White River, Middle Fork
Water Resource Inventory

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Executive Summary

This is the fourth annual report relating to the water quantity program for the White River, Middle Fork. This monitoring program is administered by Slocan Forest Products Ltd. and funded by FRBC. White River is a mountain stream located in the Rocky Mountains of the East Kootenays. This station was established to determine the baseline conditions in watersheds based on the interests of the Ministry of Water, Land and Air Protection (MWLAP), the Ministry of Sustainable Resource Management (MSRM), the Ministry of Forests (MoF) and SFP. It does not have community watershed designation, or for that matter, function as a source of potable water to a permanent community. White River is of major importance for fish habitat and recreational purposes and was identified as a representative watershed for a Provincial hydrometric network (reference Klohn and Crippen – Regional Hydrometric/Climate Network Analysis for the Kootenay Region, 1996/97).

Road building and tree removal can have significant impacts on the water quality and quantity of streams. For these reasons, White River, Middle Fork was considered a high priority stream for water quality and quantity monitoring. Nanrich Water Management Consultants Ltd. (NWMC) has conducted a water quantity study White River, Middle Fork at the Slocan Forest Products/FRBC hydrometric station. Since 1998, this study has been undertaken to provide on-going data on the current standard of water quality in White River, Middle Fork. The baseline data collected on the physical, characteristics of White River, Middle Fork will be used to develop Water Quality Guidelines consistent with the site-specific characteristics and seasonal and temporal variation inherent to this drainage. The baseline data will also be used to compare any changes observed as future development in the drainage occurs.

The project protocol was to collect continuous water level data, water and air temperatures, and precipitation information from continuous sensors. Stream flow measurements were made to develop a stage/discharge relationship for the computation of stream flow (discharge). The station operated seasonally from May 2 to October 26, 2001. The hydrometric data collected appears to be very good, with the collection of accurate, continuous data.

In summary, it is recommended that the following additions or modifications be made to the water quality and quantity sampling program on White River:

- automated, field monitoring should continue seasonally and for at least another two years, in order to determine the natural variation within the watershed on a temporal scale at this one site as activities within the watershed in the next five years is anticipated to include approximately 200 ha.

1 INTRODUCTION

1.1 BACKGROUND

Slocan Forest Products owns the infrastructure at the White River Hydrometric Gauging Station in the White River watershed near Canal Flats B.C. Slocan Forest Products (SFP) commissioned Nanrich Water Management Consultants Ltd. (NWMC), August 1998 to conduct the water quantity monitoring program for the White River. This station was established to determine the baseline conditions in watersheds based on the interests of the Ministry of Water, Air and Land Protection (MWLAP), the Ministry of Sustainable Resource Management (MSRM) and SFP. The funding for this project is administered by Slocan Forest Products through funding from Forest Renewal British Columbia (FRBC).

This project is to maintain the automated water quantity monitoring station on the White River, Middle Fork at 59.5 km, and to conduct physical water quantity measurements during the open water period. The water quantity program is to develop a stage/discharge relationship by making periodic stream flow measurements throughout the period.

1.2 RATIONALE AND OBJECTIVES

This report on the water quantity of White River, Middle Fork was funded through FRBC's Water Resources Inventory Program. This program, working in partnership with the Ministry of Water, Air and Land Protection (MWLAP), the Ministry of Forests (MoF), community groups and forest licensees, develops monitoring programs for community watersheds and watersheds with high aquatic resource values. These monitoring programs gather data and trends information on the physical, chemical and biological characteristics of high priority watersheds. A network of streams across the province is monitored to accumulate background data with which future land management decisions can be made.

The White River watershed was chosen as one of the more important watersheds for study in the Kootenay Region (Klohn and Crippen – Regional Hydrometric/Climate Network Analysis for the Kootenay Region, 1996/97). Although it does not have community watershed designation, or for that matter, function as a source of potable water to a permanent community, White River is of major importance for fish habitat and for recreational purposes. White River empties into the Kootenay River, a popular recreational area for hunting, camping, hiking and fishing. In addition to recreation, forestry activities, including timber removal and road building are ongoing within the watershed. It is considered important to track the effects of these anthropogenic influences on water bodies that are integral to the survival of a high value fisheries resource (IWAP, Armstrong & Associates, 1997 and NWMC Water Inventory Reports, 1998/2000).

