REPORT
REGULAR COUNCIL MEETING
1992 June 8

THE CORPORATION OF THE DISTRICT OF BURNABY

ENVIRONMENT AND WASTE MANAGEMENT COMMITTEE

HIS WORSHIP, THE MAYOR
AND ALDERMEN:

SUBJECT: USE OF CHLORAMINES FOR SECONDARY DISINFECTION OF DRINKING WATER

RECOMMENDATIONS:

1. THAT a copy of this report be forwarded to Mayor Greg Halsey-Brandt, Chairperson, Water Committee, Greater Vancouver Water District, 4330 Kingsway, Burnaby, B.C., V5H 4G8.

2. THAT the G.V.W.D. be requested to respond to the concerns expressed in the following report prior to consideration of implementing secondary disinfection for drinking water.

R E P O R T

The Environment and Waste Management Committee, at its meeting held 1992 May 12 received and adopted the attached staff report providing information on disinfectants and in particular chloramine used for disinfection of drinking water, and to present concerns that need to be addressed by the G.V.W.D.

The Committee therefore submits the report "Use of Chloramines for Secondary Disinfection of Drinking Water" for Council's endorsement.

Respectfully submitted,

Alderman L. Rankin
Chair

Alderman D.P. Drummond
Member

Alderman D. Evans
Member

Alderman D. Lawson
Member

Alderman C. Redman
Member

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- ACTING CHIEF PUBLIC HEALTH INSPECTOR

TO: CHAIRMAN & MEMBERS, ENVIRONMENT & WASTE MANAGEMENT COMMITTEE — 1992 MAY 26

FROM: ACTING CHIEF PUBLIC HEALTH INSPECTOR

SUBJECT: USE OF CHLORAMINES FOR SECONDARY DISINFECTION OF DRINKING WATER.

PURPOSE: TO PROVIDE INFORMATION ON DISINFECTANTS AND IN PARTICULAR CHLORAMINE USED FOR DISINFECTION OF DRINKING WATER, AND TO PRESENT CONCERNS THAT NEED TO BE ADDRESSED BY THE G.V.W.D.

RECOMMENDATIONS:

1. THAT a copy of this report be forwarded to Mayor Greg Halsey-Brandt, Chairperson, Water Committee, Greater Vancouver Water District, 4330 Kingsway, Burnaby, B.C., V5H 4G8.

2. THAT the G.V.W.D. be requested to respond to the concerns expressed in the following report prior to consideration of implementing secondary disinfection for drinking water.

REPORT

1.0 INTRODUCTION:

During the regular Council Meeting on 1991 September 16, Council received a presentation from Mr. Elmer Rudolph regarding the Greater Vancouver Water District's (G.V.W.D.) proposed use of chloramines for secondary disinfection of the lower mainland drinking water supply.

Arising from Council's concerns regarding the use of chloramines, a motion was adopted directing staff to conduct research on the issue, and to prepare a report for the consideration of the Environment and Waste Management Committee.

Subsequently, the Environment and Waste Management Committee of Council at its meeting on 1992 January 21, received a report from staff. The discussion led to a motion to refer the report to staff to allow inclusion and clarification of comments of the committee.

As a result of a further meeting of the Environment and Waste Management Committee of Council on 1992 March 18, additional questions posed were once again referred to staff for review and response.

The purpose of this report is to provide information on the disinfectants used for the treatment of drinking water and the use of chloramines for secondary disinfection of drinking water, and to present concerns that need to be addressed by the G.V.W.D.

2.0 BACKGROUND:

The G.V.W.D. is a wholesale water supplier, providing drinking water for 1.35 million people in the lower mainland of British Columbia. To supply this water, the G.V.W.D. maintains a network of mountain reservoirs, dams, treatment facilities, service reservoirs, and a transmission network that supplies the water to seventeen member municipalities, including Burnaby, who then provide direct service to the consumer (See Attachment 1).

In 1984, the City of Vancouver raised concerns regarding the quality of drinking water since it did not consistently meet the established Canadian Drinking Water Quality Guidelines and the B.C. Drinking Water Quality Standards.

It is to be noted here that in a recent letter - dated 1992 February 12 - from the Metropolitan Board of Health of Greater Vancouver, the Medical Health Officer once again reiterated the importance of secondary disinfection. Although, no recommendation was made on which disinfectant to use, the necessity of secondary disinfection was strongly implied.

