water flow during storm events.

The brook then enters the lake after a slow flat meander through alder thickets. A significant delta marks its entrance to the lake. This delta has increased in recent years, and at this point impedes direct access to the stream. Long time residents can remember rowing straight from the lake into the brook without being grounded by the shallow water of the delta.

Jim Ryan noted that the header of the culvert under Lake Shore Road needs repair.

Although the stream habitat seems favorable for spawning, there have been no recent studies or official observations of spawning activity in the stream. However, long time Greensboro residents remember observing large numbers of smelt and suckers spawning near the mouth of the brook during the spring.

A cluster of Japanese Knotweed has taken hold in the brook's northwestern drainage near the intersection of North Shore Road and Lake Shore road. There is no evidence that it has migrated any further down the drainage.

Bachelor Brook, so called, is a small brook located just to the south of and parallel to Cemetery Brook. Its drainage is approximately a quarter of a square mile; its linear length is approximately one mile. Its source is a stilling pond situated to the west of Lake Shore Road.

There is evidence that the banks of this stream have not stabilized, except for the approximately one hundred feet where the stream enters the lake. The channel above this area has degraded, causing bank erosion and sedimentation. There is a growing delta where this stream enters the lake. Some domestic drainage systems seem to be adding to the erosion.

Numerous small fish, species unknown, have been observed in the pool directly below the culvert under Lake Shore Road.

Baker Hill Brook, so called**,** is located on the eastern shore of the lake, entering the lake just to the north of Black's Point. Its drainage is approximately a quarter of a mile; its linear length is approximately half a mile.

Very little information is available for this brook. In her 1997 visit Susan Warren noted only minor sedimentation.

Intermittent Brooks and spate brooks are scattered around the lake and are sometimes no more than drainage ditches. However, some of these "brooks" have caused serious erosion problems

over the years; Lori Barg's 1999 study directly addresses this issue. Over the past twenty years, some intermittent brooks have begun to build significant deltas. Residents of the west shore have reported aggrading deltas near the south end of Aspenhurst (see Appendix 8, N,O, and P) . Susan Warren, in her inspection of the lake in 1998, confirmed this observation. Lori Barg characterized the aggrading of some of these deltas as "severe."

(4)
EROSION AND SEDIMENTATION ISSUES

There is little question that any current discussion about the feeder streams is focused upon erosion, sedimentation and aggrading deltas where the streams enter the lake. Most available evidence indicates that these issues have become more serious since the mid-1990's. As Susan Warren noted in a 1998 letter, "These large sediment deltas are not natural and may be serving as an early warning sign that the lake is receiving significant pollutant inputs."

The pollution is the result of nutrient loading in the sedimentation, particularly phosphorus loading. Even small increases in phosphorus loads can cause large algal blooms. (See Appendix 13 for a detailed explanation of the link between sediment and nutrient loading.).

That said, erosion is part of a natural process. All one needs to do is look at old pictures of the "Watson Sand Bar" to realize that sedimentation and aggrading deltas are not a new phenomenon. Over the next millennia, Caspian Lake will continue to fill in. During our watch, the best we can do is engage in practices which do not accelerate the natural process.

The studies which are available suggest that there are three principal contributors to the recent increases of sedimentation: (1) runoff from the roads and driveways which surround the lake; (2) landowner practices which increase and concentrate runoff speed and volume; (3) new development, which inevitably taxes the capacity of the watershed to buffer storm runoff.

While some would like to isolate one single cause, it will require diverse and proactive efforts to address the problem.

Greensboro residents have noted that maintenance on the dirt roads around the lake has improved dramatically in recent years, and for that they are grateful. More gravel and more frequent grading have improved travel and saved wear and tear on vehicles. However, every ton of dirt and gravel used to maintain and improve the roads inevitably gets washed downhill toward the lake. Now, more than ever, culverts and drainage ditches will accelerate runoff and erosion unless properly installed and maintained in conformance with best practices. According to Jim Ryan there are several culverts and ditches which are likely candidates for either repair or replacement. (See Appendix 3)

There are numerous resources available which identify best practices for maintaining back roads. One of the most useful is the *Better Back Roads Pocket Guide*; a link is provided in Appendix 12.

Several of the more recent repairs to west Lake Shore Road and North Shore Road have been part of Better Back Roads projects and have been designed to minimize runoff.

Riparian property owners are also contributing to the sedimentation. Riparian buffers have been compromised. Aggressive logging has taken place too close to the feeder streams. Field drains are channeling water into the riparian zones. Poorly designed or maintained domestic drainage systems and driveways are doing the same thing.

During the committee's inspection tour, Jim Ryan noted four separate instances where landowner oversight was contributing to erosion. Taken separately, landowner oversights may seem inconsequential. However, the cumulative impact can be significant.

Finally, development itself is part of the problem, because it removes land, sometimes Class Three wetlands, from the natural buffering process, which in turn puts more pressure on the feeder streams. In her 1999 study, Lori Barg expressed serious concern about the degradation of the Class Three wetlands surrounding the lake.

