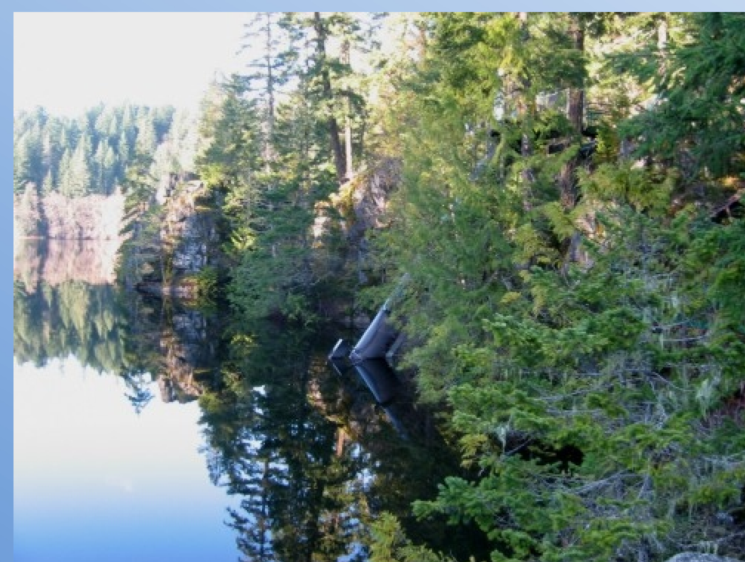
CITY OF NANAIMO
THE HARBOUR CITY

# City of Nanaimo Water Resources

## *Water Supply Strategic Plan*




Associated Engineering



January 2007

# Table of Contents

**SECTION** **PAGE NO.**

# 1 Introduction

## 1.1 WHY DEVELOP A STRATEGIC PLAN?

The City of Nanaimo is fortunate to have one of the best water supplies in Canada. However, with the introduction of new Provincial drinking policies and regulations in recent years and the aging of the water supply infrastructure, it is timely to look ahead. Critical questions are:

- How is the City going to address the issue of drinking water quality over the near and long term?
- How many dollars does the City need to set aside for replacement or major repair of the water supply components?
- How is the City going to increase the capacity of the water supply to deal with the needs of continued growth?

To address these questions, the City has embarked on the development of a *Water Supply Strategic Plan*. The objective of this Plan is to map out the direction to deal with water quality, capacity and reliability issues in the coming years.

## 1.2 THE PLAN DEVELOPMENT PROCESS

A long-term water supply plan needs to be built on consensus. The process that the City developed involves three key groups. These are:

- The Council / Water Supply Advisory Committee
- The Steering Committee
- External stakeholders

The **Water Supply Advisory Committee** is a standing committee of the City Council. This Committee provides recommendations to City Council on the adoption of the Plan. The **Steering Committee**, composed of City staff from various departments, has guided the development of the Plan and has kept the Water Supply Advisory Committee apprised of plan progress. The **External Stakeholders** are organizations or groups who impact long-term water supply decisions due to their agencies legislation or their activities. Their role has been to provide input into the Plan. External Stakeholders includes representatives from local, regional and senior government, industry groups, and First Nations. A list of participating organizations is appended to the report. Associated Engineering, an engineering consulting firm, assisted the City with the planning process and was the primary author of the Water Supply Strategic Plan.

The plan development process consisted of a number of steps.

*Step 1: Assembly of Data and Refinement of the Planning Process*
This included an inventory of the water supply system components, operating data, background studies and other relevant information. The refinement of the planning process saw the definition of project roles and the identification of an external stakeholder group.

*Step 2: Project Workshop*
The second step was a workshop with the Steering Committee and the External Stakeholders. The workshop, held in April 2005, was used to define overall water supply goals, taking into consideration the broad background and interests of the stakeholders. A series of four technical memoranda, covering the water system, previous studies, water demands and water supply issues, were circulated to participants prior to the workshop.

*Step 3: Plan Preparation*
The third step was the preparation of the first draft of the Water Supply Strategic Plan, using the input obtained from the workshop. Water supply goals were first identified. This was then followed by the development of strategies intended to assist the City in achieving these goals. Finally, specific actions, timelines and follow-up assessments were formulated as a framework for achieving each strategy.

*Step 4: Plan Review and Refinement*
The fourth and final step was review and refinement of the document. A series of review meetings were held with the Steering Committee and the External Stakeholders. The Plan was refined, based on this input. The final draft of the Water Supply Strategic Plan was presented to Water Supply Advisory Committee and the City Council in December 2006.

It is important to understand that this document is a “plan” – it is not a preliminary engineering design report. The Plan sets a long-term direction for water supply decision-making. In most cases, the Plan does not make the decision on a water supply issue, but rather provides the City with a strategy and specific actions that will lead to a decision. The Plan does provide time-lines for strategies, actions, and assessments and sets budgets for the activities.

Costs shown in the Plan are in 2006 dollars and, unless indicated, include indirect cost allowances for items such as administration, engineering and contingencies. Costs will need to be updated to the actual year of the expenditure, using appropriate inflation factors.

## 1.3 THE PLANNING HORIZON

The Plan uses a planning horizon of 50 years – or to the year 2055.

Water supply components can have a useful life as short as 15 years, for items such as controls and instrumentation equipment, to over 100 years in the case of water supply dams. Large diameter pipelines typically have an expected life of 40 to 80 years. The basic structure of a water treatment plant may last over 50 years, however, the internal treatment processes and equipment may be replaced several times over the life of the plant, as technology advances and equipment can no longer be economically maintained. Given this long life of system components, it is thus critical to get the fundamental planning decisions right. This will ensure that components are correctly sited and sized. It will also ensure that the system can be upgraded as new technologies emerge.

Why select 50 years? Fifty years provides a reasonable balance in looking at future water demands and technology changes. A horizon of less than 50 years may result in not fully planning for longer-term community, technology or climatic change. Conversely, trying to look much beyond 50 years is challenging, as we cannot fully understand the changes that may impact our water supply decisions.

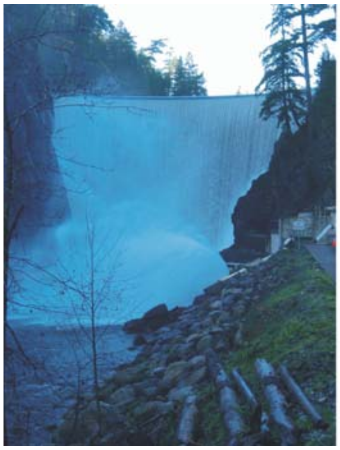
## 1.4 ACKNOWLEDGMENTS

The Water Supply Strategic Plan is the culmination of input and work by a number of groups and individuals. We would like to acknowledge the input of the members of the Water Supply Advisory Committee, the Steering Committee and the External Stakeholders. A list of the participants of these groups is contained in the appendices to this report.

# 2 The Water System

## 2.1 WATER SUPPLY HISTORY

The roots of the water supply system date back over 125 years, with the construction of the first wooden pipes to deliver water from a spring on Wesley Street by the Vancouver Coal Company (Nanaimo, 2002). Expansion of the water system continued in the early 1900s. A major step forward in the long-term supply came in 1930, with the acquisition of water licences on the Nanaimo River and the construction of the South Fork Dam. This dam, an impressive engineering feat in the day, is still a major component of the water supply system.



Large diameter water mains carry water from the dam to the City. The first main, 750 mm diameter, was constructed in 1954. This was paralleled by a second main (1200 mm diameter) in 1993.

In order to keep pace with increasing water demand, the Jump Creek Dam was constructed in the early 1970s, above the South Fork Dam. This created a watershed catchment of 230 $km^2$. In the late 1990s, the dam and spillway system was modified, increasing the live storage volume behind the dam to 16.6 million cubic metres (Koers, 2003).

The Greater Nanaimo Water District (GNWD) was established in 1953 by an Act of the British Columbia Legislature. The Act empowered the District with specific authority to regulate water usage and to finance and construct the facilities to supply water to the City of Nanaimo and the Community of Extension. In 2004, the ownership and operation was transferred to the City of Nanaimo. Today, the water supply system serves a residential population of about 80,000. The record maximum one-day water delivery, experienced in 2006, is 94 million litres.

The current value of the water system assets is estimated at $100 million. The replacement cost of these assets is about $300 million (Nanaimo, 2002).

## 2.2 THE EXISTING WATER SUPPLY

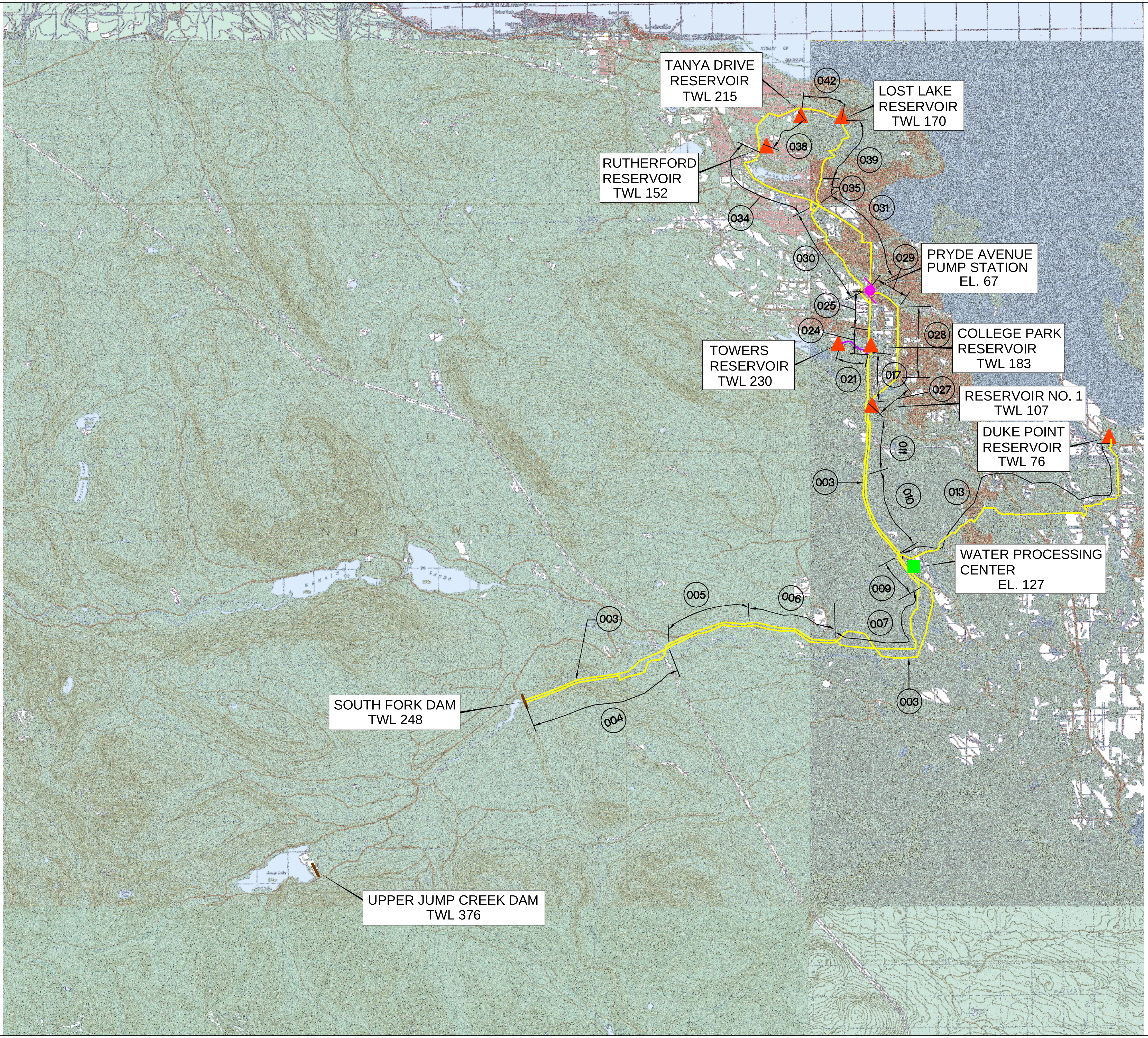
A plan of the water supply system is shown in Figure 2-1. A schematic presentation of the supply components and their elevations is shown in Figure 2-2. The water supply comes from the South Nanaimo River watershed, located southwest of the City. The majority of water is delivered by gravity. Limited pumping is required at the north end of the water system to lift the water into the higher pressure zones.

The Jump Creek raw water reservoir, at the extreme southwest end of the system, is used for seasonal storage. During the winter months, the reservoir level, controlled by floodgates, is maintained several metres below the top water level (TWL) in order to capture extreme rainfall or runoff events in the watershed above the dam. In late spring, the water level is allowed to increase to near the TWL of 378.4 m.

# FIGURE 2-1

LEGEND:

- PUMP STATION
- DAM
- PROCESSING CENTER
- RESERVOIR
- MAJOR WATERMAINS




| NO. | DESCRIPTION | DIAMETER |
|---|---|---|
| 003 | RAW WATER MAIN | 750/550/450 |
| 004 | DUPLICATE MAIN STAGE III (SOUTH) | 1200 |
| 005 | DUPLICATE MAIN STAGE IV | 1200 |
| 006 | DUPLICATE MAIN STAGE V | 1200 |
| 007 | DUPLICATE MAIN STAGE VI | 1200 |
| 009 | DUPLICATE MAIN STAGE III (NORTH) | 1200 |
| 010 | DUPLICATE MAIN STAGE II | 1050 |
| 011 | DUPLICATE MAIN STAGE I | 900 |
| 013 | MAIN FROM WPC TO DUKE POINT | 750 |
| 017 | MAIN FROM RESERVOIR 1 TO COLLEGE PARK | 750 |
| 021 | MAIN FROM COLLEGE PARK TO TOWERS | 250 |
| 024 | MAIN FROM COLLEGE PARK TO ADDISON RD. | 900 |
| 025 | MAIN FROM ADDISON RD. TO PRYDE AVE. | 900 |
| 027 | MAIN FROM RESERVOIR 1 TO WAKESIAH RD. | 900 |
| 028 | MAIN FROM WAKESIAH RD. TO WADDINGTON RD. | 700/600 |
| 029 | MAIN FROM WADDINGTON RD. TO PRYDE AVE. | 500 |
| 030 | WEST MAIN FROM PRYDE AVE. TO LABIEUX. | 750 |
| 031 | EAST MAIN FROM PRYDE AVE. TO LABIEUX. | 400 |
| 034 | MAIN FROM LABIEUX TO ROD GLENN. | 450 |
| 035 | MAIN FROM LABIEUX TO DEPARTURE BAY RD. | 400 |
| 038 | MAIN FROM ROD GLENN TO TANYA DRIVE | 300 |
| 039 | MAIN FROM DEPARTURE BAY RD. TO LOST LAKE | 600 |
| 042 | MAIN FROM LOST LAKE TO TANYA DRIVE | 600 |

FILE: Q:\042615\SKETCH\042615SK02.DWG SCALE 1:125,000 ON A1 SIZE PAPER

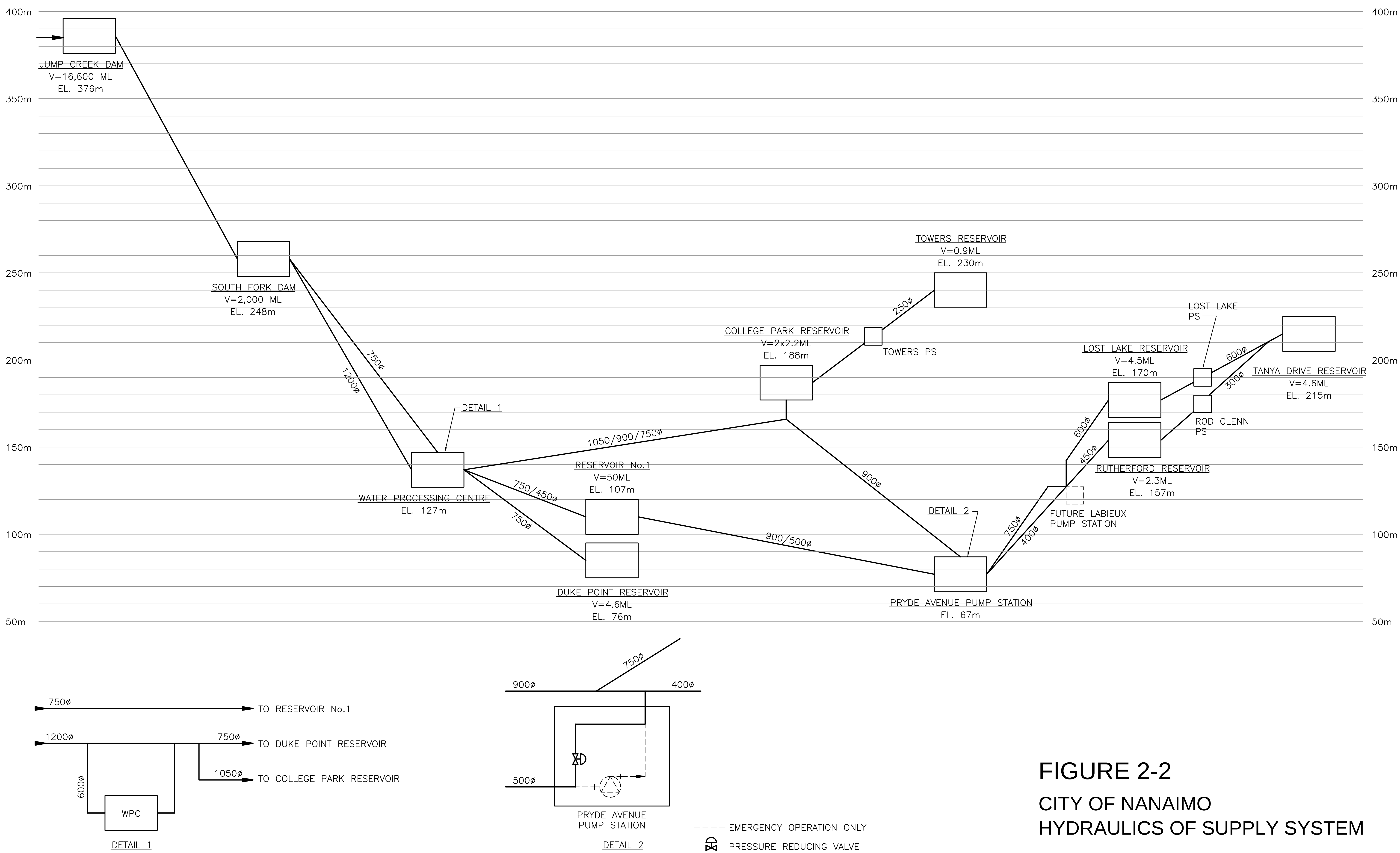



FIGURE 2-2
CITY OF NANAIMO
HYDRAULICS OF SUPPLY SYSTEM

Typically, by early July, additional water is released from behind the dam to meet increasing customer water demands and to maintain the flow in the Nanaimo River to support the fisheries resource. The water level in the Jump Creek Reservoir will continue to decrease through the summer and early fall. As the water demands drop off in the fall and precipitation increases, the reservoir refills.

The water released from the Jump Creek Dam flows down the South Nanaimo River to the South Fork Dam. The reservoir, behind the dam, is maintained near its TWL of 247.6 m, with water released either over the dam crest, through a low-level fisheries release point, or into the City's piped water supply system. The maintenance of water flow in the Nanaimo River, below the dam, is a primary management objective of the City. Under an agreement with Fisheries and Oceans, a minimum flow of 0.28 $m^3/s$ must be released from the dam reservoir (Koers, 2003).

From the South Fork Reservoir, raw water enters a piped system that supplies City customers. The piped system is twinned for a distance of about 16 km, from the South Fork Dam to the Water Processing Centre. At this point, the supply is split into two systems:

- *City Centre System*

  Raw water supply to the City Centre continues in pipeline that bypasses the Water Processing Centre (WPC) and discharges to Reservoir No. 1, located approximately 6 km north of the WPC. The open reservoir, with a TWL of 106.7 m, provides about 59 ML of storage. Water leaving the reservoir is chlorinated and flows by gravity into the City's PZ107 pressure zone.

  Approximately, 30% of the total water delivered is through this system.

