The Water Management Program
Trent-Severn Waterway
National Historic Site of Canada

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Program Context

The Trent-Severn Waterway (TSW) is a 386 kilometre inland navigation route crossing south central Ontario from Trenton on the Bay of Quinte to Port Severn on Georgian Bay. Natural rivers and lakes have been connected by man-made canal cuts, locks and controlled water levels to form a navigable route through two neighbouring watersheds – the Trent and the Severn.

There are 3 key components to the Waterway (Figure 2-1). Each of these 3 components is described in more detail in Fact Sheets provided as Appendices 1, 2 and 3 and summarized below.

The Trent River Basin is the easterly watershed and drains to Lake Ontario. The basin has an area of 12,200 square kilometres. Approximately one third of the basin lies in the Canadian Shield. The other two thirds lie in the rolling farmlands of southern Ontario. This basin contains the Kawartha Lakes, namely Rice, Katchewanooka, Clear, Stony, Lovesick, Lower Buckhorn, Buckhorn, Chemong, Pigeon, Sturgeon, Scugog, Cameron and Balsam Lakes. These lakes lie primarily south of the southern limit of the Canadian Shield in rolling countryside, where rainfall runoff is usually slow and evaporation losses in the summer are high due to the shallowness of the lakes. The Otonabee and Trent are the two primary rivers, the former connecting Katchewanooka Lake and Rice Lake and the latter connecting Rice Lake and the Bay of Quinte.

Important Facts

The rates of runoff and evaporation losses are different for the lands in the Precambrian Shield than for the lands to the south of the Shield.

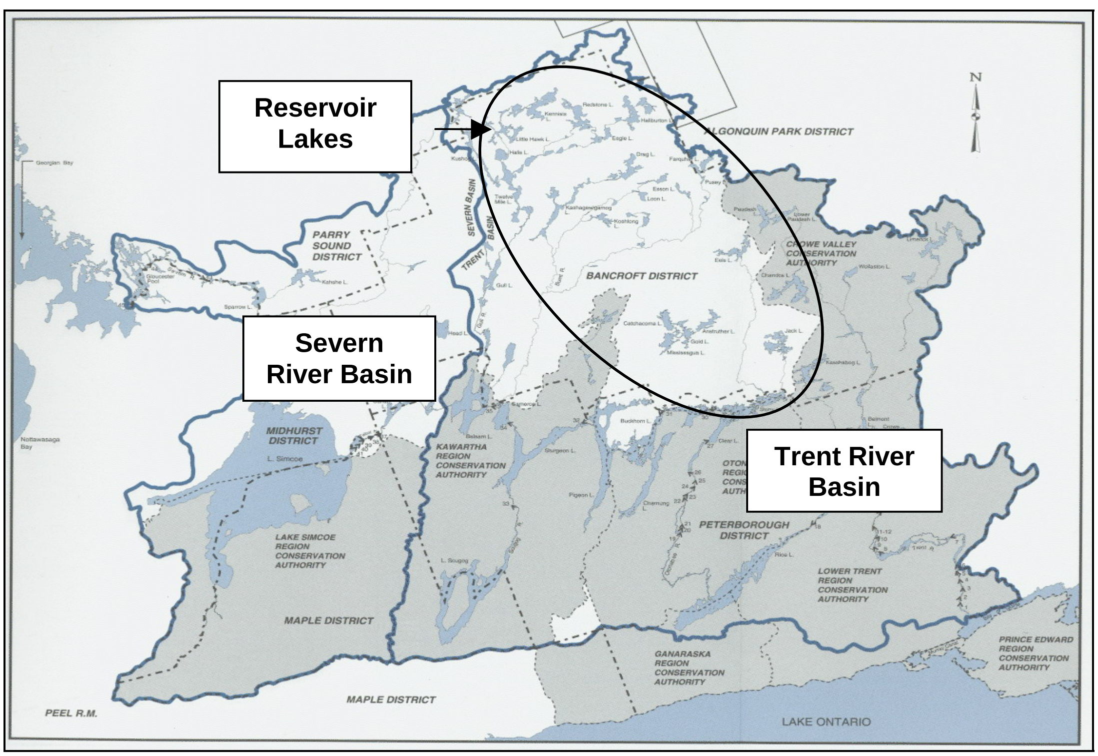
Precambrian Shield

- *Lots of rock and shallow soils.*
- *Rapid runoff.*
- *Less evaporation due to deeper lakes.*

South of the Shield

- *Deeper soils*
- *Slower runoff – depending on the time of year, only about 25% of precipitation appears as runoff flows.*
- *Greater evaporation due to shallower and larger surface*

The Reservoir Lakes to the north, consist of some forty-four lakes in the northern shield area that are dammed to collect spring runoff water. Water from these lakes is released over the summer to supply the Trent component of the Waterway. These lakes are on the tributaries of the Gull, Burnt and Mississaugua rivers, as well as Nogies, Eels and Jack creeks. The drainage area of the Haliburton tributaries (Gull and Burnt Rivers) is in the order of 3,200 square kilometres. Appendices 4, 5 and 6 provide schematic representations of the Gull, Burnt and Nogies/Mississaugua/ Eels/Jack watersheds respectively.



Watersheds of the Trent-Severn Waterway

The Severn River Watershed lies immediately west of the Trent Basin and drains into Georgian Bay. This 6,160 square kilometre drainage area has three major components:

1. The Lake Simcoe and Couchiching basin including the Talbot River.
2. The Black River watershed that feeds into the Severn River downstream of Lake Couchiching.
3. The lakes and channels of the Severn River below Washago, including Sparrow Lake, Six Mile Lake Tea Lake, and Gloucester Pool.

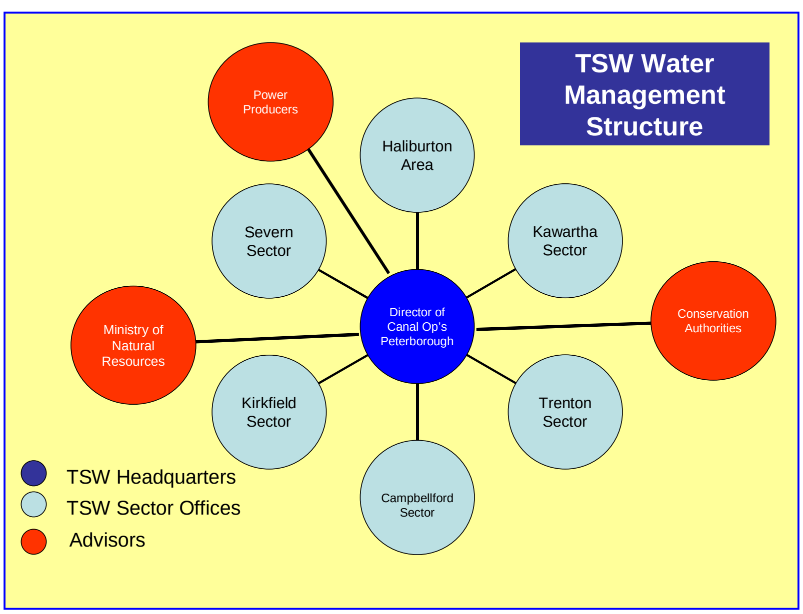
Most of the drainage area for the Lake Simcoe-Couchiching basin is in rolling farmland and deeper soils characteristic of the southern area. As a result, water run-off is slow and evaporation losses from both land and lake surfaces are high. Thus, only about 25% of the precipitation falling on this watershed eventually appears as runoff flows.