In 1985 the G.V.W.D. established a Water Quality Technical Committee to address the concerns identified in 1984. A consultant was retained and a preliminary report was presented to the committee in 1987. In January 1988, an intensive two year study was embarked upon to investigate methods of improving the region's drinking water quality.

The 1988 study included three major initiatives, namely:

- Primary Disinfection to address treatment (effectiveness against Giardia Lamblia and reduction in turbidity) at the water source.

- Secondary Disinfection to address bacterial regrowth in supply and distribution systems.

- Corrosion Control to address the deterioration of piping material and leaching of metals into the water.

The Study was submitted to the Water and Environment Committee of the G.V.W.D. in 1990 September for review and comment, and to the G.V.W.D. Board for information. Subsequently, in 1990 November the implementation of secondary disinfection by chloramine was approved in principle and it was recommended that planning and design studies be undertaken for implementation.

A report entitled "Greater Vancouver Drinking Water Quality Improvement Program Final Summary Report, September 1990" prepared by Economic and Engineering Services for G.V.W.D. is available in the Environmental Health Services office for review.

3.0 DISINFECTION OF DRINKING WATER:

The disinfection of drinking water is the most important treatment process for preventing the spread of infectious diseases. Correctly used, disinfectants provide a critical and effective barrier against waterborne diseases.

Disinfectants usually involve the use of an oxidant. For several decades, chlorine has been the disinfectant of choice for water treatment in most communities throughout North America, and in the greater Vancouver area since the 1940's.

The health risks associated with the use of the different disinfectants vary widely and may result from the presence of the disinfectant itself and/or its by-products in the water. In an effort to address this issue, the World Health Organization (WHO) investigated the issue and concluded in a 1991 June report that where local circumstances require that a choice must be made between meeting either microbiological guidelines or guidelines for disinfectants or disinfectant by-products, the microbiological quality must always take precedence.

Compounding the problem of risks to human health, are the potential environmental risks that may result from the use of some of the disinfectants.

3.1 Primary Disinfection

Primary disinfection is the major disinfection step practised in the treatment plant prior to water entering the distribution system. Primary disinfectants that have usually been used in treating drinking water are chlorine, chlorine dioxide, ozone, chloramines and UV radiation. Presently, the G.V.W.D. uses chlorine as a primary disinfectant.

In the 1988 study conducted by G.V.W.D., the impact on water quality due to primary disinfection by chlorine, chlorine dioxide and ozone was evaluated. Chlorine dioxide was discontinued from the study due to public health concerns associated with the disinfectant and its by-products. Ozone was found to have, amongst other drawbacks, questionable effectiveness on the protozoan Giardia Lamblia at high turbidity levels. Therefore, the findings recommended that chlorine be the only disinfectant used for primary disinfection.

Questions have often arisen on the use of chloramines for secondary disinfection. Although chloramines are used for primary disinfection of drinking water in some Canadian cities, this method is not viewed as a viable alternative for the G.V.W.D. system due to the low pH level of the water.

3.2 Secondary Disinfection

The objective of the secondary disinfection is to provide a disinfectant residual in the water distribution system and thereby limit the regrowth of coliforms and other bacteria in the distribution system. These coliforms may enter the distribution system as bacteria that are shielded by turbidity during primary disinfection. In addition, bacteria can enter the distribution system through cross connections, watermain breaks and repairs.

The secondary disinfectants that are usually used in addition to the primary disinfectants include chlorine, chlorine dioxide, and chloramines. Ozone and UV radiation, although they are effective disinfectants do not provide the residual needed for secondary disinfection. In addition, UV radiation is rendered ineffective in conditions of high water turbidity and is not effective against Giardia Lamblia cysts.

In order to assist in collection of data to evaluate the effectiveness of drinking water disinfection for the G.V.W.D. Study, Burnaby Environmental Health Services staff have been taking, in addition to routine water samples, an average of 520 drinking water samples per year since 1988.

The drinking water is routinely tested for the presence of coliforms as well as the general bacterial population. It is necessary to determine the concentration of the general bacterial population since high concentrations can mask the presence of coliforms and thereby prevent the detection of a potential threat to public health. The heterotrophic plate count (HPC) is most often used to determine the concentration of the general bacterial population.