- *North Nanaimo and Duke Point Systems*

  The water entering these systems is chlorinated at the Water Processing Centre. The hydraulic grade line (HGL), created by the South Fork Reservoir is maintained in the closed piping system in order to deliver water by gravity to the upper pressure zones. As the elevation of the WPC is about El. 127 m, the static pressure in the piping is approximately 121 m or 1190 kPa.

Downstream of the WPC, the pipelines separate. The eastern pipeline carries treated water to the Duke Point area, terminating at the Duke Point Reservoir (TWL of 76 m). The northern pipeline continues through the western part of the City, supplying a number of reservoirs (Rod Glenn Reservoir at TWL 152 m and the Lost Lake Reservoir at TWL 170 m) and pressure zones. Some pumping of the treated water is required in the western and northern areas of the City to lift water to the upper pressure zone reservoirs (Tanya Drive Reservoir at TWL of 215 m; Towers Reservoir at TWL of 230 m). A new booster pump station, the Labieux Pump Station, is scheduled for construction in 2008. This pump station will increase the delivery capacity to the Rod Glenn and Lost Lake reservoirs during periods of high demand.

The remaining 70% of the delivered water enters the City through these systems.

In the event of water system problems, the City can move treated water between the two water systems. Due to the higher HGL, water can be fed by gravity from the North Nanaimo system into the City Centre zone. A limited quantity of water from the City Centre zone can be pumped to the North Nanaimo system, using a backup pumping station, called the Pryde Avenue PS.

In the event of a major catastrophe, the City also has the ability to utilize portable pumps and chlorination systems to pump water from a number of smaller, low elevation surface water supplies into the main water distribution grid.

## 2.3 WATER SYSTEM ISSUES

The City, in embarking on the Plan, is tackling a number of water supply issues. These are discussed below.

### 2.3.1 Future Water Treatment

The raw water quality is in general excellent. This, coupled with the fact that watershed access can be controlled and managed, has resulted in the City being able to supply drinking quality that meets the current British Columbia regulations, with only chlorination.

The City has been proactive in recent years in ensuring that the raw water supply quality is as high as possible. Working with the principal watershed landowner, Weyerhaeuser (now Island Timberlands), watershed and logging management practices have been improved. This has resulted in a significant decrease in spikes in raw water turbidity during extreme runoff events.

The need for additional water treatment could be driven by both regulations and science. While the City is currently meeting the Provincial regulations, the development of Drinking Water Regulations in British Columbia has, in many people's minds, not been in step with other Provinces or elsewhere in North America. In addition, our knowledge of the science behind public health drinking water issues has improved in the last decade. There is evidence that occasional high turbidity events, produced by extreme runoff conditions, may increase the potential for public health problems due to pathogenic microorganisms, such as *Giardia* and *Cryptosporidium* (Earthtech, 2003). A change in regulations or further evaluation of the drinking water quality risks could thus require additional water treatment. What processes are required? How can further water treatment be implemented without losing the advantage of gravity supply? What is the likely timing? These are questions that need to be answered as planning moves forward.

### 2.3.2 Shared Water Resource Demands

The water system current supplies water to about 78,300 residential customers (2004 census data) within the City boundary and to the community of Extension. The build-out population for the water system service area, forecast in the Official Community Plan (OCP) is estimated to be 187,500 (Koers, 2003).

The City is under increasing pressure to supply new customers outside of the City boundary in the Regional District of Nanaimo (Koers, 2003). First Nations communities have also expressed interest in obtaining their share of water from the watershed. The supply of water outside the existing service area will require not only the supply capacity in the watershed but also the ability to move water through the supply mains. In particular, this is an issue in the northern parts of the water system. How much capacity can the City allocate to new customers? Are future hydraulic improvements required, if the City commits to an expansion of the water supply boundaries?

Maintaining an adequate flow in the river, downstream of the South Fork Dam, is a key part of the overall water management strategy. Water is released from the Jump Creek Dam during the dryer summer months to meet the downstream requirements for water system withdrawal, maintenance of water quality in the South Fork Reservoir, and the fisheries resource. The water in the South Nanaimo River, below South Fork Dam, comes from two sources: the water over the dam crest and the water from the low level fisheries release pipe. The quantity of release into the South Nanaimo River has been the subject of significant discussion over the years. The current agreement is that the City is to have a minimum release of 1.0 $m^3/s$ during the period of July 1 to October 1. If the water level in the Jump Creek Reservoir falls below a prescribed value during these months, the release below the South Fork Dam can be reduced to 0.28 $m^3/s$. A “rule curve” has been developed to determine what the minimum release should be during this three-month period (Koers, 2003). What rate of release will be required in the future? Can this be met with the available storage in the watershed? The issue of how the watershed can be shared is a critical element of the Water Supply Strategic Plan.

### 2.3.3 Sustainable Watershed Yield

The question of water supply yield is a combination of the precipitation amounts and patterns in the watershed and the ability to store water in the Jump Creek Reservoir. Previous projections are that the existing South Nanaimo River watershed yield and available storage can meet the water demands of a population of 129,000, while still maintaining the desired downstream flows to protect the fisheries resource (Koers, 2003). This is 65% higher than the existing population. While there is not an immediate concern, there is finite watershed yield – how many decades will it be before the City needs to develop additional supplies? With recent, new information on the impacts of climate change on Vancouver Island, should the City be updating previous studies?

A key component of overall watershed yield is the ability to store water during the late spring to early fall months, when precipitation and base groundwater return flows are low. The City has undertaken engineering studies to look at the option of raising the existing dam or constructing a new dam, below the existing reservoir. The construction costs will be significant and environmental issues will need to be addressed. The question will be – are these dollars well spent or are there other supply options?

A supplement to the existing surface water supply could be groundwater. The Cassidy Aquifer is thought to be a significant groundwater aquifer, located south of the City (Chatwin, 2002). What are the economics of developing a groundwater source? Can a reasonable quantity be developed without adversely impacting the existing users? Is development of a groundwater supply as either an intermittent or continuous source preferable to increasing surface water storage capacity? These will be key questions in development of the Water Supply Strategy.

### 2.3.4 Reliability of Delivery

The combination of gravity supply and proper planning of the water supply system has resulted in a system that is robust and reliable. Many sections of the major pipelines are "twinned". Alternatively, City staff can to reroute water flow through different pressure zones, if a pipeline problem occurs. The South Fork Dam, however, is 75 years old. Some of the major raw water supply lines are in the order of 50 years old. As water system components age, there is both a greater risk of interruption of supply, as well as catastrophic property and environmental damage should a large water main fail. As water demands increase with future growth, there will be a greater challenge in supplying customer needs in an emergency situation.

The City has a significant investment in water supply infrastructure. How can this be maintained to provide reliable service, without interrupting water supply? Is the City putting enough money aside for replacement? Strategies and actions need to be developed to ensure that the City's record of reliable delivery is maintained.

### 2.3.5 Financial Planning

Most major municipal water systems in Canada are under funded. This is most often a result of abundant and inexpensive water and the relative young age of the infrastructure. As additional sources or treatment are required, the cost of water supply rises. Similarly, as the water system infrastructure ages, dollars are needed to maintain or replace the components. Unfortunately, funding for water system maintenance competes with other costs to run a municipality. This, coupled with the desire to maintain taxes at the existing levels, leads to the water system under funding.

How much money is required on an annual basis? This depends on both the upgrading needed to deal with growth and water quality issues, as well as the replacement or repair of components. The move in the water industry is to full cost accounting – essentially identifying the true cost of servicing the customer and ensuring that the revenue streams match these costs. The Plan needs to identify a sustainable long-term financial strategy. It also needs to consider how to get there, and how to realistically finance the water system needs in the short-term.

## 2.4 RECENT STUDIES

While the City has an extensive library of studies and engineering reports dating back several decades, there are three recent reports that are particularly relevant to long term water supply planning. These reports are discussed below.

### 2.4.1 Water Source Strategy – Chatwin Engineering

This report was authored by Chatwin Engineering Ltd., a local Vancouver Island consulting firm, and Pacific Hydrology Consultants Ltd., a specialist groundwater engineering firm located in Vancouver (Chatwin, 2002). The objective of the study was to analyze various options for water source development, with particular emphasis on looking into the feasibility of groundwater development, using the Cassidy Aquifer. Previously, other engineering studies (Reid Crowther, 1998) had identified that the GNWD would need to increase the level of water treatment of its existing surface water source. In addition, the need to ultimately increase the seasonal raw water storage on the South Nanaimo River watershed had also been identified.

The report concluded that the Cassidy Aquifer is a high yield, good quality aquifer that could supply the maximum day demand to the year 2025. In addition, the report indicated that other aquifers, along the pipeline route to the Cassidy Aquifer, could likely also provide high quality groundwater for a portion of the supply. Three options were developed. The report recommended an option that would use groundwater as the primary source, on the basis that it provided better protection during a summer time turbidity event.

The Chatwin report correctly points out the potential for groundwater as a supply source. There is likelihood that this source could be developed at a reasonable cost to supplement the existing water supply. The strategy to use both surface and groundwater needs further development, particularly around the idea of using groundwater during high turbidity events in the surface supply. Further groundwater exploration appears warranted.

### 2.4.2 Water Quality Pilot Study Review – Earth Tech Canada

This study is a follow-up report to work carried out in 1997 by Reid Crowther & Partners Ltd., a western Canadian consulting firm (Reid Crowther, 1998). Reid Crowther was purchased by Earth Tech Canada. The objective of the original study was to determine a recommended approach to upgrading the existing surface water supply system. The subsequent study (Earth Tech, 2003) was commissioned due to changes in both water treatment technologies and regulations. In addition, Earth Tech was asked to conduct a peer review of the Chatwin Engineering study, discussed above. Despite the title, the report does not contain any information on new pilot testing. However, additional pilot testing of treatment technologies of the surface water supply were started subsequent to the publication of the report. This work was completed in the fall of 2005 (Earth Tech, 2005).

The 2003 report presents a review of the regulatory situation and water treatment technologies. Nine options, with various combinations of surface and groundwater supply and treatment technologies, are developed, with and without micro-hydro generation. While, the authors indicate that it was premature to finalize a specific long-term strategy, the two options that are ranked the highest (based on costs), both utilize surface water exclusively. The options both include the addition of UV treatment, but differ in how they handle short-term turbidity excursions – either off-line storage or “pre-clarification” using open basins.

The Earth Tech report clearly points out the challenge of developing a long term water supply strategy at this time, given the early stage of information on the groundwater resource and on unknowns on surface water treatment. The report focuses on costs and contains limited discussion on the risk factors of the various options. The options developed are not “apples and apples” – the higher cost options provide some of the lower risks. This is not fully conveyed to the reader. However, certain recommendations are consistent with the Chatwin report – more information and engineering planning on the potential for groundwater development is required.

### 2.4.3 Primary Watershed Storage Review – Koers & Associates Engineering

This report was prepared by Koers & Associates Engineering Ltd. of Parksville. EBA Engineering Consultants Ltd. provided input on the review of potential dam sites. The objective of the report was to review the population level that can be supported by the existing watershed catchment and raw water storage. It also looked at the requirements for future raw water storage and potential approaches to increase storage.

The analysis of current capacity concluded that the existing raw water storage is capable of supplying a population of 129,000. Based on a range of growth rates, additional storage will be needed between 2016 and 2042. Difference scenarios for future storage requirements were considered. Depending upon the required fisheries release, downstream of the South Fork Dam, and the ultimate population served, the required additional storage could range from 8 million $m^3$ to 28 million $m^3$. This compares to the current available storage of 16.6 million $m^3$. The report evaluated potential dam sites below the Jump Creek reservoir and on adjacent tributaries. The report recommended further investigations of a new dam and reservoir downstream of the Jump Creek dam, as well as investigating the raising of the Jump Creek Dam to create more reservoir storage.

The report meets its objectives of providing a preliminary level of analysis and direction on providing more capacity in the surface water system in the coming decades. Additional engineering work on the proposed dam has recently been completed (EBA, 2005). The decision on how and when to construct additional storage on the South Nanaimo River system will be a critical decision by the City. This will undoubtedly be one of the pivotal issues in the development of a long-term strategy.

# 3 Water Supply Goals

## 3.1 THE GOALS

Plan Nanaimo, the Official Community Plan (OCP) for the City, set goals relating to the vision of the City's future. The first three goals are:

- Build complete, viable communities
- Protect the environment
- Manage urban growth

These goals for the community need to be reflected in the Water Supply Strategic Plan. The Water Supply Strategic Plan will provide direction and priority for water supply initiatives. As with Plan Nanaimo, it is first necessary to identify goals. Once goals are chosen, strategies, actions and assessments to confirm the success of actions can be formulated.

Based on the dialog with the Committees and the External Stakeholders, three primary goals have been selected. These are:

*Goal 1 – Provide Safe Drinking Water*
The provision of clean, safe water is a fundamental element of all drinking water systems. The City is committed to providing clean, safe water to all of its customers. This means not only meeting required regulations but also planning ahead in a proactive manner to ensure this goal is met, both during normal operations and during emergency events.

*Goal 2 – Ensure a Sustainable Water Supply*
A sustainable water supply will ensure that the community can continue to grow and prosper while maintaining environmental quality. Sustainability has two focuses. One is continued supply of water during abnormal or emergency conditions. The second is the adequate supply of water in the future, given such impacts as global warming and climatic change. The issue of sustainability needs to consider the shared water resource demands, in particular the release of water for downstream fisheries management.

*Goal 3 – Provide Cost Effective Water Delivery*
Cost effective water delivery optimizes capacity and maintains the value of the value of the water system infrastructure asset, through planned maintenance. Required capital expenditures to maintain safe drinking water or system sustainability are planned so that they can be implemented in an affordable manner.

These goals tie into the overall community goals for viability, environmental protection and sustainable management. They provide the vision for long-term direction for water supply planning.

## 3.2 DEVELOPMENT OF STRATEGIES

In order to achieve the goals, identified above, it is necessary to develop strategies. Strategies define the approach to be taken to accomplish the desired outcome or goal. A number of strategies may be pertinent to a goal and, in fact, strategies may overlap to achieve more than one goal.

The following chapters of the Plan discuss various aspects of water supply planning. Each section ends with a recommended strategy, that relates to the identified goals. Strategies are summarized in Chapter 10: Summary - Recommended Strategies, Actions and Assessments.

## 3.3 FORMULATION OF RECOMMENDED ACTIONS AND ASSESSMENTS

The successful accomplishment of a strategy requires a series of actions. These actions may be carried out over a short time frame to allow a decision to be made. An example of this is a groundwater investigation program to decide whether to develop a groundwater supply as a secondary source of water. Actions may also extend over an indefinite time frame. An example is the continuous monitoring of treated water quality to ensure treatment goals are being met.

Assessments are tasks that review the success of the actions. The conclusions of an assessment allow an action to be modified or a new action to be carried out. Reviewing the success of a demand management every five years is an example of an assessment.

As noted above, the following chapters discuss the elements of water supply planning. Each chapter ends with a section on strategies and the related actions and assessments. Recommended actions and assessments are summarized in Chapter 10: Summary – Recommended Strategies, Actions and Assessments.

# 4 PROJECTED WATER DEMANDS

## 4.1 COMMUNITY DEVELOPMENT

### 4.1.1 Residential Growth

The water system supplies water to customers within the City boundary and to the community of Extension. The residential population served based on 2004 census data is 78,300 (Nanaimo, 2005a).

The Official Community Plan (OCP) has estimated that the build-out population in the water system service area at 187,500 (Koers, 2003). The OCP proposed low and high growth scenarios of 2% and 4% per annum. A recent review has concluded that a more reasonable long-term average growth rate would be 1.3%. Based on these growth rates, the build-out population of 187,500 would be reached in the following years (Koers, 2003):

| Average Annual Growth Rate (%) | Year Build-out Population Reached |
|---|---|
| 1.3 | 2071 |
| 2.0 | 2047 |
| 4.0 | 2025 |

The annual growth rate clearly has a significant impact on water supply planning. As in the past, the City will likely experience swings in the annual growth rate, driven by both local and external factors.

### 4.1.2 Commercial, Institutional and Industrial Development

The water supply system also supplies drinking water to commercial and institutional customers. This includes developments such as office complexes, shopping malls, schools and colleges. In most urban municipalities, the rate of growth in commercial and institutional development generally keeps pace with residential growth. The expectation is that this situation will continue to exist within the City.

The City also supplies water to industrial customers for both potable and non-potable uses. While industrial customers are located on industrial-zoned land throughout the City, the major concentration is at the Duke Point Industrial Park. The planning for this development had a significant impact on water supply planning in the 1980s. A major extension to the water distribution system was constructed to accommodate the expected water use. Unfortunately, the industrial development did not occur as quickly as anticipated. Development in the Industrial Park is only now occurring, with significantly lower water use due to the nature of the tenants. This is an example of the dilemma posed for water supply planning by industrial growth.

Given the large size of the City, the impact of individual industrial property development will be less significant than several decades ago. No major industrial development is currently planned. In general, it is possible to make the same assumption as with commercial and institutional development – that industrial water demands will keep pace with residential growth.

### 4.1.3 Development within the RDN

The Regional District of Nanaimo (RDN) currently provides drinking water to a number of small communities, to the north and south of the City. In addition, some local developments are supplied by small, private water utilities. Over the 50 year planning horizon, development outside of the City boundary will continue to occur. It is likely that the City will be under some pressure in future years to supply some of this development. This may entail an actual change in the City boundary or simply a decision to expand the water service area.

If the City were to expand the water service area to outside the existing boundary, the ultimate population would be higher than the current City build out figures discussed above. Previous studies have estimated that if the boundary is expanded to include portions of Electoral Areas A, C and D and First Nation Lands, within or adjoining the City boundary, an additional 51,700 persons would be added. This would increase the ultimate population served to 239,200 (Koers, 2003).

### 4.1.4 First Nations Development

The Snuneymuxw First Nation is part of the External Stakeholder group. They have indicated a need for water supply to their properties to provide for the desired growth. Discussions are currently underway with the Federal and Provincial Governments on the issue of land claims. Access to water is part of this discussion. The outcome of these discussions may not be known for some time. It is thus prudent and reasonable, at this time, to plan for water supply to First Nations development. This may take the form of a transfer of First Nations water, based on a Water License Agreement, through the City water transmission to the First Nations properties. Alternatively, the First Nations properties may simply be supplied as a City customer. In any case, the quantity of water is similar.

### 4.1.5 Serviced Population Growth

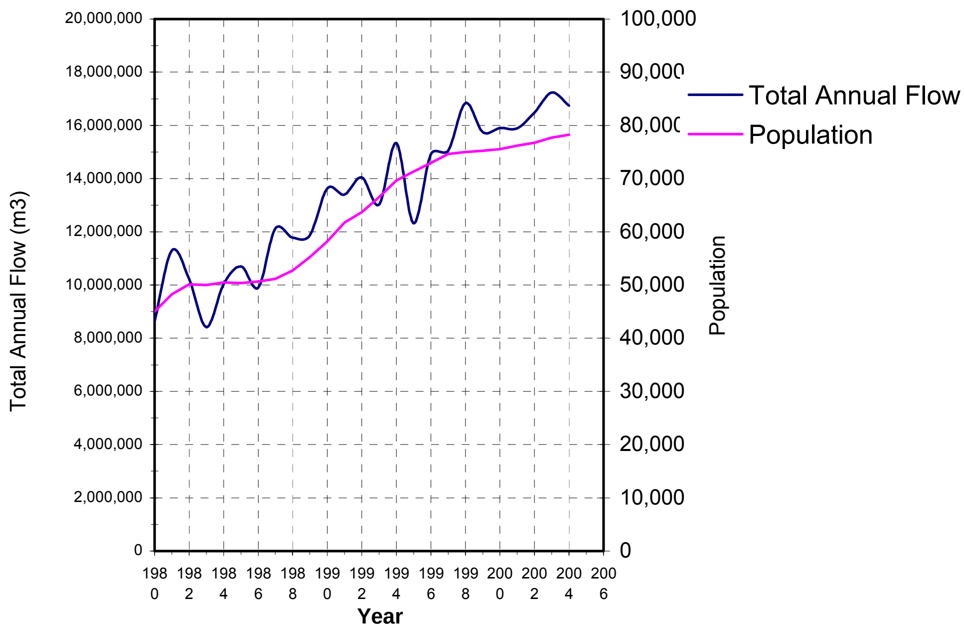
Predicting future populations for water supply planning is always uncertain. The key is selecting the most reasonable prediction, based on a 40 or 50-year horizon, and then looking at the sensitivity, relative to decision making, if either a lower or higher growth rate occurs.