There are existing state resources available to help riparian landowners who wish to minimize erosion and sedimentation. Interested landowners should contact either Amy Picotte (Amy Picotte@state.vt.us) or Justin Kenney (Justin.Kenney@state.vt.us). Both work for ANR in the Watershed Division.

(5)
EXISTING PROTECTIONS

1. **Greensboro Zoning Ordinance**

Section 3.9 of the Greensboro Zoning Bylaws requires a fifty foot setback for any new development along the feeder streams. In addition, riparian landowners must maintain a fifty foot buffer zone along the feeder streams, subject to grandfathering provisions which protect existing uses, but prohibit their expansion.

Although this provision is important and proactive, it does have some weaknesses. First, it is not clear that all riparian landowners are aware of their responsibilities. Second, the grandfathering provisions make it possible for some negative land use practices to continue.

Article Eight of the zoning bylaws creates some special protections for areas within 150 feet of Caspian Lake, which gives added protection for the feeder streams as they near the lake.

A link to the ordinance can be found in Appendix 10.

2. **Wetlands Protection**

There are numerous statutory and regulatory protections for mapped wetlands, particularly Class 1 and Class 2 wetlands. For purposes of this report, the most important of these protections is the imposition of a fifty foot buffer zone around all mapped Class 2 wetlands, which provides some level of protection for portions of Tate and Porter Brooks.

See Appendix 11 for a link to the Vermont Wetlands Regulations. Appendix 16 is an article which contains some important practical advice for landowners who may be considering altering a wet or boggy area.

(6)
CONCLUSION

The streams which flow into Caspian Lake play a vital role in the quality and ecology of the lake. They are the lake's main arteries, which means that their health is directly related to the health of the lake itself. More particularly, these streams are critical for maintaining water quality and for providing spawning habitat for many of the lake's fish species.

Fortunately, the feeder streams are healthy and functioning well, with one exception.

That exception is erosion and sedimentation, which is creating expanding deltas and contributing to unwanted nutrient loading. Sand, dirt and gravel washing downhill from the town's dirt roads are certainly a major contributing factor, but landowner oversight and new development are also adding to the problem.

According to Jim Ryan, there are some culvert and road drainage issues which should be addressed soon.

It would be a mistake to think of the feeder streams only in terms of Porter, Tate and Cemetery Brooks, the three primary year-round feeder streams. The intermittent and spate brooks can also have a significant impact on the lake, particularly since their flow is often maximized during high erosion weather events. Some of these smaller streams and water courses are linked to domestic drainage and runoff systems, some of which are not functioning effectively in terms of minimizing erosion.

It would also be a mistake to view the major feeder streams only in terms of their effect on Caspian Lake; they have ecological significance of their own, independent of the lake.

It is fair to say that the feeder streams have not received the attention that they deserve. A concerted effort needs to be made to publicize their importance and to implement best practices in the riparian zones and along town roads.

(7)
RECOMMENDATIONS

A permanent advisory and oversight committee should be formed to monitor the health of the feeder streams on an ongoing basis. The committee should issue an annual report which summarizes its activities and which makes recommendations for the coming year.

All conservation oriented organizations in Greensboro should make a concerted effort to emphasize and publicize the importance of the feeder streams. The community needs to become aware that these streams are vital to Caspian Lake's water quality and fishery.

The 2014 Greensboro Land Trust Annual Meeting should be dedicated to a discussion of the importance of the feeder streams.

All riparian landowners should be made aware of the importance of the feeder streams and of the existence of the buffer requirements of the Greensboro Zoning Ordinance. Voluntary buffering should be emphasized.

A lay monitoring committee should be formed to calculate the discharge rates from the principal feeder streams at different times of the year. Comparing this information with the discharge rates from the dam would create a better understanding of the role of the feeder streams. Information on the turbidity of the streams would also be useful.

Fish and Wildlife should be encouraged to engage in increased monitoring of fish populations in the principal feeder streams. It would be particularly beneficial to have more information about Cemetery Brook.

The town should be encouraged to address the road maintenance issues identified by Jim Ryan in his May, 2013 report.

The Greensboro Land Trust should identify the most critical and vulnerable areas of the feeder stream riparian zones and add them to its natural resources inventory.

Riparian landowners should be encouraged to take advantage of the resources offered by the state. Some important contact information is listed on page 7.

(8)
APPENDICES AND LINKS

1) Maps of the Caspian Watershed

A. USGS Map of Caspian Lake
B. entire Caspian watershed
C. Porter Brook watershed
D. Tate Brook watershed
E. Cemetery Brook watershed, which also shows Bachelor Brook to the south.

2) Greensboro Wetlands Map, link:
http://www.nrb.state.vt.us/wrp/rulemaking/wetlands2010/maps/Greensboro.pdf

3) Report of Jim Ryan, Lamoille Regional Watershed Coordinator for ANR, based on personal observations, May, 2013.