The data obtained indicates that the chlorine residuals are low and at times the bacterial counts are high, thus supporting the need for provision of secondary disinfection to reduce regrowth of bacteria in drinking water supply and distribution lines. However, the choice of a secondary disinfectant needs to be addressed.

4.0 PROPOSED USE OF CHLORAMINES FOR SECONDARY DISINFECTION OF DRINKING WATER:

Chloramines are formed when water containing ammonia is chlorinated or when chlorinated water has ammonia added to it. Chloramines are weaker disinfectants than either chlorine or chlorine dioxide, but have a much longer residual in water distribution systems than chlorine or chlorine dioxide.

The health risks of chloramine differ from those posed by chlorine to the extent that chloramine itself may present a health risk. The WHO has proposed guideline values of 3 mg/l and 5 mg/l for chloramine and chlorine respectively. However, the U.S. National Research Council Safe Drinking Water Subcommittee on Disinfectants recommends that chloramine levels in drinking water should not exceed 0.166 mg/l. It is to be noted that very little work has been done to evaluate the health risks associated with chloramine disinfected drinking water.

The U.S. Environmental Protection Agency (E.P.A.) is currently in the process of developing regulations for disinfectants and disinfection by-products. At the present time, however, no maximum levels have been established for chlorine or chloramines in drinking water.

The majority of water treatment facilities in Canada use chlorine for disinfection of drinking water. However, the city of Edmonton and the Capital Regional District have been using chloramines as a component of their drinking water disinfection program since the 1940's. More recently Toronto, Lethbridge and Fort McMurray have also implemented a chloramine disinfection program.

Although chloramines are used for disinfection of drinking water in some Canadian cities, it is presently difficult to compare, and/or evaluate their use in lower mainland due to the variability in the quality of the raw water. However, using the currently available information, it is possible to provide information comparing chlorination and chloramination (See Attachment 2).

4.1 The G.V.W.D. Secondary Disinfection Initiative

A major component of this initiative was to compare the performance of chlorine and chloramine under actual distribution system conditions. The site chosen for the demonstration was the Newton Reservoir in Surrey. The three distribution systems supplied by this reservoir have historically been the hardest hit by the effects of bacterial regrowth and were considered to be excellent test and control areas.

A secondary treatment plant was designed to simultaneously treat water supplying the Newton and South Surrey test areas, with chlorine and chloramine respectively. Water supplied to Delta served as the control and as such was to receive no secondary treatment. The subject initiative was implemented in 1988 September (see Attachment 3).

The target level established for chloramine in the South Surrey test area was 2.0 mg/l, and 0.4 mg/l free chlorine for the Newton test area. These levels are lower than the WHO recommended levels of 3 mg/l for chloramine and 5 mg/l for chlorine.

The chloramine level is however, in excess of the 0.166 mg/l established by the National Research Council Safe Drinking Water Subcommittee on Disinfectants. Due to the different guidelines established by different agencies, it is recommended that the G.V.W.D. further investigate this issue.

During 1989, chlorine and chloramine appeared to be equally effective in reducing the percentage of samples testing positive for coliform bacteria and the percentage of those with greater than 10/100 ml's. The heterotrophic plate counts (HPC) in both the South Surrey and Newton areas were also found to be significantly lower than those found in Delta the control area.

4.1.1. Environmental Impact

Although the results of the initiative indicated that chloramine was slightly more effective than chlorine at reducing HPC's, two incidents arose giving cause for concern.

On 1989 October 17, and 1990 July 10, breaks in the watermain in the vicinity of Fergus Creek in the south Surrey chloramine test area resulted in large quantities of disinfected water flowing into the creek.

The discharges to the creek caused large fish kills and subsequently resulted in the laying of charges by the Federal Department of Fisheries and Oceans against the Municipality of Surrey. The Municipality of Surrey was found guilty on all charges and was fined a sum of $3,000.

4.1.2. Environmental Assessment Review Process

Due to the concerns arising from the fish kills in the South Surrey chloramine test area, the Federal Ministry of Environment put a halt on the implementation of a similar region-wide program pending the outcome of an Environmental Assessment Review Process (E.A.R.P.).

The purpose of E.A.R.P. is to implement the Federal Government's policy on environmental assessment. The policy requires that the environmental implications of government actions be considered prior to taking irrevocable decisions and as early in the planning process as possible.

The process must ensure that the environmental implications of all proposals are fully considered. The implications must include the potential environmental effects on and from the project and directly-related social effects. Where adverse implications are potentially significant or where there is a significant public concern, the initiating department is required to refer their proposal to the Ministry of Environment for public review by a Panel.

