DATE: **March 12, 2015**

REPORT TO: **Englishman River Water Service Management Board**

FROM: **Englishman River Water Service Management Committee**

SUBJECT: **Fisheries Protection Program of Fisheries and Oceans Canada**

PURPOSE: **To provide an update regarding the Department of Fisheries and Oceans Canada position on the proposed new intake on the Englishman River**

EXECUTIVE SUMMARY

The Arrowsmith Dam has been in operation for over 14 years providing additional critical summer flow augmentation to the Englishman River for the purpose of future bulk water extraction for the region and providing additional flow requirements for fisheries purposes. The most feasible plan adopted by the community through a referendum in 1996 was a phased approach to build the Arrowsmith Dam first followed by a new intake and water treatment.

Since 1993, there have been numerous meetings and correspondence with the Department of Fisheries and Oceans Canada (DFO) regarding the next phase of construction of the new water intake.

On January 13, 2012, a Change of Works application was approved by the province for the new location of the water intake just above Highway 19 on the right bank in Top Bridge Park owned by the City of Parksville. Following the Change of Works approval the preliminary design of the new intake commenced and a request to review the project was submitted to the DFO on April 30, 2014. A formal reply letter from DFO was received on February 23, 2015, which advised the Englishman River Water Service that proposal for a new water intake will result in serious harm to fish, which is prohibited under subsection 35(1) of the Fisheries Act:

> *Permanent alteration of fish habitat that supports various salmon and trout life history stages due to the reduction of flow in the Englishman River from instantaneous water withdrawal.*

DFO's reply letter (attached as Appendix A) was brief on concluding the reasons why our project is reviewable for serious harm to fish however, in further discussions with DFO staff concluded the basis for their determination is that they consider this a new project and do not recognize the benefits of the Arrowsmith Dam. These potential fisheries impacts were previously addressed and mitigated with our original licence application and the resulting construction of the Arrowsmith Dam and augmented flow releases during critical summer months.

The review of the fisheries impact conducted by LGL in Table 10 of the Aquatic Effects Assessment review dated October 2014 determined that the benefits of the Arrowsmith Dam during the critical period summer flow median (July to October) after full withdrawal provides a flow at the hydrometric station gauge located at Highway 19A (Orange Bridge) 08HB002 that will result in a flow of 1.61 cubic meters per second. This is in conformance with our current Conditional Water Licence and there will be no net impact to fish as a result of the proposed new intake.

Since it began operation the Arrowsmith Dam and resulting summer flow augmentation has made significant fisheries improvements to the Englishman River and will continue to do so after full water extraction over and above the existing (pre-dam construction) condition. Regardless of the intake location, the flow requirements laid out in the permit, originally determined by both provincial and federal fisheries staff, will be met along the entire length of the river and such flows are greater than historical flows.

Additional consultation and application submittals to DFO will require further environmental assessment and continued First Nation consultation. In order to develop a plan, determine additional fisheries mitigation measures and obtain third party approval, it has been estimated to be an additional two years before we would have any formal comments back from DFO. This has major impacts for the project deadlines to meet both Island Health requirements and community water needs.

As a result, a contingency plan will need to be developed taking into account water demands. In an effort to meet the water needs of the City of Parksville and the Nanoose Bay Peninsula Water Service Area (NBPWSA), the following items will need to be considered:

- Developing additional wells in the interim until future surface water intake works from the Englishman River are in-place.
- Focus on achieving higher yields from existing wells through re-development.
- Impose stringent watering restrictions for the region.
- Explore community development restraints and servicing requirements to achieve a revised vision for the Community Growth Plans and Official Community Plans.
- Update the community boil water advisory and emergency preparedness plans.
- Advise Island Health of non-compliance.

RECOMMENDATION

THAT the ERWS Board:

- Receive this report and direct staff to update the project implementation plan.
- Undertake federal and provincial political involvement (MLA, MP) in lobby efforts.
- Direct staff to move forward with the application process with DFO.
- Direct staff resources and budgets towards focusing on a contingency plan to meet current and future water needs until such time as authorization for surface water extraction of the Englishman River is achieved.
- Direct staff to advise Island Health that we will not be in compliance with our Operating Permit.

BACKGROUND

The first regional surface water supply study commenced in 1972 and incorporated all the Regional District of Nanaimo's water supply needs ranging from Bowser to Cedar. At that time, three sources of future surface water supply were identified, Cameron Lake, Englishman River and Jump Creek. Between 1982 and 1994, it was concluded it was more feasible to have two separate water systems; Qualicum Beach, Parksville and Nanoose to be served by the Englishman River and Nanaimo area to be served by

Jump Creek and Nanaimo River. Cameron Lake was ruled out by the province in an effort to focus the region to look at the Englishman River for future water supply in an effort to provide additional fisheries benefits.

A referendum held in 1995 to approve design and construction of a bulk water supply system for the construction of the Arrowsmith Dam and new intake under the auspices of the Regional District of Nanaimo was defeated. A second referendum held separately by each jurisdiction went forward in 1996 as a phased approach to construct the Arrowsmith Dam and was approved. This plan limited its referendum to the borrowing for only the Arrowsmith Dam. The second phase would concentrate on an intake at the confluence of the Englishman and South Englishman Rivers with the remainder of the treatment facility located on Block 602. In 1996, a water licence application was submitted based on locating the proposed water intake at the confluence of the South Englishman River and the Englishman River.

A Conditional Water Licence was issued in March 1997 authorizing the construction of the Arrowsmith Dam and storage of 9 million cubic meters with half of that volume reserved for fisheries enhancements. The Conditional Water Licence and corresponding Provisional Operating Rule (specifying a flow of 1.60 cubic meters per second at the Highway 19A bridge) were issued based on the premise of utilizing the existing City of Parksville intake in the interim until such time as the future proposed Arrowsmith Water Service (AWS) water intake was constructed upstream of the Englishman River Water Survey Canada (WSC) hydrometric gauge (08HB002). The Provisional Operational Rule flow requirement of 1.6 cubic meters per second was an interim arbitrary number given to AWS and is a number that is greater than the instream fish flow maintenance plus future maximum monthly water withdrawal demands. The original licence application proposed to locate the intake downstream of the confluence of the Englishman River and South Englishman Rivers. As part of the stakeholder consultation process for our water licence, a Water Licence Application Report prepared by the Ministry of Environment (Attached as Appendix B) at the time the water licence was granted, references correspondence from provincial and federal fisheries.