For the purpose of the Water Supply Strategic Plan, using a growth rate of 1.5% over a 50-year horizon is suggested. This would yield a residential population of 167,300 in the year 2055. This would accommodate some expansion beyond the existing City boundary to development currently in the RDN and First Nation properties.

## 4.2 CURRENT WATER SYSTEM DEMANDS

The historical annual water demand is shown in Figure 4-1.

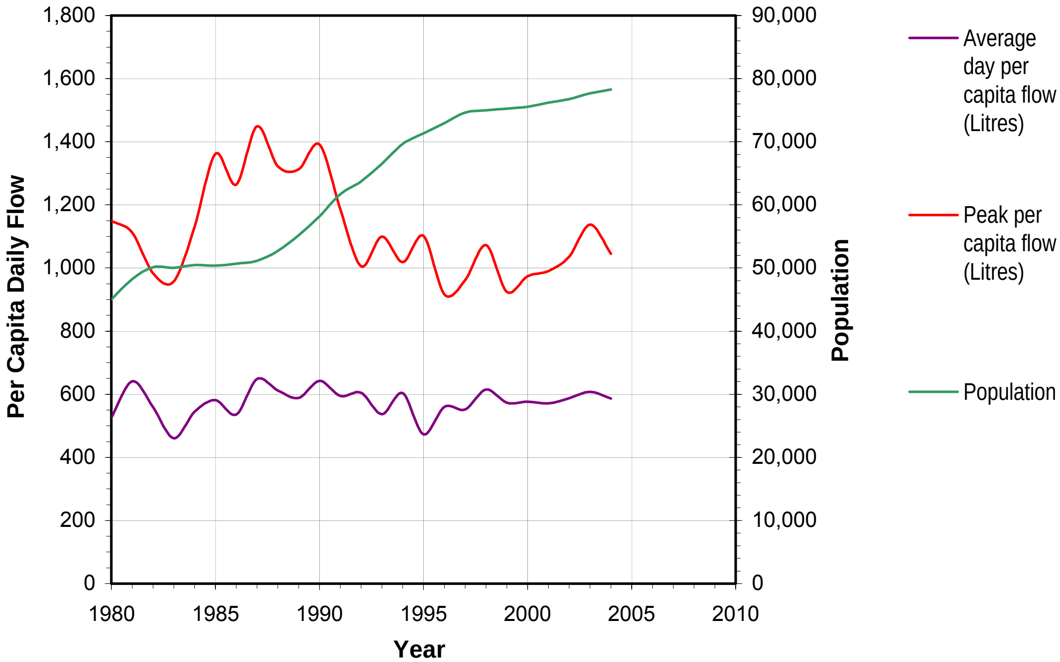
**Figure 4-1. City of Nanaimo - Annual Water Supply**




Historic per capita water use is shown in Figure 4-2. The average day value presents the average daily per capita water use throughout the year. The maximum day value represents the highest recorded water use during a 24-hour period.

The City (and the GNWD) has traditionally measured “per capita” use, based on residential population and raw water flow measurements. Other water uses such as industrial, commercial, and institutional (ICI) and unaccounted for water (UFW) are thus included in the residential per capita demand.

**Figure 4-2. Peak and Average Day Demand per Capita**




As seen in the above table, average day and maximum day demands in recent years, measured on a residential per capita base, are about 600 L and 1100 L, respectively. The year-to-year variation in these amounts is due primarily to summer weather patterns. Summers with extended hot, dry periods result in more water being used over the year and, typically, a higher maximum day demand than in "average" years.

The above usage rates are similar to other large, coastal water utilities in BC. Average annual per capita demands (based on 2004 data) for the Capital Regional District (CRD) and the Greater Vancouver Regional District (GVRD) are 538 L and 584 L, respectively. Maximum day per capita demands for the CRD and GVRD are 997 L and 921 L.

## 4.3 FUTURE INFLUENCES ON WATER DEMANDS

### 4.3.1 Demand Side Management

In Canada, the myth of water abundance has been firmly entrenched. This is starting to change. Our paradigm has been "supply oriented" – treating water as a virtually limitless resource. We are now realizing that the scarcity of supply, wasteful use, pollution, climate change and other factors can combine to increase the stress on our water resources (Brandes et al, 2005). Many water utilities facing this issue are shifting their thinking to the concept of *demand side management* (DSM). The goal of demand side management is to provide the customer the same or greater benefit using less water. By decreasing the demand, the water utility can help avoid or defer investments in new facilities or equipment.

As we look ahead over 50 years, the philosophy of demand side management will no doubt gain greater momentum. As a water utility, the City of Nanaimo will and should embrace this direction. The question is – what impact will demand side management have on the water demands and how quickly will we see this change? In many cases, the success of demand side management comes about from a change in customer habits. Is this a short-term reaction to media information or a long-term change in the way we value water? The challenge to the City is to encourage this change, yet still plan responsibility to ensure that water can be supplied in a reliable and sustainable manner.

Some of the components of a demand side management program are:

- Residential fixture replacement rebates
- High efficiency clothes washer rebates
- Irrigation device (controllers, shut-offs) rebates
- Watering restrictions
- Public education programs (schools, website, mail outs, etc)
- Native plant and irrigation workshops
- Water Stewardship Awards
- Water rate structures

The Capital Regional District, the water utility servicing the Greater Victoria area, has had a demand side management program in place for a number of years. They have seen very little change is water demand for the past 10 years, despite a 6% increase in service population (CRD, 2004).

While the City has already seen a reduction in per capita water use over the last two decades due to water efficiency use program, it is likely that continued progress could be made. For the purpose of the Plan, it is assumed that a further reduction of 15 % could be seen over the 50-year planning horizon.

### 4.3.2 Unaccounted for Water

Unaccounted for water (UFW) is water entering the water distribution system that is not accounted for in metered water use. This would include water lost through leakage, fire protection use or system maintenance such as hydrant flushing. In a typical water system, UFW is typically in the range of 10 to 20%. Analysis to date by City staff indicates that UFW is likely in the order of 15%.

Is this likely to increase over the next fifty years? While theoretically it could, due to the aging of the water system, a preventative maintenance program could maintain current levels or, in fact, reduce unaccounted for water. For the purpose of the Plan, it is assumed that the percentage of UFW, on a per capita basis, will remain the same.

### 4.3.3 Climatic Change

Climatic change will undoubtedly impact watershed yield, but will it also impact customer water use? Forecast models for Vancouver Island project milder, wetter winters and longer, drier summers with a later arrival of the winter rains (CRD, 2004). As a significant portion of the water supply is used for outdoor water use, the longer and drier summers will tend to increase the per capita water use. This will hopefully be offset by the DSM programs, which will encourage irrigation efficiency and xeriscape landscaping. For the Plan, it is assumed that any change in water use, do to climatic change, is accounted for in the estimates for the DSM reductions.

### 4.3.4 Technological Change

With advances in technology and interest worldwide in water use efficiency , new household appliances will likely be designed to use less water. This includes clothes washers, dishwashers, showerheads and toilets. While the impact on water use can be driven at a faster pace through rate programs noted above, household renovation and appliance replacement will tend to achieve a reduction over time. In the Plan, this is assumed to be accounted for in the DSM reduction.

### 4.3.5 Rainwater Harvesting

Rainwater harvesting involves collecting the rainwater that falls on a collection surface, such as a roof, and directing it to a storage container. This can be as simple as a barrel under a roof downspout, with the collected water used for garden watering. It can also be fairly complex, such as a complete roof collection system, with an underground storage tank and dual plumbing system for non-potable water distribution within the structure.

While the use of simple collection barrels and garden watering will likely increase, this will not have a significant impact on water system demands. It does, however, lead to more focus on overall water use and will improve the success of DSM programs. Currently, household dual water systems are not economic (CRD, 2004). They are, however, being used more frequently in commercial and institutional building. These facilities will likely lead the way in terms on increasing awareness and technological development.

For the purpose of the Plan, it is assumed that rainwater harvesting will be part of the DSM program.

### 4.3.6 Water Reuse

Water reuse refers to treatment of wastewater to an acceptable degree for reuse in non-potable applications. This can occur in two ways. One is treatment at a municipal wastewater treatment plant where the treated effluent is distributed back into the community. The second is at a local level, where the "grey water" from showers and sinks is treated and reused for non-potable purposes.

Water reuse from municipal wastewater treatment plants is well established in many areas of the Untied States and Canada. The City of Vernon in the Okanagan area of BC has had a water reuse program, based on farm and rangeland irrigation, for 30 years. The City of Edmonton has recently completed a water reuse program that will see advanced treated effluent used for industrial process water. In Nanaimo, the RDN handles the wastewater management function. The current wastewater treatment plant incorporates primary treatment with ocean discharge. In order to reuse the effluent for a non-potable use, a side-stream advanced treatment process would be required. As there are no large industrial or agricultural developments in the immediate area that could use a treated effluent supply, it is unlikely that a central water reuse scheme will be developed in the foreseeable future.

Water reuse at a single family residence or commercial / institutional building faces even more challenge than rainwater harvesting, as a treatment step needs to be incorporated into the plumbing and non-potable distribution system. Given the economic and regulatory hurdles that "grey water" treatment systems face, it is unlikely that we see significant development of this concept in the next few decades (CRD, 2004).

The impact of water reuse on per capita water demands is thus assumed to be negligible during the planning horizon.

## 4.4 PROJECTED WATER DEMAND – THE BASIS FOR PLANNING

Based on the cumulative impact of the factors influencing water use of the next five decades, it is likely that per capita demands will decrease. The difficultly is predicting what reduction will be seen, how quickly will it occur and will it tend to level off or even rebound back.

For planning purposes, the following per capita demands are proposed. These reflect a reduction of 15% on current usage, achieved gradually over the first 30 years, following a levelling off of demands. This is believed conservative for planning purposes and can be achieved through a moderate aggressive demand side management program.

| Year | Per Capita Daily Demand (Liters) Average Annual | Maximum Day |
|---|---|---|
| 2005 | 600 | 1100 |
| 2015 | 570 | 1045 |
| 2025 | 540 | 990 |
| 2035 | 510 | 935 |
| 2045 | 510 | 935 |
| 2055 | 510 | 935 |

Based on the population growth and per capita water usage discussed above, the projected water demands are presented in Table 4-1.

**Table 4-1**
**Projected Water Demands**

| Year | Population[1] | Water Demands | |
|---|---|---|---|
| | | Average Annual (ML/year)) | Maximum Day (ML/day) |
| 2005 | 79,500 | 17,400 | 87 |
| 2015 | 92,200 | 19,200 | 96 |
| 2025 | 107,000 | 21,100 | 106 |
| 2035 | 124,200 | 23,100 | 116 |
| 2045 | 144,200 | 26,800 | 135 |
| 2055 | 167,300 | 31,100 | 156 |

**Notes:**
1 Population growth is assumed to be 1.5% per annum.

These values are presented as planning level numbers for the Water Supply Strategic Plan. They provide a reasonable projection of water demands over the next 50 years. As more detailed planning proceeds, however, it would be worthwhile for the City to develop a more detailed categorization of water use. This will allow the impacts of system change and demand side management programs to be measured. This will be necessary to make sound, future management decisions.

## 4.5 RECOMMENDED STRATEGIES, ACTIONS AND ASSESSMENTS

The recommended strategies, actions and assessments are:

**Strategy 1: Adopt a Demand Side Management Approach**

Adopting a demand side management approach to water supply planning will assist in achieving *Goal 2 – Ensuring a Sustainable Water Supply* and *Goal 3 – Provide Cost Effective Water Delivery.* It will commence the process of cultural change in the way water is regarded. In practical terms, it should allow the City to defer supply upgrading by a number of years, resulting is more cost effective water delivery.

The recommended actions are:

- *Refine existing water use efficiency programs into a demand side management approach.*
  This should include metering, watering restrictions, and public education programs.

- *Evaluate the use of rebate programs and water rate structure changes.*
  This could include rebates for fixture replacements and improved irrigation system control devices.

The recommended assessments are:

- *Review the success of the demand side management program every five years.*
  Successful demand side management initiatives take several years to accomplish. Five years is a reasonable interval for reviewing the success and modifying the program, as required.

**Strategy 2: Measure Water Demand and Trends**

More detailed information of water demands will also assist in meeting Goals 2 and 3. Keeping track of trends in community development, water demands and the water industry will allow update of the Water Supply Strategic Plan to ensure that it stays on track.

The recommended actions are:

- *Continue to refine overall raw water and customer metering to allow more detailed tracking of water use.*
  This is targeted both at obtaining more information on unaccounted for water use, as well as monitoring change on customer water demands.

- *Monitor and participate in community development planning.*
  This includes involvement in both short-term and long-term community planning, including development outside of the City. This will allow informed input on impacts of residential, commercial and industrial development on the water system and time to incorporate servicing decisions into the long-term water supply strategy.

- *Monitor water industry trends.*
  This includes both technological trends that impact water demand, as well as successes and failures of other water utilities in areas such as demand side management and public communications programs.

The recommended assessments are:

- *Reassess future water demands on a five-year basis.*
  Annual water use records can be compared to projections in the Water Supply Strategic Plan. On a five-year basis, both population and per capita use projections should be reviewed and recalculated. This will allow adjustment of demand side management or capacity upgrade programs.

# 5 Water Quality

## 5.1 EXISTING SITUATION

The raw water quality is in general excellent. This, coupled with the fact that watershed access can be controlled and managed, has resulted in the City being able to supply drinking quality that meets the current British Columbia regulations, with only chlorination.

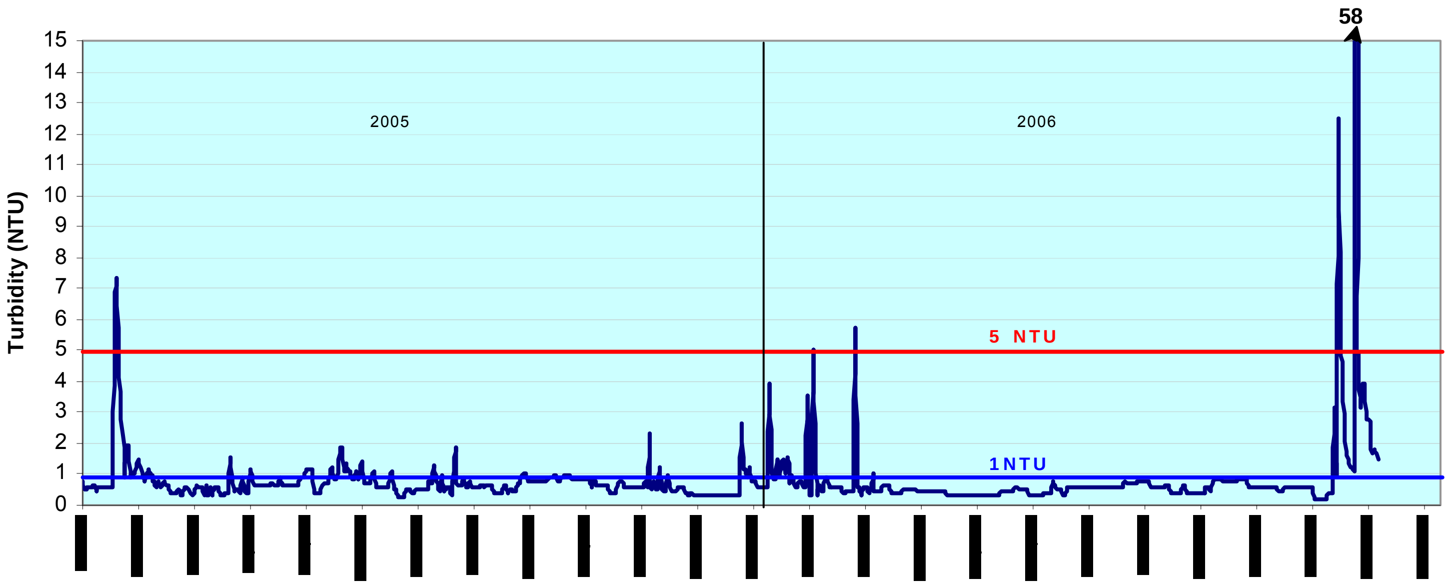
The City has a comprehensive drinking water quality monitoring program. Water quality data is collated on an annual basis. The Annual Water Quality Reports are posted on the City web site (www.nanaimo.ca). A monthly update on water quality monitoring is also provided on the web site, with any excursions above standards noted. A summary of the 2004 water quality data is presented in Table 5-1, along with a comparison to Federal Guidelines for Canadian Drinking Water Quality.

Turbidity, which is a measure of the "cloudiness" of the water, is the major water quality issue that City faces. While not a problem in itself, events that cause high turbidity, such as heavy rains in the watershed, can result in potentially higher levels of pathogenic micro-organisms in the raw water. This potential increase is acerbated by reduced disinfection efficiency, due to the higher turbidity in the raw water. The City has installed on-line turbidity monitoring, which measures turbidity on a continuous basis.

The City has also been proactive in recent years in ensuring that the raw water supply quality is as high as possible. Working with the principal watershed landowner, Weyerhaeuser (now Island Timberlands), watershed and logging management practices have been improved. This has resulted, in general, in a significant decrease in spikes in raw water turbidity during extreme runoff events.

The treated water quality currently meets the required Provincial Regulations. This, however, does not imply that there is no drinking water quality risk. The majority of the time, the raw water is clear with turbidity values of less than 1 NTU. Under this condition, the existing chorine disinfection system provides effective performance. However, heavy rainfall or snowmelt combined with rainfall, in the watershed can elevate the turbidity levels, in some cases above 5 NTU. Heavy rainfalls in November 2006 resulted in a record peak turbidity of 58 NTU and a subsequent boil water advisory lasting for several days. Figure 5-1 presents a graphical plot of turbidity levels in 2005 and 2006, showing this extreme event (Nanaimo, 2006).

**Figure 5-1**
**2005 – 2006 Turbidity Levels**




## 5.2 WATER QUALITY PROTECTION

### 5.2.1 The Provincial Regulatory Direction

Drinking water quality standards, to be met by water utilities in British Columbia, are a Provincial responsibility. The standards are defined in the Drinking Water Protection Act and Regulations, under the Heath Act. The Regulations were updated in May 2003. The legislation has a number facets including treatment, construction and operating approvals, water quality monitoring requirements and reporting, operator qualification standards and emergency response planning.

In regards to water treatment, the Regulations specify that surface water must be disinfected. The Regulations are silent on the issue of water filtration. Standards are set for fecal coliform and E. Coli. This differs from a number of other Provinces that are more prescriptive, many of whom have adopted the Federal Guidelines for Canadian Drinking Water Quality. The Provincial Ministry of Health has recently appointed Drinking Water Officers, which cover a defined geographical area of the Province. These Officers have the authority to assess water utilities and set additional performance standards.

Will the Provincial Regulations become more stringent in the future? The answer is likely – yes. Provincial water regulations in Canada have historically followed the lead of the Federal Government and to some extent, the US Environmental Protection Agency in the United States. Many of the large water utilities in British Columbia have or are currently constructing additional water treatment, beyond what is strictly required by the Provincial Regulations. A number of these utilities have based their water treatment decisions on a review of regulations and assessment tools used in other jurisdictions. It is likely that with more and more utilities moving to additional water treatment, the Provincial Regulations may change to reflect the decisions being made in the water industry.

