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1.0 Project Introduction

1.1 Background

The last update of the Water Distribution System Master Plan was prepared in 1995. Since then the City of Grande Prairie has experienced tremendous growth. An update of the master plan is warranted for the determination of upgrading requirements to accommodate future growth in the City. In addition, other communities in the vicinity of the City are interested in obtaining potable water from the City to improve their quality and supply and hence their ability to support either immediate or future developments. For these reasons, Aquatera Utilities Inc. commissioned Infrastructure Systems Ltd. to prepare an update of the 1995 Water Distribution System Master Plan. The new master plan will become a planning tool for Aquatera for the evaluation of servicing requirements for future developments and upgrading of the existing water distribution system to meet current servicing requirements.

1.2 Objective

The purpose of this study is to develop a Master Plan that outlines improvements for the deficiencies in the existing water distribution system and upgrading requirements to accommodate future developments as well as the development of a regional system.

1.3 Scope of Work

The scope of work for this assignment is described as follows:

- Update the existing water system model including model calibration
- Determine deficiencies in the existing system and improvement requirements
- Use water system model and projected future growth to determine system upgrading and expansion requirements
- Incorporate recent and proposed system acquisitions into the master plan including the Airport, Brochu Industrial, Clairmont and Sexsmith
- Estimate timing and costs for upgrading and expansion of the water system
- Review design guidelines for the water distribution system

- Recommend funding mechanisms for upgrading and expansion of the water distribution system
- Develop 5 year and 10 year capital plans
- Develop a financial plan to fund capital infrastructure, including benefiting area calculations for cost recovery
- Provide training to Aquatera staff on the operation of the water distribution system model
- Review best management practices for maintaining asset value of the existing infrastructure
- Investigate and recommend fire flow policy
- Conduct public consultations
- Prepare draft and final reports

2.0 Literature Review

One of the tasks of the water Master Plan is to perform a review of the available reports pertaining to the City of Grande Prairie's water distribution system and consider relevant issues in the Master Plan. A summary of the review is provided in the following sections.

2.1 Water Distribution Master Plan, ISL 1995

A model was developed using the Waterwork software for the water distribution system. The report identified deficiency in the existing water distribution system and servicing needs for future developments. Some of the findings of the report are listed below:

- High rate of growth is expected for Grande Prairie
- The Hillside, northeast city centre and college park may not have adequate fire flow if the area is to be redeveloped as R3 (multi family) land use.
- Fire flow is below recommended standards in:
  - Richmond Industrial Park
  - Commercial/Industrial area on 100 Street north of 116 avenue
  - Resources Industrial Park
  - East side of Ivy Lake Estates
- The water treatment facility can accommodate a population of 39,000.
- Reservoirs and water towers have adequate storage for 80,000 population
- The water consumption can be reduced by carrying out a water conservation program

2.2 Water Treatment Process Optimization Study - Associated Engineering

This report investigated the optimization method for the current water treatment process. Some of the key findings in the report are:

- WTP is adequate to supply water to 38,000 people

- The City of Grande Prairie should become the regional supplier of water to surrounding communities
- The WTP has an effective treatment process capacity of 20 ml/d
- The WTP has been running at a peak of 23ml/d
- Immediate process upgrades are necessary to maximize treated water quality so that major upgrades could be delayed.
- Raw water diversion is reaching its licensed quantity. AGUU minimum stream flow requirements during diversion may prohibit any excess diversion in winter months.
- Design criteria

	AE
Design Criteria – L/Cap/day	406
Peak Day Factor	1.5
Peak Hour Factor	3.0
WTP plant losses percentage	8%
Peak plant losses percentage	5%
Hours of operation per day	23
Fire flow (L/s)	265
Fire flow duration (hr.)	3.5

- Raw water use 0.2% annual average river flow, 1.0% of average flow in February and 5% of lowest river flow ever recorded 1961
- Approximately 90% of directed water is returned in the form of treated effluent.
- If the in stream flow guidelines are to be enforced, the construction of a 9 month storage reservoir will be required. The size pf the reservoir will be about twice the capacity of the existing ponds.
- Storage facility is only necessary if AGNU enforces minimum flow requirements.
- The addition of 3 new filters will be required to increase process capacity.
- The residence time of water in the distribution network shall be determined to identify the bottlenecks for chlorine decay.

2.3 Zone II Water Distribution System Evaluation Report –Bel MK Engineering

BelMK completed a review of the existing Zone 2 water distribution system and modeled the system using Waterworks software for Excel. It is found that due to the large elevation difference within the zone, unacceptably high and low pressures existed in the water distribution system. Some of the Key findings are shown as follows:

- It is difficult and costly to provide a fire flow of 225 L/s in the entire Zone 2 area.
- Most of the Commercial/Industrial areas have lower than recommended fire flow capabilities
- Crystal Ridge has a fire flow of only 70 L/s opposed to the recommended 95 L/s
- Most of the residential areas do meet the 95 L/s fire flow requirement
- Full development of the existing City boundaries plus expansion areas will require a new reservoir and pumphouse in the north expansion area

Based on these findings various alternatives were created and modeled in order to determine possible short term solutions as well as to provide long term plans for the upgrading of the water distribution system. The recommended actions were:

- Exercise extreme caution with reviewing/approving developments that propose 150mm diameter water mains
- Ensure that all new developments correlate with the design information provided in this study to ensure adequate fire flows
- Enact a system to notify developers of existing areas within Zone 2 that have sub-standard fire flows.
- Continually update the model as new information is available and/or system modifications occur.

2.4 Pre Design Report for Zone 3 Reservoir and Pump house GPEC

The report identified many locations having very high and very low pressures in Zone 2. To rectify this problem, the report recommended to divide a portion of Zone 2 area to create a new Zone 3. The existing boundary between Zone 1 and 2 will remain. Some key technical information on the operation of the existing zones are described as follows:

- The pressure in Zone 1 is controlled by monitoring the elevation of the water in the two existing water towers located at 113 Avenue and 94 Street at an elevation of 682. Pumps at the Zone 1 pumphouse at the south end of the City are turned on, as the water level in the towers falls and turned off as the water rises. Water is fed into the system from the Zone 1 pumphouse and reservoir.

- Zone 2 reservoir is fed from the Zone 1 distribution system through a partially dedicated 400mm supply main. The Zone 2 reservoir and pumphouse is located adjacent to the Zone 1 towers, but is isolated from Zone 1
- Zone 2 has wide variances in static pressure due to elevation differences
- The zones were divided with the following design criteria in mind
- Maximum pressure – 100 psi – 690 kpa
- Minimum pressure - 40 psi – 289kpa
- Elevation of existing zone 2 varies from 665 to 692
- The size of the existing Zone 2 reservoir at 113 Avenue is 9090m$^{3.}$ Existing pump elevations are 687m.
- Primary objective is to ensure fire flows are adequate
- The required reservoir sizes for the combined Zone 2 and Zone 3 are as follows
- Existing development – 4448 m^3
- Full development within City 7034 m^3
- Full development plus County developments – 12,552 m^3
- The Existing pumps in the Zone 2 Pumphouse are as follows:
- Two Distribution Pumps: each has a capacity of 75 L/s
- One Distribution Pump with a capacity of 50 L/s
- One Standby pump with a capacity of 375 L/s
- Two 2.2 KW VT pumps at 310 kPa to 380 kPa

2.5 West End Water Supply Solutions, EXH, 2002

This report recommended that the existing airport reservoir and pumphouse be used to provide water to Brochu subdivision during periods of high flow. The upgrades consist of the construction of a 2.5ml reservoir at the airport and 300 mm watermains to fill the reservoir from the City water distribution system during off peak period. The fire flow for the determination of the capacity of the reservoir is 225 L/s for a period of 3 hours.

The airport reservoir is currently fed by a well and has a capacity of 1.0 ML. This well has a projected fill rate of 13m^3/day but the well water does not conform with the Canadian drinking water quality standards. Therefore it is not suitable to be used for potable water.

The report stated that the current estimated average day demand (ADD) is 15.9m3/day and there was approximately 95 hectares of development remaining to be developed in the vicinity of the Airport.

Existing pumps at the Airport Pumphouse consist of:

- Two fire pumps – both 76 L/s at 92 psi (635 kPa)
- Fire pump starts at 240 kPa and shuts of at 100 psi
- Second Fire pump starts at 205kPa

2.6 List of Other References

Utilities Corporation Review Update December 2002

Aquatera Utilities Inc. 2003/2004 Business Plans/Capital & Operating Budgets

Water Distribution Master Plan, 1995

Annexation Servicing Assessment

Zone 2 Water Distribution Evaluation

Water Supply Options to Recently Annexed Western Areas

AEP Standards and Guidelines

West End Water Supply Solutions

County, City, Sexsmith Regional Water and Wastewater Systems

Recommendations Regarding Fire Flows

Letter of Intent – Town of Sexsmith

Letter of Intent – County of GP

Annexation Agreement

Intermunicipal Development Plan

Clairmont Servicing and Planning Area Study

Weyerhauser Canada Proposed Potable Water Supply Main Review and Evaluation – Gpec 2000

City of GP Water Model (2001, 1 CD)

Zone 3 Reservoir and Pump-house As-build Drawings

Zone 3) & M Manual (photocopies as required, by ISL)

Airport Reservoir and Pump-house Drawings

Airport Pump Specifications, Well Tests & Water Quality Reports

Web based Information (www.cityofgp.com)

Design Manual

Construction Manual

Utility ‘Bylaw (current)

Information Sent by E-mail

AEP Reports for 1997 through to 2003

3.0 Proposed Design Criteria

3.1 Introduction

Design criteria are critical for the assessment of existing and future water distribution systems. In order to determine the current water demand and peaking factors, we have assessed the water billing records for various types of land use, SCADA system records at the water treatment plant and water treatment plant effluent records. A comparison of current water demand design criteria of other communities was also made in the development of the water distribution system design criteria. Water consumption design criteria for the City of Grande Prairie and other municipalities are shown on Table 3.1.1.

