Water Extraction Permitting Policy

Department of Environment, Labour & Justice

January 2013

EXECUTIVE SUMMARY

- This document establishes a new policy for groundwater extraction.

- The old surface water policy was found sufficient to protect aquatic life and will remain essentially the same with only minor changes to the size of permit allocations.

- The old groundwater extraction policy - based on the effect of groundwater extraction on groundwater availability, as measured against annual recharge rates to the aquifer - was found to conserve groundwater resources, but did not necessarily provide adequate protection to aquatic life in Prince Edward Island's river systems.

- The groundwater extraction policy has been changed from an assessment of groundwater extraction as a proportion of annual recharge to an assessment of the effect of groundwater extraction on seasonal surface water flows in Prince Edward Island's streams and rivers.

- The new groundwater extraction policy will safeguard stream flow and provide greater assurance that aquatic wildlife habitat is protected, in addition to providing for the sustainable use of Prince Edward Island's groundwater resources.

- Where the proposed amount of groundwater extracted is judged to approach critical levels, detailed investigation and testing will be required to assess the impact of the proposed extraction on stream flow. The application process has been stream-lined, providing for a simplified evaluation in those cases where the effect of proposed groundwater extraction rates are judged to be well below the threshold for concern

BACKGROUND

The most recent government policy position on the permitting of water extraction from groundwater and surface water resources was presented in the Agricultural Irrigation Policy of 1995. While this policy was developed in response to increased demand for irrigation water, in practice it outlined the criteria for allocation of both groundwater and surface water regardless of final end use.

Groundwater allocation decisions were made on the basis that up to 50 per cent of the annual recharge of the local groundwater reservoir (aquifer) could be extracted without adversely impacting the environment with a primary focus on the status of groundwater availability. Permits to extract groundwater were issued with the intent that, except under special circumstances, they would not be rescinded.

Restricting groundwater withdrawals to 50 per cent of mean annual recharge has a sound scientific basis for the preservation of groundwater resources. However the assumption that the remaining 50 per cent of recharge is sufficient to maintain adequate groundwater base flow to streams, especially during seasonal dry periods of the year, was made in the absence of a firm, scientific evaluation. In contrast, the surface water extraction policy specified that withdrawals from surface water should not deplete stream flow below 70 per cent of the monthly average stream flow. This figure more fully reflected seasonal changes in stream flow.

While the old policies for groundwater extraction preserved water in streams as assessed on an annual basis, it became apparent that there was not always sufficient water to sustain healthy aquatic and riparian[1] ecosystems at all times of the year. Furthermore, because the majority of groundwater discharge is derived from the shallowest portions of the aquifer, base-flow contributions to stream flow are more sensitive to groundwater extraction rates than effects on the aquifer as a whole. The need for a scientifically defensible basis for determining an appropriate stream flow threshold for aquatic habitat protection, prompted a study of Prince Edward Island stream flow needs, and led to a revision of water management policy.

DEFINITIONS

For the purpose of this document, groundwater is defined as water that naturally occurs beneath the surface of the ground and is normally extracted by pumping from water wells. Groundwater is frequently referred to as well water.

Surface water is defined as water which is open to the atmosphere, and occurs naturally in streams, ponds, lakes, rivers or estuaries.

[1] Riparian: of, on, or relating to the banks of a natural course of water

Aquifers are defined as geological formations that yield useable quantities of groundwater.

Base-flow is the portion of stream flow originating from groundwater discharge.

Recharge is a hydrologic process where water from precipitation infiltrates the ground and migrates downward to replenish groundwater.

Maintenance flow is the amount of water required to be present in a stream in order to provide adequate aquatic habitat.

GROUNDWATER

Groundwater is the source of all drinking water and the majority of industrial water used in Prince Edward Island. The water discharged from the aquifer (base-flow) sustains a portion of Island surface waters and aquatic ecosystems. The aquifer is recharged at a rate of 20 - 40 per cent of annual precipitation (1100 mm). Under normal conditions groundwater flows through the aquifer and eventually finds its way into Island ponds, lakes, streams, rivers and the ocean, or is returned to the atmosphere via evaporation or transpiration by plants. Groundwater discharge to streams contributes as much as 60 - 70 per cent of the annual flow and nearly 100 per cent of the flow in a typical stream during summer.