The Black River watershed, located in the thin soils and rock of the Precambrian Shield, is virtually unregulated and produces rapid run-off of precipitation while evaporation losses are lower. Consequently, even though the Black River watershed is less than half of the area of the Simcoe-Couchiching basin, its long-term average flow is comparable. The Black also has high peak flows during the spring period. The natural watercourses of the Black and the Severn Rivers are constrained by numerous narrow reaches and constrictions, which are prone to increased water levels in the river and upstream flooding during high flows.

Program Operations

The water management program on the TSW is led by the Director of Canal Operations and coordinated by the Water Control Engineer who works from TSW headquarters in Peterborough. The Water Control Engineer communicates almost daily with Sector Managers working out of six different Waterway offices located in Trenton, Campbellford, Peterborough, Kirkfield, Washago and Haliburton. He is also in contact with other water control agencies such as the Ministry of Natural Resources, Conservation Authorities, Ontario Power Generation, and other public and private generation station owners.

Decisions with respect to water levels and flows are made by the Water Control Engineer using a variety of data and in consultation with the Sector Managers. Directions are then communicated to the Sector Managers who implement the changes through operations and maintenance staff who then make the necessary adjustments at the dams. The Sector Managers have the experience and authority to suggest modifications to the water management directions. These suggestions are considered by the Water Control Engineer. In short reaches, the Lockmaster is allowed to make one log adjustments to maintain water in the upstream reach within a specified range.



The job of managing water levels in such a complex system is very challenging. Making decisions about how much water to release and how much to hold can be difficult. Some days the appropriate action is obvious and other days it is not as clear. Many factors are considered and there are many natural and technical influences including:

1. Gauge readings (Has the gauge malfunctioned? Is the phone line down or the battery dead? How much has the wind altered the readings?)
2. Did the flow changes that were made yesterday work out right?
3. Has a beaver dam burst and temporarily driven the water level unusually high?
4. How much rain is to come from the next weather system?
5. How much snow do we have and what will be the rate of runoff?
6. What is appropriate - action and/or inaction? It is not always clear which is better. At times it is necessary to implement a solution that partially remedies a particular problem without causing problems elsewhere in the system should a different weather system become a factor.
7. How are high-risk areas (e.g., low-lying areas) doing as compared to the potential problems elsewhere in the system?

In simplest terms, the program is based on an annual cycle of operations augmented by over 100 years of recorded water levels, flows, weather data, and new technologies. Water levels, water current velocities and precipitation data from over 40 gauge stations are accessed by computer and analyzed on a daily and sometimes hourly basis by the Water Control Engineer. Snow cover is an important consideration when planning for the spring. Snow surveys are carried out during the winter in the reservoir lake area and the Trent and Severn watersheds.

Each of the three watersheds (Trent, Severn and Reservoir Lakes) is managed differently. During each season of the year, these three groups of lakes generally have their own set of circumstances and water control functions. Lakes throughout the system must be at certain levels at different times of the year and various water level and regulation curves provide targets for the Water Control Engineer. Coupled with this are the many external factors and priorities such as climate, power generation, fish spawning, flood mitigation, etc., that influence the program.

Cottagers, year-round residents, commercial operators, power generators, and others are all concerned about water level fluctuations in times of high spring flow and summer drought. The water management goal is to provide for safe navigation while trying to accommodate the other water users. There are a variety of constraints to reconciling the conflicting demands to regulate water levels and flows within the watersheds, not the least of which is climate, which can be neither controlled nor guaranteed.

Water Management Throughout the Year

Getting Ready for Winter

Preparation for the winter is an important step. The premise is to ready the lakes so they have sufficient capacity to catch the spring runoff and minimize flooding along each lake’s shoreline and elsewhere in the system. A drawdown schedule with weekly targets is produced. The following describes winter preparation for the 3 watersheds. The characteristics and management of each watershed are summarized in Appendices 1, 2 and 3.

The Reservoir Lakes

Thanksgiving weekend marks the end of navigation season on the Waterway. By Thanksgiving, the reservoir lakes typically contain between 30 and 50 % of their maximum storage. This is often too much water and does not allow enough storage capacity for the spring runoff. Therefore, excess water is run off the Reservoir Lakes before winter and each dam is set with a specified number of stoplogs to maintain the winter level. Depending on weather conditions this drawdown is typically done prior to October 31st to attempt to ensure that trout spawn is not exposed by falling water levels after this date. Water management in the reservoir lakes is summarized in Appendix 2.

What if it is a wet or dry year?

If it has been a wet year, drawing the lakes down takes much longer. In dry years, some lakes may have to be refilled to reach their winter setting. As spring is approaching, if there is a lack of snow, some stoplogs may need to be put in the dams as early as February to begin catching water. Through the winter the reservoirs are largely left alone.

There are several reasons for lowering the Haliburton reservoir lakes in the fall:

1. The lakes must be lowered to accommodate spring snowmelt water.
2. Many of the dams become inaccessible in winter.
3. Stoplog changes in the winter, often done by cutting the logs free of ice with chainsaws, is a costly and hazardous operation.
4. Only a reduced crew is available for winter operation and maintenance.
5. Winter enthusiasts could be endangered by changes in water levels weakening the ice cover.
6. Winter water levels must be set before Lake Trout spawn to avoid drying up or freezing out spawning beds.

The Kawartha Lakes

In the Kawarthas, the smaller navigation route lakes, (Canal, Mitchell, Cameron, Lower Buckhorn and Lovesick) are lowered to winter levels between October 15 and December 1, to avoid problems of dam access by operational staff and to reduce water control costs. The larger Kawartha Lakes are allowed to drop to the middle or bottom of their navigation range.

The larger Kawartha Lakes are then drawn down from January 1 to March 15. Normally, this ensures that all the lakes are at their natural low levels prior to the spring freshet. Some dams have all their logs out, and the date by which the final level is attained varies with the natural inflow during the winter. Winters with high inflows mean that some lakes would not drop as far as is desirable, thus reducing flood storage. Dry cold winters with low inflow can cause some lakes to drop lower than normal. Insufficient flows cause problems on the downstream river dams because there is not enough water to run over the spillways to keep stoplogs and/or gates from freezing into the dams. A summary fact sheet on the Kawartha Lake is contained in Appendix 1.

The Severn River

In the Severn River drainage basin, Lakes Simcoe and Couchiching are managed using a rule curve in effect since 1918. This curve serves as a target or guide for water levels throughout the year. Outflow from Simcoe-Couchiching is regulated to maintain the lake near its rule curve, which is a constant level from November 20 to March 20. Simcoe-Couchiching typically drops towards its lowest level over the summer and into the fall.
This very large body of water presents different management challenges. Generally speaking, because of the size of the lakes and the limited inflow and outflow relative to the effects of evaporation, whenever water levels depart from the rule curve, it is very difficult to reverse the trend.
For example, a level decline on Simcoe-Couchiching cannot be stopped by shutting off all the dams in Washago, nor can a rise be halted by opening the dams at Washago for maximum outflow. Over fall and winter, the lake is “coaxed” toward normal. This requires running higher and higher flows if the lake is above normal. If it is lower than normal, lower than normal flows are run without going lower than the historic minimum. Flows from Simcoe-Couchiching must also be co-ordinated with flows coming from the Black River to reduce the threat of high water on the Severn River and on Sparrow Lake. A fact sheet on the Severn River basin is contained in Appendix 3.

