10 Evaluation Criteria

10 Evaluation Criteria

An evaluation process was developed that would compare a proposed strategy with the current operating strategy (i.e., the Base Case). The following section describes the development of that evaluation procedure.

10.1 Overview

The identification of attributes, indicators and criteria within the watershed formed the basis for the assessment of alternative water management strategies. In compiling information on the river for which the WMP is being developed, issues and concerns were revealed as a result of consultation with the water control operators, government agencies, stakeholders and the public. From this information, a set of attributes or values was developed pertaining to priority issues within the watershed. These attributes are related to key objectives of the WMP and an approach to meeting the key objectives was then identified for each attribute. Then, by using the ARSP hydrologic computer model, the potential effects of the alternative water management strategies can be assessed using simplified indicators related to flows and water levels. The results of each alternative can be compared to the base case and to each other as a means to aid in the decision-making process. Based on conclusions drawn from these comparisons, the most effective water management strategy can be selected based on cost and others factors that included how well the preferred strategy would achieve the key objectives.

10.2 Attributes and Objectives

The identification of attributes for the Muskoka River system was founded on issues and considerations identified for the river system by the Planning Team, the PAC and through the public consultation process (as outlined in Section 3 of the Options Report and summarized in Sections 9.1 and 9.2 of this report). Based on this information, it was evident that the priority issues for the river system can be broadly grouped into those occurring within the natural environment, the social and economic environments. The key objectives of the planning process were then identified, and were used to develop indicators that were used as the basis of comparison.

These objectives and the approach to meeting the specific objective are provided in Table 10.1.

10.3 Indicators and Criteria

In order to determine whether a proposed operating strategy is an improvement over the present situation, a series of indicators were developed as the basis of comparison with the base case. Indicators are defined as specific features that can be used to evaluate the effect of a new strategy compared to the existing operating plan. Indicators provide a measurable means of determining whether the key objectives are being met.

As per MNR's Water Management Guidelines (MNR, 2002), indicators can be either quantitative or qualitative. For the Muskoka River system, estimates of water levels on the lakes and flows in the river were used as the primary indicators, and were supplemented with indicators for power generation (flow available for generation). Table 10.2 lists the indicators that were identified for each attribute. The water level and flow indicators were applied to every reservoir (defined as the affected lake upstream of the control/spill dam) and river reach (defined as the affected river section downstream of a control/spill dam). The flow available for waterpower indicator was applied at all of the waterpower sites.

Rating/evaluation criteria were developed for each indicator to define the quantitative bounds or conditions, against which effects were identified and their magnitude assessed. Criteria are defined as the numeric measures that determine if the indicator effect is positive, negative or not significant. Three criteria ratings were established to enable comparison with the base case condition. The purpose of the ratings was to determine if an alternate water management strategy is better, worse or no different than the base case.

Table 10.1
Attributes and Approach to Meeting Objectives

Attribute	Key Objective	Approach to Meeting Objective
Ecology and Natural Environment	Overall improvement in aquatic ecology	Allow a reasonable amount of annual and inter-annual variability in lake levels (based on available information and lake size).
	Recharge groundwater supplies Improve nutrient supplies to shorelines/wetland areas Access to shoreline spawning areas by spring spawning species	Raise spring levels 30 to 50 cm above established shoreline vegetation.
	Improve success of spring spawning fish species	Allow spring floodwaters to inundate shorelines for at least 45 days.
	Improve biodiversity of shoreline riparian habitat	Allow water levels to fall during the summer period by at least 20 to 30 cm.
	Improve summer baseflow in river reaches below control dams to ensure healthy aquatic ecosystems	Increase minimum flows through control dams in summer months.
	Improve lake trout spawning success	Ensure late winter/spring drawdown does not exceed fall drawdown. Preferably, the fall drawdown elevation should be 20 cm higher than the top of lake trout spawning shoals.
	Improve walleye spawning success	Maintain sufficient and consistent flows (target 14 m^3/s and 3 m^3/s in Moon River and South Falls, respectively) during the walleye spawning season (April 15 to June 3).
Social and Economic Environments	Minimize/avoid high water damage to infrastructure	TOL's on lakes not to extend above established NOZ. Minimize peak high water levels on lakes with extensive shoreline development Flows downstream of dams not to exceed maxima identified in DOM.
	Minimize ice damage to infrastructure	Delay spring high water levels until the end of April (the later the high water level the greater the potential for ice to have melted).
	Maintain continued tourism and recreational uses of lakes and waterways and access to infrastructure	Avoid excessive water level fluctuations during the summer season – target less than a 15-cm change from the present water level range between June 15 and September 30 Maintain minimum flows below dams and minimize flow fluctuations.
	Improve water quality/waste assimilation. Ensure domestic and municipal uses of water requirements met	Ensure minimum flows identified in DOM are maintained.
	Optimize power generation from renewable energy sources.	Operate control dams to release sufficient flows to meet power producer requirements.