Extraction and removal of groundwater leads to reduction in the base-flow, and consequently overall stream flow. The impacts of groundwater extraction on stream flow are determined by the pumping rate, the size of the watershed, the relative position of the well within the watershed and to the stream, the well construction, and the geological characteristics of the aquifer. [2] Island-wide, groundwater extraction is minimal compared to the total amount of available water, with only 1.4 per cent of the total recharge actually extracted. However, in certain watersheds, the intensive pumping of groundwater from wells may approach 40 per cent of recharge, leading to concerns about aquatic habitat health and sustainability.

Aquifer characteristics, including recharge rates, well yields, and groundwater/surface water interactions, vary significantly across the Province. The impacts of groundwater extraction on stream flow can be evaluated by studying stream flow during pumping tests coupled with numerical groundwater modeling. Even so, only generalizations about the impact of groundwater extraction on stream flow can be made on an Island-

[2] Generally, a well with a lower pumping rate, a greater setback distance from the stream and deeper casing, and being located in the lower portion of the watershed (i.e. drawing groundwater from a larger portion of the watershed) causes less immediate impact on the stream flow.

wide basis. For precise local information on stream flow, site specific evaluations are required to make sure that aquatic wildlife habitat are protected while still providing for the sustainable use of Prince Edward Island's groundwater resources.

SURFACE WATER

Stream flow is made up of the base flow (from groundwater discharge) and direct overland run-off. It generally increases with watershed area, and normally increases progressively from the upper to the lower reaches of a watershed. Regional differences also occur in stream flow, with the areas west of Summerside generally possessing a lower base flow per unit area of watershed than areas east of Summerside, especially during low flow periods of the year. For example, the summer base flow of the Mill River in western Prince Edward Island is (0.0042 $m^3/s/km^2$), only half of that in the Wilmot River in the central part of the Province (0.0084 $m^3/s/km^2$).

Stream flow is generally greatest in the spring (reflecting the influence of snow-melt), and lowest in late summer when evaporation rates are high.

Stream flow rate determines the quality of habitat for aquatic life in Prince Edward Island and it is necessary to maintain a minimum amount of flow (maintenance flow) in streams at all times. The 'sensitivity' of streams to flow rate varies with stream size. Regardless of whether continuous groundwater extraction or intermittent surface water withdrawals are occurring, maintenance flow is least during the low flow period of July through October.

The control of water withdrawal from surface water bodies is regulated under the *Environmental Protection Act* Watercourse and Wetland Protection Regulations. Prior to extracting water from any stream or river, a person or persons must first obtain a Watercourse or Wetland Activity Permit.

POLICY GOALS

The overall goal of water abstraction management is the sustainability of water resources. This involves ensuring reasonable amounts of water for human use while maintaining the integrity of aquatic ecosystems.

An important element in the management of water resources proposed here is the emphasis placed on the impact of groundwater extraction on stream flow, instead of the previous focus on the protection of groundwater resources.

It is necessary to establish water use priorities. They have been established for some time in Prince Edward Island and remain unchanged. In descending order of importance these priorities are:

- water use for fire protection,
- drinking water,
- environment (maintenance of ecosystems) and,
- industrial use (including agricultural irrigation).

