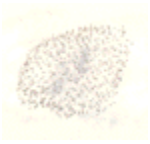
MITIGATION OF LARVAL INFESTATION (BLOODWORMS) IN THE RAW WATER SOURCE AT GJOA HAVEN

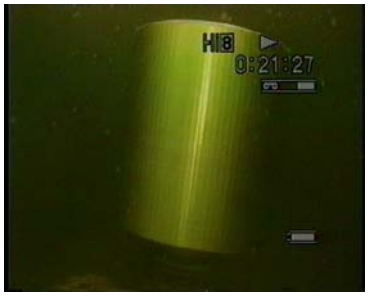
NORTHERN TERRITORIES WATER AND WASTE ASSOCIATION
2000 CONFERENCE AND ANNUAL GENERAL MEETING
YELLOWKNIFE, NWT
NOVEMBER 17&18, 2000

Presented by: Kojo O. Kumi, P.Eng.
Municipal Engineer
Community Government and Transportation
Cambridge Bay, Nunavut

MITIGATION OF LARVAL INFESTATION IN THE RAW WATER SOURCE AT GJOA HAVEN





Introduction: At the beginning of May 2000 the existing raw water intake screen (mesh screen) at Gjoa Haven was replaced with a proper intake screen. The screen was designed to eliminate the entrainment of bloodworm larvae in the water supply. A screen with narrower openings was selected. By making the size of the openings smaller than the minimum body dimension of the larvae the screen becomes an integral part of the water treatment process. In effect, it serves as the first level of filtration. The design is such that raw water flows through the screen very slowly. Thus, debris and organisms that would otherwise enter the system are allowed to remain in the raw water source thus eliminating the need for on shore handling of debris. In addition to the bloodworms, a subdivision exists in close proximity to the raw water source. This has raised concerns of potential bacteriological contamination from runoff from the subdivision. A detailed look at intake systems - their design, selection and use in controlling larval infestation is provided below.

Intake systems: In collection and distribution of water, intakes are significant components of the water treatment process, if the integral intake screen is properly designed. The wide variations in flow, quality and temperature that surface sources of water experience guide the design of intake structures – so that the required flow can be withdrawn despite the fluctuations. The intake itself normally consists of an opening (frequently screened in some manner) and a conduit, which conveys the flow to a casing, or sump from which the raw water may be pumped to the treatment plant or into delivery trucks after disinfection. Factors that are considered in locating intakes include anticipated variations in water level, navigation requirements, local currents and patterns of sediment deposition and scour, spatial and temporal variations in water quality, and the quantity of floating debris.

Intake Screen: is used to reduce the amount of floating debris and biota (living organisms) that may enter the water system. Smooth screen surfaces tend to exclude debris and biota. Thus debris and biota remain in the raw source, eliminating the need for on-shore handling of the debris. *By selecting and using screens with appropriate openings, the screen becomes an integral part of the water treatment process. In addition to providing protection to the pumps and process equipment the screen provides a first level of filtration.*

MITIGATION OF LARVAL INFESTATION IN THE RAW WATER SOURCE AT GJOA HAVEN

Intake Screen Design and Selection: choosing the slot opening size of the screen is the starting point in screen design and selection. Site conditions determine the size of the openings. For instance the size of the particles that must be excluded and/or what local environmental authorities for fish protection prescribe, normally guide the choice of slot openings. The slot openings and water withdrawal rate (normal, minimum and maximum pump rates) are the critical factors used in the preliminary selection of a suitable screen from a manufacturer's charts. The design and selection are finalized by furnishing the manufacturer with answers to or information on such parameters as:

- the nature of the water source – river, lake, reservoir, ocean?
- normal low, high and mean water depths
- frequency at which the low and high water depths occur
- is in situ cleaning of the screen required?
- direction and velocity range of prevailing currents
- intake line size and intake pump capacity
- type of connection to be used
- water quality – clean, high silt content or high degree of contamination/befouling?

The key to effective intake screen operation is maintaining a uniform low inlet velocity at the intake screen surface. Uneven flow and/or high velocities will cause debris (including biota) in suspension to cling to the screen or be sucked into the system. Proper screen design and selection culminates in a through-screen velocity less that is than or equal to 0.15 m/sec. A velocity below 0.15 m/sec precludes virtually all debris problems.

Larval forms and submerged Intake Screening Systems: screens can be used to protect larval forms from the water supply system. Borrowing from The Lee Cook Intake Screen Company:

" the first technique is to identify by field studies an area which is relatively free of these organism and then locate the screening system there. Larger fish can then be protected by sizing the openings so that larger species will not be entrained and then designing the screen to have a uniform slot velocity of 0.12 m/sec (0.4 fps (foot per second)). The second technique is to eliminate the entrainment of eggs and larvae by making the screen openings smaller than the minimum body dimension of the larval form. In eggs and larval protection by exclusion, screen orientation again becomes a factor……"

Larval Forms and Slot Size: the Screen Services Company notes that the slot size of one or two millimeters is typical for eggs and larvae; 2.5 millimeters is used for juvenile and adult fish.

Screen opening selection to eliminate the entrainment of chironomid (midge fly/bloodworm) eggs and larvae in the raw water source at Gjoa Haven was a challenge as the following responses to a request for information on the minimum body dimension of chironomid larva attest to:

The smallest eggs are apparently 170 μm long and 70 μm wide. I do not have specific information on the minimum size of first instar larvae, but since most will pass through 125 μm screens, I think you would want a screen with openings not larger than 50 μm (*Ian Walker, Okanagan University College, Kelowna, British Columbia)* Author's Note: μm ->micron

The actual measurements will vary depending upon which bloodworms you are dealing with – however the only measurement I could find relate to Chironomus pulcher from Africa, which is probably a medium size species. The figures are quoted by C Dejoux on p468 of Canadian Entomologist Vol.103 (1971); 1st instar 0.08mm (sd 0.01); 2nd instar 0.15mm (sd 0.05); 3rd instar 0.32 mm (sd 0.08); 4th instar 0.58mm(sd 0.09) The head capsule size is fixed for the duration of each instar – only the larval body growing between moults *(Jon Martin, University of Melbourne, Australia)* Author's Note: sd -> standard deviation

MITIGATION OF LARVAL INFESTATION IN THE RAW WATER SOURCE AT GJOA HAVEN

….. we had an infestation of “little red worms” - chironomid fly larvae - in the Arviat Reservoir in Feb. 1991 which caused a similar type of public outcry. The problem was solved by the installation of 0.15-mm screens on the entrances to the intake pipes *(Don Forsyth, Community Government and Transportation, Rankin Inlet, Nunavut)*

Summary: the minimum body dimension is a prime parameter in effective design and selection of an intake screen for eggs and larval forms. Environmental Health Officers should request the body dimensions as part of the identification and testing of larval samples submitted for evaluation to the laboratory. Intake screens are an integral part of the water treatment process; they provide a first level of filtration. Exclusion of biota from the water supply system is premised on the fact that unlike inanimate floating debris, living organisms including larval forms can actively avoid being sucked through a screen or trapped by velocity on the screen surface if the local velocity is low enough and if there are paths of escape. Screen design and selection of a through screen velocity below 0.15 m/sec precludes virtually all debris (animate and inanimate) problems.

Additional information is available at the following websites with respect to intake screen design.

http://www.johnsonscreens.com
http://www.screenservices.com
http://www.waterscreen.com/design_basis.html

For information on bloodworms, the Home Page for Chironomid Society can be found at

http://www.ouc.bc.ca/fwsc/iwalker/intpanis/