3.2 Residential Water Demand

3.2.1 Current Residential Water Demand

Residential water demand was determined by using water billing records for four summer months and two winter months in 2001 and 2002. The billing records for all types of residential dwellings were extracted and totalled as shown on Table 3.2.1.1. Since water usage in the summer months are generally higher and the winter months are generally lower, a factor is used to modify the per capita water demand. The factor is the quotient of the monthly average of the summer month water demand and the monthly average of the twelve months effluent records of the water treatment plant. The highest calculated per capita water demand derived from the billing records is 246 litres per day.

TABLE 3.2.1.1

EXISTING WATER DEMAND

	2001 Population = 36983		2002 Population = 38277	
	Summer	Winter	Summer	Winter
Total Water Consumption (L/day)	9,402,789	8,289,404	10,329,711	8,738,419
Per Capita Per day Consumption (L/day)	254.2	224.1	269.9	228.3
Monthly Demand Derived from WTP Records (ML)	429.6	2001/2002 438.4	447.2	447.2
Monthly Demand Derived from Monthly Billing Records (ML)	461.0	420.6	490.78	430.0
Correction Factor	1.073	0.959	1.097	0.962
Adjusted Per Capita Per Day Demand (L)	236.9	233.6	246.0	237.4

3.2.2 Unaccounted for Water

Unaccounted for water is defined as the water, which is used for public uses (hydrant flushing and street cleaning) and leakage from pipes within the distribution system. The amount of water obtained from billing records for each month and the amount of water treatment plant effluent for the same months was used for the assessment of the amount of unaccounted for water.

TABLE 3.2.2.1

UNACCOUNTED FOR WATER

	May 2001 to August 2001	December 2001 to January 2002	May 2002 to August 2002	December 2002 to January 2003
Billing Records (cu.m)	1,797,335	810,099	1,890,874	830,783
WTP Effluent (cu.m.)	1,844,020	841,173	1,961,913	860,090
Unaccounted for Water (cu.m.)	46,685	31,074	71,039	29,307
Percentage	2.6	3.8	3.8	3.5

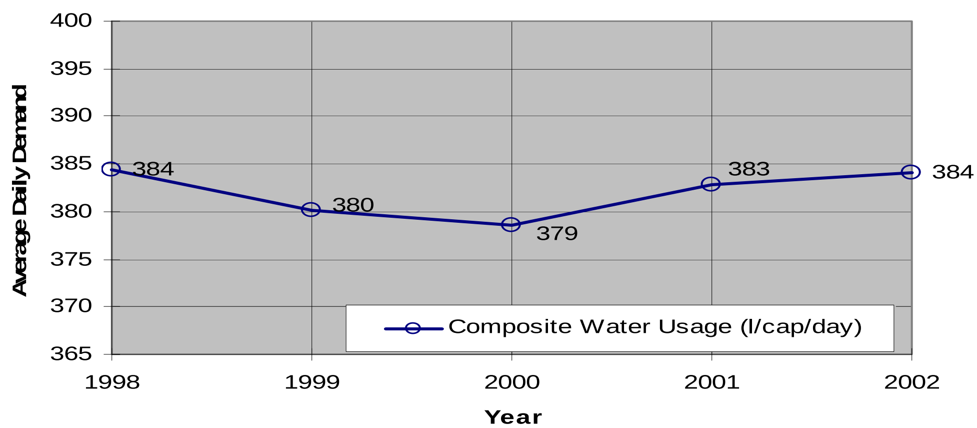
The average percentage for the unaccounted for water is approximately 3.4% of the water demand determined from water billing records.

Generally the unaccounted for water ranges from 10% to 15% of the water demand. Because the analysis was not based on year round records, a 10% rather than 3.4% of unaccounted for water is recommended for the City of Grande Prairie.

3.2.3 Proposed Residential Water Demand

The historical average daily per capita composite water demands for the City of Grande Prairie since 1998 are shown on Figure 3.2.3.1. As depicted in Figure 3.2.3.1, the variation of the average composite water demands from 1998 to 2002 is insignificant.

Figure 2.3.1 - Historical Water Consumption



The current per capita per day water demand for residential developments as stated in Section 3.2.1 is 246 litres. This amount is about 13 litre higher then the wastewater flow determined from flow monitoring records. With the addition of a 10% demand for the unaccounted for water, the water demand per capita per day would be 271 litres. Since the calculated water demand is less than the current design criteria, it is recommended that the current design criteria of 275 litres be used.

3.3 Commercial Water Demand

3.3.1 Current Commercial Water Demand

In accordance with the billing records of 25 commercial establishments, the average water demand per establishment was approximately 3000 L. The average lot size of the 25 commercial establishments is approximately 0.60 ha and therefore, the average water demand for each establishment would be approximately 5,000 l/ha. Since a commercial establishment will operate on the average, 10 hours a day, the equivalent daily (24 hours) water demand would be 12,000 L/ha. With the addition of a 10% for unaccounted for water, the current daily water demand would be 13,200 L/ha.

3.3.2 Proposed Commercial Water Demand

In Table 3.1.1, there are four municipalities which have specified the water demand for commercial developments ranging from 12,950 L/ha/day to 26,000 L/ha/day. The current water demand for the City of Grande is at the low end of the range.

Because highway commercial would generally has a higher water demand than general commercial, different water demand standards should be assigned for these commercial land use. Since flow monitoring records are not available for both types of commercial land use, a review of wastewater flow for commercial land use from municipalities was conducted in order to establish the water demand for the City. The review revealed that wastewater flow ranges from 17,280 L/ha/day to 26,000 L/ha/day. Since the wastewater flow is more or less equivalent to the water demand, the following design criteria are recommended.

- Highway commercial developments-26,000 L /ha/day
- General commercial development-20,000 L/ha/day

3.4 Industrial Water Demand

3.4.1 Current Industrial Water Demand

In the billing records, only 10 users were listed as industrial users, and some were listed under the Commercial Property code. These industrial users are located along 108th Street between 92 and 94 Avenue. Based on the water billing records, the average daily water demand was 1600 L per user for a daily operation time assumed to be 12 hours. The average industrial lot size based on a sampling of 20 industrial lots was 4000 m^2. The average daily water demand and the equivalent daily (24 hours) water demand is therefore, 4,000 L/ha/12 hours and 8,000L/ha/day respectively. The water demand including a 10% unaccounted for water would be 8,800 L/ha/day.

3.4.2 Proposed Industrial Water Demand

The calculated industrial water demand is slightly less than the current City of Grande Prairie industrial land use water demand standards of 10,000 L/ha/day. It is recommended that the current standard be used.

Since the City of Grande Prairie has a wastewater flow standard for heavy industrial land use and the water demand is approximately the same as the wastewater flow, it is recommended that a water demand standard for heavy industrial land use be added. The recommended standard is 20,000L/ha/day that is equivalent to the wastewater flow for the heavy industrial land use.

3.5 Institutional Water Demand

3.5.1 Current Institutional Water Demand

Billing records were assessed for the determination of the water demand for institutional developments including hospitals and schools. There is only one major hospital in the City of Grande Prairie and in accordance with the billing records, the average water demand for the hospital is 72,250 L/ha/day. For schools, the billing records indicated that the average water demand is much lower at an average of 13,000 L/ha/day. Unfortunately, flow monitoring records are not available to conduct a comparison with the wastewater flow from these establishments.

3.5.2 Proposed Institutional Water Demand

As shown on Table 3.1.1, out of 13 municipalities, only the City of Grande Prairie specifies the water demand standard for institutional developments. Based on the current water demand, the following standards are recommended.

- School: 20,000 L/ha/day.

A higher water demand is recommended because a school is usually also classified as an emergency shelter.

- Hospital: 30,000 L/ha/day

The water demand standard is identical to the current standard. The water demand for the hospital should be treated on an individual basis and calculated based on number of beds as per Alberta Environment guidelines.

3.6. Peaking Factors

3.6.1 Current Peaking Factor

Daily and hourly water demand/consumption records for each type of land use are not available for the determination of the maximum day and peak hour factors. In order to get some indication of an approximate maximum day and peak hour factor, the water treatment plant daily consumption and SCADA records were used. All treatment plant records are composite consumption records that consist of water consumption of all types of land use.

The maximum day peaking factor was determined using the daily water treatment plant records as shown Table 3.6.1.1

TABLE 3.6.1.1

EXISTING MAXIMUM DAY PEAKING FACTOR

Year	Average Daily Demand ML/day	Maximum Recorded Daily Demand ML/day	Factor
1998	12.9	19.0	1.5
1999	13.2	20.1	1.5
2000	13.6	21.2	1.6
2001	14.2	21.4	1.5
2002	14.7	22.2	1.5

The peak hour factor was determined on the basis of 7 days continuous SCADA information from the first week of June 2003. The SCADA information shows that the peak flow rate was approximately 33.5 ML/day. Based on the previous 5 years of data, the projected average day demand for 2003 would be 15.1ML. This gives a Peak Hour factor of 2.2. To more accurately determine a peak hour factor, the SCADA information should be monitored in summer months over some of the warmest days of the year.

3.6.2 Proposed Peaking Factors

As discussed in Section 3.6.1, the composite maximum day and peak hour factor is approximately 1.5 and 2.2 respectively. Since sufficient data is not available, these factors will be determined through literature review and comparison of design standards with other municipalities.

As shown on Table 3.1.1, the maximum day factor for residential development for other municipalities ranges from 1.8 to 2.1 and the peak hour factor ranges from 3.0 to 4.0. The Lecture Notes for the Sewer and Watermain Design Course prepared by the Ministry of Environment of Ontario, recommended that for a community with a population of 25,001 to 50,000, the maximum day factor and the peak hour factor for residential developments is 1.8 and 2.7 respectively. It is recommended that the current maximum day and peak hour factors of the City of Grande Prairie be retained.