Federal fisheries comments:

- *The recommended stream flows as measured at the WSC gauge (08HB002); spawning flow should be maintained at 8.5 cubic meters per second from October to December and should not fall below 5.67 cubic meters per second during this period of the year.*
- *Rearing flow should be maintained at 1.13 cubic meters per second as measured at the WSC gauge (08HB002), through the summer low flow period generally from July to October and should never fall below 0.71 cubic meters per second.*
- *The department has strong preference for the water intake to be sited at a location as far downstream as possible.*

Provincial fisheries comments:

- *The proposed storage on Arrowsmith Lake should provide minimum summer flow, in excess of all other withdrawals, as measured at the WSC gauge (08HB002) downstream of Highway 19A bridge crossing to be maintained at or above 1.13 cubic meters per second on a 1:20 year drought return period.*

Between 2000 and 2005, further progression of the AWS capital plan commenced focusing on the future water intake location. The capital plan took into account a triple bottom line approach of weighing environmental, financial, risk and social factors and therefore, further determined the best location would be downstream of the originally proposed intake at the confluence of the South Englishman River.

In July 2005, Koers and Associates Engineering presented a Draft Capital Plan Update report to the AWS Management Board. The report reviewed the option of locating the intake further downstream as it presented major cost savings and provided significant additional fisheries benefits. The AWS Management Board approved this recommendation and directed staff to further investigate the downstream intake option. A meeting was held on December 8, 2005, with DFO and the Vancouver Island Health Authority (VIHA) staff to discuss this option. VIHA formally replied on May 23, 2006, and indicated they would be willing to consider a downstream site, provided a risk assessment carried out by AWS could show that risks can be adequately managed.

Although this option does not provide a gravity feed and control, it was determined it represented the most attractive option as it presents substantial cost savings over the option of incorporating an upstream intake and also provides substantial fisheries benefits for the Englishman River due to extending the low flow enhancement further downstream from summer releases at the Arrowsmith Dam. This benefit will become more significant as climate change could adversely affect the low flow regime of the river as time progresses. This option received conditional support from the AWS Management Committee in July 2005 and the report was finalized in March 2008.

In 2009, the AWS retained Associated Engineering through a quality-based selection process to further develop the capital plan based on the downstream option. The primary objectives of the study were twofold:

- The first was to determine the site and development concept for a new water intake, water treatment plant (WTP) on the Englishman River.
- The second and equally important objective was to determine how the surface water and groundwater resources can best be managed.

Continued use of the existing intake was considered, but rejected for the following health, safety and operational reasons:

- Intake is located downstream of several locations where contamination/chemical spills could occur, including Highways 19 and 19A, should a serious accident occur on either bridge or the rail corridor.
- The intake site is within the flood plain and therefore, could be compromised during a catastrophic weather event.
- The existing intake would not be able to operate at the capacity required without frequent and onerous maintenance.
- The Englishman River is shallow along this area, and therefore, the intake may not be able to withdraw as much water as required during a particularly dry summer.

In April 2011, Associated Engineering (BC) Ltd. finalized the report and concluded (based on a triple line bottom approach of analyzing risk, social and environmental factors) the best location for the downstream intake location is just above the Highway 19 bridge. The report also concluded both future domestic water supply and fisheries flow requirements can be achieved by the release of additional flows from the Arrowsmith Dam during critical summer months.

The construction of the Arrowsmith Dam was the start of our plans for a regional water supply system. The proposed intake does not constitute a new project as we are merely following our original plan presented to senior government officials as a phased approach:

- First Phase: Construction of the Arrowsmith Dam
- Second Phase: Construction of a new intake
- Final Phase: Provide enhanced water treatment

Significant local water rate tax dollars have been spent to date on a federal mandate and we cannot commit to spending additional local water revenues until DFO formally recognizes and acknowledges the following:

- The additional storage provided in the Arrowsmith Dam for fisheries benefits has demonstrated a net fisheries gain in the Englishman River during critical summer flows.
- The fisheries rearing flow requirement after full maximum monthly water extraction is 1.13 cubic meters per second per DFO's original recommendations.

As a prerequisite to obtain approval of the intake from DFO, the project needed to be advanced to preliminary design stage. The ERWS submitted a revised proposal for review to DFO on December 11, 2014, and is further to the Arrowsmith Water Service original submission in April 2014.

Following discussion with DFO in September 2014, ERWS made significant changes in design and proposed operation of the water intake structure:

- Alternative water withdrawal techniques
- The weir has been deleted from the design which removes physical obstructions in the river.

It should be noted that DFO has not rejected the location of the intake. Approval was received from the provincial government for the change of works application for the new intake location. The change of works approval which took more than one year was through the water branch of the provincial government which considered DFO a stakeholder. Once approval was given for the new intake location, the next step was to obtain authorization from DFO to consider if the project is reviewable.

The DFO process determines if there is any potential for fish to be harmed through construction and also reviews the type of intake screening to avoid any impingement of fish. To get to this stage in the process to receive comments from DFO, we were required to submit full preliminary design drawings of the intake and also provide a full fish impact study. The consultant concluded that, as a phased project which included additional augmented flows from the Arrowsmith Lake reservoir during the summer months, there was no impact on fish.

The DFO review concluded the intake is a new project and as such, the additional flow augmentation provided by the Arrowsmith Lake reservoir will not be recognized by DFO. The additional flow releases from the Arrowsmith Dam since construction in 1999 greatly augment the summer base flows in the Englishman River resulting in a significant increase in the numbers of Coho, Pink, Chinook and Chum Salmon returning to the Englishman River. DFO has chosen to ignore this and now wishes additional compensation and third party authorization which will most likely add an extra two years - one year for ERWS to obtain third party authorization involving additional First Nation consultation, provide a federal environmental assessment, determine the mitigation measures we can provide and then an additional year for DFO review.

ERWS has retained professionally qualified experts in water treatment, supply, distribution geology, hydrogeology and environmental engineering to establish an efficient, reliable and cost effective treatment and distribution system. All considerations for treatment of Englishman River water and the best location for the intake, taking into account water conservation as well as the concerns of DFO and Ministry of Environment have been made. The project phasing considers current and future population from a financial perspective. We have progressed with this project to the point we can ask for proper permitting and grant funds.

Aquifer storage and recovery (ASR) is a very small part of the overall project but could be very important to meet future water demands and reduce the need for surface water extraction from the Englishman River and therefore provide more water available for fish during the critical summer months. ASR is currently being investigated and researched to determine logistical next steps.

The ERWS partners have been recognized by Island Health in its demonstration of effectiveness in long-term planning to address capacity and treatment issues. Island Health recognizes that to achieve Canadian Drinking Water quality objectives, the addition of filtration to the existing surface water supply will be required. To reduce the potential cost of filtration, ERWS is exploring ASR as a potential storage solution needed to meet the high demand summer consumption needs.

As outlined in the November 8, 2014, ERWS Water Intake and Treatment Plant Options report from the Parkville Chief Administrative Officer presented to the ERWS Management Board at the November 13, 2014, meeting, the optimal full build out of the project (Plan A) was the best option. However, as it was only financially viable with significant senior level grants which were in question, four phasing options which spread the cost over a greater time frame were prepared and evaluated by CH2M HILL based on primary criteria - water quality, technical considerations, social considerations, natural environmental considerations and economic considerations. The options were evaluated against each criterion resulting in a weighted score. After evaluating the benefits and costs, phasing option 4 was identified as the best value for ERWS. All options evaluated had a higher cost than the options identified in the Preliminary Design Report.