Through the monitoring of watersheds like White River, the Water Resources Inventory Program hopes to achieve the following objectives:

- to provide inventory information for forest managers to assist them in meeting Forest Practices Code (FPC) requirements;
- to provide information for strategic resource management planning and decision making at the community and regional level;
- to establish baseline water quantity data;
- to develop specific criteria and objectives for water quantity and quality management and attainment reporting using established baseline data;
- to assess and monitor watershed restoration initiatives and;
- to assess the efficacy of management decisions, policies, legislation and regulations.

In addition to these general goals of the Water Resources Inventory Program, specific objectives of the White River Water Resources Monitoring Program are to:

- to collect good quality water quantity data;
- to provide data leading to an accurate assessment of the state of health of the system;
- to determine the natural variability inherent in the system and;
- to determine water quality objectives specific to White River.

All of the aforementioned goals and objectives will only be achieved through repeated and consistent monitoring of the water quantity characteristics of White River. This report constitutes the forth year of sampling, however, several subsequent years worth of data is necessary to establish a baseline dataset. As well, this is only the third year that data was collected through a complete runoff season. Through the analysis of this dataset it is hoped to fully characterize and understand the physical and chemical state of this stream. This dataset will also provide a basis on which to determine the best management practices for the White River watershed.

This project was to maintain the automated water quantity monitoring station on the White River, Middle Fork that will also serve to conduct an assessment of the physical water characteristics and their spatial and temporal variability for the protection of aquatic life.

1.3 WATERSHED CHARACTERISTICS

1.3.1 LOCATION AND MORPHOMETRIC INFORMATION

The gauging station is located at the Middle Fork Forest Road bridge at 59.5 km on the Middle Fork of the White River, approximately 65 km east northeast of the community of Canal Flats. The site is located on the right bank approximately 150 meters upstream of the bridge.

The equipment is housed in a metal box on top of a 16 inch culvert pipe that is attached to the bank with very light perforated angle iron. Attached to the culvert pipe is a staff gauge to obtain outside water levels.

The streambed at the station is composed primarily of large rocks and very coarse gravel. The general course of the stream is straight for about 100 m upstream and downstream of the gauge site. The flow is confined to one channel with moderately high banks. The banks are approximately 2 -2.5 m above the streambed and may overflow during an extremely high runoff. The streambed does not appear to be subject to scour and fill and at low stage was free of aquatic growth.

The slope of the stream at the sight would be deemed as moderate. The channel is uniform with the water surface profile parallel to the bed; the slope and therefore the fall should be the same for all discharges.

This sub-basin is relatively stable, with a hydraulic control primarily made up of large rocks, and course gravel. The channels are well armored with relatively low sinuosity.

- Location: Latitude: 50:16:43N
  Longitude: 115:12:02W
- Elevation: 1442m
- Drainage Area 309.75 km^2

- Average Depth: 0.6m low water/1.0m high water
- Average Width: 17.5m
- Stream Slope 0.012 m/m
- Stream Bed Material: 20% large rocks, 50% medium cobble, 30% Gravel
- Maximum Inst. Discharge: 38.0 m^3/s @ 21:53 MST on May, 25/01
- Maximum Daily Discharge: 34.93 m^3/s on June, 19/99
- Minimum Daily Discharge: 2.65 m^3/s on October, 28/00

1.3.2 WILDLIFE OBSERVATIONS

Many types of habitats lie within the White River watershed and are capable of supporting large amounts of different species of wildlife. In general it would appear that there are large wildlife populations for many species because of the habitat abundance.

When visiting the station on a routine basis, wildlife was observed on every visit. The species most commonly observed from the White River Forest Road were black bear, grizzly bear, moose, elk, white tail deer, mule deer, coyote, and wolf. Birds also have a management emphasis within the watershed and many birds of various species were observed.