POLICY DEVELOPMENT

The Department of Environment, Labour and Justice asked the Canadian River Institute (CRI)[3] to examine the potential effects of surface water pumping on stream ecosystem health in Prince Edward Island. The study examined the response of key indicator species (benthic invertebrates[4] and brook trout) to fluctuating stream flows due to water extractions. It also assessed the existing extraction management policy for its effectiveness in protecting aquatic life. The goal of the study was to help define an appropriate level of stream flow to maintain healthy aquatic habitat. As a result of the study, the CRI recommended that Prince Edward Island adopt the United Kingdom (UK) experts' recommendations. The UK Technical Advisory Group (UKTAG) adapted the experts' recommendations for management purposes. Their protocol includes:

1) using fish as the key indicator species[5] and,
2) the maximum rate for water extraction as 15 - 35 per cent of the natural flow - calculated on a monthly basis - in the least ecologically sensitive rivers, and 7.5 - 25 per cent in those most sensitive rivers.

The CRI did not provide advice on how to deal with the impacts of continuous groundwater pumping on stream flow. However, for a geological setting typical of Prince Edward Island, UKTAG recommended groundwater extractions should be less than 10 - 20 per cent of long-term average recharge.

However, adopting UKTAG recommendation would be inappropriate for Prince Edward Island conditions since it does not consider the seasonal surface water requirements of aquatic ecosystems. The UK Environment Agency specified that groundwater abstractions should not reduce "natural" summer groundwater outflow (base flow) by

[3] The study was funded through the AAFC Canada-PEI National Water Program.

[4] Benthic invertebrates are tiny organisms found living on the bottom of water bodies. Over 95 per cent of all animal species are classed as invertebrates - or animals without backbones. Some examples are flies, slugs, leeches, beetles, worms, and crayfish.

[5] In the absence of such data, the CRI believed that the UK has done the best work to date to determine ecological needs for stream flow. The UK framework for protecting fish served as the basis for this policy revision.

more than 35 per cent and this is also listed as a guideline by UKTAG. The guideline of 35 per cent explicitly addresses in-stream water needs of low-flow seasons, which is more in-line with Prince Edward Island summer conditions. Accordingly, the principles of the UK Environment Agency Resources Assessment Management for groundwater extraction have been adopted for Prince Edward Island, with some modifications.

GROUNDWATER POLICY

The proposed new policy for groundwater extraction specifies that groundwater extraction should not be permitted to reduce the mean summer base flow in the main branch of streams by more than 35 per cent. For the purposes of this policy, the mean summer base flow is referred to as the Reference Base Flow (RBF), and is determined as the median[6] of base flow for the period of August through September. At this time of year, the stream flow is largely made up of groundwater with only intermittent increases from rainfall. Where continuous stream flow records are not available, a pro-rated median for August through September from a hydrometric station representative of the region with a minimum of 10-years of data will be used. Direct measurements of streams/rivers in the area of interest will be used to match local stream flow characteristics with the most appropriate long-term reference station when needed.

To provide an initial assessment of applications for groundwater allocation in Prince Edwards Island, Normalized Reference Base Flows (NRBF) have been developed. NRBF are calculated values[7] that can be used to estimate stream flow conditions in watersheds of different sizes. There are five hydrometric stations (index stations) used to develop NRBF in Prince Edward Island (see Table 1). NRBF vary from station to station, highlighting differences in aquifer yield and associated watershed base flow across the province.

APPLICATION ASSESSMENT

A streamlined process for the assessment of applications for groundwater extraction has been developed. It is intended to:

a) expedite those proposals where the amount of withdrawal sought is clearly below any reasonable level of concern and a groundwater extraction permit may be issued with standard testing and reporting conditions, or
b) screen out those proposals where the amount of withdrawal sought is clearly above what would normally be anticipated to meet the criteria for allowable

[6] Using the 'median' value eliminates the influence of rainfall events and provides a more reliable estimate of the average summer base flow from groundwater.
[7] The calculation value is based on the as Reference Base Flow divided by the watershed area above a hydrometric station giving a "per unit area" value.

groundwater extraction rates and the proponent would be requested to submit a more realistic proposal.

Proposals for groundwater extraction will be assessed on the basis of their impact on the local stream flow regime. If a detailed assessment is determined to be required, it would consist of stream flow monitoring, detailed pumping test requirements and, in many cases, the numerical modeling of possible impacts from pumping on the local water table and stream flow rates. Figure 1 outlines the basic elements of this screening process.