DOM = Dam Operations Manual (MNR, 1997).

Table 10.2
Criteria for Evaluating Alternative Water Management Strategies

Attribute	Indicator	Rating/Evaluation Criteria
Natural Environment		
Lake Trout Spawning Habitat	Differential between Fall Water Level (FWL) and Winter Water Level (WWL)	10 if FWL >30 cm lower than WWL 8 if FWL is 10 to 30 cm lower than WWL 6 if FWL is 0 to 10 cm lower than WWL 4 if FWL = WWL 2 if FWL is 10 to 30 cm higher than WWL 0 if FWL is >30 cm higher than WWL
Spring Wetland/ Fisheries Habitat	Elevation of Spring Peak	+ve if >10 cm higher neutral if change is within 10 cm -ve if >10 cm lower
	Timing of Spring Peak	+ve if >5 days earlier neutral if within 5 days -ve if >5 days later
	Water Level Change in 30 Days	+ve if >15 cm increase neutral if change is less than 15 cm -ve if > 15 cm decrease
Walleye Spawning	Spring Sustainable Flow	+ve if change >10% higher neutral if change is within 10% of base case -ve if change is >10% lower
	Spring Flow Duration	+ve if duration exceeds target neutral if change is within 10% of base -ve if duration is less than target
	Spring Peak Flow	+ve if change >10% lower neutral if change is within 10% of base case -ve if change is >10% higher
Summer Ecosystem Health	7Q2 and 7Q10 flows	+ve if change >20% higher neutral if change is within 20% of base case -ve if change is >20% lower
Social Environment		
Lakes - High Water Levels	Maximum Daily Water Level	+ve if change is >15 cm lower neutral if change is within 15 cm -ve if change is >15 cm higher
	High Water Zone Exceedances	+ve if change >20% fewer neutral if change is within 20% of base case -ve if change is >20% more
Ice Damage Potential	Maximum Daily Water Level	+ve if change is >15 cm lower neutral if change is within 15 cm -ve if change is >15 cm higher
River Reaches - High Water Levels	Maximum Daily Flows	+ve if change >20% lower neutral if change is within 20% of base case -ve if change is >20% more
	High Flow Exceedances	+ve if change >20% fewer neutral if change is within 20% of base case -ve if change is >20% more

Table 10.2
Criteria for Evaluating Alternative Water Management Strategies

Attribute	Indicator	Rating/Evaluation Criteria
Summer Recreational Water Level (June 15 to September 30 period)	Seasonal Range – Median summer Level	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
	Seasonal Range – 80% of the time	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
Water Levels for Infrastructure Access	Minimum Distance to Top of Average Structure	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
	Maximum Distance to Top of Average Structure	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
Summer Recreational River Flows (June 15 to September 30 period)	Minimum daily flow (over a 7 day period)	+ve if change >20% higher neutral if change is within 20% of base case -ve if change is >20% lower
	Number of daily flow fluctuations over pre-set limits	+ve if change >20% fewer neutral if change is within 20% of base case -ve if change is >20% more
Domestic/Municipal Usage	Median Weekly Flow - Summer Period - Winter Period	+ve if change >10% higher neutral if change is within 10% of base case -ve if change is >10% lower
	Minimum Weekly Flow - Summer Period - Winter Period	+ve if change >10% higher neutral if change is within 10% of base case -ve if change is >10% lower
Economic		
Flow Available for Power Generation	Quarterly and Average Annual Flows	+ve if >2% increase neutral if change is within 2% of base case -ve if change is >2% decrease

+ve – positive
-ve – negative
7Q2 – the 7Q2 is the 7-day low flow that would occur every 2 years.
7Q10 – the 7Q10 is the 7-day low flow that would occur every 10 years.