On Table 3.1.1, only the City of Grande Prairie and Red Deer have specified a maximum day and peaking factor for non-residential development. In the Lecture Notes for the Sewer and watermain Design Course prepared by the Ministry of Environment of Ontario, it is recommended that for commercial and industrial developments, the maximum day factor ranges from 1.3 to 1.6 and the peak hour factor varies from 1.5 to 2.0. The value of these factors is within the current maximum day and peaking factor of the City. It is therefore recommended that the current City of Grande Prairie standards be retained.

The maximum day and peak hour factors for residential and non-residential developments are shown on Table 3.6.2.1.

TABLE 3.6.2.1
PROPOSED PEAKING FACTORS

DEVELOPMENT	MAXIMUM DAY FACTOR	PEAK HOUR FACTOR
RESIDENTIAL	2.0	3.0
COMMERCIAL/INDUSTRIAL	1.5	2.0

3.7. Fire Flow

The method for the determination of fire flow as stated in the Water Supply for Public Fire Protection prepared by Fire Underwriters Survey has been used by municipalities in Alberta and throughout Canada for many years. The City of Grande Prairie should use this method as a standard for the determination of fire flow for the City.

The City of Grande Prairie Land Use Bylaw C-1100 has been reviewed to identify the maximum allowable building area for various types of land use. Recognized formula, which includes building area, was used for the assessment of fire flow requirements for land uses having specified floor areas. It was found that the current City of Grande Prairie fire flow standards for various land use are adequate. However, the City of Grande Prairie does not specify a fire flow for institutional land use (school and hospital). It is recommended that a fire flow of 250 litre per second be specified for institutional land use.

Since floor areas for commercial, industrial and institutional developments vary substantially, the fire flow requirements for these developments should be assessed on an individual basis. If the fire flow requirement exceeds the stated standards, a sprinkler system or on-site storage or other methods could be implemented so that the required fire flow could be reduced.

4.0 Computer Model Softwares Selection

4.1 Introduction

There are a number of software available for the assessment of a water distribution system. In order to select the most appropriate model for Aquatera, an investigation and assessment on the available models was carried out. The results of the investigation and assessment are presented in the following sections.

4.2 Selection Process

The selection process includes two steps. Initially a literature research was conducted to determine modeling softwares that would be most suitable for the need of the City of Grande Prairie water distribution system. Once this was accomplished, evaluations were carried out on all selected softwares based on the following criteria.

- ease of use
- model capabilities
- results produced
- access to results
- visual aids
- cost
- ease of updating.

4.3 Models Evaluated

The review of softwares available in the market identified that the following softwares would be suitable for the City of Grande Prairie water distribution system.

- WaterCAD
- H2ONET, H2OMAP
- SynerGEE
- WaterWorks

Other models such as EPANET and MikeNET, were considered but not chosen for further evaluation for the following reasons:

- EPANET has inferior graphical capabilities and poor user interface.
- MikeNET is a very new piece of software developed abroad that has few users in Canada.

4.4 Model Assessment

The highlight of the models is summarized in the following sections. The web based information for these models are shown in Appendix A.

4.4.1 Haestad WaterCAD

WaterCAD is a stand alone modeling program with its own graphical editor and strong modeling capabilities that feature a Windows-based user interface. WaterCAD allows dxf background maps from AutoCAD to underlay the drawing and assist in the production of a water system network graphically. As well, the finished water model can be exported to a dxf and inserted into AutoCAD or AutoCAD Map for the City's GIS system.

For data input and output, WaterCAD uses pop-up tables that are contained directly within the modeling environment, as opposed to a text-editing program. Data for populating the model with can be written to and output can be written from these tables using the database connectivity feature of WaterCAD. WaterCAD also has the ability to connect with Environmental Systems Research Institute, Inc.'s (ESRI's), GIS programs using the SHAPEFILE for model data import and export.

Haestad provides excellent support and has training courses in eastern and western Canada usually a few times a year. They have also started on-line training where the attendees can interact with the instructor and receive live visual and audio feedback. The fee for online training is $195 per hour and can be customized to meet the users needs. Through Haestad's web site the user can download free interactive tutorials to help learn the program quickly and easily.

Haestad has also developed WaterCAD for AutoCAD, previously known as CyberNET, which is integrated in the AutoCAD environment. This version is marketed with users of AutoCAD in mind and takes advantage of the advanced AutoCAD graphical environment for the creation of the model. The additional cost for a 1000 pipe version is $4,350 above the cost of the stand alone WaterCAD. This price does not include the AutoCAD

2002 or 2004 license. With the advancement of the graphical capabilities of the WaterCAD stand alone version, it is our recommendation against this higher priced version.

The cost of WaterCAD for a 1000 pipe license is $7,250 and the “clientcare” program which includes software support and upgrades costs between $1,750 and $2,000 per year depending on the level of support chosen. Haestad frequently updates their product so the clientcare is a way to keep the software current and up to date.

4.4.2 H2ONET / H2OMAP

These programs were developed by MWHSoft which is a subsidiary of the global environmental engineering, design, construction, technology, and investment firm MWH Global, Inc. MWH Soft was founded in 1996 and is based in Broomfield, Colorado. It has an extensive client list including a number of large cities in Ontario and British Columbia, but appears to have the majority of its clients in U.S.

Training for H2ONET and H2OMAP is available at the MWH headquarters in Pasadena, California. They currently do not put on courses in other locations.

H2ONET uses the AutoCAD 2002 environment to create network model drawings with all the capabilities of AutoCAD; however, H2ONET requires AutoCAD 2002 or 2004 and cannot operate as a stand-alone program. H2OMAP is a very similar program but is stand-alone and has a built in GIS platform. The cost of both versions is the same. For a 1000 link version the base price would be $5,800 with an additional $1,450 per 1000 links up to $23,200 for an unlimited number of nodes. The cost of the AutoCAD license for H2ONET would be above and beyond this cost. MWH Soft also charges a $1,200 - $1,500/year support and maintenance fee after the first year. There are also add on modules to each software which are marketed as H2ONET Suite and H2OMap Suite. The other programs include programs such as a calibrator, skeletonizer, and water quality calibrator, many of which are included in other software packages. The suite version of the software can be purchased for an additional $2,900.

4.4.3 SynerGEE

SynerGEE was originally developed by Stoner Associates which has now become part of Advantica. SynerGEE is a fairly recent addition to the stoner group of software. SynerGee operates in a windows environment and has a stand alone graphical interface. The program requires Microsoft Access to take advantage of the database integration capabilities. The modeling method of SynerGEE is ideal for very complex systems in excess of 100,000 pipes. However, the program has a number of advanced modules which make it a good choice for smaller systems as well.

During the preparation of this technical memorandum, pricing information on this product was not available from Stoner Advantica. From other sources investigated, SynerGEE does not use a staged pricing structure. One license has an unlimited number of pipes and nodes and runs at approx. $20,000 plus the annual maintenance and support fee of approx $2,600. The accuracy of these prices is yet to be confirmed.

4.4.4 Water Works

Waterworks is the software that was used for the City current model. The rights to the software have been bought by an Australian firm and currently are marketed by them. The software has not been updated since 1997 and it is likely there would be no support for any problems encountered. The software does not do fire flow analyses and the AutoCAD interface may still be for AutoCAD 14. The cost of the software for a 1000 pipe version is less than the other programs at $3,070.

The software does not share many of the advance features of the other software presented but does adequately model smaller systems.

4.4.5 Assessment Results

All software presented above are very similar in their ability to calculate system pressures and flows. Therefore it is challenging to evaluate the software on the methodology it uses or the accuracy of the model. The following are a number of criteria used in the selection of software.

- Ease of Use
- Software support

- Compatibility with the City's GIS System
- Purchase Price
- Graphical Capabilities

The rating of the each software, based on the stated criteria, are tabulated below. A rating of 1 is least favorable and a rating of 5 being most favorable.

	WaterCAD	H_2ONET/MAP	SynerGEE	WaterWorks
Ease of Use	4	4	4	3
Software support	5	4	4	1
Compatibility with the City's GIS System	4	5	3	1
Purchase Price	4	4*	3	5
Graphical Capabilities	5	5	5	2
Total	**22**	**22**	**19**	**12**

* H_2ONET requires an AutoCAD 2002 or 2004 License

As shown in Section 4.4.5, both the WaterCAD and H2OMAP software have the same rating. However, WaterCAD is recommended for the following reasons:

- Better support and training program
- Training available in Canada
- Extensive use in many Canadian cities and Municipalities
- A proven track record and long history of dependable software products

5.0 Population and Land Use Projection

5.1 Existing Land Use

The City has a total land base of approximately 6,140 ha within its current limits, of which approximately 3,100 ha (50.5%) is developed. This includes the airport, landfill and sewage treatment plant, all of which were annexed into the City in 2001.

As indicated in Figure 5.1, the majority of the City's residential development is located in the central, northeast, and southerly areas of the City. New residential development is occurring in all directions, however, most recently in the northwest, southwest and southeast quadrants.

Commercial development is concentrated in the downtown area, along 100 Street to the north City limits, at Gateway, and along the Highway 43 Bypass. Future commercial development is expected to continue to occur in these areas, with additional arterial commercial development occurring on the City's west end.

Current industrial development is concentrated on the west side of the City in the Richmond Industrial Park, with smaller pockets located on the east side near the rail yards and in the City's north end. Future industrial development is expected to continue towards the west in proximity to the airport, along the east side of the rail line, and in newly annexed lands to the north of 132nd Avenue.

Figure 5.1 also shows the locations of the various area structure plans that are in effect in the City's expansion areas.

5.2 Population Projections Rationale

The growth projection rationale is described as follows.