1.3.3 ANTHROPGENIC SEDIMENT SOURCES

The station is located in a wide gently sloping valley approximately 1600 m wide. Slopes in the basin, between the high mountains, are between 10 to 30%, steeper as the valley rises to the mountains. The station is 1442 m above mean sea level. The basin at the site has been previously logged and therefore is very sparsely timbered. There was a fire that disturbed much of the Rock Canyon Creek drainage. The soils in the watershed can be summarized as derived from metasedimentary argillites and quartzites that weather to silty materials. The area is primarily well drained gravelly, silty colluvial or morainal blankets. Moderately course fragments cover 10 - 40% of the soil surface.

1.4 MANAGEMENT ISSUES

White River has no major management issues. White River is also considered to be a moderately high resource fish stream. The upper and mid ranges of the White River watershed are part of the Elk Lakes Provincial Recreation Area.

1.4.1 RESOURCE USE

Forestry

The Middle Fork Watershed is a north-south drainage located in the Park Ranges of the Rocky Mountains. Middle Fork is one of the main tributaries of the White River. The area is approximately 31 000 ha of which 16 200 ha is designated Class A Crown Provincial Park. The operable area of the Middle Fork Watershed that is available for harvest is approximately 6500 ha. The majority of the operable area is situated along the valley bottom and low elevation stands. Approximately 2900 ha of the watershed has been harvested (IWAP – Armstrong and Associates, 1997).

Slocan Forest Product’s Forest Development Plan identifies that approximately 200 ha will be harvested in the next five years. The existing Equivalent Clearcut Area for the Middle Fork drainage is approximately 7.1% of the land base. Since the 1997 Armstrong and Associates Report, 193 ha have been harvested and 7 km of roads have been cleared. Harvesting that took place in 2001 consisted of two sub basin areas. Sub basin “D”, 31 ha and sub basin “E”, 37.1 ha were harvested. As well, there were 124.8 ha Residual and 7 km of roads in Residual harvested (Jablanzcy, Slocan Forest Products, pers. com.)

1.5 MONITORING WATERSHEDS

An ecosystem such as the White River watershed can be defined as a functional unit of the landscape comprised of a biotic community interacting within and between an abiotic environment. Abiotic (non-living and inorganic) factors such as temperature, light, water and nutrients interact with the biota (living and dead organic material) and determine the type and abundance of species found. With anthropogenic activities like forest harvesting or road building, new or additive factors are introduced to these systems.

The functioning of freshwater systems involves processes occurring in the atmosphere and the terrestrial watersheds they drain. Changes to the climate or land base can therefore have indirect effects on freshwater systems. A wide range of physical, chemical and biological changes to the environment can result in direct impacts on freshwater systems.

Careful evaluation of the status of the environment is required for a clear understanding of changes outside the natural range of variation for an aquatic system. If possible, the state of the environment prior to modern human use should be monitored for several years, to determine the natural conditions and variation inherent in the system. In this way, further study throughout the duration of the activity or stress can determine if and how the system responds. Mitigative measures can then be taken in order to reduce or minimize any negative effects. Underestimating the potential effects may result in deleterious changes to the ecosystem, but overestimating potential hazards may result in undue social and economic restrictions. This is why it is important to measure as many aspects of the aquatic environment as possible. Harvesting in a watershed can have an effect on the runoff characteristics of a stream. Climatic effects, precipitation especially, within these harvested areas can increase the discharge rapidly during freshet and other storm events, which inversely has a tendency to decrease rapidly after these events take place within the watershed. This creates a very sensitive and responsive hydrograph that closely follows the climatic events that take place in the drainage.

1.6 PHYSICAL MEASUREMENTS

Physical measurements, along with chemical measurements, are included in the abiotic or non-living components of the environment. Physical attributes of a watershed include the geology of the area as well as climatic characteristics, such as fire frequency, solar radiation, type and amount of precipitation, wind direction and speed. Physical measurements give an idea of the structure of the environment and the basic processes that support or limit its life, such as the amount of solar energy and water that it receives. This study has measured basic stream characteristics including channel width and depth, substrate composition, water level, air and water temperature and precipitation at the White River station.

2. METHODS

2.1 SITE DESCRIPTION

For this study, White River was measured at one site within its drainage basin. The site is located just upstream of the bridge crossing at 59.5 km on the Middle Fork Forest Access Road. The gravel road is used by recreational and forestry traffic and offers direct access to the White River site, which is easily accessed from late spring to late fall.