Rule Curve
A “Rule Curve” indicates the most desirable water level in a specified water body for each day of the year.

Fisheries Considerations

Fall spawning fish, such as Lake Trout, are most vulnerable to winter lowering. The concern is to ensure there is adequate water over shallow spawning beds and not to dry up these spawning beds after fish have spawned and before the eggs have hatched. It is important to draw the water down to the winter level before trout move onto the spawning beds, usually in October, so that stable water levels can be maintained during the critical spawning and incubation period. This is particularly important on lakes where spawning shoals are shallow. Lake Trout eggs hatch when water temperatures reach 0.3° – 1.0° C, usually around March-April. Kushog and Big Bob Lakes are managed for Lake Trout at the request of the Ministry of Natural Resources (OMNR). This early drawdown has not been put in place for other Lake Trout lakes because there is no evidence that the spawning beds are drying out.

The Kawartha Lakes do not tend to have fall spawners so there is less of a constraint on the timing of winter drawdown as with the Reservoir Lakes. The Kawarthas have an issue with lowered dissolved oxygen in some areas. This has resulted in “winter kill” of fish in the Kawarthas. In some locations flows are maintained during the winter to oxygenate water for fish. Sometimes “winter kill” is unavoidable where water levels cannot be maintained due to dry seasons or anticipated high spring runoff and/or cold winters with thick ice cover. The rate of fall drawdown is also important in some lakes (e.g. Mitchell Lake) to avoid stranding fish in shallow waters.

Spring spawners and fish migration are also of concern and consideration is given to water levels and flows downstream of dams to provide for Walleye migration, spawning and survival of spawn. Water levels are also important to flood wetlands used by Muskellunge for migration, spawning and fry rearing.

How Much Runoff Will There Be In The Spring?

This is a very important question. Snow surveys are conducted at five sites every two weeks from the beginning of January to the start of the freshet. There is one site in the Severn Watershed, one site in the Kawarthas and 3 sites in the Haliburtons. Information about the depth and water content of the snowpack aids in forecasting the total volume and peak runoff for the upcoming spring freshet. These data along with other information, including the lake levels on March 15, are used to predict the volume of spring freshet upstream of Lakefield. Lake levels might be adjusted to some degree after this date. For example, if a small freshet is predicted, water might be caught earlier to fill the lakes. The TSW operates a large number of water gauging stations. There are about 40 in the reservoir lakes and close to 90 in the rest of the system. Approximately 50% of these 90 stations are automated. The remaining stations are read manually.

The Spring Balancing Act

This is the most challenging time for water managers. Throughout the spring freshet, the TSW has two difficult and sometimes competing objectives – <u>To reduce or eliminate flooding, and to store as much water as possible for summer use.</u>

Once the freshet starts, some reservoir lakes and many Kawartha lakes fill or overfill even with all the stoplogs out of their dams. Downstream conditions are also critical considerations. For example, during extreme flood conditions (e.g., flows of 400-450 cubic metres per second (m^3/s) at Peterborough), a decision may be required to flood the Kawartha lakes above normal in order to prevent much more serious flooding downstream of Peterborough. After the flow peak has passed, logs are placed back in the Kawartha dams and gates are lowered as the lakes decline, until they are slightly under filled. Then, as flows continue to decline, care is taken to catch enough water to top up the lakes.

When considering the number of lakes and structures that must be manipulated on a watershed such as the Trent River, the challenge is very complex. Much of the time it is only necessary to deal with a few individual flow changes to rectify a situation where one lake is rising too fast or is too high or dropping too low. Occasionally, however, especially in spring, many sites need attention at the same time. For example, if Balsam Lake is rising too high due to rainfall, the obvious response is to increase the flow from Rosedale at its outlet. But this flow goes to Cameron Lake which is much smaller in area. If no further adjustment is made, Cameron Lake would flood. Therefore the flows must be passed on downstream at Fenelon Falls. A cascading effect usually occurs all the way to Trenton in sudden melt or heavy rain situations.

In spring conditions water flow increases accumulate as they move downstream. At some point, the changes exceed the ability of water control crews to complete the increase in one day and still be able to manage the discrepancies that can occur. Therefore, a maximum daily change is worked out that may not fix every lake in one day. When the rise of the lakes is not all passed in one day, then a second, third or fourth day is needed. The larger lakes have to absorb water by rising, while flow increases are worked through the system. This is one of the reasons for wanting to have water levels low before the freshet begins. The inflow to the Kawarthas, for example, can exceed 600 m^3/s while outflows are still rising from 250 to 350 m^3/s. The challenge is compounded by the fact that some Kawartha Lakes are considerably smaller in both area and volume than others and have less ability to absorb surges of inflow without experiencing rapid changes in water levels. Under these conditions these lakes may rise very rapidly.

As spring approaches on the Reservoir Lakes, stoplogs are placed in the dams as the lakes are rising with the runoff. Typically there is more inflow than needed to fill them and some surplus is allowed to run off. As the lakes are nearing their full levels, snow survey data and all available sources of information are checked in an effort to anticipate whether or not a larger volume of water is still coming. If only a little water is expected, then the lakes are topped up for the summer: if a lot of water is expected, then the lakes are allowed to discharge more freely. Heavy inflows can easily result in pulling stoplogs out again at dams on these lakes to expel surplus water.

In the Severn basin, the two main spring objectives are:

1. fill Lakes Simcoe-Couchiching without overfilling, and
2. minimize the effect of the peak flow from the uncontrolled Black River that joins the Severn River below the outlets of Lakes Simcoe-Couchiching at Washago.

Simultaneous peaks on Lakes Simcoe-Couchiching and the Black River can result in flooding on Lakes Simcoe-Couchiching, Sparrow Lake and Six Mile Lake. As the Black River peaks, the outflow from Lake Couchiching is restricted or shut off, if Lake Simcoe-Couchiching is not excessively high, in order to minimize flooding in Washago and on Sparrow Lake and Six Mile Lake. In spring, Lakes Simcoe-Couchiching often begin to rise, but are not full when the Black River peaks. To reduce the flooding effect on Sparrow Lake and on the Severn River, the peak freshet of the Black River is monitored and flows from Lakes Simcoe-Couchiching are reduced as much as possible until the peak passes.

Summer Drawdown

During the summer, attention shifts to maintaining water levels and flows. The three main objectives for summer water control are:

1. maintain the lakes and rivers on the main navigation system within advertised navigable depth ranges;
2. use as little water as possible from the Reservoir Lakes and maintain all Reservoir Lakes at the same percentage of storage depth; and
3. maintain sufficient flows through the system to ensure water quality.

Evaporation from the Kawartha Lakes is usually greater than can be replenished by precipitation and ground water inflows. Therefore, additional water must be supplied to these lakes from the Reservoir Lakes.

> **Equal Percentage Drawdown**
> Lakes are drawn down by an equal percentage of the storage capacity. For example, when a lake with a relatively large storage depth of 3 metres is drawn down 50%, its level will drop 1.5 metres, while a lake with 2 metres of usable storage depth will be lowered by 1 metre.

Water is drawn from each of the reservoir lakes on an equal percentage drawdown basis according to the storage range established for each lake (Table 5-1). The management of the Reservoir Lakes is assisted by a computer model. Several times a week, readings are taken of water levels at dams. Data are inputted to the model, which is run each Tuesday morning. A target percentage decline in the Reservoir Lakes over the next 2 week period is set and communicated to field staff that begins to adjust the dams to meet the target levels.