According to the 2003 Municipal Census, the population of the City of Grande Prairie is 40,226. Over the past ten years, the City has experienced an average growth rate of approximately 3.5% annually.

Based on this past trend, it is assumed that the City's population growth rate will be sustained for the next two years, and then moderate to 2.5% per year thereafter.

Since the City's population growth for the last ten years has an averaged 3.5%per year, it is assumed that this rate will continue for the next three years, but moderate to 2.5% from 2007 through 2013.

The ultimate City population is estimated to be 94,600 based on all approved and pending Area Structure Plans. The last annexation study and the Transportation Master Plan estimated the figure to be 75,000. The main reason for the discrepancy is the recent trend toward higher densities, smaller lot sizes, and generally more compact urban form.

Commercial and industrial growth is indexed to population. At present, commercial development in the City is 5ha/1,000 population. This ratio has been maintained for the three horizons (5 year/10 year/ultimate). The actual figure for the ultimate is 4.6 ha/1,000 population, based on land use allocations in all ASPs. Industrial development is approximately 11 ha/1,000 population for all horizons.

5.4 Population Projection

The population projection on an area and zone basis is shown on the Population Table in Appendix B. The location of the areas and zones are shown on Figures 5.4.1 and 5.4.2 respectively.

5.5 Commercial and Industrial Growth projection

The commercial and industrial growth projection is shown in the Commercial and Industrial Table in Appendix B. The location areas and zones are shown on Figure 5.5.1 and 5.4.2 respectively.

6.0 Water Model Development

6.1 Existing Water Distribution System

The existing water distribution system has three pressure zones. Figure 6.1 identifies the zone boundaries.

- Zone 1 is serviced by the main pumphouse and water treatment plant, and is the largest among the three zones.

- Zone 2 is serviced by an underground reservoir and pumphouse situated east of 94th street on 113 Avenue. The reservoir is fed by the water towers.

- Zone 3 was required because both significantly high and low pressures exist within Zone 2. Zone 3 is fed from a reservoir and pumphouse at 97B street and 132nd Avenue. The feed line is connected to the existing 150mm and 200mm distribution network of Zone 2 and has a limited capacity. Zone 3 was created by closing approximately 10 key valves to separate it from Zone 2. The SCADA information we have received from the City shows that between 10:00 pm and 7:00 am Zone 3 distribution pumps are not running, but the system pressures go up to Zone 2 levels. This is likely caused by a valve between Zone 2 and 3 is left open or partially open. Because of this connection the pressure will be lower than predicted system pressures in Zone 2 near the connection and higher than predicted pressures in Zone 3, as Zone 3 operates at lower pressures than Zone 2.

6.2 Development of Model for the Existing Water Distribution System

The previous water distribution model for the City of Grande Prairie was developed using the Waterwork software. The software runs within AutoCAD and all information regarding the water distribution system is stored in blocks in the model.

WaterCAD version 6.5 was chosen for the development of the water distribution system for this assignment. Node elevations, pipe size, length and roughness coefficients were extracted from the previous model and imported into the new model. Prior to importing the data into the model, a cursory review of the data was carried out using the 2003 City of Grande Prairie Base information.

The new model also included many new pipes. The pipe size and length of these pipes were extracted from the City of Grande Prairie GIS base information. The elevation for new nodes was obtained from the City of Grande Prairie 0.5 metre contour plan.

In the development of the model, a skeleton approach was taken to minimize the complexity and number of pipes in the model. However, the skeleton model will still accurately represent the existing water distribution system.

The new model has a total of 1295 pipes which has 631 pipes more than the previous model Figure 6.2 identifies pipes included in the existing system model.

With respect to the water demand at each node, a water demand spreadsheet was created based on the current water demands discussed in Chapter 3. The area within the existing City boundary was divided into more than 400 catchment areas. These areas were then divided into residential, industrial, and commercial areas. The area for various land use and the corresponding water demand were then used to determine the total water demand for each catchment area. The total water demands were then loaded into the WaterCAD software to carry out a system analysis.

6.3 Model Calibration

Twelve fire flow tests (four per zone) provided by Aquatera were used to calibrate the model. After a careful review, three of the tests were not used because they were carried out before Zone 2 was divided into two zones. The remaining tests are shown on Table 6.1 below.

Table 6.3.1
Fire Flow Tests

Test #	Date	Zone	Residual Hydrant #	Flow Hydrant Node #	Q Measured	Q Modeled	Measured /Modeled	Residual Hydrant: Test Static Pressure [psi]	Modeled Static Pressure [psi]	Static/ Modeled
1	18-Dec-02	Zone 3	J-1596	J-1518	273	276	99%	47	48.7	97%
3	2-Jun-03	Zone 3	J-1096	J-1520	167	176	95%	65	64.5	101%
4	20-Nov-02	Zone 3	J-1523	J-1525	154	112	138%	85	86.3	98%
4a	6-Jun-03	Zone 2	J-1581	J-1580	122	111	110%	80	85	94%
4b	6-Jun-03	Zone 2	J-1581	J-1579	132	118	112%	80	89	90%
5	20-Sep-02	Zone 2		J-1555	158	158	100%	68	73.7	92%
6	20-Sep-02	Zone 2		J-1566	194	190	102%	71	74.2	96%
6a	6-Jun-03	Zone 1	J-1137	J-1136	102	104	98%	44	45.6	96%
9	11-Jul-02	Zone 1		J-1588	208	213	98%	88	89	99%
10	3-Sep-02	Zone 1		J-1590	199	192	104%	70	68.9	102%

With the exception of Test #4, all hydrant flows and pressures matches very well with those modeled. One explanation for test #4 having a higher flow rate than modeled would be that a valve is open between Zone 2 and 3 in the area.

The Hazen-William roughness coefficients of the existing pipes were modified slightly to achieve a better calibration. The roughness coefficients of the existing model and those used in the new model are calibrated as follows:

	Previous Values	New Values
Pipes installed earlier than 1960 (100 and 250 mm)	100	100
Pipes installed between 1961 and 1975 (150 to 250mm)	110	110
Pipes Installed between 1961 and 1975 (>250 mm)	120	120
Pipes Installed after 1975 with C=110 (previous value)	110	120
Pipes Installed after 1975 with C=120 (previous value)	120	130

The roughness coefficients are subject to adjustment because the internal roughness of pipes will vary with age and historic water chemistry. Cast iron and steel pipes corrode or develop scale deposits increasing the friction factor, and, in extreme cases, dramatically decreasing the internal diameter. Asbestos cement and hyprescon pipe may experience either an increase or decrease in internal roughness with time. Depending on water chemistry, the resulting scaling can cause the internal surface to be smoother or rougher than the original pipe.

6.4 Model Enhancements

The model developed can be enhanced by carrying out the following tasks:

- Carry out field tests to determine the roughness coefficients for various pipe materials
- Validate the pipe size and node elevation in the database.

7.0 Existing Water System Assessment and Upgrading

7.1 Assessment Criteria

The two main criteria used to analyse the existing system were:

- The system must be able to provide a system pressure of at least 275 kPa (40 psi) to all areas during peak hour demand (PHD).

- The system must be able to provide a fire flow corresponding to the requirements of various type of land use, with a minimum system pressure of 140 kPa (20.3 psi) during maximum day demand (MDD).

The following sections discuss the deficiencies and required upgrades to bring the existing system up to current design standards.

7.2 Zone 1

7.2.1 West Industrial Area

The industrial - commercial area just south of 100th Avenue as shown on Figure 7.2.1.1, has a number of areas that cannot provide the required 225 L/s fire flow. The deficiency is mainly caused by an undersized distribution system consisting mainly of 150mm diameter mains.

In order to achieve the required fire flows, many of the existing 150mm watermains will need to be upgraded. Upgrades in the area will include upgrading 1110 m of existing 150mm distribution mains to 250mm, installation of 75 m of new 250mm watermain and 640 m of new 300mm main as shown on Figure 7.2.1.2.

Another possible upgrade is to connect the airport pumphouse and reservoir to the existing Zone 1 distribution system. This upgrade would require approximately 2600 m of 300 mm diameter watermain and upgrading of the Reservoir and pumphouse. This upgrade to the Airport system would remove the need to upgrade the 150 mm waterlines, but the new 250 and 300 mm watermains would still be required. This improvement to the airport has many other benefits such as expanding the service area and providing safe drinking water to the airport. Various upgrade options have been investigated.

The upgrading requirements for future development areas are discussed in Section 8.0.

7.2.2 96 Avenue between 106 and 104 Street

This area is zoned IG and has a required fire flow of 225 L/s. This area currently has inadequate fire flow. Upgrading 540m of existing 150mm watermain to 250mm, as shown on Figure 7.2.2, will correct the problems in this area.

7.2.3 Schools at: 91A Avenue and 96A Street
88 Avenue and 97 Street

The modeled fire flow available at the existing school at 91A Avenue is between 73.8 L/s and 90.7 L/s which is much less than the required fire flow of 250 L/s. The required upgrade would be the construction of 120 m of 250 mm watermain as shown on Figure 7.2.3.

The existing school at 88 Avenue is moderately deficient in the required fire flow because the modeled fire flow available at this location is between 150 L/s and 200 L/s. To increase the fire flow available at this location, upgrading of 240 m of existing watermains from 150mm diameter to 250mm diameter between 98 and 97 Street will be required as shown on Figure 7.2.3.

7.2.4 East Industrial Area at Park Road and 92 Street

The required fire flows for this area are 225 L/s and the modeled fire flows are as low as 95 L/s under existing conditions. The low fire flow is because the existing 300m main is a dead end watermain that terminates at the intersection of Park Road and 92 Street. By extending it to the existing distribution system on Park Road with a 300 mm main create a loop, as shown in Figure 7.2.4, fire flows will be increased to within 10% of the required 225 L/s. This new connection will ultimately become a part of the future trunk system.