2.2 CONTINUOUS MONITORING

The White River, Middle Fork site was equipped with continuous monitoring equipment. This equipment gathered water level data, air and water temperature and precipitation data.

2.2.1 HYDROMETRIC MEASUREMENTS

2.2.1.1 Water Level Data

The hydrometric station was reactivated on May 2, 2001. The methods used to measure the streamflow for water quantity are the standard operating procedures for hydrometric surveys and based on standard methods used by Water Survey of Canada which is the model used in the RIC Standards for Operating Procedures for Hydrometric Surveys in B.C. The methods used to calculate the data are based on the Water Survey of Canada, which meets or exceeds RIC Standard Operating Procedures for Hydrometric Surveys in B.C.

The stream flow records referred to above are primarily continuous records of discharge at this stream gauging station. A gauging station being a stream-site installation so instrumented and operated that a continuous record of stage and discharge can be obtained.

Continuous record of stage at White River is obtained by using a **Hobo 2K** data logger produced by *Onset Computer Corporation*. The instrument is programmed to archive data every thirty minutes.

The system is activated by using a float in a 300mm culvert pipe that is attached to a shaft encoder that records the changes in water level on a continuous basis. Changes in water level were detected as voltage changes, and an equation to convert voltage to water level was used.

This equation is as follows: ***water level in metres = 0.6343 * Volts + 0.00439292.*** Reference water levels are obtained by using an outside gauge (staff gauge plate) attached to the culvert pipe. The Logger is programmed to log and record water levels every thirty minutes.

2.2.1.2 Stream Flow Measurements

Discharge measurements are made at periodic intervals, usually every four to six weeks, to verify the stage-discharge relation or to define any change in the relation caused by changes in channel geometry and or channel roughness. Streamflow or discharge is defined as the volume rate of flow of water expressed in ***cubic meters per second (m^3/s).*** Discharge measurements are made by one of many methods. The conventional method most commonly used in gauging streams is using a current meter. When using this method, observations of width, depth and velocity are taken at intervals in a cross section of the stream while wading or by using a bridge to support the metering equipment. During winter, measurements may have to be made from the ice cover. The current meter is used to measure the velocity through a timed interval. Discharge (m3/s) in any given stream is the product of the velocity and the cross-sectional area at a given section in the stream. A Price 1210 AA current meter was used to measure velocity during this program.

During the period of operation for this report, wading measurements were made by using a dry hand wading rod to suspend the current meter in the water at low stage. A bridge frame was used to suspend the current meter and weight assembly from the bridge at medium and high flows.

2.2.1.3 Temperatures and Precipitation

Air and water temperatures are also collected on a continuous basis. The Hobo Logger is programmed to collect temperatures every thirty minutes. A ***Hobo Event Logger*** is used to collect the precipitation data. This data is recorded every time a precipitation event takes place and records the date, time and amount of precipitation when this occurs. The precipitation was measured using a tipping bucket rain gauge that measures precipitation when 1/100th of an inch of precipitation is collected. The event logger logs the 1/100th of an inch of precipitation as an event. These events are converted, using the BoxCar 4.0 program, to a precipitation graph (Appendix B, Figure 1.4)

2.3 DATA ANALYSIS

2.3.1 CONTINUOUS MONITORING

The streamflow data was analyzed according to standard operating procedures for hydrometric surveys (WSC and RIC Standards). Interpretation and detailed methodology was provided by NWMC for collecting and analyzing the automated water quality and quantity data recorded at this station. The automated data was graphed, and a comparison of discharge was made by using similar type streams and meteorological data; in this case the data and hydrograph was compared with Matthew Creek above Diversions, E231497 and meteorological data from Cranbrook.

2.4 QUALITY ASSURANCE AND QUALITY CONTROL

The field quality assurance program was a systematic procedure, with qualified, trained and experienced personnel who followed established protocol conducting the monitoring program. Quality assurance for the continuous data is slightly problematic. While operating manuals for automated monitors exist (MELP, 1998), there are no standards for ensuring the accuracy of sensors, data standards, software and hardware.