The Sector Managers are responsible for scheduling the adjustments within their sector to ensure that proportionate drawdown is achieved. Typically they will start with the upper-most dam and work downward in the system to accommodate the lag in water level response once an adjustment is made. Most of the adjustments will have been made by the end of day Wednesday.

Summer flows along the Severn River come mainly from Lake Simcoe-Couchiching, rather than the Black River. Lakes Simcoe and Couchiching are guided by the rule curve and the Washago dams are adjusted accordingly.

Dam Characteristics

Water flow discharges from the Haliburtons to the Kawarthas are controlled by dams having from one to four spillways and fitted with square timber stoplogs. Because of the greater size of the Kawartha Lakes and the greater volumes of water feeding into these lakes, the Kawartha Lakes' dams typically are progressively larger the further downstream they are. The dam at Buckhorn, for example, has four 15 metre radial sluice gates, while the Young's Point dam has six 6-meter vertical lift gates. There is also some redundancy built into these dams for safety. There is a cumulative leakage at the 10 dams with OPG generating stations of approximately 12 m^3/s (Source: Parks Canada – Dave Ness). The dam with the greatest leakage is Auburn with 3.66 m^3/s. This is an OPG dam. When the power plants are not running at capacity, this leakage represents potential lost generation potential.

The stoplogs used in the Haliburton dams are lifted in and out using winches. Some people have asked if the logs can be partially lifted to create a smaller gap between the first and second log to release less water. Partially lifted logs create a safety hazard and therefore stoplogs are fully removed. Each dam has a steel half-log, which is used to get a lesser flow than a whole log when needed.

Special Conditions

The following presents several special conditions that must be taken into account when making water management decisions.

Spring Ice Damage

Some years produce mild weather where the snow begins to melt and fill the lakes before the heavy winter ice cover has had sufficient time to soften around docks and boathouses. The rising lake level can shift some structures not designed for these conditions. In these situations, further removal of stoplogs from control dams may be insufficient to slow the level rise or may worsen conditions downstream. As with many water control situations, actions must be decided day-by-day as the conditions develop and it takes time for lake levels to react to these actions. Often ice damage is unavoidable.

Seasonal flows and hydro electric generation

Although it may be desirable to use all of the water that flows past a hydro electric power generation facilities to generate power, this is not possible. In the spring it is necessary to flow high volumes of water to prevent flooding along the system, even though these volumes exceed the capacity of the generating facilities. In most springs (March 15 to May 15), more than 120,000 hectare-metres (ha-m) of water enters the lakes of the Trent Basin upstream of Lakefield, while the total available storage volume is only 65,000 ha-m. This extra 55,000 ha-m, that must be run out of the system, does not come steadily, but rises to a peak generally far in excess of powerhouse capacities.

These periods may be followed by dry summer months when flows are lower than what the generating stations would prefer. Throughout the summer, when navigation is a priority, some flow is required from the reservoirs to compensate for evaporation, leakage, and lock operation and to maintain aesthetic quality. During these periods, this is the only available flow for power generation.

Lake levels and Stoplog Adjustments

During flood events, it can occur that not all dams are fully open (i.e. all the stoplogs removed from a control dam or gates raised wide open above the water) even though the lake it holds back is still rising and flooding. This can occur for one or more of the following reasons:

1. The dam has more capacity to pass water than dams upstream or downstream that already have all logs out. This is the case with the dam at Buckhorn;
2. The lake downstream is already experiencing high water, so releasing more water will only worsen conditions, e.g., Pigeon-Buckhorn Lake below Sturgeon Lake; and
3. A natural obstruction such as a rock ridge in the lake or river bed upstream of the dam is controlling the flow to such an extent that releasing more water only lowers the water immediately above the dam with little or no effect on the amount of flow coming over the rock ridge. This is the case with the Hastings dam at the end of Rice Lake and Lock 7 at Glen Ross.

Speed of Lake Level Changes

People often suggest that pulling one more log would alleviate the spring flooding on some Reservoir Lakes because it would lower the water level by the depth of the stoplog removed. When a 30 cm deep timber stoplog is removed from a dam, the lake level may still rise or takes several days to drop depending upon inflow volumes and length of time the dam is opened.

For example, if two logs (60 cm) are pulled at the Kennisis Lake dam with the lake full and no inflow or other outflow, it takes 14 days for the lake to drop 30 cm. In the case where a lake that is discharging 30 cm deep of water over a log is suddenly increased 5 cm by rainfall, the increased outflow would be a tiny amount. At this increased rate, which immediately starts to decline, it would take days for the lake to drop the 5 cm. A 5 cm rise in Kennisis Lake amounts to 82 ha-m of extra water. The average flow increase this causes, however, is so small that the extra water would not run off for 35 days. Rainfalls are thereby automatically caught without a lot of immediate stoplog re-insertion. Observations and adjustments are made on a weekly basis so any gains from rainfall are taken into account.

Fisheries Issues

There are a number of considerations with respect to fish spawning. In the case of Lake Trout, which spawn in the fall, the objective is to draw the water down to a level that will provide sufficient spring storage before the fish spawn. Otherwise, lowering water levels after spawning will dry out the spawning beds and destroy that year’s hatch. In those lakes where an optimum level for trout spawning has been identified, the drawdown schedule must be started soon enough to allow time to reach that optimum level even though water may not be needed down below in the system. In other locations adequate flows need to be maintained to support Walleye spawning or levels need to be maintained high enough in the spring to support pike and muskellunge spawning.

Fish can also be killed as a result of one or more factors. In shallow areas that freeze to the bottom in cold winters, fish can be killed. Fish can also be killed due to oxygen depletion. Shallow lakes with ice cover can become depleted of oxygen leading to fish suffocation. Spring die off can also occur if the fish have been stressed due to low oxygen levels over the winter and cannot recover when metabolisms increase in the spring. The added stress of spawning or greater foraging activity can be too much for weakened fish. Finally mixing of low oxygen water near the bottom of lakes with surface water may be fatal to fish near the surface.

Finally a particular problem occurs on Mitchell Lake. The lake is very shallow and too rapid a drawdown can strand fish in shallow areas. The normal practice is to draw Mitchell Lake down slowly to allow time for fish to move to deeper water.

Flooding on the System

In an average year flooding is not much of an issue. Spring conditions occasionally result in flooding in the "flood-prone" areas along the system. Some specific locations are:

- above and below Lock #7 - Glen Ross,
- Percy Reach and Meyers Island,
- upstream from Healey Falls around Trent River bridge,
- below Lock #18 - Hastings,
- below Lock #19 - Peterborough,
- above Cameron Lake on the lower Burnt River,
- Shadow Lake north of Coboconk,
- below Talbot Dam on the Talbot River,
- the Holland River and Marsh area at the southern end of Lake Simcoe,
- below dams C,D,E in Washago,
- Lake St. John,
- the Black River above and below Highway #169 bridges,
- Sparrow Lake and the reach upstream to Lock #42, and
- below the Big Chute Generating Station (upstream of Little Chute especially in the Six Mile Channel below the Six Mile Dam).

Each of these areas suffers from one or both of the following conditions:

1. uncontrollable peak flows or levels, and
2. downstream natural restrictions that impede high flows.