The total length of the proposed new 300mm watermain is 180 m. This upgrade will be installed at the developer's cost as further development of this area occurs.

7.2.5 School Site at 112 Avenue and 105 Street

The modeled fire flow for this area is between 110 L/s and 130 L/s which is much less than the required 250 L/s. By upgrading 220 m of existing 200 mm Ø, fire flows would be increased to acceptable levels.

7.2.6 Other Fire Flow Deficiency Areas

The other fire flow deficiency areas in Zone 1 can easily be improved by the construction of pressure reducing valve (PRV) stations that will increase the supply of fire flow from Zone 3 into Zone 1. The PRV can be set so that flows from Zone 3 will only enter Zone 1 during times of low pressure such as peak hour or during a fire in Zone 1. Since PRV stations can only operate in one flow direction, fire flows from Zone 1 will not flow into Zone 3. The following three locations have been identified for the installation of PRV stations to improve deficient fire flows in Zone 1:

- ***116 Avenue and 100 Street*** – The required fire flow in Zone 1 at this location is 225 L/s and the modeled fire flows range from 95 to 130 L/s. By installing a PRV station at this location, fire flows can be improved to approximately 225 L/s. In addition to a PRV station, the improvements necessary to bring the entire area to the required flow is an upsizing of 440m of 150mm watermain to 250mm as shown on Figure 7.2.6.1. The PRV should be set to provide 345 kPa (50 psi) from Zone 3 to Zone 1. If the pressure in Zone 1 at this location is above 345 kPa the PRV will remain closed.

- ***106 Avenue and 92 Street*** – Required fire flows in this area are 95 L/s and 150 L/s for residential and business areas respectively. Many areas are deficient in fire flow. To correct the deficiency, the most cost effective solution is the installation of a PRV station to allow fire flows from Zone 3 to Zone 1. The PRV should be set to provide 324 kPa from Zone 3 to Zone 1 to ensure that it only operates under fire or peak hour flow conditions. No other upgrades will be required. Figure 7.2.6.2 illustrates the upgrade.

7.3 Zone 2

7.3.1 North Industrial Area – 97B Street and 128 Avenue

The required fire flow for this area is 225 L/s and the modeled existing flows are as low as 60 L/s. In order to provide adequate fire flows, the following upgrades are necessary.

- Replace 740 m of existing 150mm mains with 250mm lines.

- Install a 250mm main from Crystal Lake and connect to the Zone 3 reservoir supply line at 132 Avenue and 97B Street.

  In addition to increasing fire flow in this area, this new watermain will also supply water to the Zone 3 reservoir. The modeled maximum water supply from Zone 2 to the Zone 3 reservoir is approximately 55 L/s under maximum day demands, which is much less than the modeled 89 L/s that the Zone 3 pumphouse needs to provide under MDD.

  These upgrades will bring the fire flows nearer to the 225 L/s requirement as well as increasing the supply rate from Zone 2 to Zone 3 to 136 L/s.

  Another option to increase fire flows would be to install a PRV station at 128 Avenue and the CNR tracks to feed fire flow to this area from Zone 3. The PRV should be set to supply fire flows from Zone 3 to Zone 2 at a pressure of 343 kPa and should only operate during fire flows in Zone 2. As Zone 2 feeds the Zone 3 pumphouse, there is a possibility of short circuiting but this would only happen if the Zone 3 pumphouse is being filled during a fire in Zone 2. Our modeling shows that if short circuitry did occur it would only be a small amount of flow and would not negatively affect the system.

7.4 Zone 3

7.4.1 North Industrial Area Within the City Limit

The required fire flows for most of this area are 225 L/s and the modeled existing fire flows in a number of areas is 150 L/s. To provide the adequate fire flows the following upgrades are necessary as shown on Figure 7.4.1.

- Replace 290m of 150mm water mains with 250mm lines
- Replace 440m of 200mm line with 250mm diameter line.

  The proposed upgrading on 128 Avenue not only improves flows in the Zone 3 area but also improves fire flow to the Zone 2 Area, when combined with the installation of the optional PRV shown in Figure 7.3.1.

The above improvements will have insignificant impact on the ability to supply fire flows to the future development in the County North Industrial Park.

An option of installing a 250mm loop from 124 Avenue and 101 Street west to 102 Street and then North to 132 Avenue was investigated. This option did provide better fire flows to the 132 Avenue area, but still did not improve fire flows to 101 Street where major deficiencies were identified.

7.4.2 116 to 124 Avenue Between 99 and 101 Street

The majority of this area is highway commercial that requires a fire flow of 225 L/s. Currently the available fire flows range from 140 to 200 L/s. Required upgrades to bring fire flows to 225 L/s include upgrading of 300m of a private 150mm watermain to 250mm as shown in Figure 7.4.2. As this line is on private property its' upgrading will be at the cost of this development. Until this upgrading occurs new buildings in the area must confirm that they meet the recommendations of the Fire Underwriter Survey (FUS). An option of installing a Pressure Reducing Valve between Zone 2 and Zone 3 at this location was investigated. Modeling shows that this upgrade would only improve fire flows marginally and is not recommended.

7.4.3 Royal Oaks Subdivision

This residential subdivision currently has no fire flow deficiencies, but the commercial lots on the south edge along 116th Avenue (Hwy 43) do have some deficiencies. The required upgrading consists of the construction of a 250mm main on 123 Avenue from 102 Street to 105 Street as shown in Figure 7.4.3. Since this area has only one dedicated supply main along 116 Avenue, this new watermain will also increase the reliability of the water distribution system in the subdivision and improve the fire flows in the commercial area along 116th Avenue. This upgrade should be implemented by developers as the Royal Oaks subdivision develops.

7.4.4 104 to 108 Avenue Between 93 and 96 Street

This area is mainly a residential area with a school site in the middle. Available fire flows in this area range from 60 to 140 L/s which is much less than the required fire flows. Upgrades in this area to bring the fire flows to the required fire flow include installing 100m of new 250mm mains, replacing 100m of 150mm mains with 250mm and the installation of 100m of new 200 mm mains as shown in Figure 7.4.4.

7.4.5 Schools at 90 Street – 110 Avenue and 88C Street and 109 Avenue

Both of these schools are currently deficient of the 250 L/s fire flow required for schools. The modeled fire flow available is between 110 L/s on the east and 200 L/s on the west. There are few alternatives for upgrading that would not involve extensive replacements of existing mains, except the installation of a PRV and connection to the 350mm main in Zone 2 along 116 Street as shown in Figure 7.4.5. The PRV at this location would need to be set at 380 kPa (55 psi) and should be sized at 250mm. 625 m of 250mm watermain would need to be installed.

8.0 Upgrading Requirements for Future Developments

As new developments occur, the existing water distribution system will require upgrading to accommodate proposed developments. The proposed watermain distribution system, in most cases will be an extension of the existing system. However, in some areas, major upgrades will be necessary to accommodate new developments.

Upgrading requirements for 2008, 2013 and ultimate development condition were assessed and discussed in the following sections:

8.1 Pumphouses and Reservoirs Upgrading

8.1.1 Zone 1 Pumphouse

The existing Zone 1 pumphouse has 2 – 100L/s pumps and 4 – 200L/s pumps. One of the 100 L/s pumps is equipped with a variable speed drive. The total maximum day demand (MDD) is approximately 450 L/s. Table 8.1.1 below shows the projected MDD for developments within the City limit, the County North Industrial Area, the regional supply line to Clairmont and Sexsmith and developments located to the south-east of the City in the County.

Table 8.1.1 Zone 1 Maximum Day Demands (L/s)

	Inside City Limits (L/s)	County North Industrial Area (L/s)	Regional Supply Main (L/s)	South East County Development.(L/s)	Total (L/s)
Current MDD	400	0	50**	0	450
2008 MDD	485	50*	96	20*	651
2013 MDD	550	110	143	40	843
Ultimate MDD	1070	155	236***	65***	1526

* Approximate – not clear how fast area will develop.
** Requirement once Regional Line is constructed.
*** Estimated 2024 demand

The existing pumping capacity of the Zone 1 pumphouse is in the order of 1000 L/s which is adequate for approximately 15 years. The supply to the external developments should be monitored as the flow for the regional system and south County areas are estimated only.

The current water treatment plant has the capacity to treat approximately 32 ML/day of raw water. This is equivalent to 370 L/s, therefore the water treatment plant would need upgrading in the near future. Since this is beyond the scope of work for this assignment, further investigation was not carried out.

8.1.2 Zone 1 Reservoir

The reservoir capacity for Zone 1 consists of 9.0 ML of underground storage adjacent to the pumphouse and two 3.4 ML water towers adjacent to Zone 2 pumphouse. The total reservoir storage capacity is 15.8 ML

Alberta Environmental recommends that minimum storage requirement for a reservoir be calculated in the following manner.

SV	=	A+B+C
SV	=	Total Storage Volume Required
A	=	Fire storage
B	=	Equalization Storage (25% of Maximum Day Demand)
C	=	Emergency Storage (minimum 15% of Average Day Demand)

The fire storage requirement is based on the highest fire flow requirement of 250 l/s for institutional developments. The Fire Underwriters Survey Guide to Recommended Practice, stipulates the fire flow should be available for a duration of 3.25 hours. Based on these fire flow requirements, a per capita demand of 275 L/day and a maximum peak day factor of 2.0 the Zone 1 existing storage facilities should be able to accommodate a design population of 72,000 people. This volume of storage is more than sufficient for ultimate development within the City boundary.

8.1.3 Zone 2 and 3 Pumphouse

The Zone 2 pumphouse currently has one 50 L/s and two 75 L/s distribution pumps and a 375 L/s fire pump. Zone 2 pumphouse feeds both Zone 2 and Zone 3 through a PRV station. The amount of flow provided to Zone 3 by the Zone 2 pumphouse varies depending on the demand. Generally, the supply is approximately one third of the required fire flow but it can be increased to one half during a fire. The maximum flow that this pumphouse can provide is approximately 575 L/s.