Table 5.2 lists the criteria that were developed for each indicator, while the following sections provide the rationale for the selection of the indicators and the rating criteria.

10.3.1 Natural Environment

The health of aquatic and riparian habitat is directly affected by water levels and flows, and reacts to year-to-year, seasonal and daily patterns of fluctuation. As noted previously (Section 3), natural ecosystem have limits, and may respond negatively to imposed changes that significantly reduce or increase variability (i.e., changes that are too large or too small). The following identifies the ecological/natural environment indicators that were selected for the Muskoka River watershed and provides the rationale for their selection and the proposed limits of change (as pertaining to water levels or flows):

- **Differential between Fall and Winter Water Level for Lake Trout Habitat** -- On many of the large lakes, water levels are drawn down in the late winter/spring to reduce the potential for spring flooding (increases storage to capture the spring freshet) and provide flow for waterpower production during the winter months. Lake trout are present in many of these managed lakes, and spawn during the fall (mid-late October) in water as shallow as 0.1 m deep. Eggs and developing fry remain within the spawning substrate until late April-early May before the juveniles disperse to open water. A late winter/early spring water level that is lower than the level during lake trout spawning may be exposing eggs or fry to desiccation or ice scour.

  The differential between fall and winter water level was used as the basis for this comparison. The evaluation criteria ranks the current and the proposed operating strategy, and then compares the two values to provide an overall rating. Considering the possibility of ice cover/ice scour, the best case scenario is one in which the winter drawdown level is 30 cm above the fall drawdown level (i.e., there would be at least 40 cm of water/ice over eggs/fry during the incubation and development period). While this situation is considered the best, the least favorable case is one where the winter drawdown is 30 cm or more below the fall level. In this situation eggs or fry near the top of the shoal may be dewatered and exposed or subjected to ice scour. A range of scores was developed for potential scenarios between those two limits.

- **Spring Water Levels for Wetlands/Fisheries** -- Spring water levels, that inundate the riparian zone and maintain that high level for a longer time period (so as to allow progeny of spring spawning fish and amphibian species that utilize floodplain habitat to return to the main water body) would provide preferred conditions for wetlands and the species that depend upon them. In addition, higher spring levels recharge groundwater supplies and transfer flood water nutrients to the riparian zone. Three indicators were developed to evaluate this attribute. The elevation of the spring peak, the timing/date of the spring peak (earlier or later), and the duration of the spring peak (as measured by the amount of water level change over the 30-day period after the spring peak) were used to assess whether spring lake conditions were improved for wetland ecology and spring spawning fish species.

- **Spring Flows for Walleye Spawning** -- A consistent, sustainable flow for the entire duration of the spawning season is an extremely important factor in hatching/incubation success. In addition, large variability in flows and/or peak flows could induce spawning in areas that are subsequently dewatered later in the season when flows naturally decline, and/or could result in stranding or dislocation of eggs/fry and are therefore considered a negative effect. Three indicators were developed to evaluate whether spring flows in the two major walleye spawning areas (South Falls and the Moon River) were improved.

- **Summer Base/Low Flows for Ecosystem Health** -- Low flows/base flows within a river system are an indicator of the ability of the system to sustain aquatic life during periods of drought and provide a good indicator of ecosystem health. In addition, flow values that would be present under an undeveloped or natural flow regime, can be calculated and compared to the existing situation and any proposed case. For this comparison, the indicators selected for this attribute were the 7Q2 and 7Q10 flow values. The 7Q2 is the 7-day low flow that would occur once every 2 years, while the 7Q10 is the 7-day low flow that would occur once every 10 years. An increase of more than 20% was deemed to be a positive effect.

10.3.2 Social Environment

The social indicators were developed primarily to assess the potential effects of water level and flow changes on the built environment (i.e., docks and boathouses) and shoreline residents who require access to these structures. The availability of water to meet domestic and municipal needs was also assessed. The social indicators include the following.