4) 1997-1998 inspection report and recommendations of Susan Warren, then an aquatic biologist for ANR.

5) 1999 study by Lori Barg, consulting geologist, prepared for Christine Cano and Cynthia Meyers.

6) 1999 study by a group of Sterling College students, prepared for the Greensboro Association.

7) Report and observations of John Schweizer concerning Tate Brook delta expansion, September, 1999

8) Pictures

A. Watson Sand Bar, so called, Tate Brook, 1930's (?)
B. mouth of Cemetery Brook, May 2013
C. Cemetery Brook delta, October 2013
D. field drains, Cemetery Brook, May 2013
E. Bachelor Brook, showing delta, October 2013
F. Tate Brook, lower reaches, May 2013
G. Tate Brook culvert, North Shore Road, May 2013
H. Tate Brook delta, new sedimentation layer, October 2013
I. Tate Brook delta, October 2013
J. Porter Brook above Craftsbury Road, May 2013
K. Porter Brook delta, October 2013
L. Porter Brook delta, showing new sedimentation layer, October, 2013
M. spate brook, north shore, October 2013

N. intermittent stream, west shore, November 2013
O. intermittent stream, west shore, showing delta, November 2013
P. intermittent stream, west shore, recent sedimentation layer, November 2013

9. Partial summary of 2004 Sterling College study.

10. Greensboro Zoning Ordinance, link:
http://www.greensborovt.org/wp-content/uploads/2012/10/Zoning-Bylaw-Original.pdf

11: Vermont Wetland Rules, link:
http://www.nrb.state.vt.us/wrp/publications/wetrule2002.pdf

12: *Better Back Roads Pocket Guide*, link:
ftp://ftp-fc.sc.egov.usda.gov/VT/RCD/BBR%202008/pocket_guide.pdf

13: *Riparian Buffers and Corridors*, link:
http://www.anr.state.vt.us/site/html/buff/buffer-tech-final.pdf

14. *ANR Buffer Guidance*, link:
http://www.anr.state.vt.us/site/html/buff/BufferGuidanceFINAL-120905.pdf

15. Caspian Lake Report Card, link:
http://www.vtwaterquality.org/lakes/htm/lp_lakescorecard.htm. For methodology see [http://www.vtwaterquality.org/lakes/docs/lp_lakereportsheet.pdf].

16. Legal impacts of unpermitted wetland development, from *The Vermont Digger*, link:
http://vtdigger.org/2013/11/17/vermonts-wetlands-rules-put-onus-landowners/

(9)
RESOURCES

Vermont Watershed Management Home Page. Numerous links to relevant and useful information. http://www.vtwaterquality.org/wqdhome.htm

Vermont Surface Water Management Regulations
http://www.vtwaterquality.org/wqd_mgtplan/swms_appA.htm

Better Back Roads, ANR Watershed Division
http://www.vtwaterquality.org/erp/htm/backroads.htm]

Better Back Roads grant application data
[http://www.nvtrcd.org/bbr.html]

guide for landowners to prevent erosion: Useful information from Watershed Management Division web site.
http://www.vtwaterquality.org/stormwater/htm/sw_gi_systemsandfunctions.htm

Vermont River Conservancy home page:
http://www.vermontriverconservancy.org

ANR Lake Conservation Site Guide: Useful directory for lakeshore best practices.
http://www.anr.state.vt.us/dec/waterq/lakes/docs/lp_lakebmps.pdf

ANR mapping homepage: An excellent source for mapping and overlays.
http://www.anr.state.vt.us/site/html/maps.htm

Riparian Buffers and Corridors: An excellent summary of the necessity for riparian buffers.
http://www.anr.state.vt.us/site/html/buff/buffer-tech-final.pdf

River Corridor Protection Guide: Detailed technical explanation for creation of river corridors:
http://www.vtwaterquality.org/rivers/docs/rv_RiverCorridorProtectionGuide.pdf

ANR Buffer Guidance: ANR's policy and methodology for recommending various buffer areas.
http://www.anr.state.vt.us/site/html/buff/BufferGuidanceFINAL-120905.pdf

ANR Lake Report Card: Allows a viewer to access information on most Vermont lakes through Google Earth
http://www.vtwaterquality.org/lakes/htm/lp_lakescorecard.htm

Living in Harmony With Streams: Excellent guide for understanding how to maintain stream health.
http://www.winooskiriver.org/images/userfiles/files/Stream%20Guide%201-25-2012%20FINAL.pdf

ANR publication about the perils of restricting the passage of aquatic organisms
http://www.vtwaterquality.org/rivers/docs/Educational%20Resources/rv_AOPPresentationoDTF.pdf

Vermont Lake Wise home page: An excellent overview of how riparian landowners can improve water quality in Vermont lakes.
http://www.vtwaterquality.org/lakes/htm/lp_lakewise.htm