The data loggers used for this project (HOBO) are not of the quality and accuracy recommended for use by WSC. They therefore have to be very closely monitored for discrepancies in water level/data logger readings. A logger correction table is produced (Appendix B, Table 1.3) to record these logger corrections and these corrections are applied linearly to the water levels collected by the logger from visit to visit (Hydrometric Technician Career Development Program, Volume 1-5, Water Survey of Canada, Environment Canada).

As previously mentioned, reference water levels are obtained by using an outside gauge (staff gauge plate) attached to the culvert pipe. Twice a year the staff gauge is checked for stability by using a survey-leveling instrument and referenced to permanent benchmarks established at the sites.

Quality assurance of the data is confirmed by comparing the data and hydrograph with that of a similar type stations in the area; in this case the data and hydrograph was compared with Matthew Creek above Diversions, E231497.

3. RESULTS AND DISCUSSION

3.1 HYDROMETRIC SUMMARY

The Hydrometric Station at White River was operated and maintained by NWMC personnel from May 2 to October 26, 2001. Five discharge measurements were made to qualify the stage/discharge relationship of the stream. Continuous data was collected from May 2 until discontinued, for the season, on October 26.

The 2001-runoff characteristics were typical of high mountain streams in the interior of BC. There were two major and significant peaks, during the freshet period. The steep shallow soils of the White River basin yield significant amounts of precipitation to stream flow and this creates a hydrograph dominated by high flows in the spring when precipitation is high and transpiration is low. Flows are normally reduced through high transpiration rates during the summer with low precipitation rates. This year the precipitation rates were high during the spring, sustaining a near normal runoff through to the first week in July. Also significant with runoff characteristics in this basin, which yields high flows in July, is the runoff from the high glacial reservoirs in the north of the drainage basin which runoff with the warmer summer temperatures.

During the winter, there was a below normal snow pack, approximately 50% of normal, within the watershed area (MWLAP – Snow Survey Bulletin). Cool spring temperatures continued into the middle of May when the runoff started to increase. There was a peak on May 25 that cleaned off the snow in the mid to upper elevations of the mountains, brought about by a week of warm, wet weather. This was the maximum for the year. The second and less significant peak occurred on May 28. The flows generally declined in June but remained above normal throughout July and August as the melt from the glaciers in the north of the drainage reduced the high elevation snow pack. Temperatures were high and precipitation low from mid July through August. There were several significant precipitation events in September that increased the flows slightly during the first and third week. October brought cooler temperatures with some precipitation at the beginning and end of the month. Runoff throughout this period remained normal and dropped significantly with the cooler temperatures at the end of October.

The total discharge for the period of operation amounted to 114,452 dam^3 and the average daily discharge for the six-month period was 7.46 m^3/s. The maximum daily discharge for the period occurred on May 26 with a discharge of 20.7 m^3/s, the maximum instantaneous discharge occurred at 21:53 MST on May 25 and was 38.0 m^3/s. The low for the period of record was 1.88 m^3/s on May 3 (Appendix B, Tables 1.6 & 1.7). There were no data gaps for the period and corrections were made to the gauge reading using the logger corrections obtained from each visit (Logger Correction Appendix B, Table 1.3). Overall the record from the station for the period May 2 to October 26 can be rated as very good. The stage/discharge relationship is also very good well within the +/- 5.0% deviation, the average being <1.5% from *Stage Discharge Curve #5* (Appendix B, Figures 1.1, Water Quantity Data and Computations). A hydrograph (Appendix B, Figure 1.2) showing the trend in the flow characteristics is displayed in Appendix B.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 STUDY SITES

Through the incorporation and concurrent interpretation of the physical data gathered from the White River site, it is possible to make some conclusions regarding the structure and functioning of this watershed. While at least several more years of data are required to fully characterize the water quantity and its variation at White River, several preliminary conclusions can be made.