However at a meeting of the G.V.W.D. Water Committee in 1992 March, a report was presented by the G.V.W.D. staff indicating that the interpretation of a recent judgment by the Court of Appeal concerning the applicability of E.A.R.P. in the Oldman River Dam case in Alberta has probably removed the Department of Fisheries and Oceans ability to apply the E.A.R.P. to the District's proposed plan for chloramination of drinking water. While awaiting for a clarification from the Department of Fisheries and Oceans, the G.V.W.D. staff proposed that a Water Quality Improvement Plan Review (W.Q.I.P.R.) be conducted by an independent Panel instead of the E.A.R.P.

The G.V.W.D. staff report indicated that the costs for the W.Q.I.P.R. option will be considerably lower than those incurred by an E.A.R.P. Should requirement for the E.A.R.P. be withdrawn, the W.Q.I.P.R. may provide an adequate assessment. However, should the requirement for an E.A.R.P. not be withdrawn, the W.Q.I.P.R. could form a component of the E.A.R.P.

4.1.3 Cost of Implementation and Maintenance

One of the advantages alluded to by the G.V.W.D. for using chloramines for disinfection was the lower cost of implementation and maintenance. The estimated capital costs for secondary disinfection with chloramine are $7 million, and as high as $70 million for chlorine.

Furthermore, the annual operating and maintenance cost would be significantly higher for chlorine - $5.5 million - compared to chloramine - $1.2 million - due to chemical and labour costs that are associated with the larger number of chlorine stations.

It is imperative that a complete cost benefit analysis is completed comparing the two systems prior to making a decision on a suitable method of secondary disinfection.

5.0 WATERSHED MANAGEMENT

The G.V.W.D. has indicted that the level of chemical contaminants in the raw water are well below the maximum allowable concentrations set forth in the Guidelines for Canadian Drinking Water Quality. In addition, coliform levels in the raw water meet the U.S. E.P.A. bacteriological B criteria nonfiltered sources. However, there is concern regarding the turbidity levels of the raw water.

The turbidity in source waters is associated with fall and winter rains, resulting in rapid run-off and soil erosion in the watersheds. In addition to the turbidity being of aesthetic concern, high turbidity poses a health related concern because it can impair the effectiveness of disinfectants by shielding micro-organisms.

Some regulatory agencies allow a turbidity level of 1 nephelometric turbidity unit (NTU) or less, however, the Canadian Drinking Water Quality Guidelines will allow up to 5 NTU if disinfection is not compromised. It is to be noted that turbidity levels in the raw water of the G.V.W.D. watersheds have been as high as 23.9 NTU.

Concerns have been raised by several environmental organizations that continued logging in the G.V.W.D. watershed area will increase soil erosion in the area thus leading to increased turbidity. At a 1992 February 13 meeting, the G.V.W.D. Water Committee resolved that harvesting be continued in 1992 based on areas presently approved by the Ministry of Forests. It was also resolved that logging during and after 1993 be continued based on Ministry of Forests approved forest plans and that all relevant data from the ecological inventory and the Review Panel's risk management criteria be incorporated into the future logging program subject to annual Board approval.

6.0 THE G.V.W.D. CORROSION CONTROL INITIATIVE:

This initiative proposes that sodium bicarbonate and/or lime be added to the drinking water to raise the pH. Low pH water may pose a problem in piping systems and some municipal distribution systems. The effects of pH control may be categorized into three areas.

a) Health - with an increase in pH and alkalinity, the water would have reduced levels of lead and copper. However, if pH is increased, the trihalomethane formation as a by-product of chlorination will also increase. In addition, since higher pH levels make free chlorine less effective as a disinfectant, pH and alkalinity would have to be increased <u>after</u> primary disinfection.

b) Economics - pH and alkalinity adjustments increase the life of copper piping.

c) Aesthetics - pH and alkalinity adjustments could almost completely eliminate the nuisance of blue and green stains on fixtures.

In addition, should chloramination be implemented as a method of secondary disinfection, pH levels would need to be raised to reduce the formation of dichloramines and trichloramines which impart a bad taste and odour to the water.