At the meeting on November 13, 2014, the ERWS Management Board approved the reduced scope phased option 4 should government funding not be awarded by May 31, 2015. Based on the results of the phasing options analysis, funding discussions with senior government officials, capacity limitations on existing intake and the December 31, 2016, deadline for compliance with Island Health's treatment requirements, the ERWS Management Board recommended staff continue with project development based on the pre-design report scope of work (Plan A) and that project development work should give priority to design of the river intake.

OPTIONS

1. Obtain authorization for the intake construction permit at the proposed location above Highway 19 pursuant to paragraph 35(2)(b) of the Fisheries Act.

2. Request assistance from Island Health and local Members of Parliament to request DFO review their position and accept the benefit provided by the Arrowsmith Dam as meeting all habitat compensation requirements pursuant to paragraph 35(2)(b) of the Fisheries Act.

3. Direct staff to focus on providing a contingency plan to meet current and future water needs until such time as authorization for surface water extraction of the Englishman River is achieved.

ANALYSIS

OPTION 1

The construction permit process determines if there is any potential for fish to be harmed through construction and also reviews the type of intake screening to avoid any impingement of fish. This process will most likely add two years - one year for ERWS to obtain third party authorization involving

First Nation consultation, provide a federal environmental assessment, determine the mitigation measures we can provide and then an additional year for DFO review.

Water demands in the Parksville and Nanoose Bay Peninsula continue to increase. The existing river intake capacity is limited to 12.2 ML/d and ERWS wells have a maximum capacity of 11.8 ML/d. Stress on the aquifer continues to increase because of demand and the number of wells outside the ERWS accessing the aquifer. ERWS reliance on groundwater is being compromised.

The Nanoose system is directly linked to the Parksville system during peak summer months. About 40% of peak summer supply to Nanoose is provided through this partnership. With Parksville anticipated to reach maximum supply capacity in 2016, impacts on supply or water quality will affect both Parksville and Nanoose.

With the decision by DFO, as outlined in their February 23, 2016, letter, it will no longer be possible to meet the December 31, 2016, deadline imposed by Island Health. The communities of Parksville and the Nanoose Bay Peninsula will be placed at risk, both from a health perspective and financially.

After December 31, 2016, our inability to meet the treatment guidelines imposed by Island Health combined by demand exceeding supply will result in severe consequences.

A two-year delay will have severe impacts:

- After December 31, 2016, in order to be in compliance with Island Health operating rules, a boil water order would be required whenever the river intake is used (until the water treatment plant is built and approved). Current Parksville groundwater sources supply 9,000 cubic meters per day. Current Parkville summer demand exceeds 20,000 cubic meters per day. To avoid a boil water advisory only groundwater sources will be available. Accordingly in Parksville, without the river intake, severe water use restrictions would be required.
- Annual operating costs for the existing intake will continue to increase. The intake is already past its optimal lifespan. Significant and increasing maintenance is required to keep the infiltration screens clear of river sediment.
- Parksville's summer requirements will exceed groundwater and the existing intake's capacity in 2016. When this occurs, to meet its own demands, Parksville will no longer be in a position to supply Nanoose with bulk water through the existing intake. This will result in a potential 40% reduction in the Nanoose area water supply.
- Increased pressure on groundwater supplies to meet demand.
- Severe water restrictions including significant sprinkling regulations, most likely level 3, possibly 4.
- Fire protection will emerge as the number two priority after drinking water adding pressure on the need to limit other uses.
- Limitation on all rezoning applications resulting in additional water requirements over what would normally be expected within the existing zoning.
- Rejection of this project by DFO has jeopardized potential funding from the New Canada Building Strategic Priorities Fund and also the Federal Gas Tax Fund. It is expected funding announcements will be made in fall 2015.

OPTION 2

As outline in the background and Option 1 above, any delay of the project, whether it proceed as the optimal Plan A or as the phased Plan B, Option 4, will have severe consequences to Parkville and Nanoose. This option if successful would provide the least delay.

OPTION 3

Community Impacts

- After December 31, 2016, in order to comply with Island Health operating rules, a boil water order would be required whenever the river intake was used until the water treatment plant is built and approved.
- Annual operating costs will continue to increase. The intake is already past its optimal lifespan. Significant and increasing maintenance is required to keep the infiltration screens clear of river sediment.
- Parksville's requirements will exceed the existing intake capacity in 2016. When this occurs, to meet its own demands, Parksville will no longer be in a position to supply Nanoose with bulk water resulting in a reduced water supply for Nanoose.
- Increased pressure on groundwater supplies to meet demand.
- Severe water restrictions including significant sprinkling regulations, most likely level 3, possibly level 4.
- Fire protection will emerge as the number two priority after drinking water adding pressure on the need to limit other uses.

The City of Parksville and the Nanoose Peninsula Water Service Area (NBPWSA) communities have a shared, historical interest in the development of the ERWS intake and treatment system. Since 1996, water supply from the Englishman River has been planned for and recognized as the key water resource for the communities.

This partnership approach to water supply has been included in decision making since that time. With the commissioning of the Arrowsmith Dam in 2000, the Regional District of Nanaimo was able to move forward with the design and construction of the Nanoose water supply trunk main from Craig Bay to Red Gap in 2002. The installation of a new reservoir in 2005 in the City of Parksville's Top Bridge Park was done in partnership with the RDN in recognition of its need to balance flows in the southern Parksville area and to supply Nanoose then and for the future ERWS system.

This improved infrastructure, put in place for the anticipated ERWS supply in 2016, provides surface water flows into Nanoose via the City of Parksville distribution system during peak demand periods. A combination of the City of Parksville river intake and both communities' groundwater wells allows for this allocation of surplus water supply to Nanoose to meet its needs and currently provides up to 40% of peak water demand in the summer.

All of the water infrastructure planning and implementation efforts since 1996 have been carried out with the establishment of a water intake and treatment facility to meet the community needs. Over the years, the step-by-step development of the plan with many agencies, including DFO, has provided a road map to future water supply.

DFO has destabilized the decision making process and put many years' work at risk that has potential to compromise current and future water supply. This decision will have significant community planning, water use and financial implications for both the City of Parksville and the Nanoose Peninsula Water Service Area.

Implications of DFO Decision

A significant delay in the approval process will impact growth and peak water use in both communities. For the Nanoose Bay Peninsula Water Service Area, a continued ban on development, except where a developer locates and proves a sufficiently sized well, would remain in place. Negotiations on the

allowable water transfer between the City of Parksville and the NBPWSA would have to be renegotiated to ensure equitable water use between the two communities.

Following is a list of further implications to consider in light of DFO's decision.