- **Maximum Lake Levels --** High spring levels may inundate docks, boathouses and other shoreline structures, and result in damage to the integrity of these structures. Two indicators were developed to compare the base and proposed case concerning the potential effect of high water levels on lakes. The maximum daily water level, calculated as the average of the maximum daily level over 50 years of simulated data, was used to compare the base case and a proposed case. An increase of more than 15 cm (6 in.) was considered significant, and would be a negative effect. Similarly, a 15 cm lower level would be a positive effect. The second indicator was the number of exceedances of the high water zone (HWZ) as defined by the elevation identified for each lake on the present operating curves. The HWZ elevation has been identified as the lake elevation above which the chance of property damage increases. Fewer exceedances of this HWZ level would be considered a positive outcome.

- **Ice Damage Potential** -- High spring water levels can increase the potential for ice damage to docks and other structures, and can be used to compare the two operating strategies with respect to their potential for ice damage. Ice-out dates are variable throughout the years, are not a reliable indicator of the potential for damage, and are therefore not taken into consideration. Again, average maximum water levels that are more than 15 cm (6 in.) higher have an increased potential to result in ice damage to structures, and would be rated negatively for this criteria. Water levels 15 cm lower would be positive.

- **Maximum River Levels/Flows** -- Two criteria were developed to examine the potential effect of high river water levels and flows. While no information is available to relate flows to water levels for the river reaches throughout the watershed, an indication of improved or deteriorated conditions can be obtained by comparing maximum flows. Similar to maximum water level, the flow value selected for comparison is the average of the maximum daily flow over 50 years of simulated data. A maximum flow value greater than 20% lower is considered a positive effect, while a maximum flow 20% higher is considered negative. The second criteria compared the number of exceedances of the maximum flow value for individual reaches as identified in the DOM with the maximum daily flow value derived from the model runs. Fewer exceedances of the DOM value (by >20%) were considered a positive outcome, while an increase of more than 20% was considered to be negative.

- **Summer Recreational Season Water Levels** -- Two indicators were used to assess the effect of the proposed strategy on summer recreation season water levels. The first examined median water levels during the June 15 to September 30 period, and compared the seasonal range (determined as the difference between the maximum median level and the minimum median level during the above-noted time period) between the two operating strategies. The second examined the 80^{th} percentile range over the same seasonal time period. While the first criteria would provide average conditions, the second would provide more wide-ranging conditions (i.e., the seasonal range that could be expected 80% of the time). In both cases, a change of 15 cm was considered significant (positive if less than 15 cm, negative if more).

- **Infrastructure Access** -- The average elevation for the top of docks and docks associated with boathouses on most developed lakes was determined during the study (A&A, 2002 and Acres, 2004c). These elevations were compared to the maximum and minimum median water levels during the summer recreation season (June 15 to September 30) to determine whether the proposed strategies improved or hindered access to this infrastructure. An increase of more than 15 cm was considered negative, while a reduction of more than 15 cm was considered positive.

- **Summer Recreation Season River Flows --** Two indicators were developed to examine river low flows and the change in river flow (on a daily basis) during the summer recreation season. The first indicator compared the minimum flow value over a 7-day period between the base case and the proposed case. The second indicator examined the change in river flow on a daily basis above a pre-established flow value that varied according to location within the watershed. The indicator compared daily flow fluctuations greater than 1 m^3/s for upstream river reaches, daily flow changes above 3 m^3/s for mid watershed river reaches, and daily flow changes greater than 5 m^3/s for the lower watershed reach (i.e., below Bala dams). The various flow values were selected on the basis of the existing target base flows within the respective watershed areas.

- **Domestic/Municipal Water Uses** -- Four indicators were used to assess this attribute. Median and minimum weekly flows for both the summer period (May to October) and winter period (November to April) were evaluated. Flows that were 10% higher were considered to provide a positive rating.

10.3.3 Economic Indicator

While it is recognized that many of the social indicators noted above have economic implications (particularly with respect to access to resort docks and facilities, suitable water levels for recreational activities, etc), a single indicator was selected to compare economic attributes between the present and future strategy, being a comparison of the flow available for waterpower generation. Flow was intentionally selected, as opposed to megawatt-hours or dollars of power generated, as the opening of the competitive electricity market allowed producers to target specific daily or seasonal periods, which means that available flow may be utilized selectively. Quarterly and annual average flows were calculated and compared, with an increase of over 2% considered to be a positive outcome, while a 2% reduction would be a negative outcome.