### 5.2.2 Federal Guidelines

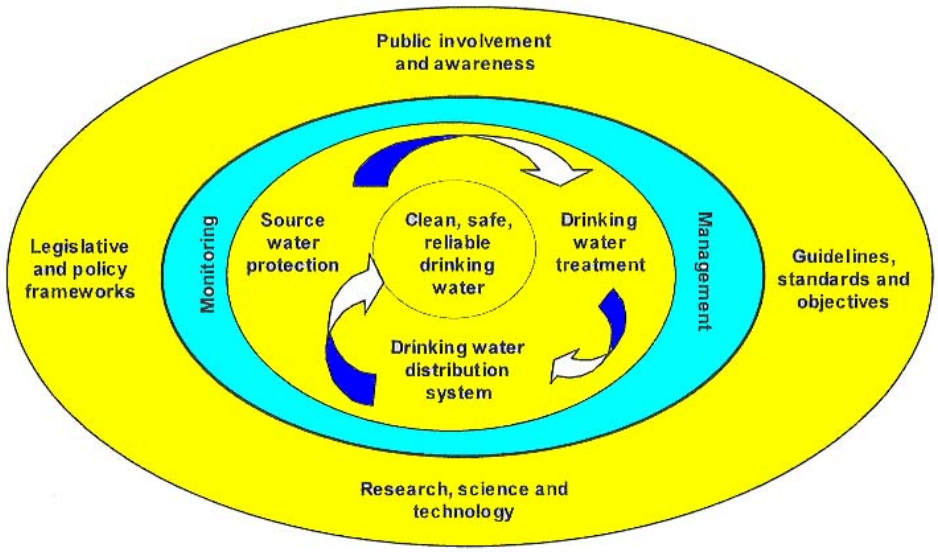
The Guidelines for Canadian Drinking Water Quality (GCDWQ) have been developed by Health Canada to assist the Provinces in establishing local legislation. The guidelines are very comprehensive and are a key source of information on water quality and water treatment decisions. These have been developed by a Federal / Provincial Committee and are in a continuous process of review, based on changes in our scientific knowledge base. The most recently published GCDWQ is the 6$^{th}$ Edition in 1996. A Summary of Guidelines for Canadian Drinking Water Quality is also published to keep the industry abreast of changes between publications of the complete guide. The most recent version in March 2006, available at www.hc-sc.gc.ca.

In the March 2006 document, the Committee stated that waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet turbidity limits, as defined for specific treatment technologies. The limits for chemically assisted filtration and membrane filtration are 0.3 NTU and 0.1 NTU, respectively. The present stance by the Committee is based on previous work examining the turbidity issue. This was compiled in a document entitled Guidelines for Canadian Drinking Water Quality - Supporting Documentation -Turbidity, October 2003. The document is pertinent to the Nanaimo situation as contains a section on “Criteria for Avoiding Filtration for Waterworks Systems”. This criteria mimics similar regulations developed by the US EPA. Four criteria are proposed encompassing disinfection performance, raw water pathogenic micro-organisms concentrations, turbidity levels and watershed control programs. The turbidity level criteria states that, to avoid the need filtration, the turbidity should not exceed 5 NTU for more than two days in a 12-month period.

### 5.2.3 The Multi-Barrier Approach

As can be seen from the above discussion on the Provincial and Federal regulatory situation, there is not a prescriptive way forward in managing the water quality issue. How can this issue best be managed? The answer lies in a *multi-barrier approach*. This concept, adopted by a number of water utilities in North America, is an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water from source to tap in order to reduce risks to public health (FPTC, 2002). Figure 5-2 shows the multi-barrier approach schematically.

**Figure 5-2: The Multi-Barrier Approach**




While 100 percent protection cannot be guaranteed all of the time, experience has demonstrated that a multi-barrier management approach is the most effective way to manage drinking water systems. The goal of this approach is to reduce the risk of contamination of the drinking water and to increase the effectiveness of remedial control and preventative options. As part of multi-barrier risk management, redundancies are built in the system, wherever feasible. Contingency plans are put in place to respond to incidents that impact drinking water quality.

Under a multi-barrier approach, all potential control barriers are identified along with their limitations. Limitations could include risks of pathogens and contaminants passing through a barrier. Individually, the barriers may be inadequate in removing or preventing contamination of drinking water, but together they offer greater assurance that the water will be safe to drink (FPTC, 2002).

As illustrated in Figure 5-2 – legislative and policy frameworks, research and technology, guidelines, standards and objectives and public involvement and awareness - are the starting points for any multi-barrier strategy. At the core of the approach are source water protection, drinking water treatment and drinking water distribution. An example of how these fit into a multi-barrier approach for the Nanaimo situation is provided below:

*Source Water Protection and Management*

In any drinking water system, protecting source water is a critical step towards avoiding drinking water contamination. While the City does not have the luxury of a “closed” water system, activities can be controlled. The City and the forest industry stakeholders have already made significant strides in watershed management, particularly related to turbidity levels in the raw water. Continued watershed management, to reduce both the potential level of pathogenic micro-organisms in the water and the impact of high turbidity is thus the “first” barrier in the multi-barrier approach.

*Drinking Water Treatment*

Water treatment provides the “second” key barrier. Water treatment plants need to be designed based on the results of source water assessments, recognizing regulatory requirements. Within the treatment processes itself, the multi-barrier approach must be employed. This includes the possible “series operation” of treatment processes, such that if one process is not operating in an optimum fashion, the next process will still continue to provide the desired degree of protection. Proper redundancy of equipment, power, control and pumping systems are also all part of the multi-barrier design approach.

The City will be making decisions on upgrading the current level of surface water treatment. In making these decisions, the role of water treatment in the multi-barrier approach needs to be considered. Can the surface water be managed such that the raw water quality will allow water treatment upgrades to be phased? Will clarification and/or filtration be required in the initial phase?

*Water Distribution Systems*

The distribution system is the “third” and final barrier in the multi-barrier approach. The quality of drinking water, leaving the treatment plant, must be maintained throughout the distribution system. This requires that items such as proper reservoir and piping system design and construction, best management maintenance practices, cross connection control programs and emergency operation programs.

While the term “multi-barrier approach” has come into vogue in recent years, the City, in fact, has been practicing this approach for some time. As noted above, the City has achieved successes in watershed management. The City has also developed well planned preventative maintenance and emergency operation programs. As the City moves ahead in the coming decades, the concept needs to expanded and brought into all the levels of decision making and communication in regards to development of a long-term, sustainable water supply.

## 5.3 WATER TREATMENT

The decision on further water treatment is the major decision facing the City in the short-term and one of the main reasons for the development of the Water Supply Strategic Plan. The two key elements of the decision are the water treatment technology to employ and the siting or location of the water treatment works. These are discussed below:

### 5.3.1 Water Treatment Technology

Water treatment technologies, in general, can be divided into either separation or disinfection. Separation processes remove specific physical, chemical or biological constituents in the raw water. These are normally located upstream of a disinfection process. Disinfection is strictly aimed at destroying pathogenic micro-organisms, which may still be in the water following the separation process.

Separation technologies include processes such as clarification, dissolved air floatation (DAF), gravity filtration or membrane separation. These processes can be used in combination, depending upon the quality of the raw water. They also generally employ chemical addition steps to enhance the operation of the separation step.

In very pristine waters, disinfection may be used alone. Historically, chlorination has been the typical disinfection technology. In recent years, ultraviolet (UV) radiation has been employed, in combination with chlorination, in order to more effectively target parasitic organisms such as Giardia cysts and Cryptosporidium oocysts.

A key factor in looking at the issue of water treatment technology is the rapid change of the technology. A number of the technologies in use in recent plant design (enhanced clarification, DAF, membranes and UV) were only in the research and development stage a decade or two ago. Equally important, some technologies that looked very promising 10 years ago, proved to be uneconomic or did not live up to the expected performance goals. This obviously makes selection of technologies for long term water treatment planning challenging.

It is not the purpose of this Plan to provide a detailed engineering evaluation of water treatment technologies for the Nanaimo situation. This level of detail will be carried out following the approval of this Plan. The City has already undertaken some pilot studies of technologies and is acquiring a database on the specific performance of the technologies on the South Nanaimo River water (Earth Tech, 2005). Several conclusions, however, can be drawn based on the work to date and the current trends in the water treatment technology field. These are:

- *UV disinfection, combined with chlorination, is an attractive disinfection approach.* This combination of technologies provides a very cost effective barrier against bacteria, viruses, Giarida cysts and Cryptosporidium oocysts. It also ensures protection is maintained throughout the distribution system. A number of recent water treatment plants in BC (Victoria, Campbell River, Seymour Capilano, Kelowna, and Vernon) have all implemented this technology. This approach, by itself, however is only viable if the turbidity levels in the raw water are low – generally less than 5 NTU. If turbidity is higher, a separation step is required ahead of the disinfection step. Depending upon the technology used for separation, it may not be necessary to incorporate UV disinfection – chlorination alone may achieve the required log reductions in pathogenic microorganisms.

- *Dissolved air flotation (DAF) has been shown to be an effective separation process for the South Nanaimo River water.* The DAF process is well established in the water treatment industry and is well suited to the soft, low alkalinity, low turbidity surface water found in coastal BC. The pilot study work has demonstrated that DAF should reduce the water turbidity to below 5 NTU in all cases. This could also be combined with granular filtration to reduce the turbidity to below the 0.3 NTU criteria. The piloting looked at conventional, low rate DAF. High rate DAF processes, that would reduce the plant process footprint and, presumably the cost, have been developed and are currently at the introduction stage into the water industry. The use of filtration alone, termed direct filtration, is also a technology that may prove effective from a performance and cost viewpoint, given the high raw water quality.

- *Membrane technology may be effective as a stand-alone separation process, ahead of disinfection.* Membrane separation technology has seen a major advancement in the last decade. Although the City has not yet piloted this process, it may be both effective from a performance and cost viewpoint as an alternative to DAF-granular filtration.

In conclusion, there are a number of ways forward in regards to water treatment. The answers are intertwined with the issue of where the water treatment works can best be sited and if the surface water supply can be managed to allow a phasing of the water treatment technologies.

### 5.3.2 Water Treatment Plant Siting

There are currently two water treatment plants, both employing chlorination. These are:

- *Water Process Centre* – located at El. 127 m. This plant provides treated water to the North Nanaimo and Duke Point distribution systems, which serve about 70% of the customers.

- *Reservoir No. 1 Plant* – located at El. 107 m. The plant directs water to the city centre and serves about 30% of the demands.

The Water Process Centre (WPC) operates under line pressure. In other words, the pressure head from the South Fork Dam is not lost. Static pressure at the Centre is about 121 m or 1190 kPa. At the Reservoir No. 1 plant, chlorine is injected downstream of the raw water reservoir. The hydraulic grade line (HGL) is thus the reservoir level or about 107 m at TWL. As a reference, the South Fork Dam TWL is El. 248 m.

In parallel with completion of this Plan, the City undertook a separate study to investigate potential siting of additional water treatment facilities (Associated Engineering, 2006a). This study identified seven potential sites, along the corridor between South Fork Dam and Reservoir No. 1. The potential sites were ranked according to the following criteria:

- water source location
- hydraulic efficiency
- land area
- ease of access
- utility connections
- safety and security

Conceptual plant layouts were developed for the two top ranked sites. A water treatment process consisting of dissolved air floatation (DAF) followed by filtration and chlorination was assumed. An analysis of the capital and operating and maintenance costs were then developed.

The most attractive location for a water treatment site would be along Nanaimo Lakes Road, just north of the intersection with Nanaimo River Road. A plant located in this vicinity would be connected to the existing water transmission main system, via a short section of new pipe. Raw water, driven by the hydraulic head from the water behind the South Fork Dam, would flow to the water treatment plant by gravity. Treated water from the plant would flow back to the water transmission mains by gravity, after the loss of several metres of hydraulic head through the treatment processes. As part of the treatment upgrades, the existing open reservoir at the Reservoir No. 1 site would be covered or replaced by a covered reservoir, in order to maintain the treatment integrity of the incoming water.

The next steps in finalizing the plant siting decisions will be the identification of specific properties that could be acquired by the City and further engineering steps to confirm the detailed hydraulics and site development requirements.

## 5.4 OPERATIONAL CONSIDERATIONS

### 5.4.1 Seasonal Water Quality

As discussed above, the raw water quality from the South Nanaimo River, in general, is excellent. Chemical constituents, such as alkalinity and hardness, tend to be consistent year round. Seasonal variations occur in turbidity and, to a lesser extent in colour. These are caused by heavy precipitation events that bring a higher than normal silt load into the upper reservoir and lower stretches of the river, above the South Fork Dam.

Climatic changes over the coming decades will likely impact water quality. Warmer temperatures during the winter months will lead to a rise in the snow levels. The lower elevations of the watershed are thus not protected by snow cover, leading to the increased potential for erosion and higher turbidity due to intense winter precipitation events. Long, dry summers will also tend to dry out the upper soil layers, leading to increased erosion and turbidity caused the heavy early fall rains. The hotter summers will also tend to increase water temperature. While this is not a significant issue from a drinking water viewpoint, it is critically important for the downstream fisheries resource.

The City already has an reservoir operational strategy to minimize the impact of seasonal water changes and peak turbidity events. The water level in the Jump Creek reservoir is lowered in the early spring, in anticipation of high spring runoff. During high turbidity events, the flow out of the reservoir can be reduced, allowing additional settling time in the reservoir. As demands increase, the balance between managing the reservoir to maximize water quality and ensuring that there is sufficient storage to meet summer drinking water and fisheries demands will become more challenging.

It is of interest to note that the turbidity levels in the raw water leaving Reservoir No. 1 are consistently lower that the levels in the South Fork River water during elevated events. This presumably is a result of the quiescent settling in the reservoir. As demands allow during these events, City staff can maximize the flow from the Reservoir No. 1 entry point to optimize the water quality in the distribution system. Increasing the routing of flow through this reservoir and thus decreasing the retention time, however, may reduce the effectiveness of the settling.

### 5.4.2 Emergency Situations

As witnessed by a number of natural catastrophes in the world in recent years, the ability to maintain or quickly reinstitute drinking water supply is of critical importance. Events that could impact the water system include earthquakes, major storms events, terrorist activities and component failure.

City staff already has emergency operational planning in place. Elements of the planning include:

- Written emergency response protocols and actions.
- Spare materials and equipment to repair water main breaks or treatment equipment.
- Portable pumps and generator sets.
- Portable, emergency chlorination equipment.
- Temporary intakes on local surfaced water sources.

Emergency water system response plans should be reviewed on a frequent basis to ensure that they current relative to system operation and encompass any recent system changes. The most frequently encountered emergency problems are watermain failures. While small leaks are not of significant consequent, the failure of a major watermain can caused catastrophic damage and interruption of service. The emergency plan needs to ensure that watermain sections can be isolated by operation of line valves and that repair materials are on hand. This is discussed further in Chapter 7.

With the possible construction of additional water treatment works, possibly at a more remote location, the issue of security becomes more significant. The water industry in both Canada and the United States has spend considerable effort on this issue in recent years. The American Waterworks Association (AWWA) and other major utilities are excellent sources of information and procedures for water system security management.

### 5.4.3 Water Quality Risks during Distribution

The major water quality risk during the distribution of water from the water treatment facilities is the deterioration in water quality from a pathogenic organism viewpoint. This can be caused by two major factors:

- *Regrowth of micro organisms in the distribution system.*
  The build-up of organic material on the interior of pipelines can provide an excellent medium for the regrowth of micro-organisms, event though an effective disinfection process was employed at the water treatment plant. This is typically combated in three ways – adequate circulation, system flushing and maintenance of a chlorine residual. Historically, regrowth has not been a significant issue in the City system and has been managed through maintenance of a chlorine residual and general water system maintenance. The issue of chlorine residual needs to be looked at in conjunction with the issue of source water treatment. Changes in treated water quality and relocation of chlorine addition points will impact the issue of chlorine residual maintenance. Numerical water distribution hydraulic models can be effectively used to model the decay of chlorine residual in the water distribution system.

- *Introduction of a contaminated water.*
  Contaminated water can be introduced in a distribution system through cross-connections with non-potable sources. In recent years, this has received greater recognition in the water industry. Discussions are currently proceeding regarding possible legislative changes to the Plumbing Code that would see more stringent cross-connection control requirements. While the City currently requires back-flow prevention devices through the Building Permit process, the need for a cross-connection control program should be reviewed once future legislative changes are defined.

These issues are discussed further in Chapter 7.

## 5.5 WATER QUALITY CRITERIA – THE BASIS FOR PLANNING

As discussed above, the Provincial regulations govern the operation of drinking water system in British Columbia. The City is currently meeting the regulations established by the Province. Is this enough? As noted, the Province of British Columbia has not gone as far as other jurisdictions in setting "prescriptive" standards. It has also not adopted the Guidelines for Canadian Drinking Water Quality (GCDWQ). It has however appointed Drinking Water Officers, who can direct water utilities on water treatment or operations requirements. The question arises – what will the Officers use as guidance in making decisions?

It is recommended that the City follow the lead of other major water utilities in British Columbia and look beyond the existing Provincial regulations. Specifically, the City should consider the Guidelines for Canadian Drinking Water Quality (GCDWQ). This approach is suggested, as there is a strong likelihood that in the future, the Province will bring in more stringent water treatment requirements. These more stringent requirements will likely reflect the GCDWQ.

Planning on this basis allows the City to be proactive in dealing with the issue of drinking water quality. The decisions on water treatment can be brought into a multi-barrier risk management approach. It also allows the City to make decisions on water treatment at an early date, providing the opportunity for the scheduling of upgrade projects and financial planning to minimize the impact on water rates.

## 5.6 RECOMMENDED STRATEGIES, ACTIONS AND ASSESSMENTS

The recommended strategy, actions and assessments are:

**Strategy 1: Adopt a multi-barrier approach to drinking water quality management.**
Adopting a multi-barrier approach to drinking water quality management will move the City towards meeting all three water supply goals – provision of safe drinking water; ensuring a sustainable water supply and providing cost effective delivery. A multi-barrier approach provides a holistic view of the water quality issue, of the potential impacts on water quality and of system wide solutions.

The recommended actions are:

- *Continuation and possible augmentation of the raw water quality monitoring program.*
  A comprehensive raw water quality data base will be required for the City to make informed decisions on water treatment strategies and on water treatment plant design. The existing monitoring program should be reviewed and additional parameters added, as required, to ensure that complete and comprehensive historic raw water quality data is obtained.

- *Monitor drinking water quality legislation.*
  Future changes to Provincial legislation and Federal guidelines should be monitored through various water industry media sources. Particularly important is the issue of management of unfiltered water supplies.

- *Continue current source water protection and watershed management programs.*
  Source water protection and watershed management are key element of the multi-barrier approach. While successes have been achieved, it is important that the program continue to look at ways of improving raw water quality. This not only includes drinking water but also the downstream water quality requirement of the fisheries resource. This program should also include monitoring of continued research in the issue of climatic change on Vancouver Island watershed.

- *Review scenarios for long-term tenure of the watershed.* The South Nanaimo watershed is privately owned land (Island Timberlands and TimberWest) used for forestry operations. The City holds a Provincial surface water extraction license. The watershed has been historically managed on a partnership basis, considering the needs of the multiple stakeholders. Other major water utilities (GVRD and CRD) in the Province have ownership of their watersheds and the question has been raised – should the City proceed in this direction? The City should review the various options for long-term tenure and management of the watershed from a business case viewpoint. The review needs to compare the sustainability of the current cooperative management structure against the feasibility and costs of the City acquiring land ownership and managing the watershed lands on an ongoing basis.

- *Carry out preliminary level engineering for water treatment upgrading.*
  The City has completed pilot testing on possible water treatment technology approaches, as well as a preliminary review of water treatment siting options. The next step is preliminary level engineering, focusing on the acquisition of property for the water treatment plant, water treatment process technology and possible phasing of the implementation of additional water treatment. The decision on timing and possible phasing will require continued dialog with the Provincial Ministry of Health Services and the Vancouver Island Health Authority. A reasonable target to have additional water treatment in place is 2011 to 2016.

- *Monitor water treatment technology trends.*
  We are in a period of rapid development of water process technology that will impact the decisions by the City. A number of major water utilities in British Columbia are implementing water treatment projects. The City should monitor the developments in the water industry and the successes and problems of other utilities in implementing additional water treatment measures.

- *Continue to monitor treated water quality throughout the distribution system.*
  The City should continue its existing water distribution monitoring program. This has several aims. The first is to confirm that water quality goals, immediately prior to the customer, are met. Secondly, it allows the City to acquire a data based for future calibration of a distribution system chlorine residual tracking model. Finally, it will allow any chlorine residual maintenance problems to be identified and remedial actions taken.