Most of the flooding trouble on the Black and Severn Rivers is due to the unregulated nature of the Black River. It drains a large rocky basin area that absorbs very little melt water, but is an area that is also in the Georgian Bay snow belt. This causes rapid and high runoff of spring flows from an area with very little controllable storage. The sudden release of water is often great enough to overtop the Lake St. John Dam, aggravating local conditions, and flooding residents along the Black River down to Washago. Below Washago, even though flow from Lakes Simcoe - Couchiching is completely cut off during peak flows from the Black, the levels can rise to flooding stage in the Village of Washago, as well as on Sparrow Lake.

Sparrow Lake flooding is partially caused by natural constriction in the Severn River at Sparrow Lake Chute, McDonald's Rapids and Hydro Glen. The cost of removing these constrictions is prohibitive and would not wholly eliminate the flooding.

Areas of flood hazard in the Trent Basin generally result from restrictions and shallow gradients. The Trent River is not typically a "flashy" river because of the natural storage in the lakes, the soil infiltration in the Kawartha Basin, and near average snowfall. The peak flow is generally slowly attained and lingers considerably during its decline. Tributary streams, such as the Burnt River, Eels Creek and Jack Creek, are more volatile and sometimes cause flooding in low lying areas.

The system is drawn down in the fall/winter to mitigate the potential for spring flooding. However, when conditions lead to flooding, efforts are made to mitigate the flooding effects. Often, very little can be done to avoid flooding.

Floodwater Storage in River Reaches

It is frequently asked why river reaches are not used to hold spring meltwaters. At high flows, available storage volumes in rivers fill rapidly. For example, a 10 cm level change on a river reach may take 3 days at summer flows, but may take only 5 or 6 hours at spring flows. Peak inflows above Lakefield can reach 850 m^3/s while maximum outflows past Peterborough are 450 m^3/s. The difference of 400 m^3/s that is going into storage would fill the entire usual available volume in 16 days. River reaches that appear large can accommodate a small increase in flow for a short period in summer, but in spring, this amount of storage volume is so small there is virtually no potential flood relief.

Floodwater Storage in Lakes

Questions are also raised as to why lakes themselves are not used for flood storage. In fact, the lakes are not really designed for flood control. Most of the lakes were in existence before canal construction. In the spring, most lakes (with the exception of some Reservoir Lakes) would have risen to approximately the same high level as they do now. There is little excess volume available now for flood storage than there was in the natural condition. Because of forest removal and increased shoreline development, runoff rates are greater now than in the early years.

System Shutdown due to High Flows

High currents can also create unsafe conditions. Manoeuvrability of vessels is affected by water current velocity. In high currents and narrow channels some vessels have difficulty negotiating tight turns. Vessels also have difficulty crossing currents to move from one lock to the next (e.g. Lock #25 and #26). The cross current can direct boats towards hazardous areas. As well, navigation aids can become submerged and themselves become dangerous obstacles rather than safety markers. There are times when the system is closed to navigation due to high flows. The TSW has established shutdown flows at specific locations. When these flows are reached, the navigation locks are shut down. The shutdown flows for strategic locations throughout the canal are as follows:

- Lock 2 - 230 m^3/s
- Otonabee River at Peterborough - 130 m^3/s
- Bobcaygeon - 160 m^3/s
- Fenelon Falls - 100 m^3/s
- Port Severn - 75 to 100 m^3/s depending on the elevation of Georgian Bay. As the bay drops, navigation underneath the Highway 400 bridge becomes increasingly more difficult.

These navigation shutdown flows have been arrived at largely as a result of years of observing the difficulty boaters encounter while navigating. Typically larger, under powered vessels (e.g. houseboats) have the most difficultly when navigating during high flow periods.

The TSW issues press releases to inform users of closures and to provide warnings when warranted.

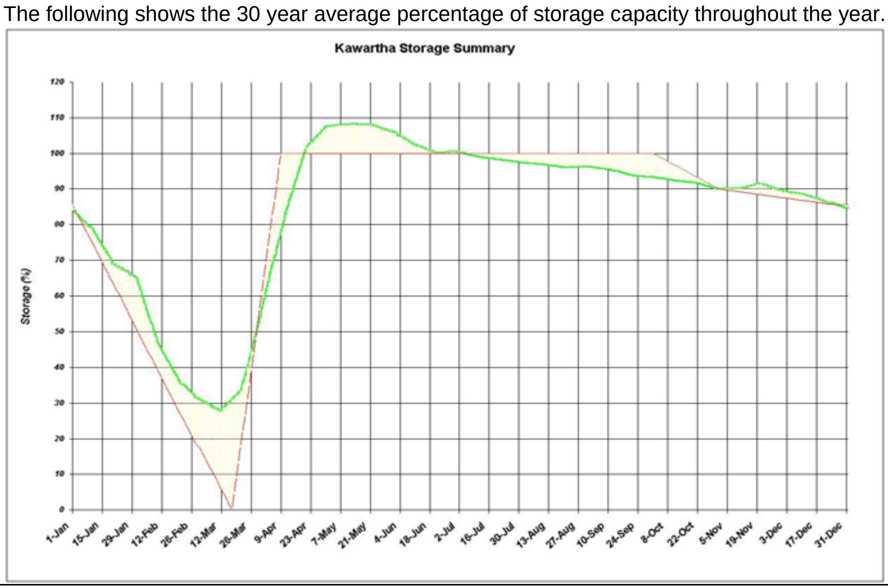
Municipal Water Intakes and Sewage Outfalls

Many municipalities depend on the water in the Waterway for their water supply and to provide assimilative capacity for its water pollution control plant discharges. Water levels, therefore, need to be maintained to provide sufficient depths at water intakes. For example, the City of Kawartha Lakes has several water treatment plants drawing water from the Waterway. Currently low water conditions at water intakes can bring the intake to within 1.0 metre of the surface. Similarly adequate flows are needed at water pollution control plant outfalls.

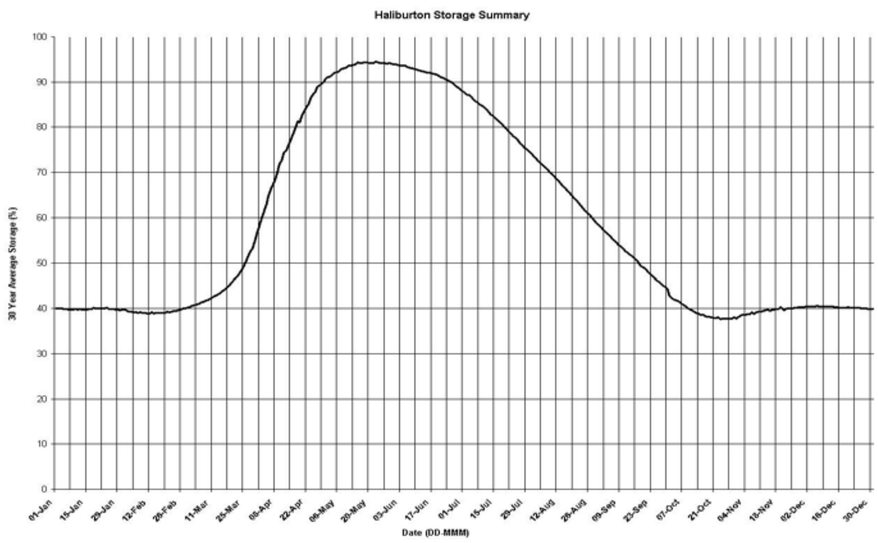
Special Agreements and Licenses

Parks Canada administers a number of licenses with various power generation companies under the *Dominion Water Power Act*. During low flow conditions, power generation companies control water levels in river reaches under the direction of TSW. In addition to formal agreements, there are a number of informal agreements on flows and levels to accommodate local issues.