7.0 CONCERNS REQUIRING CLARIFICATION ON THE DISINFECTION OF DRINKING WATER:

The following concerns which need to be addressed by the G.V.W.D. prior to implementation of the proposed secondary disinfection of drinking water were expressed by the Environment and Waste Management Committee of Council upon review of the subject report prepared by staff.

- A detailed cost benefit analysis for both disinfection options including the required number of disinfection stations is needed.

- The implications of the use of chloraminated water on municipal operations need to be addressed.

- Impacts on the environment from the general use of chloraminated water for purposes such as car washing on the streets and watering of gardens by residents, and the run-off water from fire fighting need to be defined.

- A recent break in the watermain running under Burnaby Lake resulted in some drinking water leaking out. What would the environmental impact have been had this water been chloraminated.

- The possibility that towards the ends of the distribution areas, dissipation of chloramination levels may necessitate the requirement of re-chloramination stations or perhaps higher levels of chloramination at the source based stations requires clarification.

- Would future expansions of the distribution system due to development of urban areas result in the necessity of rechloramination stations?

- How much water does an average person consume daily? Is any there information available on the possible health effects of drinking these volumes of chloraminated water?

- With the increased use of bottled water for drinking purposes, is there any information on the percentage of population consuming bottled water?

- It is generally recognized that disease causing organisms in water are usually associated with animal or human excrement that comes into contact with the water. Could the risk of these disease causing organisms be eliminated by better watershed management prior to considering the need for secondary disinfection of drinking water?

- Has the chlorine residual in drinking water been altered since 1984 when the study was initiated? If so, what are the results and how does this reflect on the need for having secondary disinfection?

- Have any studies been conducted to evaluate the possibility of allergies to chlorine or chloramine?

- How long does it take for the chloramine residual in drinking water to dissipate?

- Is there any information available on the costs that would be incurred by kidney dialysis patients who would have to treat the chloraminated water?

- The target chloramine level indicated by the G.V.W.D. is in excess of the 0.166 mg/l level established by the U.S. National Research Council Safe Drinking Water Subcommittee on Disinfectants. Will there be further investigation of this issue?

- It is recognized that chloramines are weaker oxidizing agents. As such, the effectiveness of chloramines as a bactericide needs further investigation.

8.0 CONCLUSION:

Despite the overwhelming importance of adequate secondary disinfection, the possible toxicological risks to the consumer and the risks to the environment must be considered when evaluating the different disinfectants available.

Review of information on the suitability of chlorine disinfection and chloramine disinfection indicates that there is a great deal of information available supporting both schools of thought, with most of it focusing primarily on the risks to human health.

However, it would be prudent to evaluate the environmental impact of disinfectants in addition to the potential risks to human health. As such, staff recommend that the G.V.W.D. consider the environmental and health aspects of both water disinfection methods, and provide comment on the questions and concerns brought forth in this report.