The recommended assessments are:

- *Assess the outcome of water quality actions in two years.*
  A number of the above actions that impact the decision of water treatment will be completed within the next 12 months. These conclusions, coupled with the completion of actions recommended in other chapters, will put the City in the position to make the final decisions regarding water treatment upgrading and supply development. The City should thus plan to assess the conclusions reached and make a decision on water treatment implementation by early 2008.

- *Assess the multi-barrier approach on a five-year basis.*
  The progress and success of using the multi-barrier approach to water system management should be reviewed every five years. This will allow the City to look at where changes are required and incorporate new ideas and information into the management approach.

# 6 Water Source Development

## 6.1 PROJECTED WATER SUPPLY REQUIREMENTS

The current annual average drinking water demand is about 17,400 ML. As discussed in Chapter 4, by the end of the planning horizon, 50 years in the future, this is expected to rise to 31,100 ML. The estimate is based on assumptions on growth within the existing City boundary, the potential supply to customers outside the current boundary and water efficiency gains through a demand management strategy.

Is this estimate reasonable? Certainly the accuracy of any projection 50 years in the future can be questioned, as it is influenced by a number of variables. The actual water use in 2055 will, in all likelihood, be higher or lower. The estimate, however, does provide a yardstick for long-term planning.

The existing water supply cannot provide this quantity of water. It will thus be necessary to develop additional capacity, either through additional storage in the existing watershed, development of additional surface water sources or the development of groundwater sources. In looking at the question of water supply, it needs to recognize that water is a shared resource. Water to support human activities is only one use. We need to maintain a portion of the flow in our rivers and lakes to meet the environmental needs for long term sustainability. We also need to ensure that withdrawal of water from groundwater aquifers is not excessive and that natural recharge regimes are not negatively impacted. For many Vancouver Island rivers, the issue of maintaining downstream flows to support the fisheries resource is a critical water use. With climatic change indicating a possible reduction and warming of summertime river flows, the issue of “sharing” the resource will be even more critical.

## 6.2 OVERVIEW OF SOURCES

There are three potential water sources to increase the water supply capacity, once the existing capacity of the South Nanaimo River system is utilized. These are:

- Additional seasonal storage on the South Nanaimo River
- Development of other surface water supplies
- Development of groundwater supplies

The South Nanaimo River watershed has the potential for further supply development, through the construction of additional seasonal storage. Given the high quality water, the gravity feed and the significant investments in infrastructure made to date, this source will remain as the main supply source to the City. Studies to investigate the overall yield of the watershed and the economics of development of additional storage have been undertaken in parallel with the development of this Plan.

Other major surface water sources in the area, which offer the same potential as the South Nanaimo River watershed, are limited. Immediately to the north is the Nanaimo River watershed. Water licenses for industrial extraction already exist and potential storage has been developed. If this were to change in the long term, the main stem of the Nanaimo River could be a supplement raw water source. In any event, the management of the Nanaimo River flows will continue to be an integral part of the overall watershed management from a fisheries viewpoint. Further north is the Englishman River drainage. While this system offers high quality water, the quantity of water available is limited due to existing license commitments and limited potential to further increase storage. It is also a significant distance from the core area of water use. To the south is the Chemainus River drainage. This drainage is relatively small with limited seasonal storage potential. Cowichan Lake is located further south. The logistics and distance to bring water to the core area make this source impractical.

Groundwater offers a number of attractions as a supplement source. The presence of a potentially large groundwater aquifer, the Cassidy Aquifer, to the south of the City has been documented in past reports. The potential for a high quality, reasonable yield source makes groundwater an option that needs further consideration.

## 6.3 SOUTH NANAIMO RIVER

### 6.3.1 Development Strategy

The watershed area, above the lower dam (South Fork Dam), is about 230 square kilometres (Nanaimo, 2002). Storage is provided in two reservoirs within the watershed – the South Fork Reservoir and the Jump Creek Reservoir. The total available storage in the two reservoirs is approximately 18.6 million $m^3$. As the South Fork Reservoir is maintained at the top water level (TWL), only the Jump Creek Reservoir is available for live storage. The current live storage volume is about 16.6 million $m^3$. This is approximately equal to a year of water usage, at the current population level.

The capacity of this water source to serve the City's long-term needs is governed by the water yield of the watershed and the availability of seasonal storage. There are two options for increasing the amount of seasonal storage – raising the existing Jump Creek Dam or constructing a new dam and reservoir between the Jump Creek Dam and the South Fork Dam. A recent engineering study (Koers, 2003) investigated these two options and identified a preferred location for the new dam, if it was constructed. Subsequent more detailed analysis (EBA, 2005) suggested that construction of the new dam is the preferred approach. The new dam offers a number of advantages in terms of reduced construction risk, additional catchment area, operational flexibility and lower construction costs. The new dam would add approximately 21,000 ML of storage. This volume, added to the existing 16,600 ML of live storage, yields a total reservoir live storage of 37,600 ML. This equates to about 15 months of average demand at the projected 2055 usage.

One of the most attractive features is the potential to extend the existing intake system from South Fork Dam to the new dam. This would allow the option of taking the 75-year South Fork Dam out of service in the future for either major maintenance, replacement or decommissioning.

### 6.3.2 Watershed Capacity

The question of the capacity of the South Nanaimo River watershed is predicated on two factors – the amount of precipitation and the ability to capture and store the runoff. In order to provide a more definitive estimate of watershed capacity, the City commissioned a hydrologic study in parallel with the completion of the Plan. This study (Associated Engineering, 2006b) looked at not only the existing climatic factors that govern the capacity, but also the longer-term outlook based on expectations for climatic change.

Current climate change models for Vancouver Island predict a warming trend with similar total precipitation to current levels. This means that the winter snow pack will tend to be lower with snowlines at a higher elevation. A higher percentage of the precipitation will come as rainfall, particularly during the late fall and early spring periods. When the models are applied to the South Nanaimo River watershed, the conclusion is that the annual watershed yield could decrease by about 13%, based on a 10-year drought return period.

The study concluded that the South Nanaimo River watershed should have sufficient capacity to meet the needs of the stakeholders for many decades into the future. Based on a 50-year drought return frequency and the assumption that one-third of the water is available to the City (the remainder going to downstream fisheries release), the watershed could support a population of about 365,000 persons. This is well in excess of the forecasted build-out population of 239,000. With the currently planned additional storage provided by the new dam, the watershed will be able to provide a reliable supply to about 250,000 persons, based on the 10-year drought return frequency and a one-month “buffer”. These forecasts assume a summertime fisheries water release similar to the current releases, as well as a conservative prediction on the impacts of climate change.

### 6.3.3 Timing of Dam Construction

The construction of the new dam is a significant civil engineering project. The acquisition of the property, the environmental assessments and the regulatory approval process will take several years to complete. The key question is – when is additional storage required from a capacity viewpoint? The above reference hydrological study addressed this question.

The adequacy of the existing storage depends upon three factors.

- the water required for municipal use
- the water released from the South Fork Dam to support the fisheries resource
- annual precipitation

The UBC WATERSHED software was used to develop runoff volumes based on historic and forecast precipitation data. Climate change scenarios were introduced using downscaled climate data developed by the federal Atmospheric Environment Service (AES). Runoff routing and storage volume modeling was carried out using Microsoft EXCEL. The significant precipitation that is received in the watershed during the winter period means that the reservoir behind the Jump Creek Dam is at the top water level (TWL) in the early spring. The critical issues are thus how this stored water is released during the late spring, summer and fall period and how much additional precipitation falls during the late spring to the time when the sustained, fall rains occur.

The question of timing depends to a large extend on risk tolerance. For the purpose of developing projections, a drought return frequency of 10 years was selected in conjunction with a "buffer" of one month. In other words, the precipitation amount forecast from July 1 to September 30 reflects the lowest amount in 10 years. In addition to this, it was assumed that one month of water storage would remain in the reservoir to meet the municipal and fisheries release requirements for the month of October, assuming that no additional precipitation that added to the storage fell. The fisheries water release was assumed to be 1 $m^3/s$ up to July 30 and 0.28 $m^3/s$ from August 1 to the end of October. This assumption is the same as the current "rule" curve on water release. Under the above precipitation and fisheries release assumptions, the additional storage provided by the new dam will be required between the year 2020 and 2025, depending upon the climate change assumptions.

Given the length of time to implement the construction of a major dam, the City should commence activities in the near future to secure the land tenure and the approvals to proceed with the project, with a view to have the additional storage in place by 2020. The decision on the development of a supplemental groundwater supply will have a potential bearing on the timing of the new dam. This is discussed in Section 6.4.4.

### 6.3.4 Water Treatment

The water treatment requirements for the South Nanaimo River are discussed in Section 5.3.

### 6.3.5 Economic Considerations

Preliminary cost estimates for construction of the new dam are about $62 million (EBA, 2005). This is clearly a significant expenditure. It must be remembered, however, that the life expectancy of a major earth-fill dam is in excess of 100 years. This must thus be compared with other supply alternatives that may have a lower initial cost, but a higher operating and maintenance cost.

## 6.4 GROUNDWATER

### 6.4.1 Development Strategy

Groundwater aquifers are used extensively on the eastern side of Vancouver Island as municipal and industrial water sources. The aquifers are a result of the deposition and redistribution of sands and gravel during the past ice ages (Chatwin, 2002). The Cassidy aquifer, just south of Nanaimo, was identified almost a century ago as a potential water source. In the late 1940s, as part of the Harmac (now Pope & Talbot) pulp mill planning, the aquifer was explored in some detail. This led to Harmac developing part of the aquifer as a water source for the mill. This supply has now been in use for over 50 years.

The potential for the City to develop the Cassidy Aquifer, as part of a water source supply strategy, was investigated in a report by Pacific Hydrology Consultants, as part of the Chatwin Engineering work (Chatwin, 2002). The report concluded that the potential capacity of the aquifer is large and that there is substantial evidence that the required groundwater source could be developed with out significantly impacting other users. The authors noted that the water is generally of high quality and the potential for contamination from surface human activities are either low or can be managed. Other potential groundwater sources, between the Cassidy Aquifer and the raw water main route from the South Fork Dam, were suggested.

Further discussions were held with the primary report author regarding the possibility of aquifer development aimed as a supplement water source (Pacific Hydrology, 2005). Pacific Hydrology has indicated that, in addition to potential areas west and northwest of the Cassidy Aquifer identified in the original report, that the valley bottom of the North Nanaimo River, northeast of the Lower Nanaimo Lake may be a potential groundwater source. The valley is more than 3 km wide and extends for about 7 km. Elevations are in the range of El 200 to 260 m (this compares to the South Fork Dam TWL of 248 m).

A groundwater supply, that would supplement the surface water source, is attractive if sufficient quantity can be developed at a reasonable cost. The groundwater development target would be in the order of 30 ML/d or about 25% of the maximum day demand for the year 2025. The magnitude of yield would allow groundwater to supplement the peak demands in the summer and thus yield additional flow for fisheries release. This would allow the construction of the new dam and reservoir on the South Nanaimo River to be deferred for several years. Perhaps, the most significant advantage of a supplemental groundwater source is as an emergency backup in the event of breach of the water transmission system between the surface supply source and the distribution system.

Given the attraction of a supplemental groundwater source, the City embarked on a further groundwater investigation program, in parallel with the completion of the Plan. This program was targeted at three possible sources:

- the North Nanaimo River Valley
- the Pope & Talbot groundwater system
- the Cassidy Aquifer

A preliminary reconnaissance, followed by the installation of test wells, was carried out in the North Nanaimo River Valley in early 2006. While a groundwater aquifer was located, test well performance indicated that the capacity that could be developed was well below the target goal (Thurber, 2006). A decision was made to not pursue further exploration in this area.

Discussions were held with Pope & Talbot in the summer of 2006 regarding their long-term water management plans and the potential for the sharing of resources with the City. In addition to their groundwater supply, Pope & Talbot also have an adjacent surface water supply on the Nanaimo River, east of the mill site. The combined groundwater and surface water supplies can provide the mill with up to 152 ML/d of water, with approximately 50 ML/d coming from the groundwater source (Associated Engineering, 2006c). The groundwater system components are nearing the end of their useful life. If the system was to supply water to the City, replacement of the pumps, motors and associated discharge piping would be required due to the higher hydraulic head of the City's pressure zone. At the current time, the groundwater source is more valuable to the mill, due to its higher quality. Pope & Talbot staff indicated that their current plan is to utilize the groundwater as their primary water source. If this groundwater supply was available in the future, acquisition by the City may be attractive, in spite of the investment that would be required to rehabilitate the system for City use. Alternatively, the City could consider partnering with Pope & Talbot to rehabilitate the groundwater system with a view to the water being available to the City in an emergency situation.

A preliminary groundwater investigation of the City developing its own groundwater supply in the area of the Cassidy Aquifer is underway. The conclusions of this investigation should be available in early 2007. The City will then be in a position to decide if a supplemental groundwater supply is a viable direction.

### 6.4.2 Potential Yield

Groundwater aquifers are typically developed through a series of well fields. The production of a particular well is dependent upon the aquifer conditions, including the recharge of the groundwater aquifer. Yield thus, to some extent, depends upon the areal extent of the well field. The original Pacific Hydrology study suggested that a production well in the area of the Cassidy Aquifer might generate about 7.5 ML/d (Chatwin, 2002). A well field of four production wells would thus generate the target supply of about 30 ML/d.

### 6.4.3 Water Treatment

Groundwater can suffer from high hardness, high iron and manganese and taste and odour problems. If the groundwater aquifer is shallow and recharged directly from the surface, a risk of contamination from human activities, such as on-site wastewater management, agricultural operations or industrial development, is possible. Historically, groundwater from the Cassidy Aquifer has been very high quality and does not appear to have been impacted by development activities.

Does this mean that groundwater will not require treatment, beyond chlorination? This is difficult to predict without a groundwater investigation program. Given the history of groundwater development in the area and in similar locations on the east side of Vancouver Island, the answer might be a cautious “yes”. If it determined that the groundwater supply could be impacted by surface activities, then an enhanced disinfection step using both ultraviolet disinfection and chlorination could be required. Issues such as high iron and manganese or taste and odour issues would require additional treatment steps.

#### 6.4.4 Economic Considerations

Based on the estimates in the previous study (Chatwin, 2002) and extrapolating to a 30 ML/d groundwater yield, the construction costs might be in the order of $5 million in 2006 dollars. The costs of a transmission main to connect to the existing water supply system would be in addition to this cost. If a groundwater supply can be developed in the northern area of the Cassidy Aquifer, the total cost, including the connections to the existing City water system, could be about $10 million.

The other economic consideration in development of a supplemental groundwater supply is the ability to defer the construction of the new dam on the South Nanaimo River. Based on the hydrological modeling, if a 30 ML/d groundwater supply could be developed and if this supply could be sustained for a three-month period in late summer and early fall, it would be possible to defer the construction of the dam by about 20 years. This is significant financial advantage given the cost of the new dam construction. It must be emphasized, however, that the availability of this quantity of groundwater, at this time of the year, has not been substantiated.

## 6.5 DEVELOPMENT OF A FUTURE SUPPLY STRATEGY

The City is in the fortunate position of having two potential options for increasing the water supply in the future – additional storage on the existing surface water system and development of a supplemental groundwater supply.

Based on the work to date, both options appear feasible. The development of additional water storage through the construction of a new dam, upstream of the South Fork Dam is attractive from a number of viewpoints. It comes, however, with a significant initial construction cost. There are also engineering and environmental questions to still be answered. While groundwater may not replace a surface water supply, it may be attractive to utilize groundwater as a supplemental supply to delay the construction of additional surface water storage and, more importantly, provide an emergency supplemental water supply. In terms of an overall water source strategy, the questions are – what are the costs to development and operate a groundwater supply? What are the environmental risks? Can this source be developed within the existing and future groundwater legislation without impacting existing users?

It is recommended that the City proceed with a parallel supply development strategy at this time – looking at both construction of a new dam and development of a groundwater supply. The objective is to continue to gather information that will ultimately allow the City to make the best decision on how and when to proceed with additional water supply source development.

## 6.6 RECOMMENDED STRATEGIES, ACTIONS AND ASSESSMENTS

The recommended strategies, actions and assessments are:

**Strategy 1: Evaluate both expansion of the surface water supply and development of a groundwater supply.**
Continuing to keep the future water supply options open and obtaining more information to allow a better informed decision to be made, meets two of the water supply goals - ensuring a sustainable water supply and providing cost effective delivery. A supplemental groundwater supply could play a role in the overall water treatment strategy by deferring the construction of the new dam and providing uninterrupted (but more limited) supply if the primary surface supply was not available due to an emergency situation.

The recommended actions are:

- *Commence land acquisition and environmental approvals for the new dam on the South Nanaimo River.*
  Conceptual level engineering studies have been completed. The next steps are discussions regarding land acquisition for the dam and the reservoir and commencement of the environmental approval process. As this is expected to take several years, activities should commence in 2007. This work will include further discussions on the overall water management of the Nanaimo River watershed with the stakeholder groups. The comprehensive watershed hydrology model, developed in parallel with this Plan, will provide a basis for discussions and ongoing assessments of fisheries release scenarios.

- *Continue with the groundwater supply investigation.*
  The preliminary results on the Cassidy Aquifer investigation should be available in early 2007. This study could conclude that sufficient groundwater appears to be available and could be developed at a reasonable cost. The next steps would be to carry out test well investigations and further determination of the required groundwater system infrastructure. If the groundwater supply still appears feasible at this stage, the City could embark on the regulatory approval process. As this magnitude of groundwater development will trigger a Provincial Environmental Assessment, the overall duration of the approval process could be up to two years. The potential for a partnered approach with Pope & Talbot on the rehabilitation of their groundwater supply and emergency use by the City should also be considered.

The recommended assessment is:

- *Assess the outcome of the actions in two years.*
  The above actions regarding water supply investigations will be completed in about 12 months. This ties into the completion of actions regarding water treatment. The City should thus be in a position to make final decisions on water supply and treatment in early 2008.

**Strategy 2: Continue to recognize water as a shared resource.**

Meeting the goal of a sustainable water supply requires that planning and development be conducted on a watershed wide basis. The need to maintain a healthy and sustainable environment is of paramount importance. A key part of this is the provision of downstream flows in the Nanaimo River system to support and enhance the fisheries resources. If groundwater development is pursued, it must be done in a sustainable manner ensuring that the balance of recharge and return flows to the surface watercourses are not negatively impacted.

The recommended action is:

- *Continue to participate in regional watershed management planning.*
  The City has a long history of participation and cooperation with other water users and the Provincial agencies in watershed planning. The involvement of external stakeholders in the development of the City's Water Supply Strategic Plan is an example of this cooperation and recognition of water as a shared resource. This participation should continue in the future. Discussions should be held with the stakeholder groups on a formal mechanism to continue dialog on common water management interests.

The recommended assessment is:

- *Assess the success of required watershed management planning on a five-year basis.*
  Is it working? Any changes required? There are questions that should be reviewed on a five-year basis.

# 7 Water Transmission And Distribution

## 7.1 SYSTEM PLANNING

While the focus of the Water Supply Strategic Plan is on the supply of drinking water, this issue of water transmission and distribution from the source to the customer's tap is impacted by the future decisions on supply and water treatment.

*Water transmission* typically refers to the large diameter water mains that carry raw water to the treatment works and treated water to the area of distribution. They are usually designed to meet the maximum day demands. This is the quantity of water required over the highest use 24-hour period.

*Water distribution* is usually defined as the smaller water mains and reservoirs that are fed at points along the water transmission system. Water distribution systems are designed on the basis of pressure zones. A zone "spread", or difference between adjacent zone hydraulic grade lines (HGL), is about 45 to 60 m. The water distribution system must provide the peak water flows demanded by the customers. The difference between the maximum day flow, provided by the water transmission system, and the peak flow is provided by "equalization storage" in the distribution reservoirs. In reality, particularly in large, gravity water systems, the function of water transmission and water distribution blend. If the transmission system has additional capacity, a portion of the peak demands will come directly from the transmission mains. It is thus necessary to consider the overall hydraulic operation of the water delivery system.