The hydrometric data collected appears to be very good. As previously discussed the infrastructure proved to be very successful in the collection of accurate, continuous data. The stream is relatively stable to changes in streambed control, resulting in minor changes to the stage/discharge relationship when major runoff takes place. The steep shallow soils of the White River basin yield significant amounts of precipitation to stream flow, creating a hydrograph that is dominated by several peaks of high flows during the spring and summer runoff when precipitation is high and transpiration is low. Normally during the summer and fall months flows are reduced through high transpiration and low precipitation rates. This year, during the summer months, the flow remained above normal; with appreciable increases in July from the high glacial reservoirs in the north of the drainage basin which runoff with the hot summer temperatures. Late fall storm events were also noted as slight increases in flow, indicating that the creek is very responsive to watershed events. Even though the total runoff was 70% less than 2000, the instantaneous maximum for 2001, was higher for the three years of record, but decreased very quickly in June as compared to the other year’s data. Quality assurance of the data was confirmed by comparing the Middle Fork data and hydrograph with that of a similar type stations in the area; in this case the data and hydrograph was compared with Matthew Creek above Diversions, E231497. The data and hydrographs compared very well even though the drainages are in different areas.

Precipitation data collected at the station was very good (Appendix B, Figure 1.4). The discharge hydrograph (Appendix B, Table 1.2) followed very closely the events that took place within the drainage. The discharge hydrograph is very responsive to the storm events that take place and show definite increases in flow when these events take place.

A water quantity inventory program establishes a database for future development within that watershed. The main value of water quantity monitoring is to determine the physical characterization of the stream. The data collected to date is unlikely to give representative values of the stream. Continuous long-term monitoring enables us to more accurately determine the various parameters of the stream during seasonal and climatic changes within the watershed.

The present infrastructure is established and developed to monitor and produce such data. This inventory will provide information to produce a database that will facilitate adaptive management of the Forest Practices Code standards for forest development planning and can be used to measure the efficiency of such planning in protecting the water resource on forestlands.
The water quantity data gathered so far at White River, Middle Fork forms the basis of a baseline data set. As long as the established monitoring programs continue, along with recommended improvements, this project will provide important information on the structure and functioning of this aquatic system. Following the collection of several years of quality assured data, enough information should be present to give an excellent understanding of the seasonal dynamics to correlate the physical characteristics of this stream. It is hoped that this information will be of use to the general public as well as to government and industry. This information could be key in influencing water management decisions, in addition to helping the forestry industry make sound forestry practices which minimize the impacts on water quality and quantity.

4.2 SAMPLING DESIGN AND TECHNIQUES

It is recommended that water quantity monitoring continue at this site for at least another two years. Sampling should continue seasonal in order to determine the natural variation at this site on a temporal scale, especially since no other sites are monitored for spatial differences. The addition of chemistry and biological sampling would greatly enhance and support the water quantity data gathered at this site, particularly because of the high fisheries values of the river. Additional water chemistry information such as nutrients (nitrogen and phosphorus), metals (toxic metals and essential elements), hardness and alkalinity would greatly increase NWMC's ability to characterize and describe this watershed. The hydrometric parameters measured in this study can go far in describing a site, however, an enhanced understanding of White River is possible through additional parameters.

Unfortunately, the infrastructure as it presently exists can only be operated seasonally (May to November), at best, as the culvert well freezes when the temperatures drop below freezing. When the water freezes in the well the float freezes into the ice and cannot move up and down with changes in stage. This situation can continue into the first week in May unless maintenance work is performed to thaw the ice in the culvert well.

4.3 SUMMARY OF RECOMMENDATIONS FOR FURTHER WORK

In summary, it is recommended that the following additions or modifications be made to the water quality and quantity sampling program on White River:

- automated, field monitoring should continue seasonally and for at least another two years, in order to determine the natural variation within the watershed on a temporal scale at this one site;
- periphyton and benthic invertebrate sampling should be included into the program, due to their importance in providing fish habitat in this high value fish stream. This biological sampling should occur throughout all seasons, however, if this is not feasible, sampling should occur in the early fall;
- habitat analysis for benthic invertebrates and fish should be conducted in addition to a detailed fish inventory. If this information has already been collected, then future reports should consolidate this fisheries information with the water quality and quantity information gathered from this program so as to best characterize and describe White River.

The water quantity data gathered from White River to date forms the beginning of a baseline data set. As long as the established monitoring program continues, along with recommended improvements, this project will provide important information on the structure and functioning of this aquatic system. Following the collection of several years of quality assured data, enough information should be present to give an excellent understanding of the seasonal dynamics and correlations of the physical characteristics of this stream.