The Zone 3 pumphouse has two 75 L/s pumps and one 225 L/s fire pump. It is difficult to identify how demands are divided between these two pumphouses because the rate of water supply to Zone 3 pumphouse from Zone 2 varies. For this reason Zone 2 and 3 water demands were combined as shown in Table 8.1.3.1 for the evaluation of the pumphouse and reservoir upgrading requirements. The table shows the projected MDD for development within the City limit, the County North Industrial Area, and the regional supply line to Clairmont and Sexsmith for current, 2008, 2013 and ultimate developments.

Table 8.1.3.1 Zone 2 and 3 Maximum Day Demands (L/s)

	Inside City Limits (L/s)	County North Industrial Area (L/s)	Regional Supply Main (L/s)	Total (L/s)
Current MDD	100	0	50**	150
2008 MDD	120	50*	96	266
2013 MDD	141	110	143	394
Ultimate MDD	336	155	236***	727

* Approximate – not clear how fast area will develop.
** Requirement once Regional Line is constructed
*** Estimated 2024 demand

The Zone 2 distribution pumps can currently supply 200 L/s. From Table 8.1.3.1 the required demand (not including fire flow) will be 266 L/s by 2008, which indicates some improvements are required before this time. If pumphouse # 2 was relieved of the task of supplying Zone 3 and the Regional supply Main water, improvements would not be required for at least 20 years. A dedicated supply main to Zone 3 pumphouse is discussed below.

The existing water distribution system in Zone 1 can supply a limited amount of water to Zone 2 and similarly the distribution system in Zone 2 can supply a limited amount of water to Zone 3. The available supply through the Zone 1 water distribution system to the Zone 2 pumphouse is approximately 220 L/s. Based on the above projections the Zone 1 water distribution system should be adequate until 2008.

The existing Zone 2 water distribution system can supply approximately 55 L/s to the Zone 3 Reservoir. Since the demands of the regional supply main, the County north industrial area, and Zone 3 will soon require more than 55 L/s, upgrading of the distribution system is required.

A solution specific to supply of water to Zone 3 is the construction of a 250mm watermain from the new Lakeland subdivision in Zone 2 to the Zone 3 fill line at 97B Street, along 132 Avenue as shown in Figure 7.3.1. The construction of this watermain would increase the water supply to Zone 3 from 55 L/s to 140 L/s to meet the projected 2008 requirements.

A more permanent solution requires the construction of a dedicated supply line from Zone 1 pumphouse to the Zone 3 reservoir as shown in Figure 8.1.3.

The most feasible routing for a dedicated supply line would be along the east edge of the current City boundary so that the disturbance to existing infrastructure during the installation could be minimized. This main will not only supply water to the Regional Transmission Main and County North Industrial Area, but will also remove or reduce the current burden of Zone 2 pumphouse to supply water to Zone 3. This feeder main will ultimately need to supply water at the rate of approximately 500 L/s to Zone 3. To meet the ultimate conditions within the City, the County North Industrial, and Regional Supply Line, two options have been considered.

The first would be to construct a trunk main sized for the ultimate City of Grande Prairie requirements as well as beyond the projected 20 year growth for the County. This would consist of 12 km of 750mm trunk main with an order of magnitude estimated cost of $9.4 million. The second option would be to install the trunk as two stages with the first stage being a 500mm trunk and then twin it as required, approximately 15 – 20 years in the future. Since the first stage could provide enough supply for Zone 2 and Zone 3 for approximately the next 15 years with the minor system improvements outlined in chapter seven, the entire cost of the first of the twinned pipes would reasonably be paid for by the County. The estimated order of magnitude cost of 12 km of 500mm watermain is

$7.0 million. When the requirements of the City and County are revisited in the future a cost sharing arrangement could be negotiated for the second pipe.

8.1.4 Zone 2 and 3 Reservoir

The available reservoir storage in Zone 2 is 9.1 ML. and it would be capable to accommodate a design population of 34,500 people. The reservoir storage in Zone 3 currently has 1.75 ML of storage. Zone two feeds Zone 3 through one existing PRV station and therefore the storage volumes for Zone 2 and 3 can be combined together. This combined storage would be able to accommodate a design population of 44,300 people. Since the projected ultimate population of Zone 2 is 15,300 and Zone 3 is 30,000, (excluding the proposed North Industrial area) the combined storage can meet the ultimate storage requirements.

The proposed North Industrial area will be a part of Zone 3. The North Industrial area ADD is based on a water usage of 10,000 L/ha/day for RM-2 land use and 26,000 L/ha/day for RM-4 land use. The RM-2 land use area is 511 hectares and RM-4 land use area is 145 hectares. Storage required for these areas would be 5.0 ML including fire flow storage for 95 L/s for 2hrs (0.68ML). The current storage in the Zone 3 reservoir is 1.75 ML so that when areas develop in the North Industrial area the storage in the Zone 3 reservoir will need to be increased. Because the County North Industrial area is far away from Zone 2, the Zone 2 reservoir will not be capable to provide a portion of this storage to this area. It is recommended that once the development reaches 40 ha of RM-4 or 100 ha of RM-2 the Zone 3 reservoir should be upgraded.

The Zone 2 and 3 reservoirs will not provide any storage for the Regional Supply Main as storage is provided at the County's local reservoirs in case of supply interruption such as a supply main break or pumphouse failure.

8.1.5 Airport Pumphouse

The recent report prepared by EXH in January 2003 named "West End Water Supply Solutions", recommended that the existing airport pumphouse be modified to service the recently annexed western areas and other future development in the west end of the City. This pumphouse/reservoir would be connected into the existing Zone 1 system and also would function as a booster pumphouse for the Zone 1 area. The existing pumps in the existing pumphouse consist of 2 – 2.2 KW distribution pumps and 2 – 76L/s fire pumps. As this area develops, the demand requirements will need to be monitored to determine when the distribution pumps will need to be upgraded.

It has been suggested that the system pressure for the airport area should not exceed 344 kPa as this is the maximum pressure rating of the existing distribution pipes. Based on the modeling, the existing distribution system at the airport, connected to the City system could provide fire flows in the range of 170 to 220 L/s to the majority of the existing area. To increase the flows to the 225 L/s as required, it would require the replacement of many of the existing 200mm watermain. The pressure rating of the Airport distribution piping should be verified before undertaking this upgrade.

The required storage for this reservoir as recommended by the EXH is 3.52 ML. Therefore, the required expansion will be the construction of a 2.5 ML reservoir.

8.2 Piping Upgrades

8.2.1 Zone 1

Zone 1 is the largest among the three zones. Areas remaining to be developed in Zone 1 include the southwest, east, and northwest areas as shown in Figure 8.2.1. For the modeling of future developments it was assumed that the three PRV stations discussed in section 7.2.5 will be installed, as these PRV stations play a major role in providing fire flows to Zone 1. Piping networks in undeveloped areas have been modeled on alignments assumed to be convenient for future servicing of the entire area within the existing City boundary. The alignment can be modified to conform to future developments since the area outside the City boundary may tie into the City's water distribution system. The proposed watermains are also extended to the City boundary to allow for looping of the watermain in future developments outside the City into the City's water distribution system areas.

The south west area will require a network of mostly 300mm mains, connected to the existing system at key locations as shown in Figure 8.2.1. The pipe sizes of this network should be considered part of the normal distribution system for the area, and should be installed by the developer. A 350mm connection to the partially existing Flyingshot Lake area through Pinnacle Ridge area is required to complete the network. This connection should be constructed as development progresses and should also be considered as normal sizing for a development and installed by the developer. The 500mm feeder main along 68th avenue will be adequate for future flows to the west areas.

The Airport booster pumphouse will ultimately assist in providing fire flows, peak hour demand (PHD) flows, and some MDD flows to the northwest area. A network of 300mm mains will be adequate for this area. Locations of proposed connections of the network to the existing system are shown on Figure 8.2.1.

The improvements to the Airport will benefit both the existing area and the undeveloped northwest area. The total directly benefiting area is 890 ha of which 770 is undeveloped area and 120 is developed area. The estimated cost of the improvements to the Airport pumphouse and reservoir in the EXH report was $870,000 which transpires to approximately $980 per hectare. The construction of the 300mm watermain connection is approximately $1.185 million.

In the east area a network of 300mm diameter watermains will be required to service the new areas as shown in Figure 8.2.1. As with other areas, on-site fire flow testing and ongoing modeling should be carried out as development progresses so that the requirement for the construction of major loops can be determined. The upgrade to the existing system proposed in Section 7.2.4 (300mm connection at 86 Avenue and 92 Street) will need to be completed for the future system.

8.2.2 Zone 2

The undeveloped area in Zone 2 is located at north and east of the existing Crystal Lake area. A network of 300mm mains will be required for this area. The pipe sizes of this network should be considered as a part of the normal distribution system for this area, and should be installed by the developer. Connections to the existing system should be made at key locations as shown in Figure 8.2.2. For the modeling of this area it has been assumed that the connection between the Zone 3 reservoir and Crystal Lake has been constructed as it is an important supply feature for the Zone 3 reservoir.

8.2.3 Zone 3

Areas remaining to be developed in Zone 3 include the north-west area and the east central areas as shown on Figure 8.2.3. The north-west area will require a 300mm distribution network and a number of key connections to the existing system. The pipe sizes of this network should be considered part of the normal distribution system for the area, and should be installed by the developer.

The east central area will require the construction of a network of 250mm mains and PRV stations as discussed in Section 7.4.5 to achieve a fire flow of 95 L/s. As with other areas, pipe sizes of this network should be considered as a part of the normal distribution system for the area, and should be installed by the developer.