- Increased demand on existing ground water supplies to meet any additional demand.
- A re-assessment of the well inventory for both communities to assist in supply.
- Increased watering restrictions to reduce demand and meet supply.
- Increased focus on fire protection supply over outdoor water use.
- Possible boil water order advisements issued by Island Health should the December 2016 deadline for treatment not be met.

REFERENCES:

February 23, 2015 – Reply letter from DFO - Appendix A
January 17, 2013 – Approval of Change of Works Application
April 18, 2012 – Water Licence Amendment – Province of BC
June 12, 2012 – Reply letter to DFO regarding the new intake
June 6, 2012 – Correspondence from DFO regarding new intake
September 28, 2012 – Reply letter to DFO on proposed intake
September 20, 2012 – DFO comments on proposed relocation of intake
December 16, 2011 – Letter from Provincial Minister Steve Thompson
September 7, 2011 – DFO comments on proposed relocation of intake
Water Licence Application Report – Appendix B

File: P:\USERS\AWS & ERWS\2015\MTB ERWS DFO Report (Rev6).doc

ERWS Report:

Fisheries Protection Program of Fisheries and Oceans Canada

Appendix A

DFO Reply Letter – Englishman River Water Withdrawal Project

Fisheries and Oceans Canada | Pêches et Océans Canada

200 – 401 Burrard Street
Vancouver, BC V6C 3S4

Your file *Votre référence*

FEB 23 2015 2015

Our file *Notre référence*
14-HPAC- 01184

Mr. Mike Squire
Englishman River Water Service
P.O. Box 1390
Parksville, BC V9P 2H3

Dear Mr. Squire:

Subject: Proposal likely to result in serious harm to fish. DFO authorization required.

The Fisheries Protection Program of Fisheries and Oceans Canada (DFO) received your revised proposal on 12 December 2014. Please refer to the file number and title below:

DFO File No.: **14-HPAC- 01184**
Title: **Englishman River Water Withdrawal Project, Parksville**

Your proposal has been reviewed to determine whether it is likely to result in serious harm to fish, which is prohibited under subsection 35(1) of the *Fisheries Act.*

Our review consisted of:

- Project Notification and Review Application Form, dated 28 October, 2014
- Fisheries Component of Aquatic Effects Assessment of Proposed Bulk Water Supply Intake in Englishman River, prepared by LGL Ltd, dated October, 2014

We understand that you propose to:

- Construct a temporary coffer dam and stream diversion to isolate works from stream flow during construction of an intake weir and intake structure
- Construct a water intake structure on the right (north) bank of Englishman River immediately upstream of the Highway 19 bridge, fitted with 10.5 m wide inclined wedge wire screen with 2.54 mm slots
- Construct a raw water pumping station with a capacity of 28.8 ML/day (0.33 m^3/s), which equates to ~20% of the 1.6 m^3/s currently required by a Provisional Operating Rule for average year releases from the Arrowsmith reservoir to be delivered to reaches >2 km downstream of the proposed extraction site.
- Withdraw up to 0.33 m^3/s (instantaneous) flows for municipal water consumption for up to a maximum average daily withdrawal in July of 24 ML/day (24-hr average of 0.27 m^3/s) at current demand.

.../2

Based on the above information, DFO has concluded that your proposal is likely to result in serious harm to fish (as follows), which is prohibited under subsection 35(1) of the *Fisheries Act:*

- permanent alteration of fish habitat that supports various salmon and trout life history stages due to the reduction of flow in the Englishman River from instantaneous water withdrawal;

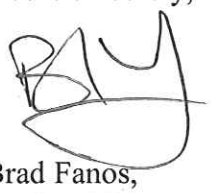
In order to be in compliance with the above legislation you must obtain an authorization from DFO pursuant to paragraph 35(2)(b) of the *Fisheries Act*.

Should you choose to proceed with your proposal, please complete the Application for Authorization under Paragraph 35(2)(b) of the *Fisheries Act* Form (http://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/index-eng.html).

Please be advised that any unauthorized work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or supports such a fishery that would result from proceeding with your proposal without first obtaining a *Fisheries Act* authorization could lead to corrective action such as enforcement. It is also your *Duty to Notify* DFO if you have caused, or about to cause, serious harm to fish that are part of or support a commercial, recreational or Aboriginal fishery. Such notifications should be directed to (http://www.dfo-mpo.gc.ca/pnw-ppe/violation-infraction/index-eng.html).

If you have any questions, please contact Herb Klassen at our Vancouver office at (604-666-9126), by fax at (604-666-0417), or by email at (Herb.Klassen@dfo-mpo.gc.ca). Please refer to the file number referenced above when corresponding with DFO.

Yours sincerely,



Brad Fanos,
Regional Manager, Fisheries Protection Program

cc. Herb Klassen (DFO)

ERWS Report:

Fisheries Protection Program of Fisheries and Oceans Canada

Appendix B

Water Licence Application Report

Water Licence Application Report

File Number: 1001868 Watershed: Englishman River

Source: Englishman River Tributary to: ocean

Recommendation Summary:

I recommend that separate water licences issue for each of the following purposes:

Purpose:	**Quantity:**	**Period of Use:**	**Appurtenance:**
Waterworks	1,540,000,000 gallons per year but not to exceed 10,550,000 gallons per day	Whole year	all lands within the boundaries
Storage	7300 ac.ft.	Whole year	Support of above water licence

See Plan: Englishman River Water Allocation Plan

Special Clauses/Conditions:

For both licences recommended herein:

The intakes shall be adequately screened to prevent debris and fish from entering the intake works.

The licensee shall be responsible for the monitoring of water levels on Arrowsmith Lake and the streamflow on Arrowsmith Creek and Englishman River as required by the Engineer under the Water Act.

For waterworks purpose licence:

The diversion of water authorized under this licence may be restricted or prohibited at any time by an order in writing of the Engineer under the Water Act in order to maintain a minimum flow in the stream.

The water authorized to be diverted and used under this licence during the period June to October must be fully supported from storage provided in the reservoir authorized.

A flow measuring device suitable to the Engineer under the Water Act shall be incorporated into the works at the source.

For storage purpose licence:

Construction of the dam/works authorized under clause (h) hereof shall not be commenced until plans prepared by a professional engineer registered in B.C. have been submitted to, and leave to commence construction granted, by an Engineer under the Water Act.

The development of storage on Arrowsmith Lake shall require debris and vegetation removal from the lands subject to flooding, the restoration of inlet stream channels, creation of fish spawning terraces, and construction of a cartop boat access to the lake.

The licensee shall make releases of water past the dam/diversion structure authorized under clause (h) hereof as may from time to time be ordered by the Engineer under the Water Act.