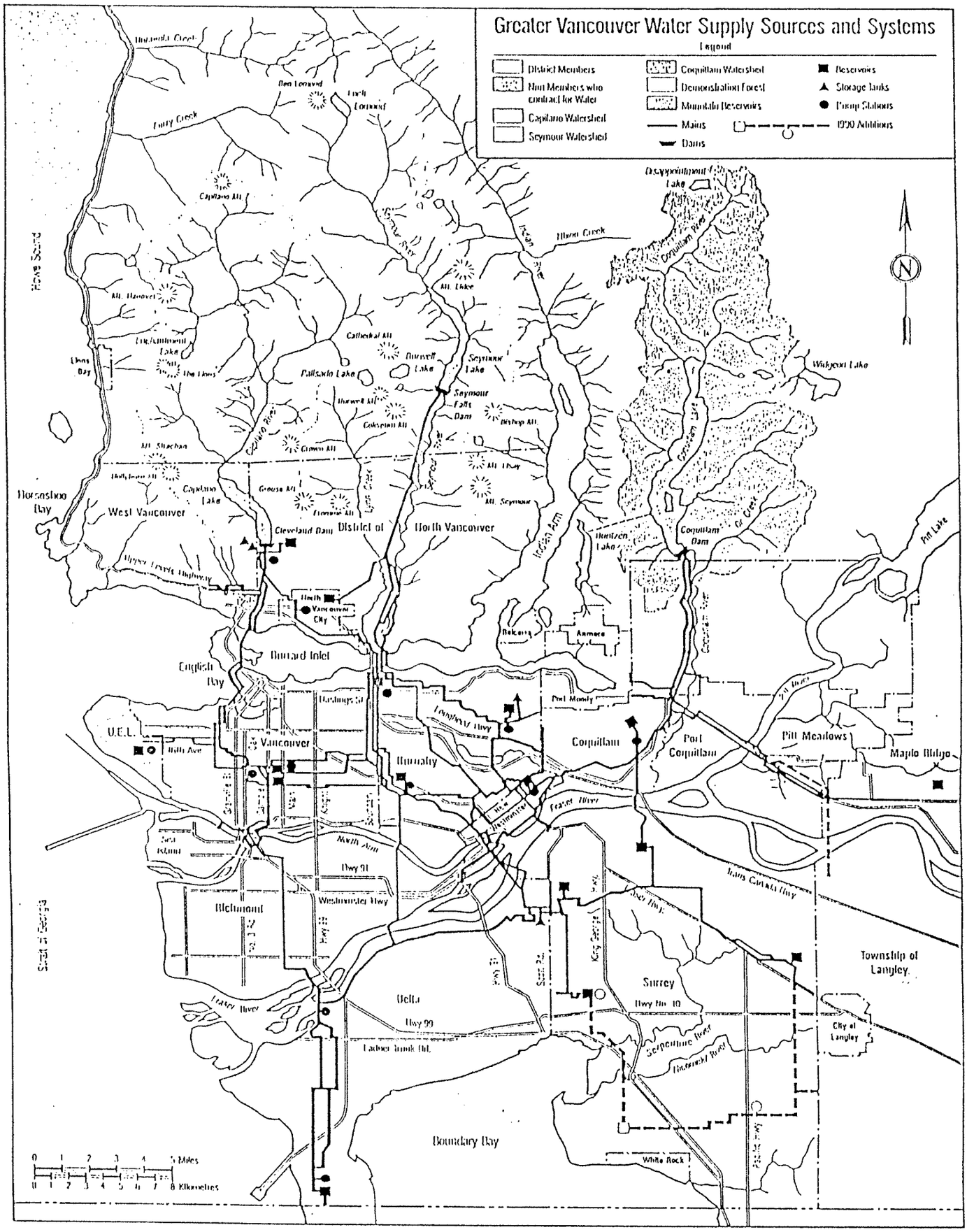
K.C. Johnston, C.P.H.I.(C)
ACTING CHIEF PUBLIC HEALTH INSPECTOR

DD/KS/KCJ/gl

Attachments

cc: Medical Health Officer
Director Administrative &
Community Services
Director Engineering