There may also be a need in the new south-east areas to control high pressures with PRV's, as the elevation of this area decreases to the east. The option of moving the south-east ¼ section to become part of Zone 1, was investigated but Zone 1 cannot supply fire flows to this area.

9.0 Construction Cost Estimates

9.1 Assumptions

The construction costs presented below were estimated on the basis of the following assumptions.

- 2004 Unit Prices
- Normal ground condition
- Watermain of diameter smaller than 300mm shall be PVC C900
- Watermain of diameter greater than 300mm shall be PVC C905
- Depth of bury will be 3.0 m
- All road crossing will be installed by augering method with steel casing pipes
- Fittings will be estimated to be 15% of the cost of the watermain
- Per metre unit prices for various size of watermains are listed as follow.
- 30% for engineering and contingencies

Summary for Construction Costs for Proposed Upgrades

Upgrade Required	Size	Length	Cost	Total
7.2.1 West Industrial Area				
Upgrading of Airport Pumphouse and Reservoir and connection to existing Zone 1 distribution system.(Includes Eng. & Cont.)				**$863,000**
Other Required Upgrades				
Install 75 m of new 250mm watermain	250	75	490	$36,750
Install 640 m of new 300mm main	300	640	500	$320,000
	30% Engineering And Contingencies			$365,930
			Total	**$1,585,680**
7.2.2 96 Avenue between 106 & 104 Streets				
Upgrade 540m of existing 150mm watermain to 250mm	250	540	490	$264,600
	30% Engineering And Contingencies			$79,380
			Total	**$343,980**
7.2.3 Schools at 91A Avenue & 96A Street / 88 Avenue and 97 Street				
Install 120 m of new 250mm watermain	250	120	490	$58,800
Upgrade 240 m of existing 150mm watermains to 250mm	250	240	490	$117,600
	30% Engineering And Contingencies			$52,920
			Total	**$229,320**
7.2.4 East Industrial Area at Park Road & 92 Street				
Install 180 m proposed new 300mm watermain (Developer Cost)	300	180	0	0
	30% Engineering And Contingencies			0
			Total	**0**
7.2.5 School Site at 112 Avenue & 105 Street				
Upgrade 220 m of 200mm watermain to 250mm	250	220	490	$107,800
	30% Engineering And Contingencies			$32,340
			Total	**$140,140**
7.2.6.1 PRV at 116 Ave & 100 St.				
Install new PRV Station		1	25000	$25,000
Upgrade 270 m of 150mm watermain to 250mm	250	270	490	$132,300
Upgrade 180m of 150mm to 200 mm	200	180	480	$86,400
Install 90m of new 200 mm	200	90	480	$43,200
	30% Engineering and Contingencies			78,570
			Total	**$340,470**

7.2.6.2 PRV at 106 Ave. & 92 St.				
Install new PRV Station		1	25000	$25,000
	30% Engineering And Contingencies			$7,500
			Total	**$32,500**
7.3.1 North Industrial Area 97B Street & 128 Avenue				
Upgrade 740 m of existing 150mm mains to 250mm	250	740	490	$362,600
250mm connection from the new Crystal Lake system up 95th Street to 132nd Ave	250	200	490	$98,000
Install new PRV Station (Optional)		1	25000	$25,000
	30% Engineering And Contingencies			$145,680
			Total	**$631,280**
7.4.1 North Industrial Area within City Limit				
Upgrade 1350m of 150mm water mains with 250mm lines	250	1350	490	$661,500
Upgrade 260m of 200mm mains with 250mm	250	260	490	$127,400
	30% Engineering And Contingencies			$236,670
			Total	**$1,025,570**
7.4.2 116 to 124 Avenues between 99 & 101 Streets				
Upgrade 300m of 150mm watermain to 250mm	250	300	490	$147,000
	30% Engineering And Contingencies			$44,100
			Total	**$191,100**
7.4.3 Royal Oaks Subdivision				
Install 300mm main on 123 Avenue from 102-105 St. (Developer Cost)	300	690	0	0
	30% Engineering And Contingencies			$0
			Total	**$0**
7.4.4 104 to 108 Avenues between 93 and 96 Streets				
Install 100m of new 200mm mains	200	100	480	$48,000
Upgrade 200 m of 150m mains with 250mm.	250	100	490	$49,000
Install 100 m of new 250mm	250	100	490	$49,000
	30% Engineering And Contingencies			$43,800
			Total	**$189,800**
7.4.5 Schools at 90 Street – 110 Avenue and 88C Street and 109 Avenue				
Install 400m of 300mm watermain	300	400	500	$200,000
Install new PRV Station		1	25000	$25,000
	30% Engineering And Contingencies			$67,500
			Total	**$292,500**
			Total Upgrade Works	**$5,002,430**

10.0 Funding Mechanism

10.1 Introduction to Service Connection Fees

To provide growth related water infrastructure in and around the City of Grande Prairie Aquatera is considering charging new service users with a service connection fee. The service connection fee would be charged to any developments that require new or expanded water or sewer services. The service connection fee would be charged to the developer at the time that the development connects to an Aquatera water service. As such Aquatera would be required to front-end construction of water infrastructure facilities in new growth areas in and surrounding the City of Grande Prairie in anticipation of future development.

This section of the report considers the development of service connection fees used to recover water infrastructure constructed by Aquatera to support service growth. This report describes future growth areas, the infrastructure required to service these areas, the service connection fees required to recover infrastructure investments as well as the impact of infrastructure front-ending on Aquatera.

10.2 New Growth Service Area

In order to establish water service connection fees the new development growth must be defined. These areas have been identified and are itemized in terms of area in Table 10.1. In estimating areas that are available for future development allowances for non-developable lands within the new growth areas has been estimated. Table 10.1 provides an estimate of this net development area by deducting allowances for municipal reserves and environmental reserves from gross land areas. The following summarizes the total area in new grow areas, non-developable allowances and resulting development areas:

	Area (ha.)
Gross Area	3,006.90
Municipal Reserves	202.35
Other Reserve Allowances	183.01
Net Developable Area	**2,621.54**

In reviewing the new grow service area it should be noted that the development area is very large and capable of supporting growth that is approximately 1.8 times greater than the current population of the City of Grande Prairie. We estimate that the new grow service area is capable of supporting a population of over 72,000 based upon development densities used in this study. Base upon current growth rates this represents a service area that will not be fully developed for 60 to 80 years into the future.

10.3 New Growth Service Area Land Use

Development within the new grow service area can take various forms which will directly impact the demand for water service. We estimated the future form that development will take and as such have categorized all new grow service areas into industrial, commercial, single-family residential and multifamily residential land use classifications. Table 10.2 outlines land use in new growth service area. The following summarizes the net development area for each land use classification:

	Net Area (ha.)
Industrial Land Area	624.86
Commercial Land Area	402.54
Single Family Land Area	1,232.62
Multi Family Land Area	361.52
Net Developable Area	**2,621.54**

10.4 Water Demand Factors

As previously stated differences in land use will results in variations in demand for water service. That is, a hectare of multi family development will require different water service support than a hectare of single-family development. The following table outlines water demand factors for each land use classification defined earlier. The table considers water and sewer service demand based upon developments relationship to single family development water and sewer service demands. For example a hectare of single-family development is provided with a water demand factor of 1, while a hector of industrial land development is considered a demand equivalent to single family development and a hectare of multi-family development is considered to have 4 times the water and sewer service as a hectare of single family development.

Land Use	Water Demand Factor
Industrial Land Use	1.00
Commercial Land Use	2.60
Single Family Land Use	1.00
Multi Family Land Use	4.00

10.5 Development Densities

In order to determine development charge values we have assumed a common development densities for each land use classification. These development densities will be used to determine the number of service connections that can be anticipated for each land use. The following table outlines common development densities that have been used in the development of water and sewer service connection rates.

Land Use	Description
Single Family	10 lots per ha.
Multi Family	4 complexes per ha.
Commercial	3 lots per ha.
Industrial	3 lots per ha.

10.6 New Growth Area Water Infrastructure

Table 10.3 outlines water related infrastructure required to support growth in the new growth service area. Water infrastructure has been classified into two groupings, first those water capital projects that are earmarked to support only the new growth service area, which total $2,048,000 and second those projects that support existing service areas as well as the new growth service area—system wide infrastructure improvements. In this regard the new growth service area will be charged for is proportionate share of these system wide infrastructure improvements. We have allocated system wide improvement costs between the existing service area and new service area based upon the population being served by the improvement. The share of system wide improvements related to the new development area is $26,072,000 (see table 10.4). Based upon both specific and a proportionate share of system wide infrastructure improvements new growth areas will receive $28,120,000 in water infrastructure.

10.7 New Growth Area Water Service Connection Fees

Based upon the growth service areas as defined, projected land uses, development densities and related service demand factors for water we have developed water service connection rates to recover growth area water infrastructure costs. The rates have been developed assuming that all growth area water related infrastructure is recovered through the application of costs over a single collection basin—a single water rate for each land use within the new growth area. Furthermore the water service connection fee estimates assume that all areas as defined will be fully developed—that is no new growth area will remain undeveloped. Table 10.5 outlines the water connection rates that are applicable for each development area. The rates for each land use are summarized as follows:

Land Use	**Water Fee Per Connection**
Industrial Land Use	$ 2,152.56
Commercial Land Use	$ 5,596.67
Single Family Land Use	$ 646.42
Multi Family Land Use	$ 6,464.16

It should be noted that the rates that are stated above describe the rates that must be in effect today in order to recover water infrastructure costs. In the future as water infrastructure costs escalate so to must water service connection rates increase in order to recover all future infrastructure costs.