Authorized Works:

For both licences recommended herein:

nil

For waterworks purpose licence:

intake, pipe and pumps

For storage purpose licence:

dam located at outlet to Arrowsmith Lake

Address Objections, Concerns, & Comments:

A. Legal Objectors

The following have been considered as legal objectors under the Water Act:

1. MacMillan Bloedel Limited

As the land owner of Blk 1324 surrounding Arrowsmith Lake, representatives of MacMillan Bloedel Limited have indicated that property rights would be affected by the flooding of lands and control of access.

Response: MacMillan Bloedel Limited and the applicants have reached substantial agreement on compensating M&B for the loss of property rights and for providing the applicants access for construction, operation, and maintenance of the storage facility on Arrowsmith Lake.

2. Miles Porter, Parksville

Mr. Porter is a downstream riparian landowner who has expressed objections to the issuance of this licence for the following reasons:

- water conservation should be implemented before developing new sources,
- Englishman River should remain as a "wild river",
- population growth should be controlled, and
- logging and herbicide application should be controlled within the Englishman River watershed.

Response: Mr. Porter's rights as a downstream riparian owner should not be affected by the issuance of this licence.

3. Davis & Avis, Barristers & Solicitors on behalf of B.C. Water Service

B.C. Water Service has a water licence (C045309) to divert a maximum of 3000 gallons per day from the Englishman River for the purpose of water delivery. The POD is located upstream of the existing Island Highway. Concern is for the proposed upstream community water supply intake causing "an interruption or substantial diminishment of flow" at the B.C. Water Service authorized POD.

Response: Issuance of a water licence will not affect this licensee's rights to divert water for water delivery. During the low flow period, the proposed withdrawal will be fully supported by storage.

4. Englishman Aggregates Ltd. (Terry Molony)

Englishman Aggregates Ltd. leases property (Block 579, Nanoose Land District) owned by Timberwest Forest Ltd. An application has been made for a mining permit to develop a gravel pit operation on this land which is bounded by the Englishman and South Englishman Rivers. Englishman Aggregates Ltd. has objected to the issuance of a water licence if water withdrawal or waterworks interfere with their gravel pit proposal.

Response: Issuance of this downstream water licence to divert water for waterworks purpose or for a water licence to store and release water on Arrowsmith Lake to support the summer withdrawals will not affect Englishman Aggregates Ltd.'s application for a gravel pit operation. The proposed waterworks are not located on the Englishman Aggregates Ltd's leased property. This water licence will not require any additional community watershed requirements, as there are already existing licensed withdrawals for individual and community water supplies located downstream of this proposed development.

B. Other Government Agencies

1. Provincial Fisheries

Comments regarding provincial fisheries' interests are summarized in George Reid's letter of October 22, 1992. In order to provide minimum fisheries maintenance flows in the Englishman River, the proposed storage on Arrowsmith Lake should provide: "minimum summer flow, in excess of all other withdrawals, as measured at the Water Survey of Canada Gauging Station Number 08HB002 (downstream of Highway 19 bridge crossing) to be maintained at or above 40cfs (1.13 m3/s) on a 1:20 year return period".

Other comments and recommendations by the BCE Fisheries Section included:

- a committee to be formed to consider matters such as appropriate minimum fisheries flows in years where storage would not provide 40 cfs throughout the anticipated dry summer period,

- optimal fisheries maintenance flows is regarded as 15% mean annual discharge (approximately 75 cfs). In the event of further water storage development in the Englishman River watershed, flow enhancement should strive for optimal fisheries flows.

- in response to the proposed intake locations in the predesign report, the downstream pumping site at the South Englishman River is preferred to the upstream gravity intake.

- mitigation for impacts on fisheries values on Arrowsmith Lake

should include: removal of vegetation and logging debris around lake perimeter that is subject to flooding; restore inlet stream channels; create terraces for spawning habitat; construct cartop boat access for recreational fisheries; and assist in the stocking of other lakes within the watershed (Hidden, Fishtail, Rowbotham Lakes).

2. Federal Fisheries

Fisheries and Oceans Canada (DFO) comments are presented in Richard Eliason's letter dated November 24, 1992. The recommended streamflows as "measured at the lower river gauge # 08HB002, spawning flow should be maintained at 300 cfs (8.50 cms) from October to December and should not fall below 200 cfs (5.67 cms) during this period of the year. Rearing flow should be maintained at 40 cfs (1.13 cms) through the summer low flow period generally from July to October and should never (even in a drought year) fall below 25 cfs (0.71 cms)".

Additional recommendations included:

- the provision of fish migration pulse flows in late August-early September to move chinook stocks upstream to their spawning grounds;

- the development of an operating rule curve so that reservoir operating plan (storage and release regime) can be completed to ensure adequate annual water requirements for all user groups;

- the establishment of a committee of DFO, MOELP, RDN, and municipal waterworks staff to determine reservoir releases;

- the water intake to be located as far downstream as is technically feasible on the Englishman River to maintain as much flow and wetted area for fish over the longest possible distance in the river prior to the withdrawal point.

Response to #1 & #2: The proposed development of storage on Arrowsmith Lake to support the summer domestic water demand downstream on the Englishman River should provide an opportunity to enhance flows for the fisheries resource.

The existing flows on the Englishman River near Parksville (08HB002) frequently fall below 40 cfs (1.13 m3/s), the fisheries rearing flow as recommended above by both the federal and provincial fisheries agencies. Further, there are 17 months during the period of record where the mean monthly flows are less than the 25 cfs (0.71 m3/s) considered the "absolute lowest sustainable rearing flow" by DFO. The development of up to 9,000,000 m3 of storage on Arrowsmith Lake to support the summer water demands will provide additional water for enhancement of Englishman River baseflows.

Upstream of the water supply intake, the Englishman River base flow will be increased during the low flow period by the water released to support the community water supply withdrawals and the water released to meet fisheries flow targets. Below the intake, flow enhancement will be gained by the fisheries release only. Initially, water withdrawals will be made at the existing City of Parksville's intake near the mouth of the Englishman River.

The existing streamflows during the salmon spawning period in October are frequently lower than that recommended by DFO. Water releases from Arrowsmith Lake storage for spawning flows or migration pulse flows will only be available when licensed water withdrawal can be supported to the end of the low streamflow period and when agreed by fisheries agencies to deviate from the fisheries baseflow targets.

A provisional operation rule will be implemented to provide direction for the release of water from the Arrowsmith Lake storage. After the initial years of operation, the operation rule will be reviewed in consultation with the applicants and fisheries agencies to maximize benefits to the fisheries resource while continuing to support the water demands.

The development of storage on Arrowsmith Lake will require vegetation and debris removal for the lands to be flooded, the restoration of inlet stream channels and the creation of terraced spawning beds in the inlet stream areas.

The promotion of recreational fisheries opportunities is supported by the applicants. A commitment to work with provincial fisheries in providing cartop boat access on Arrowsmith Lake and to assist in a fish stocking program has been confirmed. However, as most of the lands in the Englishman River watershed are under private ownership, agreement with the landowner(s) is also required.