The City water transmission and distribution system has evolved over several decades, as the service base has grown, both in areal extent and in water demands. The existing system is described in Chapter 2. The majority of drinking water is delivery by gravity through the zones. Booster pumping is required to supply some of the zones in the northern area of the City. Over the 50 year planning horizon, water demands will increase both due to densification of development within the existing service area and the provision of water to customers currently outside of the service area. This will put additional demands on the piping system to move water across the water distribution system. It will also put demands on the reservoirs to meet the equalization storage requirements.

Water transmission and distribution system planning entails looking ahead and determining what expansion in capacity is required to meet future demands. This may entail the construction of additional water mains or the replacement of older pipes with water mains of greater capacity. It may also involve expansion of reservoir capacity at an existing site or construction of new reservoirs. System planning also involves consideration of the remaining life of the components and when replacement or remediation will be required. City staff has been utilizing a combination of staff resources and outside consulting services to plan the future distribution needs. A comprehensive hydraulic model, using the WATERCAD software, has been developed. The following sections of this chapter provide a discussion on elements of water transmission and distribution that impact future planning.

## 7.2 DELIVERY CAPACITY

Maximum day water demands are forecast to increase by about 80% of the next 50 years. The impact of this increase depends upon the location of these demands across the water system. The capacity needs of the water system can best be planned using a numerical hydraulic model. Key factors to consider are:

- *Use of a dynamic hydraulic model.*
  A dynamic model allows time simulations of water system operation. This is important, given the interaction of pipeline capacity and variable reservoir storage. The City's existing software allows dynamic modeling and the City has been using it in this fashion. It is understood that the model has reached it capacity and will need to be replaced with either an expanded version of the current software or new software that has a capacity to handle the entire system.

- *Calibration of the hydraulic model.*
  Calibration of the model is a time consuming, yet critical part of the model development and operation. Calibration consists of gathering of actual metering, pressure and reservoir level data over critical scenarios and simulating the same conditions with the model. Adjustments can made in undefined items such as unaccounted for water to "fit" the model to the actual conditions. Without calibration, assumptions may be too "coarse" and can lead to onerous results

Currently the City has developed the hydraulic model internally. The data files are occasionally lent to outside consultants to carry out particular planning tasks. The critical issue in model development and maintenance is quality control. As the models become more sophisticated, this issue becomes more important. The best approach is to control model development internally, using staff with appropriate training. A quality control system should be in place to ensure that any changes to the model or to the input data files are correct. This ensures that errors are not introduced that could compromise model results and lead to wrong water system planning decisions.

As noted in Chapter 5, numerical dynamic hydraulic models can also be used for water quality planning. The most common application is the tracking of chlorine residuals that decay over time. Models can also be used to predict the water quality from blending of two or more sources of differing quality. Modeling using computational fluid dynamics or transient hydraulic analysis can also be performed to investigate specific system issues such as reservoir short-circuiting and pressure wave analysis in pipelines. These are specialized analyses that are best done by water industry experts.

## 7.3 RELIABILITY AND REDUNDANCY

The reliability of the water delivery system is a critical element is overall system management. The system must be capable to meeting the water demands of the customer on a continuous basis. This means that proper planning to meet the peak delivery needs, as well as planning to accommodate the failure of system components. Failure can occur is a number of ways:

- Loss of power
- Failure of equipment
- Leakage / breakage of pipelines

Loss of the main electrical power supply can be accommodated by a dedicated standby power source, a portable standby power source or by gravity storage. The City is in the fortunate position that the majority of the supply is by direct gravity flow from the supply source or fed by a reservoir at the top of the pressure zone. The short-term loss of power is thus not critical. Pumping stations with no or limited gravity storage can be equipped with stationary gen-sets, that are started in the event of power failure.

Failure of equipment is generally dealt with through redundancy. Depending upon the nature of the equipment, this could be 100% backup with automatic switchover or simply stocking the required spare parts. Requirements for redundancy start with the initial design process. As much of the City's distribution infrastructure is already in-place, design decisions on redundancy have already been made. The City now needs to look at the existing installations - have operating conditions have changed? Does the age of the equipment require a different redundancy strategy?

Leakage or breakage of pipelines is the largest risk for the City. While the reliability record has been very good, the waterman system continues to age, with some of the major transmission mains over 50 years old. This issue of reliability depends upon a number of variables – the type of material, the age, the external conditions, and the operating conditions. Pipe materials such as steel fail through the gradual development of pinhole leaks. Other materials such as prestressed concrete cylinder pipe (PCCP) or asbestos cement (AC) can fail catastrophically.

The issue of risk is linked to reliability. The magnitude of the risk in dependence upon the impact of the failure. For example, the sudden failure of a 1200 mm diameter transmission main, that causes significant property damage and interrupts the water delivery to 20,000 customers, presents a much higher degree of risk than the failure of a 150 mm diameter distribution main in a rural area.

The majority of the City's water transmission system is well planned and maintained. The upper sections from the South Fork Dam to the Water Processing Centre are twinned and constructed with steel pipe. The historical lack of problems with the pipelines indicates that the mains were constructed with proper thrust restraint and bedding and that the areas traversed by the pipelines are fairly stable. The fact that this section is twinned, provides the ability to continue water flow, if routine maintenance or emergency shutdown of one pipeline is required. This is an example where the consequences of a failure are high but the risk of a failure is low. Other lower sections of the transmission system were constructed at a later date and used a variety of pipe materials. Sections that are constructed out of PCCP or AC pipe are considered to be at a higher risk. This risk increases in these sections are not twinned or cannot be bypassed to continue supply to customers.

A water system inventory has been developed as a separate document to the Water Supply Strategic Plan. This inventory documents to the age, material and risk of failure of various sections of the water transmission mains, as well as other system components. This inventory can be used as a starting point by the City to develop a risk management strategy for the water delivery system. This strategy would identify critical waterman sections, based on a scoring system. The scoring would consider:

- Chance of failure
- Mechanism of failure (gradual leakage or abrupt breakage)
- Potential for property or environmental damage
- Degree of supply interruption
- Environmental impact (the release of chlorinated water to fish bearing stream)

This would allow the City to focus resources and budget on mitigative measures, based on the water mains with the highest degree of risk. Mitigative measures could include in-situ inspection and testing to refine the knowledge on chance of failure, additional emergency planning, installation of additional shut-off valves, pipeline twinning, pipeline remediation or replacement.

Distribution storage facilities should also be included in the risk management strategy. Although the chance of failure is low, the consequences could be very significant. The City already has a program of planned inspection and preventative maintenance for the reservoirs. This is a key element of a risk mitigation strategy.

## 7.4 EMERGENCY OPERATION

Emergency operation, relative to the management of water quality, was discussed in Section 5.4.2. Much of this is also relevant to water transmission and distribution system emergency operation.

Specific elements for water transmission and distribution are:

- Written emergency response protocols and actions, particularly relative to isolation of waterman sections.
- Spare pipe sections including repair couplings and connections.
- Availability of equipment and personnel to carry out the repair.
- Procedures and equipment to flush and disinfect the repaired section prior to commissioning.

A major seismic event will cause the largest challenge for emergency operation. This could result is a number of areas of water system damage. Emergency response teams may also have difficultly in responding, due to travel problems, and the City's resources and materials may be overwhelmed.

As noted in Chapter 5, the City does have emergency response plans in place. These should be reviewed and updated in conjunction with community wide response planning.

## 7.5 RECOMMENDED STRATEGIES, ACTIONS AND ASSESSMENTS

The recommended strategies, actions and assessments are:

**Strategy 1: Proactively manage the distribution of water to the customers.**
This strategy will assist the City in the goals of ensuring a sustainable water supply and providing cost effective water delivery. The key is continued proactive planning to ensure that the future demands will be met and that the water transmission and distribution system is maintained to reduce the risks and consequences of component failure.

The recommended actions are:

- *Continue the development and use of a system-wide numerical hydraulic model.*
  The City has been proactive in the development and calibration of a model that allows dynamic simulation of the water distribution system. This is the critical element for water distribution planning. Updating of the software is required. The City should also ensure that quality control procedures are in place on model development and use to ensure accurate results and sound decision-making.

- *Consider the expansion of the model to evaluate water quality issues or utilize specialized software and expertise to investigate specific water distribution issues.*
  The dynamic model can be expanded to evaluate issues such as chlorine residual decay in the distribution system. Issues such as reservoir short-circuiting or transient pressure problems can be evaluated using expertise in the water industry.

- *Develop a risk management strategy to prioritize water transmission and distribution risk mitigation activities.*
  The water system inventory should be expanded to include a scoring system encompassing items such as the chance of failure, mechanism of failure, potential for property or environmental damage, degree of supply interruption and environmental impact. This would provide a tool for the prioritization of resources to manage water delivery system risk.

- *Ensure that emergency response planning is in place and up to date*.
  This includes both response to water transmission and distribution problems encountered in normal operation, as well as to major seismic events.

The recommended assessments are:

- *Assess water delivery performance on a five-year basis.*
  This would include review of water delivery interruptions or events where performance did not meet expectations. Evaluations can be made on whether the problem was due to lack of delivery capacity or system component failure. Progress on long-term distribution system expansion can be monitored.

- *Review the success of the risk management strategy on an annual basis.*
  The progress and success in developing or updating the water distribution risk management strategy should be reviewed. This would include a review of the success in carrying out mitigative actions. The program can then be adjusted as required.

# 8 Water Utility Management

## 8.1 OVERVIEW

The City of Nanaimo water supply system has a long history of sound water utility management. The objective of this chapter is to discuss current water industry issues and trends, relative to utility management. These are then used to develop strategies and actions to assist utility management in the coming years.

## 8.2 HUMAN RESOURCES

### 8.2.1 Staffing

There are a number of drivers that will impact City staffing in the coming decade. The first is the increasing complexity of the water supply operation and maintenance with the introduction of additional water treatment works. This will mean additional staff, as well as staff with additional skill sets. The second is the "graying" of the works staff. The City, like many North American utilities, has been impacted by the economic cycles of the past decades. This has resulted in a large percent of water utility operating staff near the end of their career, coupled with a corresponding gap in younger to middle-career employees. The third factor is the competition for skilled water industry professionals in Western Canada. Growth in Alberta and British Columbia, as well the construction of several new water treatment plants in BC, is leading to a serious shortage of skilled water treatment plant operators.

The City will likely need to be aggressive in recruiting skilled water industry professionals. The City should also be proactive in participating with water industry organizations to ensure that young people are attracted into the industry. This requires cooperation with educational institutions and active participation in apprentice and co-op job placement programs.

### 8.2.2 Certification and Training

The Province is phasing in mandatory operator certification in the water industry. Operator certification is undertaken by the Environmental Operators Certification Program (EOCP), a non-profit organization legislated with this responsibility in BC (www.eocp.org). Operator certification is available for both water distribution and water treatment, at levels ranging from Level 1 to Level 4. The required staff certification level and the number of certified operators are dependent on the size and complexity of the water system. The February 2004, the EOCP introduced the requirement of continuing education (CEU) credits for existing, certified operators. After feedback from the industry, the deadline for obtaining these credits was extended. Certified operators now have until January 2008 to obtain the required number of CEU credits.

Operator training is a combination of on-the-job experience and academic training. Training is available through a number of venues, including the British Columbia Water & Waste Association (BCWWA), educational institutes, on-line training programs and private sector firms. To date, BCWWA has been the primary provider of training to industry professionals, offering a variety of one to five day courses throughout the Province. CEU credits can be obtained on BCWWA courses and some seminars. Post-secondary institutes, such as Camosun College and BCIT, have provided diploma and degree programs for people entering the industry. Private sector firms have primarily been involved in advanced Water Treatment Level 3 or 4 training, most usually done on a custom basis for utilities.

The exact requirements for operator certification are not entirely clear at this time. It is clear, however, that the City will need to embark on additional training and certification of staff in the coming years. The City should be proactive and a leader in the area. This will provide a competitive edge in both retaining staff and recruiting new staff to meet the future needs.

Continuing education will also be critical for senior professional, technical and managerial staff. Management of the water utility will continue to be more complex. Decisions on additional water treatment, as well as management of the aging infrastructure, will mean that staff needs to be conversant with new technologies. Networking with other utilities in North America to determine their successes and failures in dealing with industry issues will also be critical. Participation in industry organizations, such as BCWWA and AWWA, is an excellent way of achieving both the continuing education and networking needs.

### 8.2.3 Outsourcing and In-sourcing

As discussed, water utility operation and management is becoming more complex. In previous decades, large water utilities tended to do all of the work in house. This often included the construction of capital works.

The trend in recent years has been for utilities to rely more and more on services from outside of the utility. This can range professional services such as engineering design to maintenance assistance in areas such as instrumentation calibration. The City has effectively used out-sourcing for professional and contractor services for a number of years. Examples of this are the recent pipe interior rehabilitation projects. Looking ahead, it is likely that the City will continue and perhaps increase the amount of work done by out-source contracts. The management infrastructure needs to be in place to ensure that these support services are used in an effective and efficient manner.

Another aspect of “out-sourcing” is the partnering with other utilities. Examples could be joint technical pilot projects with similar sized utilities such as the GVRD and CRD. This could also be extended to management initiatives such as demand side management (DSM) trials. Partnering could also be extended on a more global basis through active participation in industry research organizations such as the American Water Works Research Foundation (AWWRF). This organization provides opportunities for partnered research activities in the water industry with both the public and private sector.

The term "in-sourcing" has been adopted by utilities. It refers to collaborative services with other departments within a local government structure. The sharing of IT and accounting systems, warehousing of spare parts and specialized technical skills are examples of potential in-sourcing. This is already common practice within the City.

## 8.3 OPERATIONS AND MAINTENANCE

### 8.3.1 Operational Procedures

The City has done an excellent job of documenting operational procedures for both normal and emergency operation of the water supply system. As additional water treatment facilities are implemented, however, operational procedures will become more complex. In addition, as water demands increase, the management of water release from the reservoirs will also be more critical.

In looking ahead, the City should consider the development of two "tools" to assist in operational management. These are:

- Reservoir forecast model
- Electronic operational manual

A numerical reservoir forecast model would be a supplement of the watershed hydrology assessment recommended in Chapter 6. The computer model would allow the City to look at "what if" scenarios for the reservoir management, based on inputs of historical hydrologic data and assumed conditions. For example, the model could be used in the spring to determine possible water release scenarios to meet both drinking water and fisheries demands, given snow pack and predicted longer term weather conditions. The model can be built on a number of software platforms, ranging from the inexpensive UBC Watershed Model to a more sophisticated dynamic model, used by energy utilities such as BC Hydro. Model operation could be either by City staff or out-sourced to a specialist consultant.

An electronic based operational manual has a number of advantages. First, it allows easy updating as situations and operational procedures change. Second, an electronic format can be accessed from various locations and staff levels in the City. Third, it can be an excellent basis for the training of new staff or staff who are changing roles in the organization. A variety of software is available for manual preparation. One of the most common is Adobe Acrobat. Text is typically prepared in WORD, with photos and schematic developed in graphics software. The electronic files are then converted to a .pdf format and hyper-links created for efficient access to the required information. A key word search engine is also commonly provided.

### 8.3.2 Safety

The City has always placed a high emphasis on employee safety. It should continue to be a high management priority. Managerial responsibilities include:

- Providing appropriate training on safe work practices.
- Providing equipment and tools that enable safe work performance.
- Conducting periodic work area inspections to ensure utility standards are followed.
- Holding supervisory staff accountable for safety matters.

Safe work practices in the water industry will continue to evolve. The construction of additional water treatment works may also introduce new work practices. In particular, work practices around confined space entry and "double block and bleed" procedures for isolating active watermains may require a review of historical worker safety activities. Partnering with other large water utilities is an excellent way of staying current on changing safety practices, .

### 8.3.3 Preventive Maintenance

Water system maintenance falls into two categories – reactive and preventative. The City already has an excellent preventative maintenance program, encompassing the water supply dams, major pipelines and closed reservoirs. As components continue to age, preventive maintenance to obtain the optimum service life will become increasing important. Examples of preventative maintenance include:

- Painting or coating repair of above-grade pipes and components.
- Testing valve operations on a defined schedule.
- Lubrication, alignment and inspection of bearing on pumps and motors.
- Inspecting and repair of coatings of storage facilities.
- Conducting cathodic protection and leak surveys on water mains.

On major water mains, it is not always practical or possible to remove them from service to carry out inspection or maintenance. This is the case with several of the City's water transmission mains. In this case, preventative maintenance would entail monitoring the external conditions of the pipelines and determining service life based a combination of pipeline material, history and observations. Preventive maintenance may, in fact, be "predictive" maintenance. This essentially means predicting developing problems and carrying out early replacement or "twinning" to allow the waterman to be removed from service to allow internal rehabilitation.

The percentage of reactive versus preventative maintenance will vary from utility to utility, depending upon a number of factors. A "rule of thumb", developed by the AWWA, is that 80 to 90%

of overall maintenance expenditures should be for planned preventative maintenance (AWWA 2005). The remaining 10 to 20% would be set aside for reactive maintenance.

Preventative maintenance software is commercially available or can be custom programmed. This allows utilities to electronically archive historical maintenance, schedule future maintenance, develop annual budgets and generate work orders for specific tasks. With the future additional water treatment works, the City should review the potential use of a computerized maintenance management system (CMMS) software.

### 8.3.4 Information Systems

Information technology (IT) and information systems (IS) are playing an increasing role in water supply management. Information systems encompass accounting, billing, customer service, human resources management and supervisory control and data acquisition (SCADA). The challenge for a water supply utility is not just to be able to acquire the information, but to effectively use the information and the capability of the systems to better management the water system. The technology environment continues to change at a rapid pace. It is thus critical that information management systems to effectively operate the water utility are a high priority for City management.

The IS currently in place for operating the water utility is near the end of its useful life. Future IS decisions required for managing the water utility need to interface with IS decisions made overall by the City. With implementation of additional water treatment works on the horizon in the next few years, it is timely to review the IS needs of the water utility and integrate them into the overall IS direction of the City. This review needs to encompass not only the SCADA requirements for water system operation and monitoring but also billing, customer communications, and computerized operations and maintenance systems.

### 8.3.5 Utility Security

Security has long been a concern in the water industry, as drinking water systems have been considered as potential targets of terrorist acts. The key elements in dealing with security issues are:

- Vulnerability assessments
- Emergency response plans (ERP)

Vulnerability assessments provide an excellent road map for utilities to increase security, as well as improve operating practices. These include not only physical assessments of water system component but human resources and financial management practices as well. With the increased attention to security in the USA in recent years, there are excellent materials and programs available from a variety of sources in the water industry to assist the City in undertaking a vulnerability assessment.

Emergency response plans for response to natural occurrences or system emergencies have been discussed elsewhere in the Plan. This plan can be expanded to include water system security issues. The ERP needs to specify responses and assign responsibilities through all levels of the water utility, with the primary objective of protecting the water system, its employees and its customers. A critical part of emergency response planning in crisis communication. As previously noted, crisis communication for the water supply system needs to be integrated into the overall City emergency management planning.

## 8.4 BEST MANAGEMENT PRACTICES

### 8.4.1 Continuous Improvement

Water utilities are challenged to provide levels of service that meet or exceed ever-increasing expectations while maintaining competitive levels of productivity. One of the best management practices to tackle this challenge is the concept of *Continuous Improvement.* Continuous improvement means a commitment to training and managing a diverse workforce that has divergent goals and needs. Key elements of continuous improvement include:

- Expanding staff's effectiveness with technology
- Increasing employees' value through training and empowerment
- Reengineering business processes
- Managing customers' expectations by communicating service levels
- Identifying opportunities for collaboration, outsourcing and in-sourcing

A Continuous Improvement program needs to integrate both the functions of supply and distribution. Feedback from customers, in the form of a survey, can be useful to determine how the City is performing and where improvement is necessary. Development of a Continuous Improvement program can be done either on a Department basis or integrated into overall City management programs.

### 8.4.2 QualServ Program

AWWA's QualServ Program is part of the toolkit that water utilities can adopt as part of best management practice. The QualServ Program essentially engages the utility in a self-assessment with utility peer teams, resulting in suggestions for improved efficiency and effectiveness. It can be geared to both small and large utilities and participation is on a fee basis.