To determine the allowable upper and lower screening criteria, the range of NRBF across Prince Edward Island was examined. When the base flow of the area of concern is not known, the lowest yielding river (see Table 1) is used to determine the lowest rate and the highest yielding river is used for the upper rate. For the lower rate, 30 per cent of the NRBF represents the level below which there would be no scientific concern that the mean summer base flow in the main branch of streams would be adversely affected by water extraction (well pumping). For the upper rate, 100 per cent of the NRBF represents the level above which there would be scientific concern that an unacceptable impact on the flow rates of surface water streams could occur.

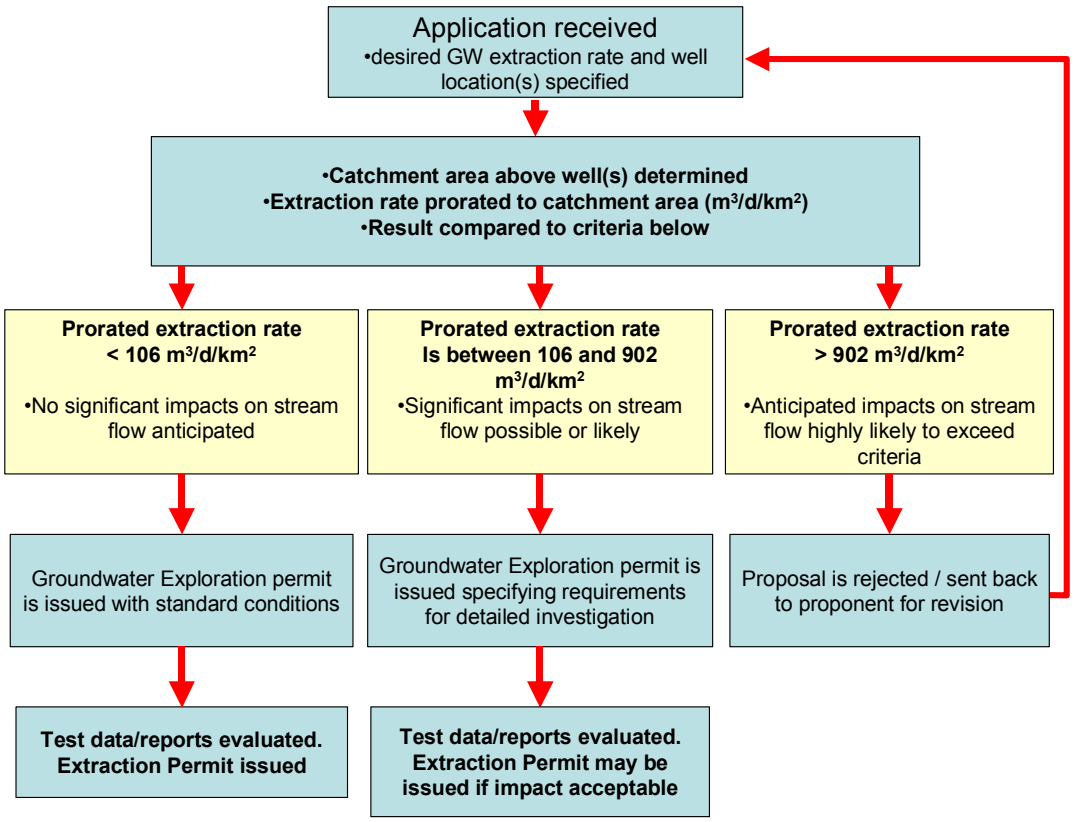

Figure 1 Flow chart for screening process for groundwater extraction applications

Proposals for extraction rates that fall between the 30 per cent and 100 per cent of the NRBF require investigations to determine the impact on any affected streams. When detailed investigation shows that the impact would be greater than the policy allows, the extraction permitted would be reduced accordingly.