Appendix 1

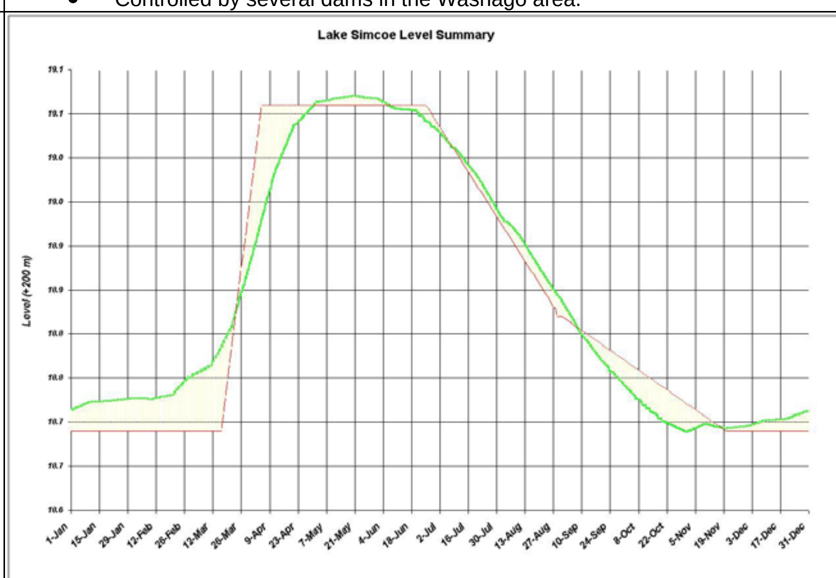
Trent River Watershed - Kawarthas		
COMPONENTS		• Include Katchewanooka, Clear, Stony, Lovesick, Deer Bay, Chemong, Buckhorn, Pigeon, Sturgeon, Scugog, Cameron and Balsam Lakes.
WATERSHED CHARACTERISTICS	**Size**	• The easterly watershed of the Trent-Severn Waterway • 12,200 square kilometres.
	Physiography	• Lies off the southern limit of the Canadian Shield in rolling countryside. • One third of the basin lies in the Canadian Shield. • Two thirds lie in the rolling farmlands of southern Ontario.
	Water Sources	• Rain, snow and ground water. • The reservoir lakes in the Haliburton Highlands.
	Runoff /Evaporation	• Rainfall run-off is slow. • Evaporation losses in the summer are high due to the shallowness of the lakes.
	Dams	• Because of the greater size of the Kawartha Lakes, and the greater volumes of water feeding into these lakes, the Kawartha Lake dams are larger. The dam at Buckhorn, for example, has four 15 metre radial sluice gates, while the Young's Point dam has six vertical gates.
BASIS OF WATER MANAGEMENT		Water levels decline over the winter to accommodate spring runoff. Levels are maintained at navigation levels during the summer and fall by supplementing local water supply with water from the Reservoir Lakes. The following shows the 30 year average percentage of storage capacity throughout the year. 
WATER MANAGEMENT APPROACH	**Winter**	• The larger Kawartha Lakes are drawn down from January 1 to March 15. • Normally, this ensures that all the lakes are at their natural low levels prior to the spring freshet. • Some dams have all their logs out, and the final level attained varies with the natural inflow during the winter. • Winters with high inflows mean that some lakes would not drop as far as we would like, thus reducing flood storage. • Dry cold winters with low inflow can cause some lakes to drop lower than normal. This causes problems on the dams because there is not enough water to run over the spillways to keep stoplogs from freezing in.
	Spring	• During spring, flows are managed to mitigate flooding and to bring the lakes to navigation levels. In some locations, flows are also managed to accommodate spring spawning fish.
	Summer	• Summer flows on the Kawartha Lakes are generally the result of reservoir storage. • Since evaporation takes more from the Kawarthas than can be replenished by natural precipitation and ground water inflows, additional water must be supplied to these lakes from the reservoir lakes.
	Fall	• In the Kawarthas, the smaller navigation route lakes, (Canal, Mitchell, Cameron, Lower Buckhorn and Lovesick) are lowered to winter levels between October 15 and December 1, to avoid problems of access and to reduce water control costs. • The larger Kawartha Lakes are allowed to drop to the middle or bottom of their navigation range.
SPECIAL CONSIDERATIONS		• The flows from the Crowe Watershed are managed by the Crowe Valley Conservation Authority (CVCA). Although there are good communications with the CVCA, the CVCA manages flows and water levels to meet its objectives. Therefore there can be a significant uncontrolled contribution of water from the Crowe Watershed into the TSW. Water from the Kawarthas needs to be controlled in relation to the Crowe flows to prevent downstream flooding.
ISSUES	**Navigation**	• Water levels are maintained at levels that provide sufficient depth for safe boat navigation. • Water is required for lock operations.
	Flooding	• During extreme flood conditions (400-450 m3/s at Peterborough), a decision may be made to flood the Kawartha Lakes above normal in order to prevent much more serious flooding downstream of Peterborough. • After the flow peak has passed, logs are placed back in the Kawartha dams as the lakes decline, until they are slightly under filled. • Then, when flows start to drop off, care is taken to catch enough water to top up the lakes.
	Water Quality	• Flows are required to dilute and flush pollutants through the system thereby maintaining water quality and reducing undesirable weed and algae growth. • Water levels need to be maintained at sufficient levels over municipal water intakes.
	Fish & Wildlife	• Spring flooding can adversely affect nesting loons. • Post freshet spring flows need to be sufficient to protect spring spawning fish (e.g. walleye). • Slow fall drawdown of Mitchell Lake is needed to avoid stranding fish.