The baseline characteristics of water quantity, which have begun to be established on White River, can be affected by anthropogenic activities, including the forest harvesting occurring within this watershed. Ecosystems that have been subjected to events such as road building and logging may continue to respond to them for decades or centuries. The projected long-term responses, so often ignored, are complex and important to discover. Long-term studies may be the only way to detect slow processes, rare events and subtle changes. They may also be the only way of understanding cumulative impacts, both natural and anthropogenic.

Because forest harvesting is ongoing within White River, a stream with high fish values, it is imperative that its water quality and quantity be documented in order to best manage these two important users of the watershed. It is hoped that this information will be of use to the general public as well as to municipal and provincial governments and the forestry industry. This information could be key in helping the forestry industry follow sound harvesting and road-building practices to minimize the impacts on water quality and quantity. Eventually, site specific Water Quality Objectives will be determined by the Ministry of Water, Air and Land Protection (MWLAP) to ensure the water resource will be available to all its users. These Objectives are defined as limitations on water quality variables, including many of those measured in this study, to prevent the degradation of the water resource. In the meantime, the collection of high quality data from this high priority watershed is required for at least five years prior to the introduction of any human activities, if possible. In order to successfully complete these objectives, a sufficient base of quality information is needed, the first step of which has been taken in the form this report on the water quantity of White River, Middle Fork.

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6. GLOSSARY OF TERMS

bank, right or left - the margin of a channel as viewed facing downstream. The expression "right" or "left" applies similarly to right or left abutments, cableway towers, etc.

bench mark - a permanent, fixed reference point for which the elevation is known. It may when practicable, be related to GSC datum.

control -the condition downstream from a gauging station that determines the stage/discharge relation. It may be a stretch of rapids, a weir or other artificial structure. In the absence of such features, the control may be a less obvious condition such as a convergence of the channel or even simply the resistance to flow through the downstream reach. A shifting control exists where the stage/discharge relation tends to change because of impermanent beds or banks.

cross section of a stream - a specified vertical plane through a stream bounded by the wetted perimeter and the free surface.

cubic decameter (dam^3) – the volume of water required to cover an area of one square decameter (1000 m^2) to a depth of one meter.

Discharge Q) - the volume of liquid flowing through a cross section per unit of time. It is not synonymous with "flow".

discharge measurement - the determination of the rate of discharge at a gauging station on a stream, including an observation of "no flow", which is classed as a discharge measurement.

flow - the movement of water in a channel without reference to rate, depth, etc.

gauge correction - any correction that must be applied to the gauge observation or gauge reading to obtain the correct gauge height.

gauge height - the height of the water surface above the gauge datum; it is used interchangeably with the terms "stage" and "water level".

gauge observation/reading - an actual notation of the height of the water surface as indicated by a gauge, it is the same as a "gauge height" on when the 0.000 metre mark of the gauge is set at the "gauge datum".

gauging station - the complete installation at a measuring site where systematic records of water level and/or discharge are obtained.

level check - the procedure followed to determine the movement of a gauge with respect to the gauge datum.

metric – a measurable attribute determined by it, as a measure of length, capacity and weight.

reference point - a point of known elevation from which measurements may be made to a water surface. It is also known as a measuring point.

shift - a change in the stream control, which alters the stage/discharge relationship. The change can be either temporary or permanent.

stage; gauge height; water level - the elevation of the free surface of a stream, lake or reservoir relative to a gauge datum.

stage/discharge relation - a curve, equation or table which expresses the relation between the stage and the discharge in an open channel at a given stream cross-section.

stilling well - a well (tube) connected with the stream in such a way as to permit the measurement of the stage in a relatively still condition (natural surge dampened).

stream - the generic term for water flowing in an open channel.

stream gauging - all of the operations necessary for measuring discharge.

temperature - the temperature of the water directly affects the productivity of the system through influencing the chemical reactions occurring within the water as well as the growth of plants and animals. Extremes of either temperature will negatively affect growth, but in our temperate environment, it is more important that temperature is not allowed to rise too high.

wading rod – a light hand held, graduated, rigid rod, for sounding the depth and positioning the current meter in order to measure the velocity in shallow streams suitable for wading. It may also be used from boats or ice cover in shallow streams.