ATTACHMENT #1



GREATER VANCOUVER WATER SUPPLY SOURCES AND SYSTEMS

CHLORINE VS. CHLORAMINATION FOR SECONDARY DISINFECTION

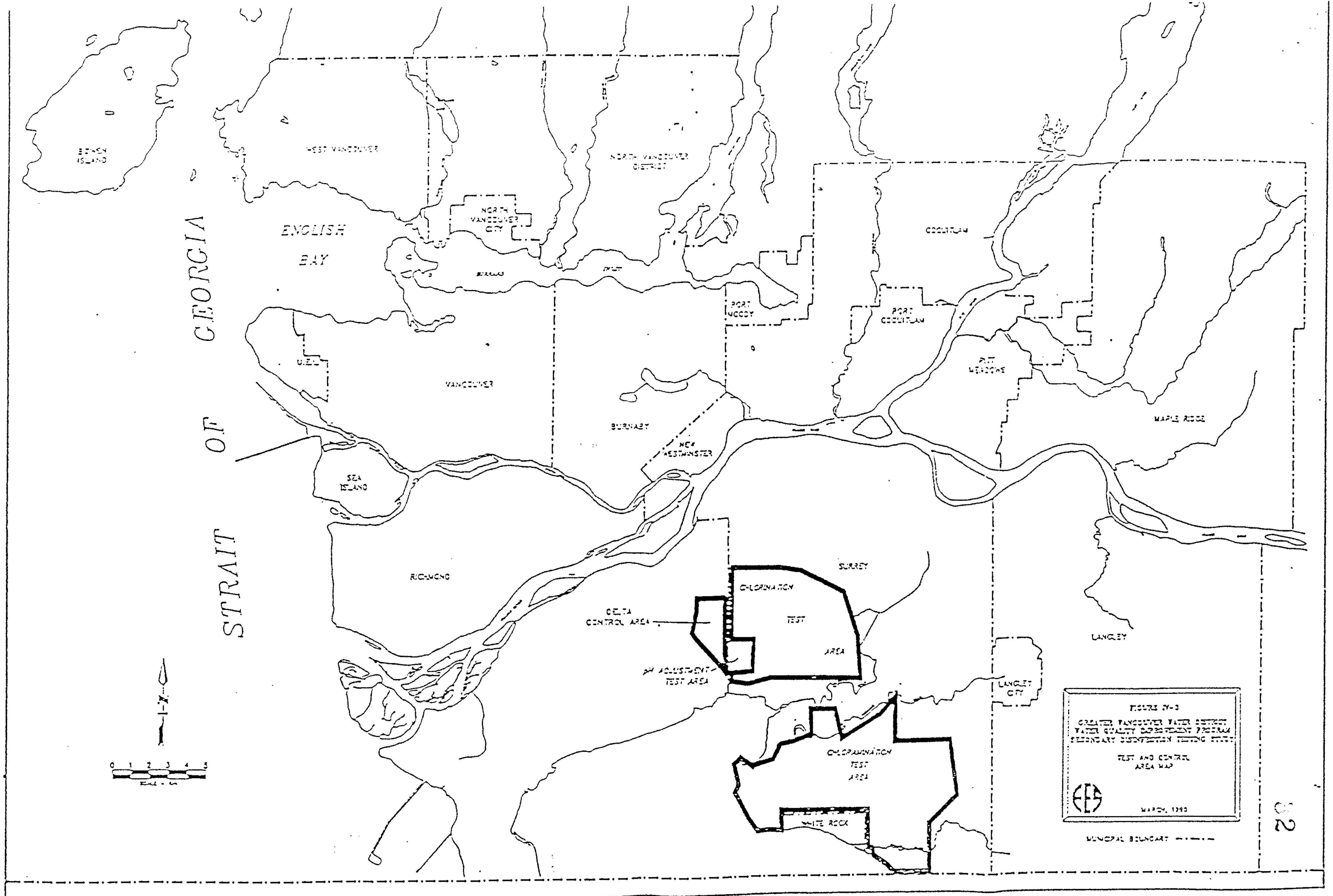
ATTACHMENT 2

CRITERIA	CHLORINE	CHLORAMINATION
Disinfection Capability	- Excellent disinfectant. - More effective at low pH. (G.V.W.D. water has a pH range of 5.5 to 6).	- Weaker disinfectant. - More effective at high pH (chemicals such as sodium bicarbonate and/or lime would be added to increase pH to approximately 8).
	- Needs to be at concentration of at least 0.4 mg/l to be effective.	- Needs to be a concentration of at least 1.0 mg/l and may need to be increased to 2.0 mg/l during the summer.
Residual Maintenance	- Relatively unstable residual.	- Relatively stable residual.
Taste and Odour	- Detectable at higher concentrations.	- Detectable at higher concentrations.
Toxicological Effects	- THM's * produced.	- THM's produced (at lower levels than with chlorination)
	- Cyanogen Chloride, formaldehyde & acetaldehyde produced (at lower levels than with chloramination).	- Cyanogen chloride, formaldehyde, acetaldehyde produced.
	- Interferes with kidney dialysis (easily removed from water).	- Interferes with kidney dialysis (difficult to remove from water).

CRITERIA	CHLORINE	CHLORAMINATION
Environmental Effects	- Toxic to fish (easily removed from water).	- Toxic to fish (more so than chlorine and difficult to remove from water).
Cost of Implementation	- Lower cost per system compared to chloramination but more treatment systems would be required.	- Higher cost per system compared to chlorine disinfection but fewer treatment systems would be required.
Treatment Jurisdiction	- Would require wider distribution of facilities with plant operation responsibilities placed on G.V.W.D. and member municipalities.	- Would permit centralized treatment by G.V.W.D.

* Trihalomethanes (THM) are chlorinated organic chemicals that result from reactions between aqueous chlorine and natural aquatic humic material. The THM's most commonly found in water are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. Since there exists the possibility of a relationship between THM's and cancer, the presence of these chemicals in drinking water do pose a cause for concern.

Presently, the THM concentrations found in G.V.W.D. drinking water are below the maximum levels established in the Canadian Drinking Water Guidelines, both in chlorine and chloramine disinfected waters.



ATTACHMENT #3