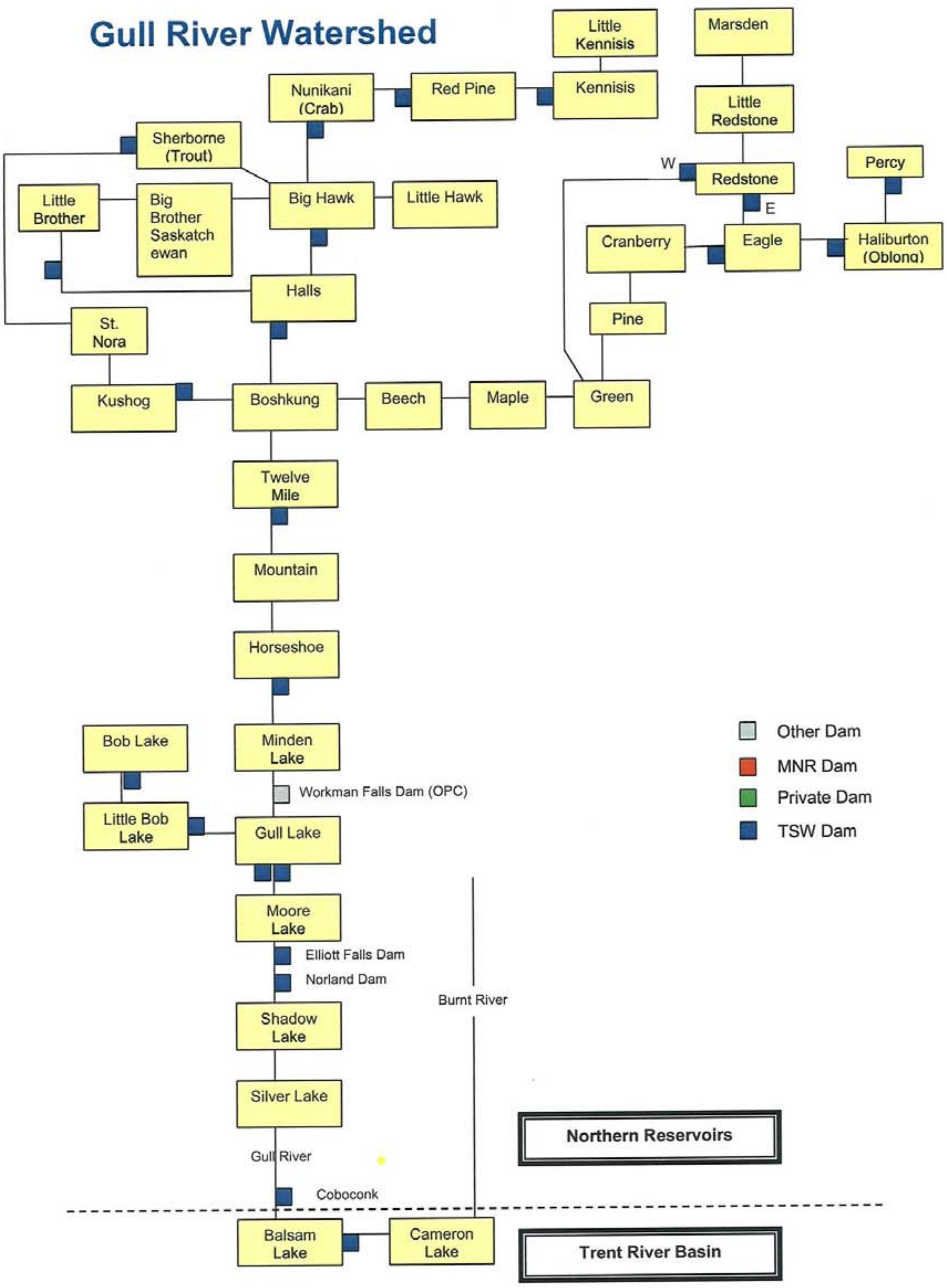
Appendix 2

Reservoir Lakes		
COMPONENTS		• Over 40 lakes in the Haliburton Highlands are dammed to store water and then flow this water to the Trent Watershed component of the Trent-Severn Waterway during the navigation period. • These lakes are on the tributaries of the Gull, Burnt and Mississaugua rivers, as well as Nogies, Eels and Jack creeks, which drain south into the Kawartha Lakes.
WATERSHED CHARACTERISTICS	**Size**	• 3,200 square kilometres of drainage area.
	Physiography	• Lies in an area of Precambrian bedrock with shallow soils.
	Water Sources	• Rain and snow melt
	Runoff /Evaporation	• Fast run-off response to rainfall and snowmelt.
	Dams	• Some forty reservoir lakes are dammed to collect spring run off water. • The dams have from one to four spillways, which are fitted with square timber stoplogs.
BASIS OF WATER MANAGEMENT		The water levels are managed according to the percentage of the 30 year average storage, which is shown in the following graph. Water is drawn from each of the lakes on an equal percentage basis according to the storage range established for that lake. For example, when a lake with a relatively large storage range of 3 metres is drawn down 50%, its level will drop 1.5 metres, while a lake with 2 metres of usable storage will be lowered by 1 metre. 
WATER MANAGEMENT APPROACH	**Winter**	• Through the winter the reservoirs are largely left alone. There are several reasons for lowering the Haliburton Reservoir Lakes in the fall: 1. The lakes must be lowered to receive spring snowmelt water. 2. Many of the dams become inaccessible in winter, and stoplog changes, often done by cutting the logs free of ice with chainsaws, is a costly and hazardous operation. 3. Only a reduced crew is available for operation and maintenance. 4. Winter enthusiasts would be endangered by changes in water levels weakening the ice cover. 5. To reach Lake Trout spawning levels before spawning occurs.
	Spring	• As spring approaches stoplogs are placed in the dams as the lakes are rising with the runoff. • If the snow is lacking, some stoplogs may be put in the dams as early as February to begin catching water. • Typically there is more inflow than needed and some surplus is allowed to run off. • As the lakes are nearing their full levels, snow survey data and all available sources of information are checked to try to determine remaining runoff volumes. • If low volumes are expected then lakes are topped up for summer. • If high volumes are expected then lakes are allowed to discharge more freely. • Heavy inflows can easily result in pulling stoplogs again to spill the surplus.
	Summer	• Summer flows on the Kawartha Lakes are generally the result of reservoir storage. • Since evaporation takes more from the Kawarthas than can be replenished by natural precipitation and ground water inflows, additional water must be supplied to the Kawartha Lakes from the reservoir lakes. • Several times a week, TSW staff reads water levels at dams and make the necessary log changes ensuring that drawdowns are proportionate.
	Fall	• Thanksgiving weekend marks the end of navigation season on the TSW. • The Reservoir Lakes typically contain between 30 and 50 % of their maximum storage. • Excess water is then run off the reservoirs and the dams are set with a certain number of stoplogs in each dam. This is done prior to October 31, to ensure that trout spawn is not exposed by falling water levels after this date. • If it has been wet, lowering the lakes takes much longer. • In dry years some lakes have to fill back up to reach their winter setting.
SPECIAL CONSIDERATIONS		• Shadow Lake near Coboconk does not have a control dam and relies on flows to maintain water levels in the lake. Modest changes in flow rates in the Gull River can have dramatic effects on water levels in Shadow Lake.
ISSUES	**Navigation**	• Movement through shallow areas and connecting channels are difficult at low water.
	Flooding	• High spring water levels can flood low lying areas.
	Fish & Wildlife	• Fall drawdown is done prior to October 31, to ensure that Lake Trout spawn is not exposed by falling water levels after this date.