C. First Nations

The Nanoose Indian Band have inquired by telephone as to whether the fisheries resource was protected. Also, Mr. Jeff Bob met on September 20, 1996 for an update on the re-structured water supply proposal. He was interested on whether the Regional District intended to serve the Lantzville side of the Nanoose harbour.

Response: The band was advised that DFO recommendations for enhancement of base flows were being proposed. Mr. Bob was provided access to information on the proposal. He was also advised that contact should be made directly to the Regional District to discuss the opportunity for the Band to be serviced by the proposed system.

D. Others

Numerous objections, concerns, and comments were made by other persons both by correspondence and by oral presentation at the June 20, 1996 public meeting. The concerns can be categorized into four main issues: growth management, water conservation, alternative sources (ie. groundwater), and the fisheries resource.

The opportunity to address the growth management issue is best provided in the development of both the Regional District Growth Management Strategy and the local official community plans.

The water demand (average 0.55m^3/day/capita, maximum 1.375m^3/d/c) is based on a existing water use which is similar to the water consumption by other communities on the east coast of Vancouver Island. All three jurisdictions have implemented water conservation programs and it is anticipated that changing attitudes on water use will reduce water consumption. Nevertheless, a prudent water supply strategy should be based on the current demands with the benefits of water conservation programs extending the supply capacity to serve other users or service areas over a longer period.

All three jurisdictions have investigated the possibility of developing additional groundwater sources to meet future demands. The studies have concluded that although some of the aquifers are large in volume, the annual recharge rate would be inadequate to provide a reliable yield to satisfy future demand.

There should be no negative impacts to the fisheries resource in the Englishman River as the applicant's water withdrawals will be supported by storage during the low flow period. Any impacts to the fisheries resource on Arrowsmith Lake will be mitigated by releases of additional water downstream to enhance natural low flows on the Englishman River. Further mitigation measures to be provided include: creation of lake spawning beds; restoration of inlet stream channels; and construction of cartop boat access.

Quantity Required:

For waterworks purpose licence:

Application: The water quantity required in the initial water licence application was for a range of "initially 595,000,000 up to 2,513,000,000 gallons a year at 25 years". Water would be pumped from the confluence of Englishman River and South Englishman River.

Initial water demand projections were based on a Regional District Bulk Water Supply to serve the area from Lantzville to Qualicum inclusive with a 4.0% average annual growth rate over 25 years. As funding for this bulk water supply proposal was rejected in a public referendum on November 4, 1995, the various jurisdictions re-evaluated their options for future water supply. The current water supply proposal is based on a revised joint venture agreement to serve the City of Parksville, the Town of Qualicum Beach and the Regional District's water systems in the French Creek and Nanoose Bay areas.

The existing (1996) and projected 25 year (2021) water demand, as shown in Table 1, is based on 4% annual growth rate, average consumption 0.55m3/day/capita, maximum consumption 1.375m3/d/capita; peaking factor 2.5.

Table 1 Parksville, Qualicum, and RDN Service Areas
Population & Water Demand Projections

	1996			2021			90% Groundwater	Surface water
	Pop	Avg day m3/d	Max Day m3/d	Pop	Avg day m3/d	Max Day m3/d	Max Day m3/day	Max Day m3/day
City of Parksville	9,857	5,421	13,553	26,277	14,452	36,131	8,618	27,513
Town of Qualicum Beach	6,661	3,664	9,159	15,000	8,250	20,625	12,453	8,172
RDN-French Creek	2,967	1,632	4,080	7,910	4,350	10,876	5,468	5,944
RDN-Nanoose	3,573	1,965	4,913	9,525	5,239	13,097	6,837	6,260
Total	23,058	12,682	31,705	58,712	32,291	80,729	33,377	47,888

based on information by G.Scott, fax dated November 1, 1996

The use of a 25 year horizon for water demand is warranted as the design and construction of works (dam, intake, etc) would be cost effective and a longer amortization period is required.

The water demand (average 0.55m^3/day/capita, maximum 1.375m^3/d/c) is based on a existing water use which is similar to the water consumption by other communities on the east coast of Vancouver Island. All three jurisdictions have implemented water conservation programs and it is anticipated that changing attitudes on water use will reduce water consumption. Nevertheless, a prudent water supply strategy should be based on

the current demands with the benefits of water conservation programs extending the supply capacity to serve other users or service areas over a longer period.

The 25 year projected water demand shown in Table 1 is to be satisfied by both the proposed Englishman River withdrawal and the existing groundwater wells and licensed springs that are considered reliable. The reliable groundwater/spring sources currently produce a total maximum output of 37,086 m3/day. Based on past experiences with diminishing yields, a conservative estimate of long term capacity is based on a 10% reduction over the next 25 years. Therefore, the groundwater/spring sources will contribute 33,377 m3/day.

By using the maximum day water demand from Table 1 and subtracting the capacity of the existing groundwater/spring supplies, a **47,888 m3/day maximum day demand** from the Englishman River is required. The **6,991,663 m3/year annual demand** from the Englishman River is calculated by using the 2.5 peaking factor and multiplying the average day demand (19,155 m3/day) by 365.

With a conversion to imperial units, a water licence for waterworks purpose would state **1,540,000,000 gallons per year but not to exceed 10,550,000 gallons per day.**

The proposed point of diversion is the existing City of Parksville's water intake. There are no licensed points of diversion located downstream of this location. Even if the point of diversion was located further upstream as originally proposed, the demand is to be fully supported by storage during the summer low flow period and therefore, would not have any impact on any existing downstream withdrawals.

The City of Parksville currently has four existing water licences on the Englishman River for waterworks purpose. These licences are shown in Table 2.

Table 2 Existing Water Licences - City of Parksville

Licence	Priority Date	Source	Purpose	Quantity
C022058	1954/03/30	Englishman River	Waterworks	200,000 gpd
C023297	1956/01/10	Englishman River	Waterworks	50,000 gpd
C026692	1961/05/11	Englishman River	Waterworks	1,000,000 gpd
C057408	1978/11/03	Englishman River	Waterworks	1,500,000 gpd
C057409	1980/10/22	Fishtail, Hidden, & Arrowsmith Lakes	Storage	650 ac-ft

The use of water authorised in water licence C057408 is contingent on the development of supporting storage under water licence

C057409. The City of Parksville has not developed the supporting storage or made use of the waterworks licence. This licence application is, in part, a substitution of these licences. .

The other water licences shall remain in the name of City of Parksville as they will be required prior to storage being developed to support the new licence.

Inquiries have been made by other communities (Lantzville Improvement District, Nanoose Indian Band, Errington/Coombs area) regarding the opportunity to participate in this water supply proposal at a later date or to develop independent water supplies on the Englishman River. A request for a Water Reserve under Section 44 of the Water Act should be made for the unrecorded water of Arrowsmith Lake and the Englishman River to provide an adequate time for communities north of the City of Nanaimo within the Nanaimo Regional District to determine their future water supply needs.