The Program involves three steps:

- Self-assessment
- Peer review
- Benchmarking

The self assessment step involves an internal survey, completed by various employee levels. This provides both information to the utility and a starting point for the peer review. The peer review is conducted by experienced water industry utility personnel. It targets areas such as organizational development, business management, customer relations and operations. The final step is benchmarking. Benchmarking essentially compares the utility to the perform of other utilities in the water industry. It identifies areas where the utility is above the industry standard in terms of performance, as well as where improvements could be made. Benchmarking is not a single event, but rather a continuous annual assessment. This thus links to a Continuous Improvement Program, discussed above. The City of Kelowna, City of Calgary and Regional Municipality of Ottawa-Carleton have all participated in the AWWA QualServ Program.

## 8.5 RECOMMENDED STRATEGIES, ACTIONS AND ASSESSMENTS

The recommended strategies, actions and assessments are:

**Strategy 1: Continue to build an effective water utility team.**
This will assist in meeting all three water supply goals. Due to the “graying” of the personnel, the water industry is facing a shortage of skilled water professionals in the coming years. This is aggravated in British Columbia by the need for senior level operators to run newly constructed water treatment plants.

The recommended actions are:

- *Continue to work with educational institutions to attract young people into the industry.*
  This includes participation in high school programs, co-op job placements and apprenticeship programs.

- *Continue to participate in continuing education and certification programs for existing staff.*
  Continuing education for professionals already in the industry is primarily offered by BCWWA through local one to five day courses. These courses are usually run in conjunction with the EOCP certification examinations. Participation of staff in industry organizations such as BCWWA and AWWA are also a critical part of continuing education and building an effective team.

- *Utilize outsourcing or in-sourcing with other City departments.*
  Many professional services such as engineering design or specialized maintenance work are most effectively done by out-sourcing to private sector firms. In-sourcing with other City Departments

can also be a way to sharing the costs for the development of specialized services. Partnering with other water utilities is also an effective means of sharing information or services.

The recommended assessment is:

- *Assess water utility staffing on an annual basis.*
  The assessment should consider whether the water utility is meeting its staffing goals. It should be integrated with the City's overall human resources programs. The assessment should also encompass the success of individual career development programs and succession planning.

**Strategy 2: Improve utility operations effectiveness through appropriate use of informational technology.**

If properly planned and executed, computer based information technology tools can assist a water utility in making efficiency gains and assist in meeting the goals for a safe and cost effective water supply. Possible areas of application include computerized operations plans, computerized maintenance management systems and SCADA systems.

The recommended actions are:

- *Develop an electronic Operations Plan for water supply system operation.*
  An electronic Operations Plan allows easy updating, multiple work station and remote access and staff training opportunities. The development of an electronic Operations Plan should be considered as part of the future water treatment plant design.

- *Review the use of computerized maintenance management system (CMMS) software.*
  Preventative maintenance will become increasingly important as water system components reach the latter part of their service life. CMMS allows efficient tracking of maintenance history, scheduling of future maintenance, generation of work orders and budgeting. The City should review commercial or custom software to determine how it may fit into future maintenance management.

- *Review the supervisory control and data acquisition (SCADA) strategy, as part of the water treatment preliminary design.*
  Components of the current SCADA system are nearing the end of their service life. With the future construction of new water treatment facilities, the required SCADA strategy and architecture should be reviewed. This can best be done in conjunction with the conceptual level engineering planning for the water treatment facility.

The recommended assessment is:

- *Review the IT strategy on a five-year basis.*

Have the goals of the strategy been met? What changes are required? This assessment could focus solely on the IT strategy of the water utility or be part of a City wide IT strategic assessment and review.

**Strategy 3: Continue to improve the efficiency and effectiveness of management of the water utility.**
A water utility is very much a business. Utility managers constantly face challenges from customer demands and the need to provide more with less resources. This challenge can be in part tackled through the concept of Continuous Improvement. This strategy should assist in meeting all three goals.

The recommended actions are:

- *Develop and follow the concept of Continuous Improvement.*
  This can be either part of an overall City program or specifically focused on the Water Utility.

- *Consider participation in the AWWA QualServ Program.*
  This is program encompassing self-assessment, peer review and benchmarking. It allows comparison with water industry standards and can be used as part of a continuous improvement program to increase utility management effectiveness.

The recommended assessment is:

- *Assess the success of the Continuous Program on a two-year basis.*
  Has the program achieved its goals? Has success been demonstrated through increased customer satisfaction, fewer service interruptions or other definable yardsticks?

# 9 Financial Management

## 9.1 OVERVIEW

The water infrastructure in British Columbia was primarily built over the last five decades. Much of this infrastructure was partially funded by senior government programs. The debt serviced by local water utilities, to the most extent, has been paid off. This has resulted in many water utilities collecting only sufficient revenues to pay for operating and minor maintenance costs, resulting in very low water rates compared to other Provinces.

This is now changing. With the water infrastructure aging and with many utilities facing high capital costs for new water treatment works, there is a need to generate increased revenue. While a portion of this revenue may still come from senior government programs, the majority of the revenue will need to come from increased water rates.

The City has had one of the lowest water rates in British Columbia. This is as a result of having a high quality gravity water supply, capital works debt that is primarily retired and prudent management. Even with the low rates, the City has implemented a significant preventative maintenance program to get the optimum life out of water system components. The City, however, will be facing cost increases over the next two decades. Additional water treatment will add to both capital and operating and maintenance costs. In the longer term, significant dollar outlays may be required for construction of a new water supply dam. Major water system components, such as water mains and reservoir, will continue to age and will need rehabilitation. A growth in water customers will also mean that portions of the water supply infrastructure will need to be expanded.

The City, however, has the time to develop a financial strategy to continue to manage the water utility in the most cost effective manner. The following sections of this chapter highlight the key considerations in financial planning and set out the expected order-of-magnitude budget costs for elements sited in the Plan.

## 9.2 ACCOUNTING

### 9.2.1 Full Cost Accounting

The concept of full cost accounting, as applied to a water utility, is that the utility should be managed so that the revenues are sufficient to provide for the “full cost” of water service. The “full cost” not only includes current capital costs or debt and operating and maintenance costs, but also the costs to maintain the infrastructure in a sustainable manner. This includes any environmental costs.

In the United States, the requirement for full cost accounting has been recently legislated under the Governmental Accounting Standards Board Statement Number 34 (termed GASB 34). Among its many provisions, GASB 34 requires that state and local governments begin to report on the value of their infrastructure assets (Dolan et al, 2003). The intent is to ensure that utilities provide reliable information about the long-term viability of all of the capital assets. The GASB 34 provides for some variation in capital value reporting. Principally, it allows a modified reporting basis (also termed preservation reporting) that focuses on reporting the remaining life of the asset, based on an asset management program. The program must include maintenance and reinvestment, determined through a systematic condition assessment of the asset.

In Canada, the Province of Ontario has adopted a similar approach to the United States. The Province introduced The Sustainable Water and Sewage Systems Act in December 2002 (Brandes et al, 2005). This legislation requires utilities to prepare a Full Cost Report, followed by a Cost Recovery Plan, demonstrating how the utility will pay for the full cost of water services. British Columbia has not adopted similar legislation, however, some utilities such as the Capital Regional District have moved ahead with full cost accounting (CRD, 2004).

The City should move towards a full cost accounting strategy. The actual approach will depend upon possible future legislative changes adopted by the Province. The approach also needs to be in concert with overall City financial management.

### 9.2.2 Asset Management and Sustainability

The issue of asset management and sustainability is linked to the issue of full cost accounting. As noted in Chapter 2, the replacement cost of the water supply asset is about $300 million – a staggering number. These assets need to be maintained to obtain the optimum service life and to provide the best value to the water system owners – the taxpayers. At some point, these water system components will need to be replaced. How can this best be planned and financed?

Unfortunately, as much of the water infrastructure is buried, it is not necessarily straightforward to assess the remaining life and the timing of rehabilitation or replacement. For example, given the possible catastrophic effects of the failure of a large diameter waterman, it is necessary to be conservative and ideally replace the pipeline prior to failure. Replacement decisions are also dictated by supply capacity or changing technology. An aging component may be replaced by a different water delivery strategy.

Asset management is thus directly linked to long term water supply planning. In developing water supply planning and engineering designs, it is necessary to consider the service life of existing components. Water supply elements, such as new pipelines or pumping stations, will likely form the dual function of increasing capacity and replacing older components, which are reaching the end of their useful serviced life.

The City thus needs to consider financial planning to meet future water supply needs in concert with managing the existing infrastructure. A water system inventory has been prepared as a separate document to this Plan. The City can use this inventory as the basis for a more formal asset management plan. This asset management plan will provide the information needed to move to a full cost accounting program, as well as provide the information needed to integrate capacity expansion planning with infrastructure replacement.

### 9.2.3 Revenues and Rates

Water system revenues are generated through senior government funding programs, capital charges or user rates.

While senior government funding programs may be available for certain expenditures such as water treatment plants, their future is uncertain and the long-term direction appears to be away from funding programs. Nevertheless, the City should position itself to take advantage of senior government funding, if it is available in the near term.

Capital charges include development cost charges or other capital charge paid for the provision of the water service. Development cost charges or DCCs will be a key element of future revenue, as much of the capital works will be driven by capacity increases needed to service growth. The City has a DCC program in place. It should be reviewed from time to time to ensure the revenue calculations are reflective of expected construction costs and fully account to the capacity share of the infrastructure.

The City currently employs an increasing block water rate billing system. Under this approach, the customer pays higher incremental rates for higher quantities of water use. As noted in Chapter 4, this has been an effective part of the City's demand management system and reductions in per capita water use have been demonstrated. No change in this billing approach is proposed.

## 9.3 WATER SUPPLY STRATEGIC PLAN – THE COSTS

The Water Supply Strategic Plan identifies a number of strategies and actions that are required to complete the decision making to meet the water supply goals or to effectively manage the water utility. Some of these will be completed in the short term; others are ongoing. Arising from the decision making will be a number of water system upgrading or expansion projects. These will be implemented over the 50-year planning time frame.

In order to assist the City with development of a financial strategy, order of magnitude budgets for the activities and expected projects have been developed. These costs are in 2006 dollars. They will need to be updated using an appropriate inflation index to the period in which the expenditure occurs. Where applicable, the budget figures include allowances for administration, engineering and contingencies.

Estimated budgets to implement the strategies and actions in this Plan are presented in Table 9-1. Expected expenditures over the next five years are shown. The activities will require a combination of internal staff time and external consulting engineering input. It is assumed that the required input by senior City management staff can be accommodated within the existing resources. It is assumed that the actual tasks would be carried by a combination of City staff and external consultant resources. An allowance is shown in the table for an additional full-time intermediate level City staff member.

A summary of the estimated water system project costs over the next 20 years is shown in Table 9-2. The summary is based on water system component categories. The details on actual projects within the categories are presented in Appendix B. As decision-making is at a preliminary stage, the budgets are shown for general guidance on the expected cost order-of-magnitude. Actual projects still need to be confirmed and the budgets will be refined following the completion of the strategies and actions step. The projects shown reflect water system upgrading that would not normally be part of the City's annual maintenance program. These costs are thus in addition to City's annual operating and maintenance activities. Although the capital projects will be primarily carried out by outside forces, the City will likely undertake some of the administrative, engineering and construction activities using City resources.

**Table 9-1**
**Water Supply Strategic Plan**
**Strategies/Actions Budget**

| STRATEGY | ACTION | ANNUAL BUDGET ($) | | | |
|---|---|---|---|---|---|
| | | 2007 | 2008 | 2009 | 2010 |
| **Projected Water Demands** | | | | | |
| 1. Adopt a demand side management approach. | • Refine existing water use efficiency programs into a demand side management approach.<br>• Evaluate the use of rebate programs and water rate structure changes. | Note 1<br>Note 1 | Note 1<br>Note 1 | Note 1<br>Note 1 | Note 1<br>Note 1 |
| 2. Measure water demand and trends. | • Continue to refine overall raw water and customer metering to allow more detailed tracking of water use.<br>• Monitor and participate in community development planning.<br>• Monitor water industry trends. | Notes 1& 2<br>Note 1<br>Note 1 | Notes 1 & 2<br>Note 1<br>Note 1 | Notes 1 & 2<br>Note 1<br>Note 1 | Notes 1 & 2<br>Note 1<br>Note 1 |

| STRATEGY | ACTION | ANNUAL BUDGET ($) | | | |
|---|---|---|---|---|---|
| | | 2007 | 2008 | 2009 | 2010 |
| **Water Quality** | | | | | |
| 1. Adopt a multi-barrier approach to drinking water quality management. | • Continuation and possible augmentation of the raw water quality monitoring program. | $50,000 | $50,000 | | |
| | • Monitor drinking water quality legislation. | Note 1 | Note 1 | Note 1 | Note 1 |
| | • Continue current source water protection and watershed management programs. | Note 3 | Note 3 | Note 3 | Note 3 |
| | • Review scenarios for long-term tenure of the watershed. | | $50,000 | | |
| | • Carry out preliminary engineering for water treatment upgrading. | $200,000 | $200,000 | $200,000 | |
| | • Monitor water treatment technology trends. | Note 1 | Note 1 | Note 1 | Note 1 |
| | • Continue to monitor treated water quality throughout the distribution system. | Note 3 | Note 3 | Note 3 | Note 3 |
| **Water Source Development** | | | | | |
| 1. Evaluate both expansion of the surface water supply and development of a groundwater supply. | • Commence land acquisition and environmental approvals for the new dam on the South Nanaimo River. | $100,000 | $200,000 | $200,000 | |
| | • Continue with the groundwater supply investigation. | $150,000 | | | |
| 2. Continue to recognize water as a shared resource. | • Continue to participate in regional watershed management planning. | Note 3 | Note 3 | Note 3 | Note 3 |

| STRATEGY | ACTION | ANNUAL BUDGET ($) | | | |
|---|---|---|---|---|---|
| | | 2007 | 2008 | 2009 | 2010 |
| **Water Transmission and Distribution** | | | | | |
| 1. Proactively manage the distribution of water to the customers. | • Continue the development and use of a system-wide numerical hydraulic model. | Note 3 | Note 3 | Note 3 | Note 3 |
| | • Consider the expansion of the model to evaluate water quality issues or utilize specialized software and expertise to investigate specific water distribution issues. | Note 3 | $50,000; Note 3 | Note 3 | Note 3 |
| | • Develop a risk management strategy to prioritize water transmission and distribution risk mitigation activities. | Note 3 | Note 3 | Note 3 | Note 3 |
| | • Ensure that emergency response planning is in place and up to date. | Note 3 | Note 3 | Note 3 | Note 3 |
| **Water Utility Management** | | | | | |
| 1. Continue to build an effective water utility team. | • Continue to work with educational institutions to attract young people into the industry. | Note 3 | Note 3 | Note 3 | Note 3 |
| | • Continue to participate in continuing education and certification programs for existing staff. | Note 4 | Note 4 | Note 4 | Note 4 |
| | • Utilize outsourcing or in-sourcing with other City departments. | Note 3 | Note 3 | Note 3 | Note 3 |
| 2. Improve utility opportunities effectiveness through appropriate use of informational technology. | • Develop an electronic Operations Plan for water supply system operation. | | | Note 5 | |
| | • Review the use of computerized maintenance management system (CMMS) software. | | | Note 5 | |
| | • Review the supervisory control and data acquisition (SCADA) strategy, as part of the water treatment preliminary design. | Note 6 | | | |
| 3. Continue to improve the efficiency and effectiveness of management of the water utility. | • Develop and follow the concept of Continuous Improvement. | Note 3 | Note 3 | Note 3 | Note 3 |
| | • Consider participation in the AWWA QualServ Program. | Note 3 | Note 3 | Note 3 | Note 3 |

| STRATEGY | ACTION | ANNUAL BUDGET ($) | | | |
|---|---|---|---|---|---|
| | | 2007 | 2008 | 2009 | 2010 |
| **Financial Management** | | | | | |
| 1. Manage the finances of the water utility on a sustainable basis. | • Monitor current directions in utility accounting practice and Provincial legislation.<br>• Move towards a full cost accounting basis. | Note 3<br>Note 3 | Note 3<br>Note 3 | Note 3<br>Note 3 | Note 3<br>Note 3 |
| **TOTAL ANNUAL BUDGET (See Note 1 for Additional Internal Staff Cost)** | | **$500,000** | **$550,000** | **$400,000** | **--** |

**Notes:**
1 Activities are assumed to be carried out by a City intermediate-level engineering staff member. An annual payroll cost of $110,000 is assumed.
2 Capital costs to upgrade raw water metering are assumed to be part of the City's annual O&M budget. Improvements in customer metering are assumed to be recovered from the customer.
3 Costs are assumed to be part of the current City administration and engineering activities. Additional resources are provided as per Note 1.
4 Additional operator training will likely be required with the move to more advanced water treatment processes. A specific dollar figure is not included at this time.
5 Costs are included in the engineering services for the detailed design of the water treatment plant.
6 Cost is included in the preliminary engineering for the water treatment plant.

## Table 9-2
## Summary of Future Water System Project Budgets
## 2006 to 2025

| Category | Budget ($ million) | | | | Total Budget ($ million) |
|---|---|---|---|---|---|
| | 2007 to 2010 | 2011 to 2015 | 2016 to 2020 | 2021 to 2025 | |
| **Supply** | 6.91 | 6.05 | 62.55 | 12.5 | 88.01 |
| **Treatment** | 6.54 | 40.10 | 0 | 0 | 46.64 |
| **Transmission and Distribution** | 12.35 | 12.86 | 2.35 | 35.27 | 62.83 |
| **Total** | **25.80** | **59.01** | **64.90** | **47.77** | **197.48** |

**Notes:**
1 See Appendix B for details on actual projects in each category. Costs are in 2006 dollars.

## 9.4 RECOMMENDED STRATEGIES, ACTIONS AND ASSESSMENTS

The recommended strategy, action and assessment is:

**Strategy 1: Manage the finances of the water utility on a sustainable basis.**
This strategy will help the City meet all three goals. The key element is to move towards full cost accounting based on a clear measurement of what is needed to operate the water system on a sustainable basis. This is a long-term strategy that requires recognition of near term capital expenditures.

The recommended actions are:

- *Monitor current directions in utility accounting practice and Provincial legislation.*
  Legislation has been recently adopted by Ontario, based on GASB accounting changes in the United States in regards to utility practice. The City should monitor the experiences of Ontario utilities in adapting to this legislation. The City should also monitor discussion at the Provincial level regarding similar legislation for British Columbia.

- *Move towards a full cost accounting basis.*
  While not legislated, the future direction towards full cost accounting is clear. The City should move the financial management of the water utility in this direction, in concert with overall City financial planning and accounting.

The recommended assessment is:

- *Assess the progress towards full cost accounting on a five-year basis.*
  This should be done in concert with overall City financial planning.

# 10 Summary, Recommended Strategies, Actions and Assessments

The development of the Water Supply Strategic Plan has used a stakeholder review process to ensure that the views of both City staff members and interested, external groups have been considered in long-term water supply planning. Based on the input from the stakeholders, three goals have been identified. These are:

*Goal 1 – Provide Safe Drinking Water*
The provision of clean, safe water is a fundamental element of all drinking water systems. The City is committed to providing clean, safe water to all of its customers. This means not only meeting required regulations but also planning ahead in a proactive manner to ensure this goal is met, both during normal operations and during emergency events.

*Goal 2 – Ensure a Sustainable Water Supply*
A sustainable water supply will ensure that the community can continue to grow and prosper while maintaining environmental quality. Sustainability has two focuses. One is continued supply of water during abnormal or emergency conditions. The second is the adequate supply of water in the future, given such impacts as global warming and climatic change. The issue of sustainability needs to consider the shared water resource demands, in particular the release of water for downstream fisheries management.

*Goal 3 – Provide Cost Effective Water Delivery*
Cost effective water delivery optimizes capacity and maintains the value of the value of the water system infrastructure asset, through planned maintenance. Required capital expenditures to maintain safe drinking water or system sustainability are planned so that they can be implemented in an affordable manner.

These goals tie into the overall community goals for viability, environmental protection and sustainable management. They provide the vision for long-term direction for water supply planning. The previous chapters have taken these water supply goals and developed strategies, actions and assessments to meet the goals. These are summarized on the attached table.