Appendix 3

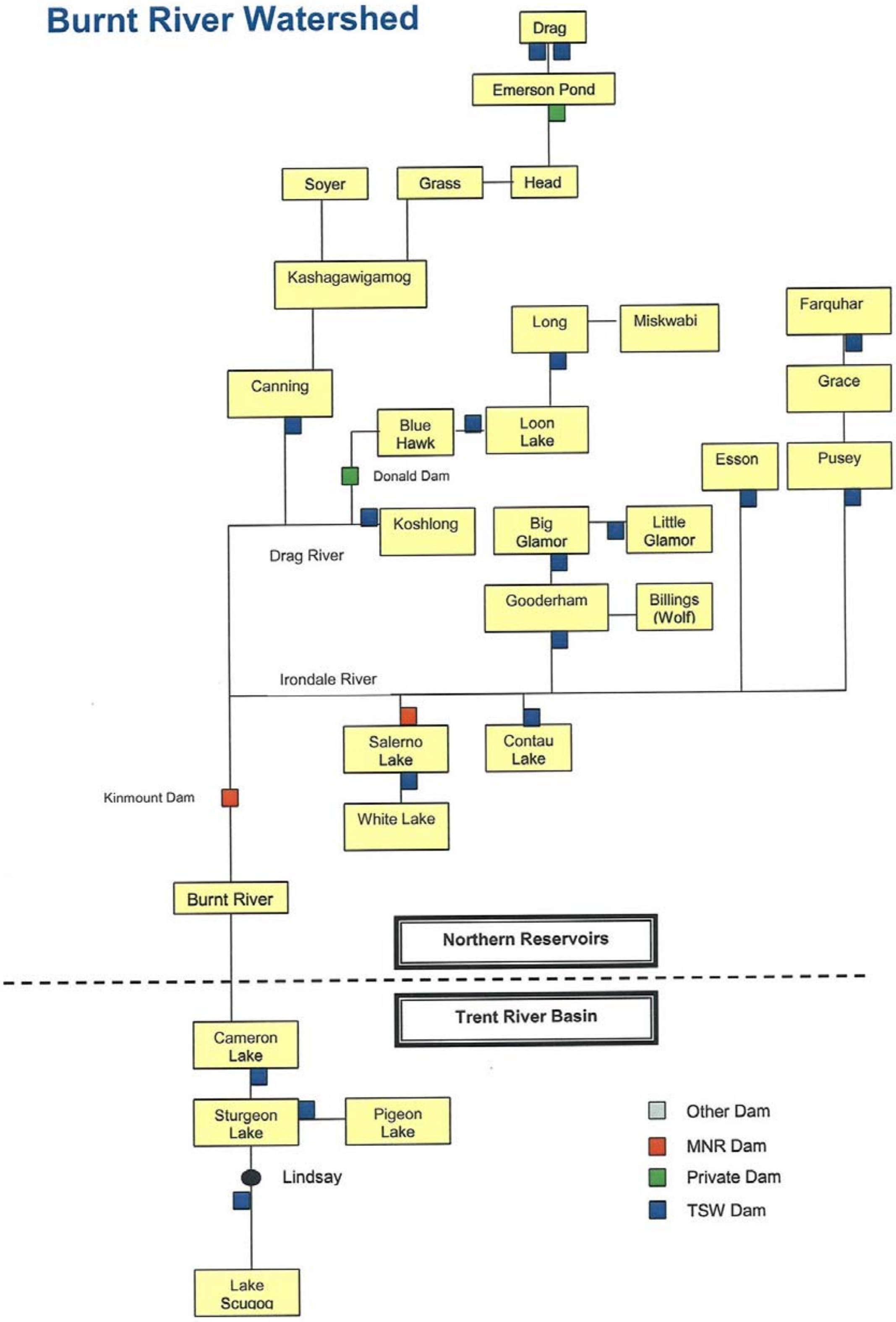
Severn River Watershed

COMPONENTS			• Lake Simcoe and Lake Couchiching Basin. • The Black River watershed feeds into the Severn River downstream of Lake Couchiching. • The lakes and channels of the Severn River below Washago include Sparrow Lake, Six Mile Lake and Gloucester Pool.
WATERSHED CHARACTERISTICS	**Size**		• 6,160 square kilometre drainage area.
	Physiography		• Lake Simcoe and Couchiching Basin mostly rolling farmland with deeper soils. • Black River Watershed is located in the thin soils and rock of the Precambrian shield.
	Water Sources		• Rain, snowmelt and ground water.
	Runoff/ Evaporation	**Lake Simcoe – Couchiching Basin**	• run-off is slow for the Lake Simcoe and Lake Couchiching Basin. • only 25% of the precipitation falling on this watershed eventually appears as a run-off flow. • drains into Georgian Bay. • receives high snow fall. • evaporation losses from both land and lake surfaces are high. • long-term average flow is 26.7 m^3/s for the Lake Simcoe and Couchiching Basin.
		Black River Watershed	• joins the Severn River below the outlets of Lakes Simcoe- Couchiching at Washago. • virtually unregulated. • produces rapid run-off of precipitation. • lower evaporation losses. • long-term average flow is 21.7 m^3/s. • high peak flows during the spring period. • maximum recorded daily flow at the Black River gauge station for the period 1915 to 2006 was in excess of 225 m^3/s. • the lowest summer minimum daily flow was only 0.4 m^3/s.
	Dams		• Controlled by several dams in the Washago area.
BASIS OF WATER MANAGEMENT			 Lakes Simcoe and Couchiching are managed using a rule curve that has been in effect since 1918. This curve serves as a target or guide for water levels throughout the year. The rule curve is shown above.
WATER MANAGEMENT APPROACH	**Winter**		• Outflow from Simcoe-Couchiching is regulated to maintain the lake near its rule curve, which is a constant level from November 20 to March20.
	Spring		• The two main Spring objectives are: 1. Fill Lakes Simcoe-Couchiching without overfilling, and 2. Minimize the effect of the peak flow from the uncontrolled Black River. • Simultaneous peaks on Lakes Simcoe-Couchiching and the Black River can result in flooding on both Lakes Simcoe-Couchiching and Sparrow Lake. The outflow from Lake Couchiching is restricted or shut off as the Black River peak passes, in order not to aggravate flooding in Washago and on Sparrow Lake. While the Black peaks, flow is reduced from Lakes Simcoe-Couchiching as much as possible to reduce the downstream flooding effect.
	Summer		• During the summer, levels are managed to the rule curve.
	Fall		• Simcoe-Couchiching is typically dropping to its lowest level without dropping below historic minimums.
SPECIAL CONSIDERATIONS			• Lakes Simcoe-Couchiching is a very large body of water and presents different management challenges. The levels take a long time to respond to adjustments. Flows are adjusted according to the lake levels. If the lake levels are higher than normal, higher outflows will be maintained. Similarly if the lake is lower than normal then lower outflows will be maintained. • Flows from Simcoe-Couchiching must also be coordinated with flows coming from the Black River to reduce the threat of high water on the Severn River and Sparrow Lake. • The natural watercourses of the Black and the Severn Rivers are constrained by numerous narrow reaches, which cause rises in river levels during high flows.
ISSUES	**Flooding**		• The Black and Severn Rivers are prone to rapid and high runoff of spring flows from an area with very little controllable storage. • The sudden release of water often overtops the Lake St. John dam, aggravating its local conditions, and flooding residents along the Black River down to Washago. • Below Washago, peak flows from the Black River can raise levels to flooding stage in the village of Washago, as well as on Sparrow Lake. • Sparrow Lake flooding is partially caused by constriction in the Severn River at Sparrow Lake Chute, McDonald's Rapids and Hydro Glen. • The cost of removing these restrictions, however, would be prohibitive, especially compared to actual economic losses due to flooding which would not be wholly eliminated by the excavations.



Gull River Watershed
Little Kennisis
Marsden
Nunikani (Crab)
Red Pine
Kennisis
Little Redstone
Sherborne (Trout)
W
Redstone
Percy
Little Brother
Big Brother Saskatchewan
Big Hawk
Little Hawk
E
Cranberry
Eagle
Haliburton (Oblong)
Halls
Pine
St. Nora
Kushog
Boshkung
Beech
Maple
Green
Twelve Mile
Mountain
Horseshoe
Bob Lake
Minden Lake
Workman Falls Dam (OPC)
Other Dam
MNR Dam
Private Dam
TSW Dam
Little Bob Lake
Gull Lake
Moore Lake
Elliott Falls Dam
Norland Dam
Burnt River
Shadow Lake
Silver Lake
Northern Reservoirs
Gull River
Coboconk
Balsam Lake
Cameron Lake
Trent River Basin

Burnt River Watershed



Nogies Creek, Mississaugua River, Eels Creek & Jack Creek Watersheds