As per the Englishman River Allocation Plan (1993), the water extraction from the Englishman River during the low streamflow period must be fully supported by storage.

For storage purpose licence:

Application: The application stated a proposed development of 9,000,000 m^3 water storage on "Arrowsmith Lake (Healy Lake alternately/additionally)". Storage would be created by a 13.5 metre dam and a 48.6 ha reservoir.

Although Healy Lake was indicated in the initial water licence application as a possible storage site, focus has been completely directed to the development of storage on Arrowsmith Lake only.

Updated flow records from the Water Survey of Canada Station (08HB002) on the Englishman River near Parksville for the 1913-1995 period are attached. Applying the Regional Water Management Policy for instream fisheries requirements to the Englishman River flows, the extractive water demand for the period June to October must be supported by storage.

Table 3 Monthly Demand Distribution during Low Flow Period

Month	June	July	Aug	Sept	Oct	Total
% Annual Demand	11.9%	14.7%	14.1%	8.0%	7.3%	56%
Demand m3	832,008	1,027,774	985,824	559,333	510,391	3,915,331

The monthly distribution of the applicants' existing water demand, shown in Table 3, was used to calculate the volume of water that must be supported by storage. In addition, a volume of water is required to account for miscellaneous losses including evaporation in the reservoir and stream channel losses between the lake

storage and the river intake. A conservative estimate of 280,000 m3 based on 0.6 metres depth over the full supply area (46.7 ha) should account for any losses. Therefore, for the period June to October inclusive, the total storage volume required on Arrowsmith Lake to support the extractive water demand downstream on Englishman River is 4,410,000 m3.

The applicants propose to develop up to 9,000,000 m3 of storage to not only support their 25 year projected demand but also to improve existing low flow fisheries conditions in the Englishman River. As the storage development on Arrowsmith Lake would have a impact on the fisheries resource due to the lake level fluctuations, fisheries mitigation is proposed.

A streamflow target of 1.55 m3/s at the WSC station on Englishman River was used to estimate storage requirements on Arrowsmith Lake. The streamflow target included the maintenance of 1.13 m3/s (40 cfs) in Englishman River plus an additional 0.38 m3/s (13.4 cfs) to support the projected maximum monthly water supply demand. The estimated storage requirements for each year of complete streamflow records on the Englishman River are shown in Table 4.

Table 4 Arrowsmith Lake Storage Requirements

Year	Storage Deficit (m3)
1915	4,387,880
1916	2,412,465
1980	3,380,327
1981	4,193,869
1982	4,210,631
1983	3,487,463
1984	3,701,735
1985	4,834,162
1986	6,018,524
1987	8,693,650
1988	6,315,070
1989	5,504,039
1990	4,619,890
1991	4,870,969
1992	5,752,854
1993	6,325,496
1994	6,336,745
1995	5,308,775

For all years during the period of streamflow record, the proposed 9,000,000 m3 of storage could meet the target release conditions. Even during 1987 with the lowest summer flows on record, the storage requirements are slightly less than the quantity being proposed. Table 5 shows the storage requirements to meet the target streamflows at various low flow return periods

Table 5 Storage Requirements - Return Intervals	
Return Year	Storage Deficit (m3)
1:2	4,885,000
1:5	6,185,000
1:10	6,950,000
1:20	7,630,000
based on Log Normal & Pearson Type III Distribution	

The proposed 9,000,000 m3 of storage should satisfy the fisheries requirement of 40 cfs in a 1:20 return year plus fully support the projected water demand during the summer low flow period.

A water licence for storage should be issued for up to 7,300 acre-feet in support of the waterworks purpose licence.

Proposed Works:

For waterworks purpose licence:

The current proposal is to use the existing City of Parksville intake location, approximately 400 metres downstream of the Island Highway. The existing intake will require upgrading to improve withdrawal capacity.

Future plans are to re-locate the intake further upstream above the urban development. The initial water licence application indicated that the intake location would be near the confluence with the South Englishman River. In discussions with the applicants and fisheries agencies, the future intake location would be located on the Englishman River between the South Englishman River confluence and the new Island Highway bridge. A Change of Works application will be submitted when the location and design specifications are finalized.

For storage purpose licence:

To fully support the water demand during the June to October low flow period, the development of storage on Arrowsmith Lake is being proposed. The concept, as outlined in the 1995 KRC Report and subsequent letters, is to utilize 4,000,000 m3 of water below the existing lake levels and to obtain an additional 5,000,000 m3 of storage by raising the present lake level 12 metres (spillway elevation).

A dam would be constructed on the bedrock sill outlet of Arrowsmith Lake. The preliminary designs show a concrete-faced rockfill dam extending approximately 65 metres between the rock outcrops on the north and south sides of the lake outlet. A concrete spillway (elevation 828.5m) would be 12 metres above the existing lake level (el.816.5m) with 1.5 metres of freeboard to the dam crest (el.830m). Two outlet pipes are proposed to provide

flexibility of operation and extraction of water at different levels (el.810m & el.802m).

Physical characteristics of Arrowsmith Lake under existing conditions and those with a dam to provide 9,000,000 m3 of storage are summarized in the letter report dated April 15, 1996 from Gartner Lee Limited and shown in Table 6.

Table 6 Physical Characteristics of Arrowsmith Lake Under Existing and Dammed Conditions

	Existing	With Dam
Lake Surface Elevation (m)	816.5	828.5 (max) 802.0 (min)
Area (ha)	36.2	46.7 (max)
Average Depth (m)	36	43 (max) 29 (min)
Volume (m3)	11-13 million	16-18 million (max) 7-9 million (min)
Length of Shoreline (m)	2,515	2,880 (max)
Storage Available for Release Downstream (m3)	0	9,000,000

Arrowsmith Lake has a relatively small catchment area of approximately 5 km2 which is only 1.5% of the total Englishman River drainage area (324 km2).

The contributing drainage area is comprised of steep rock bluffs and forested slopes with 4 or 5 streams. The two main tributaries are located at the west end of the lake - one stream flowing from Hidden Lake (el.1090m) and the watershed divide on Mount Arrowsmith (el.1570m). The flows of these creeks are braided or infiltrate to ground in the logged section between the old logging road and the gravel beach on the lakeshore. Another small gravel beach is formed where two other small creeks enter the south side of the lake.

The shoreline is comprised of either steep bedrock or steep rubble with the two small gravel beach areas at the west and south side tributaries. Some filling of the lake shore has occurred near the outlet and along the south shore where the logging road was constructed.

Accountability:

For both licences recommended herein:

At the time of issuance of this water licence, the City of Parksville's existing water licences, C057408 and C057409, for the diversion of a maximum 1,500,000 gallons per day from Englishman River supported by 650 acre-feet of storage on Arrowsmith, Fishtail, and Hidden Lakes should be cancelled. This licence is a replacement in part for these existing licences.