Wells located in upper, headwater portions of watersheds require special consideration, as even small streams in these areas may serve as fish spawning grounds and are considered sensitive habitat zones. Zero impacts near headwaters are impossible under conditions of continuous groundwater pumping, and furthermore, because of their small size, reliable characterization of normal seasonal stream flow conditions or the prediction of the impact of pumping on stream flow is very challenging. To limit the impact on headwater streams, the new policy requires that no more than 100 m of the main branch (s) of headwater stream be predicted to dry up during the low flow time of year as a result of groundwater extraction. This is expected to be generally protective of smaller streams for which more reliable assessments are not possible. In special circumstances, such as critical habitat for a significant population, additional

consideration beyond this general policy may be made. Provided the proposed extraction does not violate the above criteria, an extraction permit will be granted.

Some existing permitted groundwater extractions may violate some provisions of the new policy. As communities or industries increase their water needs, the Department of Environment, Labour and Justice will require that the expansion of existing water supply facilities, or the development of new groundwater extraction proposals comply with the new policy. The Department of Environment, Labour and Justice will also actively seek to adjust the current extractions, on a case by case basis, so that they fall as closely to the new policy provisions as possible, as soon as is reasonably practical.

SURFACE WATER POLICY

The UKTAG guidelines for protecting fish were examined against the existing surface water allocation policy (Table 2). They were found to generally correspond and as such the existing surface water allocation policy will be maintained. The current provincial policy is designed to keep a maintenance flow in the stream at 70 per cent of the median monthly flow. Permits are issued so that permit holders, have access to water approximately 70 per cent of the time.

The impact of existing groundwater extraction on stream flow is also considered when determining maintenance flow, so that the amount of water available for joint extraction from both groundwater and surface water would not reduce the mean summer base flow by more than 35 per cent.

Maintenance flow for each surface water withdrawal application is determined by pro-rating the maintenance flow for the nearest long-term flow monitoring station against the location of the application by watershed area. Maintenance flows will be determined on a monthly basis which, for permits for irrigation purposes, is generally from June through September. Water will only be permitted to be withdrawn when the actual stream flow is above the monthly maintenance flow.

West of Summerside, the stream flow observed per unit area of watershed is generally much less than that east of Summerside. The methodology of calculating maintenance flow accounts for this regional difference and is utilized in all areas of the province. However, due to the lower basin yields in areas west of Summerside, the amount of available water for extraction per unit area of watershed can be as little as $^1/_3$ to $^1/_2$ of that available east of Summerside.

A Watercourse or Wetland Activity Permit is required when withdrawing water from a surface water body at a rate in excess of 50 igpm or when the total daily withdrawal exceeds 10,000 imperial gallons. The primary use for water extracted from surface

water is for industrial uses, of which the main activity is agricultural irrigation. The 1995 Agricultural Irrigation Policy outlines, in detail, the mechanisms by which available surface water is allocated to permit holders. For the most part, these mechanisms remain unchanged. One change is made to the 1995 policy to ensure that permits are practical for the types of pumping equipment typically used on Prince Edward Island. Permits will be generally issued in allotments of either 400 or 800 igpm. Previously, only 400 igpm allotments were issued.

The policy change does not affect parts of the 1995 policy that address the process of obtaining a Watercourse Wetland Activity Permit, or the amount of water available and or allocation of the permits on a watershed priority list. Within a watershed priority list for surface water irrigation, permit holders with bypass ponds that reduce the direct impact on the stream have priority, followed by previous permit holders renewing their permits in the subsequent year. Remaining water is permitted on a first come, first served basis. Flow meters are required on irrigation equipment to verify that pumping rates remain within permitted rates. A log of water pumped is also required, and pumping must cease when stream flows fall below the maintenance flow.

SUMMARY

- Through experimental analysis of water abstraction in Prince Edward Island and a review of water management procedures elsewhere, the Canadian Rivers Institute has provided recommendations that have helped the province of Prince Edward Island to develop policy that better manages water usage and reduces adverse impacts to aquatic life in Island water bodies.