**TABLE 10-1**
**Summary – Strategies, Actions and Assessments**

| STRATEGY | GOALS ADDRESSED | ACTION | ASSESSMENT |
|---|---|---|---|
| PROJECTED WATER DEMANDS | | | |
| 1. Adopt a demand side management approach. | 2, 3 | ● Refine existing water use efficiency programs into a demand side management approach.<br>● Evaluate the use of rebate programs and water rate structure changes. | ● Review the success of the demand side management program every five years. |
| 2. Measure water demand and trends. | 2, 3 | ● Continue to refine overall raw water and customer metering to allow more detailed tracking of water use.<br>● Monitor and participate in community development planning.<br>● Monitor water industry trends. | ● Reassess future water demands on a five-year basis. |
| WATER QUALITY | | | |
| 1. Adopt a multi-barrier approach to drinking water quality management. | 1, 2, 3 | ● Continuation and possible augmentation of the raw water quality monitoring program.<br>● Monitor drinking water quality legislation.<br>● Continue current source water protection and watershed management programs.<br>● Review scenarios for long-term tenure of the watershed.<br>● Carry out preliminary level engineering for water treatment upgrading.<br>● Monitor water treatment technology trends.<br>● Continue to monitor treated water quality throughout the distribution system. | ● Assess the outcome of water quality actions in two years.<br>● Assess the multi-barrier approach on a five-year basis. |

| STRATEGY | GOALS ADDRESSED | ACTION | ASSESSMENT |
|---|---|---|---|
| WATER SOURCE DEVELOPMENT | | | |
| 1. Evaluate both expansion of the surface water supply and development of a groundwater supply. | 2, 3 | ● Commence land acquisition and environmental approvals for the new dam on the South Nanaimo River.<br>● Continue with the groundwater supply investigation. | ● Assess the outcome of the actions in two years. |
| 2. Continue to recognize water as a shared resource. | 2 | ● Continue to participate in regional watershed management planning. | ● Assess the success of required watershed management planning on a five-year basis. |
| WATER TRANSMISSION AND DISTRIBUTION | | | |
| 1. Proactively manage the distribution of water to the customers. | 2, 3 | ● Continue the development and use of a system-wide numerical hydraulic model.<br>● Consider the expansion of the model to evaluate water quality issues or utilize specialized software and expertise to investigate specific water distribution issues.<br>● Develop a risk management strategy to prioritize water transmission and distribution risk mitigation activities.<br>● Ensure that emergency response planning is in place and up to date. | ● Assess water delivery performance on a five-year basis.<br>● Review the success of the risk management strategy on an annual basis. |

| STRATEGY | GOALS ADDRESSED | ACTION | ASSESSMENT |
|---|---|---|---|
| WATER UTILITY MANAGEMENT | | | |
| 1. Continue to build an effective water utility team. | 1, 2, 3 | ● Continue to work with educational institutions to attract young people into the industry.<br>● Continue to participate in continuing education and certification programs for existing staff.<br>● Utilize outsourcing or in-sourcing with other City departments. | ● Assess water utility staffing on an annual basis. |
| 2. Improve utility opportunities effectiveness through appropriate use of informational technology. | 1, 3 | ● Develop an electronic Operations Plan for water supply system operation.<br>● Review the use of computerized maintenance management system (CMMS) software.<br>● Review the supervisory control and data acquisition (SCADA) strategy, as part of the water treatment preliminary design. | ● Review the IT strategy on a five-year basis. |
| 3. Continue to improve the efficiency and effectiveness of management of the water utility. | 1, 2, 3 | ● Develop and follow the concept of Continuous Improvement.<br>● Consider participation in the AWWA QualServ Program. | ● Assess the success of the Continuous Program on a two-year basis. |
| FINANCIAL MANAGEMENT | | | |
| 1. Manage the finances of the water utility on a sustainable basis. | 1, 2, 3 | ● Monitor current directions in utility accounting practice and Provincial legislation.<br>● Move towards a full cost accounting basis. | ● Assess the progress towards full cost accounting on a five-year basis. |

# References


1 American Water Works Association. 2005. *Water Utility Management.* Manual of Water Supply Practices M5.

2 Associated Engineering. 2006a. *Water Treatment Plant Siting Study (Draft), October 2006*. City of Nanaimo.

3 Associated Engineering. 2006b. *South Nanaimo River Watershed Yield Assessment (Draft), October 2006*. City of Nanaimo.

4 Associated Engineering. 2006c. *Personal communication with Pope & Talbot staff, Internal Memo dated October 13, 2006.* City of Nanaimo.

5 Brandes et al. 2005. *At A Watershed: Ecological Governance and Sustainable Water Management in Canada.* Environmental Law Centre Society. University of Victoria.

6 Chatwin Engineering Ltd. 2002. *Water Source Strategy*. Greater Nanaimo Water District.

7 Capital Regional District. 2004. *2004 Review of the Strategic Plan for Water Management.*

8 Dolan et al. 2003. *Managing the Water and Wastewater Utility*. Water Environment Federation.

9 EBA Engineering Consultants Ltd. 2005. *Additional Storage Facility at Jump Creek – Preliminary Design and Cost Estimate (Draft).* City of Nanaimo.

10 Earth Tech (Canada) Ltd. 2003. *Water Quality Pilot Study Review.* Greater Nanaimo Water District.

11 Earth Tech (Canada) Ltd. 2005. *Water Treatment Pilot Testing – Final Report*. City of Nanaimo.

12 Federal-Provincial-Territorial Committee on Drinking Water. 2002. *From Source to Tap – The Multi-Barrier Approach to Safe Drinking Water.* Canadian Council of Ministers of the Environment.

13 Greater Vancouver Regional District. 2005. *Drinking Water – Quality on Tap. Drinking Water* Management *Plan* (Draft).

14 Koers & Associates Engineering Ltd. 2003. *Primary Watershed Storage Review.* Greater Nanaimo Water District.

15 Nanaimo, City of and Greater Nanaimo Water District. 2002. *Nanaimo's Most Precious Resource*.

16 Nanaimo, City of. 2005a. Update of the Water Conservation Plan, Appendix B, Unpublished water demand data.

17 Nanaimo, City of. 2006. *Unpublished raw water data from the on-line turbidity meter at the WPC.*

18 Reid Crowther & Partners Ltd. 1998. *Water Quality Pilot Study.* Greater Nanaimo Water District.

19 Thurber Engineering. 2006. *Nanaimo Lakes Area Groundwater Study. Memo 06-1.* June 2006. City of Nanaimo.

A

# Appendix A - Water Supply Strategic Plan Participants

# Water Supply Strategic Plan Participants

Brian Clemens - City of Nanaimo
Scott Crane – City of Nanaimo
John Elliot - City of Nanaimo
Ritchie Fulla - City of Nanaimo
Andy Laidlaw - City of Nanaimo
Wayne Hansen - City of Nanaimo
Mac MacKenzie - City of Nanaimo
Tom Moscrip - City of Nanaimo
Scott Pamminger - City of Nanaimo
Bill Sims – City of Nanaimo
Frank Raimondo - CVRD
Brian Tutty - DFO Nanaimo
Mel Sheng - DFO Nanaimo
David Hunter - Nanaimo Airport Commission
Mike Donnelly – Regional District of Nanaimo
John Baldwin – MoE Water Stewardship
Pieter Bekker – MoE Water Stewardship
Glen Davidson – MoE Water Stewardship
Mike McCulloch – MoE Fish & Wildlife
Craig Wightman – MoE F&W Nanaimo
Glen Brown – MoCS Victoria
Andrew Riecker – MoF SIFO
Dan Biggs – MoF Port Alberni
Gilbert Richir – MoF Port Alberni
Murray Sexton – Vancouver Island Health Authority
Jill Lucko – Vancouver Island Health Authority
Shelly Higman – Island Timberlands
Jim Sears – Island Timberlands
Dave Rodgers - Pope & Talbot
Dave Groeneveld - Pope & Talbot
David Bramley - Pope & Talbot
John Wesley - Snuneymuxw First Nation
Dave Mannix - Snueymuxw First Nation
Rick Corbett - Associated Engineering

# B Appendix B - Budget Estimate Details

Revision Date: January 3, 2007
File: 042615

**CITY OF NANAIMO**
**WATER SUPPLY STRATEGIC PLAN**

## WATER SYSTEM PROJECT COSTS

| Reference | Item | Description | Unit | Cost Quantity | Unit Price ($/m) | Cost ($ million) | Budget ($ million) | | | | Total 2007 to 2025 ($ million) | Deferred Costs ($ million) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2007 to 2010 | 2011 to 2015 | 2016 to 2020 | 2021 to 2025 | | | |
| | **WATER SUPPLY** | | | | | | | | | | | | |
| 001 | Upper Jump Creek Dam | Existing 16.6 million $m^3$ reservoir | LS | | | 5.00 | | | | 5.00 | 5.00 | | Major maintenance / replacement of control structure / tunnel lining |
| | Lower Jump Creek Dam | Future 21 million $m^3$ reservoir | LS | | | 62.00 | 5.00 | 5.00 | 52.00 | | 62.00 | | Assumes dam construction in the 2016 to 2020 period. |
| 002 | South Fork Dam | Water intake control dam | LS | | | 5.00 | 0.50 | 0.50 | | 4.00 | 5.00 | | General maintenance. Structural upgrading and silt removal in 2021 to 2025 after the new dam is in place. |
| 045 | Upper Chase River Dam | Back up dam | LS | | | 1.00 | 1.00 | | | | 1.00 | | Spillway repair and piping replacement |
| | Groundwater | Future | LS | | | 10.00 | | | 10.00 | | 10.00 | | Assumes 30 ML/d of groundwater development in the Cassidy Aquifer area is feasible. |
| | Water Supply Dams | Safety inspections | LS | | | 1.73 | 0.13 | 0.20 | 0.20 | 0.15 | 0.68 | 1.05 | Regulatory requirement. Major inspection every 3 years. Minor inspection on other years. |
| | SCADA | General improvements | LS | | | 1.47 | 0.12 | 0.15 | 0.15 | 0.15 | 0.57 | 0.90 | General improvements to SCADA system. |
| | Watershed | Maintenance | LS | | | 0.98 | 0.08 | 0.10 | 0.10 | 0.10 | 0.38 | 0.60 | General access road maintenance. |
| | Right of Ways | Acquisitions | LS | | | 0.38 | 0.08 | 0.10 | 0.10 | 0.10 | 0.38 | | Continued procurement of RoW easements. |
| | Micro Hydro Generation | New facility on Berkely Creek | LS | | | 3.00 | | | | 3.00 | 3.00 | | Potential electrical supply to WTP. |
| | **subtotal** | | | | | | **6.91** | **6.05** | **62.55** | **12.50** | **88.01** | | |
| | **WATER TREATMENT** | | | | | | | | | | | | |
| 008 | Water Processing Centre | Chlorination facility for North Nanaimo and Duke Point | LS | | | 0.10 | | 0.10 | | | 0.10 | | Assumed to be decommissioned after new WTP constructed. |
| 012 | Reservoir No. 1 | Raw water dam and chlorination facility for City Centre | LS | | | 0.54 | 0.54 | | | | 0.54 | | General maintenance. Cost to cover or replace reservoir with a closed structure included in WTP cost below. |
| | Water Treatment Plant | Future WTP located on Nanaimo Lakes Road | LS | | | 60.00 | 6.00 | 40.00 | | | 46.00 | 14.00 | Stage 1 includes high rate clarification/ filtration / Cl with a max day capacity of 106 ML/d. Stage 2 expands max day capacity to 156 ML/d. |
| | **subtotal** | | | | | | **6.54** | **40.10** | **0.00** | **0.00** | **46.64** | | |
| | **WATER TRANSMISSION AND DISTRIBUTION** | | | | | | | | | | | | |
| | **Raw Water Mains** | | | | | | | | | | | | |
| 003 | Water Main - Original | South Fork Dam to Reservoir 1 | m | 16000 | 750 | 12.00 | | | | 12.00 | 12.00 | | Internal rehabilitation and external spot repair as required. |
| 004 | Water Main - Duplicate Stage III (South) | South Fork Dam to WPC | m | 4229 | 1150 | 4.86 | | | | | 0.00 | 4.86 | Assumes that rehabilitation is not required until after 2025. |
| 005 | Water Main - Duplicate Stage IV | South Fork Dam to WPC | m | 3869 | 1150 | 4.45 | | | | | 0.00 | 4.45 | Assumes that rehabilitation is not required until after 2025. |
| 006 | Water Main - Duplicate Stage V | South Fork Dam to WPC | m | 2514 | 1150 | 2.89 | | | | | 0.00 | 2.89 | Assumes that rehabilitation is not required until after 2025. |
| 007 | Water Main - Duplicate Stage VI | South Fork Dam to WPC | m | 5109 | 1150 | 5.88 | | | | | 0.00 | 5.88 | Assumes that rehabilitation is not required until after 2025. |
| 009 | Water Main - Duplicate Stage III (North) | WPC to Reservoir 1 | m | 834 | 1150 | 0.96 | | | | | 0.00 | 0.96 | Assumes that rehabilitation is not required until after 2025. |
| 010 | Water Main - Duplicate Stage II | WPC to Reservoir 1 | m | 2230 | 1000 | 2.23 | | | | | 0.00 | 2.23 | Assumes that rehabilitation is not required until after 2025. |
| 011 | Water Main - Duplicate Stage I | WPC to Reservoir 1 | m | 8266 | 870 | 7.19 | | | | | 0.00 | 7.19 | Assumes that rehabilitation is not required until after 2025. |
| | Miscellaneous | | | | | 0.40 | 0.10 | 0.10 | 0.10 | 0.10 | 0.40 | | Miscellaneous repair |
| | **Water System - Duke Point** | | | | | | | | | | | | |
| 013 | Water Main | WPC to Duke Point - Section G | | | | 1.00 | | 1.00 | | | 1.00 | | Final section of internal lining rehabilitation. |
| 013 | Water Main | WPC to Duke Point | m | 10940 | 750 | 8.21 | | | | | 0.00 | 8.21 | Assumes that rehabilitation is not required until after 2025. |
| 014 | Duke Point Reservoir | | LS | | | 0.50 | | | | 0.50 | 0.50 | | Internal and external rehabilitation |
| 015 | Duke Point PRV Station | | LS | | | 0.05 | | | 0.05 | | 0.05 | | Major maintenance |
| 016 | Duke Point Pump Station | | LS | | | | | | | | 0.00 | | Currently not in use. |
| | South Nanaimo Reservoir | New reservoir, TWL 155 m | LS | | | 8.50 | 4.25 | 4.25 | | | 8.50 | | Two cells at 4.9 ML each. Includes connecting watermains. |
| | Miscellaneous | | | | | 0.40 | 0.10 | 0.10 | 0.10 | 0.10 | 0.40 | | Miscellaneous repair |
| | **Water System - North Nanaimo (South Section)** | | | | | | | | | | | | |
| 017 | Water Main | Reservoir 1 to College Park | m | 2000 | 2200 | 4.40 | 4.40 | | | | 4.40 | | Twin with 900 mm main |
| 018 | College Park Reservoirs | Concrete | LS | | | 0.50 | 0.05 | | | 0.45 | 0.50 | | Internal and external rehabilitation |
| 019 | College Park PRV Station | | LS | | | 0.05 | | 0.05 | | | 0.05 | | Major maintenance |
| 020 | College Park Pump Station | | LS | | | 0.90 | | 0.90 | | | 0.90 | | Major maintenance and upgrade to pumps and diesel drive. |
| 021 | Water Main | College Park to Towers | m | 1000 | 400 | 0.40 | | | 0.40 | | 0.40 | | Replacement with 300 mm main |
| 022 | Towers Reservoir | | LS | | | 0.50 | | | 0.50 | | 0.50 | | Internal and external rehabilitation |
| 023 | Towers Pump Station | | LS | | | 0.10 | | 0.10 | | | 0.10 | | Major maintenance |
| 024 | Water Main | College Park to Addison Road | m | 600 | 2200 | 1.32 | | | | 1.32 | 1.32 | | Twin with 900 mm main |
| 025 | Water Main | Addison Road to Pryde Avenue | m | 1500 | 900 | 1.35 | | | | 1.35 | 1.35 | | Internal rehabilitation and external spot repair as required. |
| 026 | Pryde Avenue Pump Station and PRV | Emergency use only | LS | | | 0.60 | | 0.60 | | | 0.60 | | Major maintenance and voltage upgrade. |
| | Miscellaneous | | | | | 0.40 | 0.10 | 0.10 | 0.10 | 0.10 | 0.40 | | Miscellaneous repair |
| | **Water System - City Centre** | | | | | | | | | | | | |
| 027 | Water Main | Reservoir 1 to Wakesiah Road | m | 1300 | 900 | 1.17 | | 1.17 | | | 1.17 | | Internal rehabilitation and external spot repair as required. |
| 028 | Water Main | Wakesiah Road to Waddington Road | m | 3000 | 800 | 2.40 | | 2.40 | | | 2.40 | | Internal rehabilitation and external spot repair as required. |
| 029 | Water Main | Waddington Road to Pryde Ave PS | m | 1257 | 500 | 0.63 | | 0.63 | | | 0.63 | | Internal rehabilitation and external spot repair as required. |
| | Miscellaneous | | | | | 0.40 | 0.10 | 0.10 | 0.10 | 0.10 | 0.40 | | Miscellaneous repair |
| | **Water System - North Nanaimo (North Section)** | | | | | | | | | | | | |
| 030 | Water Main | West line from Pryde PS to Madelis PS | m | 3411 | 2200 | 7.50 | | | | | 0.00 | 7.50 | Replacement with 900 mm main |
| 031 | Water Main | East line from Pryde PS to Madelis PS | m | 4000 | 1825 | 7.30 | | | | 7.30 | 7.30 | | Replacement with 750 mm main |
| | Labieux Booster Pump Station | Future | LS | | | 2.10 | 2.10 | | | | 2.10 | | New PS |
| 034 | Water Main | Labieux PS to Rod Glenn Reservoir | m | 4000 | 925 | 3.70 | | | | | 0.00 | 3.70 | Assumes that rehabilitation is not required until after 2025. |
| 035 | Water Main | Labieux PS to Departure Bay Rd. | m | 900 | 1400 | 1.26 | | 1.26 | | | 1.26 | | Replace with 600 mm |
| 036 | Rod Glenn Reservoir | | LS | | | 0.25 | 0.05 | | | 0.20 | 0.25 | | Internal and external rehabilitation |
| 037 | Rod Glenn Pump Station | | LS | | | 0.15 | | | | 0.15 | 0.15 | | Major maintenance |
| 038 | Water Main | Rod Glenn Reservoir to Tanya Drive Reservoir | m | 2500 | 400 | 1.00 | | | | | 0.00 | 1.00 | Assumes replacement with a 300 mm main after 2025. |
| 039 | Water Main | Departure Bay Road to Lost Lake Reservoir | m | 2600 | 600 | 1.56 | | | | | 0.00 | 1.56 | Assumes that rehabilitation is not required until after 2025. |
| 040 | Lost Lake Reservoir | | LS | | | 0.50 | | | 0.50 | | 0.50 | | Internal and external rehabilitation |
| 041 | Lost Lake Pump Station | | LS | | | 0.15 | | | | | 0.00 | 0.15 | Major maintenance |
| 042 | Water Main | Lost Lake Reservoir to Tanya Drive Reservoir | m | 1240 | 1400 | 1.74 | | | | | 0.00 | 1.74 | Assumes that rehabilitation is not required until after 2025. |
| 043 | Tanya Drive Reservoir | | LS | | | 0.50 | | | | | 0.00 | 0.50 | Internal and external rehabilitation |
| | Randerson Road Reservoir | Future | LS | | | 7.50 | 1.00 | | 0.4 | 6.10 | 7.50 | | TWL 170 m. Volume 9.23 ML. |
| | Water Main | Rock City to Turner Road | m | 4500 | 1200 | 5.40 | | | | 5.40 | 5.40 | | |
| | Miscellaneous | | | | | 0.40 | 0.10 | 0.10 | 0.10 | 0.10 | 0.40 | | Miscellaneous repair |
| | **subtotal** | | | | | | **12.35** | **12.86** | **2.35** | **35.27** | **62.83** | | |
| | **BUDGET** | | | | | 266.84 | 25.80 | 59.01 | 64.90 | 47.77 | 197.48 | 69.36 | |