The water licensees are required to monitor the streamflow in the Englishman River and Arrowsmith Creek, the lake levels in Arrowsmith Lake, and the water withdrawals from the Englishman River. Monitoring and the submission of records are to be performed as directed by the Engineer under the Water Act.

The works authorized by this licence shall be operated and maintained by a joint works agreement between the Regional District of Nanaimo, the City of Parksville, and the Town of Qualicum Beach. The Town of Qualicum Beach will act as manager for the first five years.

For waterworks purpose licence:

The Engineer under the Water Act may regulate water withdrawals from the Englishman River in order to maintain a minimum flow in the Englishman River

For storage purpose licence:

The licensee(s) are required to submit detailed designs of the storage structure. Approval by the Engineer under the Water Act is required prior to construction.

The licensee shall operate and maintain the water storage reservoir on Arrowsmith Lake and release of water past the dam as directed by the Engineer under the Water Act. A Provisional Operation Rule is attached.

Other Notes:

The licence should be issued in the name of all three jurisdictions - Regional District of Nanaimo, City of Parksville, and Town of Qualicum Beach.

The mailing address: Town of Qualicum Beach, Box 130, Qualicum Beach, B.C., V9K 1S7 Attn: Mr. R.K. Weir, P.Eng, Director of Engineering and Development Services

Signed: _____ Date: Nov 3/96

	Station Name:			ENGLISHMAN RIVER NEAR PARKSVILLE										
	Station Number:			08HB002										
	Natural or Regulated:			N										
	Drainage Area (sq.km.):			324			Degrees	Minutes	Seconds					
	Location (Decimal):		Latitude	49.31667		Latitude	49	19	0					
			Longitude	124.28278		Longitude	124	16	58					

STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MN ANN
08HB002	1913	M	M	7.66	M	M	9.25	5.43	1.01	M	7.94	M	M	M
08HB002	1914	M	M	M	M	M	7.24	2.42	0.626	M	M	M	M	M
08HB002	1915	17.4	17.3	18.6	17.1	6.51	3.04	1.24	0.781	0.679	17.5	18.2	34.7	12.7
08HB002	1916	5.38	29.3	32.9	21.7	20.9	17.3	9.11	3.04	1.15	2.18	10.4	10.1	13.6
08HB002	1917	10.2	11.7	6.02	14.6	19.1	11.7	4.6	1.24	1.42	M	M	M	M
08HB002	1970	M	M	M	M	10.8	6.38	1.43	0.651	0.882	M	M	M	M
08HB002	1971	M	M	M	17.6	21.5	13.3	7.11	2.06	2.04	M	M	M	M
08HB002	1979	M	M	M	6.37	9.82	2.85	2.4	0.652	6.06	12.9	8.05	54.5	M
08HB002	1980	19.8	29.5	13.1	17.4	7.19	5.94	3.39	0.843	1.21	1.61	41.7	53.3	16.2
08HB002	1981	19.2	34.6	7.85	17.3	9.56	4.95	1.75	0.647	2.84	21.5	39.2	44	16.8
08HB002	1982	17.5	33.1	13	10.3	13.9	12	3.5	1.03	0.708	22.8	11.8	40	14.9
08HB002	1983	33.6	57.1	31.9	9.97	10.1	6.59	5.16	1.04	0.969	2.96	61.1	11.5	19
08HB002	1984	32	24.3	16.4	10.5	13.8	7.33	2.84	0.721	1.21	17.2	30.2	17.1	14.4
08HB002	1985	6.48	9.18	6.11	16.8	10.9	4.64	1.29	0.498	0.854	10.3	6.88	9.13	6.89
08HB002	1986	42.9	29.9	20.3	6.32	11.3	4.88	1.79	0.529	0.417	1.29	19.6	31.6	14.2
08HB002	1987	35.2	22.7	30.5	10.5	8.11	5.94	1.55	0.579	0.335	0.289	6.82	20.9	11.9
08HB002	1988	16.3	11.5	13.9	18.7	12.9	8.32	3.07	0.868	0.701	1.84	24.4	16.6	10.7
08HB002	1989	18.3	10	15	17.4	7.97	4.32	1.93	0.869	0.402	5.79	11	16.4	9.13
08HB002	1990	19.9	18.9	13.4	12.3	6.35	6.65	1.32	0.376	1.02	21.6	83.1	57.7	20.2
08HB002	1991	17.9	42	6.6	11.3	4.55	2.15	0.891	7.1	3.1	0.636	19.2	21.2	11.2
08HB002	1992	54.9	29.4	8.12	7.55	4.65	1.31	1.04	0.415	0.842	6.87	16	8.62	11.6
08HB002	1993	12.6	11	21.8	14.2	11.1	6.17	1.34	0.498	0.248	1.13	3.59	25.5	9.12
08HB002	1994	25.6	20.7	32.4	11.5	5.55	4.06	1.14	0.477	0.462	3.36	15.6	41.8	13.6
08HB002	1995	25.2	34.1	21.9	9.33	7.95	4.89	1.62	0.99	0.35	7.45	44.6	41.2	16.63
MEAN		22.7	25.1	16.9	13.3	10.7	6.7	2.8	1.1	1.3	8.4	24.8	29.3	13.5
% of MAD		168%	186%	125%	98%	79.0%	49.8%	20.8%	8.5%	9.4%	62.0%	184%	217%	100%

	Station Name:			ARROWSMITH CREEK AT OUTLET OF ARROWSMITH LAKE										
	Station Number:			08HB080										
	Natural or Regulated:			N										
	Drainage Area (sq.km.):						Degrees	Minutes	Seconds					
	Location (Decimal):		Latitude	49.22111		Latitude	49	13	16					
			Longitude	124.53472		Longitude	124	32	5					

STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	MN ANN
08HB080	1990	M	M	M	M	M	M	M	M	M	0.248	0.915	0.36	M
08HB080	1991	0.453	0.877	0.164	0.326	0.44	0.237	0.1	0.302	0.138	0.045	0.545	0.477	0.338
08HB080	1992	1.06	0.695	0.299	0.373	0.253	0.094	0.042	0.011	0.027	0.348	0.42	0.189	0.316
08HB080	1993	0.197	0.25	0.441	0.388	0.729	0.324	0.076	0.026	0.009	0.062	0.112	0.507	0.261
08HB080	1994	0.567	0.24	0.623	0.468	0.443	0.368	0.112	0.021	0.015	0.072	0.399	0.895	0.353
08HB080	1995	0.451	0.823	0.492	0.256	0.62	0.415	0.147	0.085	0.037	0.378	1.17	0.752	0.469
MEAN		0.546	0.577	0.404	0.362	0.497	0.288	0.095	0.089	0.045	0.192	0.594	0.530	0.347
% of MAD		157%	166%	116%	104%	143%	82.8%	27.5%	25.6%	13.0%	55.3%	171%	153%	100%