- Advances in watershed management and new procedures for managing groundwater extraction means that Prince Edward Island's groundwater and surface water policies are more effective in protecting aquatic life.

- These advances will ensure that Prince Edward Island's water resources are managed in a sustainable fashion.

REFERENCES

Acreman, M., M., Dunbar, J. Hannaford et al., 2008. Developing environmental standards for abstractions from UK rivers to implement the EU Water Framework Directive, Hydrological Sciences Journal, 53 (6): 1105—1120.

Monk, A.W. and R.A., Curry, 2009. Planning and Managing for Surface Water Abstraction on Prince Edward Island. Canadian Rivers Institute, New Brunswick Cooperative Fish and Wildlife Research Unit Report #04-09.

PEI Department of Environment, Prince Edward Island Agricultural Irrigation Policy, 1995.

SNIFFER (Scotland and Northern Ireland Forum for Environmental Research), 2006. Development of Environmental Standards (Water Resources), Stage 3: Environmental Standards, Project WFD48. www.sniffer.org.uk

UK Environment Agency, 2002. Resource Assessment and Management Framework Report and User Manual (Version 3). UK Environment Agency R&D Technical Manual W6-066M.

GLOSSARY OF TERMS

AP: Assessment point, a point in the stream in question that is closest to the centre of the proposed well field.

AA: Assessment area-watershed area above the assessment point (AP).

CRI: Canadian Rivers Institute.

EARAM: UK Environment Agency Resources Assessment & Management.

NRBF: Normalized reference base flow, which is the reference base flow divided by the watershed area above the gauging station.

Q_{70}: 70 per cent of the flow duration, a given flow rate is equaled or exceeded 70 percent of the time.

RBF: Reference base flow, which is the median of August and September discharge series.

UKTAG: UK Technical Advisory Group consisting of authorities responsible for implementing the EU Water Framework Directive.

km^2: square kilometer

m^3/s: cubic meters per second

igpm: Imperial gallons per minute

$m^3/d/ km^2$: cubic meters per day per square kilometer

Table 1 Reference base flow (RBF) and normalized reference base flow (NRBF) for the summer period in Prince Edward Island

Station	Area (km^2)	RBF (m^3/s)	NRBF		30 % NRBF	
			$m^3/d/km^2$	$igpm/km^2$	$m^3/d/km^2$	$igpm/km^2$
Mill R. (1961-2005)	46.0	0.192	361	55.1	108	16.5
Wilmot R. (1972-2005)	49.2	0.408	717	110	215	32.8
Dunk R. (1961-2005)	114.0	1.120	849	130	255	38.9
West R. (1989-2008)	70.0	0.732	903	138	271	41.4
Bear R. (1995-2008)	15.3	0.098	553	84.6	166	25.4

Legend
km^2 = square kilometer
m^3/s = cubic meters per second
igpm = Imperial gallons per minute
$m^3/d/ km^2$ = cubic meters per day per square kilometer

Table 2 Comparison of current Prince Edward Island surface water policy to the United Kingdom guideline

River	Month	PEI Policy Available Flow* (m^3/s)	UK Guideline 20 % x 70 % FD (m^3/s)
Dunk River	July	0.255	0.254
	August	0.235	0.213
	September	0.217	0.193
West River	July	0.182	0.168
	August	0.180	0.141
	September	0.156	0.125
Wilmot River	July	0.100	0.093
	August	0.096	0.079
	September	0.094	0.072
Mill River	July	0.030	0.044
	August	0.026	0.033
	September	0.020	0.030
Bear River	July	0.022	0.022
	August	0.017	0.015
	September	0.008	0.014

Legend
m^3/s = cubic meters per second
FD = Flow duration

* The available flow is calculated using the formula: Available Flow = Q70 - (0.70 x Q50), where the Q70 and Q50 is the flow of water which is equaled or exceeded 70 and 50 per cent of the time respectively.

NOTE: The UK maximum extraction policy of 20 per cent of the natural flow corresponds approximately to the current Prince Edward Island policy for withdrawals from surface water.