10.8 Impact of Service Connection Rates on Aquatera

We have considered the impact of front-ending construction and subsequently collecting service connection fees on Aquatera finances. Front-ending growth related infrastructure can be onerous to a utility particularly when significant infrastructure must be front-ended and when related development recovery is slated to occur over a lengthy period. Both of these circumstances exist in Aquatera's case. In order to permit area growth significant infrastructure investment is required near immediately. Over a 10-year period Aquatera will make over $23.3 M in infrastructure related disbursements (both earmarked water and sewer investments and a proportionate share of system wide water and sewer infrastructure improvements) to serve development in the new growth area.

As previously noted recovery of these funds in made more difficult as the size of the development being served will not be fully developed for 60 to 80 years.

In our analysis we have assumed that the previously mentioned rates are applied to the growth service area and also to any infill development within exist service areas contained within the City of Grande Prairie. Our analysis assumes that approximately 744 new development permits will be subject to both water and sewer service connection fees in 2005 and that this level of development will grow by 3% per annum over our 10-year review time frame. We have further assumed that all fees gained from both water and sewer service connection fees will be used to finance both earmarked growth area infrastructure requirements as well as the growth areas proportion share of system wide infrastructure improvements.

Table 10.6 provides a cash flow analysis of water related service connection receipts and infrastructure disbursements. The cash flow model also considers any existing reserves that may be applied as a source of financing, as well as interest on cash / debt balances over the 10-year review period.

As indicated in Table 10.6, receipts from the growth and infill areas are sufficient to adequately finance water related infrastructure investments. As shown in the table, a funding surplus can be anticipated at the end of the second year of our 10-year review period and this surplus will continue throughout out the review period.

We have considered the financial impact of water and sewer proceeds and disbursements jointly. Table 10.7 shows the financial impacts of receipts and disbursements on a combined water / sewer basis. As shown in the table the magnitude of the sewer cash flow deficit has been reduced by the favourable position of the water fund surplus however over the 10-year review period a significant deficit remains.

Based upon our analysis water and sewer service connection fees that will recover the costs of new growth infrastructure are inadequate to support the cash flow demands associated with infrastructure construction. That is the funding of infrastructure investment requirements service connection fees and an interim financing source. Based upon our analysis it is likely that Aquatera would require as much as $8 M to $10

M in interim financing for a 10 to 15 years while water and sewer infrastructure improvements are being constructed and new growth area service fees amass.

10.9 Sensitivity Analysis of Service Connection Rates

During the course of our review we were requested to determine service connections fee impacts if service connection fees were to meet water and sewer infrastructure investment without Aquatera undertaking any interim financing arrangements. Table 10.8 provides cash flow impacts that result from a lower water service connection fee rate and a higher sewer service connection fee rate. The service connection fee rates that best meet cash flow requirements are outlined below.

Land Use	Water Fees	Sewer Fees	Total Fees
Industrial	$ 1,665.00	$ 8,325.00	$ 9,990.00
Commercial	$ 4,328.98	$ 16,650.00	$ 20,978.98
Single Family	$ 500.00	$ 2,500.00	$ 3,000.00
Multi Family	$ 5,000.00	$ 25,000.00	$ 30,000.00

As indicated in Table 10.8, while interim financing cannot be completely eliminated (year one and two infrastructure investments are far greater than development proceeds stemming from any near reasonable service connection fee rates), the 10-year capital infrastructure cash flow requirements can be better met.

We have attempted to demonstrate the impact on cash flow over the 10-year review period if the relationship between water and sewer service connection fees are maintained and overall cash requirements are managed as best as possible. In this regard a continuum of possibilities exist. In our analysis we have attempted to highlight rates that we believe are near the extreme ends of service connection fee limits. In this regard we have illustrated impacts from a maximum combined fee rate of $3,000 and a minimum fee rate of $2,300 based upon single family development. Table 10.9 outlines the cash flow impacts of the combined maximum $3,000 rate and table 10.10 outlines impacts associated with the minimum $2,300 single family rate.

Our analysis of the maximum rate situation indicates that a combined $3,000 single-family rate can reduce interim financing down to a minimal level of $4,8M (as indicated in Table 10.9). However the service connection fee rates result in a very large surplus at the end of the 10-year review period of $16.2 M. As such we are concerned that the maximum rate of $3,000 would be judged as excessive if reviewed by an external objective party. The service connection water and sewer fee rates related to the combined $3,000 maximum are outlined below.

Land Use	Water Fees	Sewer Fees	Total Fees
Industrial	$ 4,254.82	$ 5,724.36	$ 9,979.18
Commercial	$ 11,062.47	$ 11,468.52	$ 22,530.99
Single Family	$ 1,277.72	$ 1,722.00	$ 2,999.72
Multi Family	$ 12,777.24	$ 17,220.00	$ 29,997.24

As indicated in Table 10.10 a combined minimum rate of $2,300 will have a marginally higher interim financing requirement ($7.2 M) for Aquatera. It should be noted that interim financing requirements are short-lived in that by the end of the 10-year review period a surplus of only $6.0 M will have amassed. While this service connection fee rate places some stress on Aquatera's financing abilities we believe that the rate is a far more reasonable response in rate establishment. The service connection water and sewer fee rates related to the combined $2,300 minimum are outlined below.

Land Use	Water Fees	Sewer Fees	Total Fees
Industrial	$ 3,261.54	$ 4,395.60	$ 7,657.14
Commercial	$ 8,479.94	$ 8,791.20	$ 17,271.14
Single Family	$ 979.44	$ 1,320.00	$ 2,299.44
Multi Family	$ 9,794.40	$ 13,220.00	$ 23,014.40

10.10 Service Connection Rate Conclusion

As indicated earlier, front-ending development infrastructure can be onerous to a utility particularly where front-end investments are large and when infrastructure recovery is slated to occur over an extended period. It is our opinion that while the service connection rates for water ($644.88 single family rate) and sewer ($869.06 single family rate) will fully recover water and sewer new growth area infrastructure investments, the period of recovery (60 to 80 years) is unreasonable. As such we believe that Aquatera should consider service connection fees that closer to the minimums and maximums established in our sensitivity analysis. These rates should not only be determined based upon financial requirements and financing limitation but upon the market impact of rates on development in the City of Grande Prairie and surrounding area.

11.0 Fire Flow Policy Evaluation

11.1 Outline for Fire Flow Policy

Based upon our review of background materials regarding Grande Prairie's fire flow situation and requirements, authorities arising from the Municipal Government Act and the practices, policies and guidelines of various municipalities the following is a recommended outline for Grande Prairies fire flow policy.

1. Purpose
2. Background
3. Authority
4. Fire Flow Protection Commitment
5. Liability Statement
6. Construction and Rehabilitation of the Fire Flow Network
7. Fire Flow Network Standards
8. Accessing the Fire Flow Network

Based on the above outline and information the following is a draft fire flow policy for consideration by Aquatera.

11.1.1 Purpose

This policy is intended to support and protect the safety, health and welfare of people and property of the City of Grande Prairie through the creation, maintenance and operation of a fire flow network that will provide an immediate, adequate and reliable supply of water for firefighting purposes.

11.1.2 Background

The need for a fire flow policy has arisen with the creation of a new public utility enterprise, Aquatera, and with the City of Grande Prairie's recognition that Municipalities are expected to articulate and enforce infrastructure and other standards that reflect requirements for livability, affordability and safety of the City of Grande Prairie.

Currently some areas of the City's existing fire flow network are below desired fire protection standards. There is also need to ensure new developments meet with desired fire protection standards. Furthermore there is a need to create a consolidated policy framework that considers how the fire flow network is to be developed, maintained and operated.

This fire flow policy is intended to outline Aquatera's fire flow protection requirements and the role that building owners, developers, and others will play in its creation, maintenance and operation of it.

11.1.3 Authority

The Municipal Government Act outlines the authorities and responsibilities of a municipality. The Act indicates that a Council may pass municipal bylaws for the safety, health and welfare of people and the protection of people and property. Furthermore a municipality may establish a system of approvals, regulating or prohibiting any development or activity within the municipality until the municipality has granted approval for the development or activity. To help enforce such bylaws the municipality may impose fines or penalties for any breach of bylaw and may establish such inspection processes as may be necessary to determine that bylaws are complied with.

The City of Grande Prairie is identified as a Municipal Corporation that owns and operates a water system, AQUATERA, as a public utility for the purpose of supplying and distributing water to residents; industrial and commercial users; for fire protection and to all other consumers within the City of Grande Prairie. AQUATERA is responsible for the administration and enforcement of the system of water works and water services including requirements for the creation, maintenance and operation of the fire flow network. AQUATERA's authority is outlined throughout this policy and through other policies and bylaws of the City of Grande Prairie.

11.1.4 Fire Flow Protection Commitment

It is the intention of Aquatera to establish, maintain and operate a fire flow network that will provide an immediate, adequate and reliable supply of water for firefighting purposes. However, due to the nature and extent of existing infrastructure within the City of Grande Prairie, and the high cost associated with providing an infrastructure required to meet standards, the construction of appropriate infrastructure in some areas of the City may not be done in a cost effective fashion. In these areas appropriate infrastructure may not be constructed and fire flow capabilities in these areas will remain below the desired standard for fire flow protection.

AQUATERA will evaluate fire flow network protection capabilities of all areas within the City and establish and implement a plan to upgrade any deficient areas that can be brought to the desired standard in a cost effective fashion. For areas of the City where the fire flow network cannot be brought up to desired standards in a cost effective fashion AQUATERA will maintain an inventory of deficient areas and periodically assess improvement opportunities.

Regarding new developments and subdivisions, AQUATERA will establish a system of standards, approvals and inspections to ensure desired fire flow standards are achieved by developers.

11.1.5 Liability Statement

AQUATERA is committed to the provision of water services including providing an immediate, adequate and reliable supply of water for firefighting purposes. However AQUATERA shall not be liable for any loss, injury, damage, expense, charge, cost or liability of any kind, whether of direct, indirect, special or consequential nature arising out of or in any way connected with any failure, defect, fluctuation, reduction or interruption in the provision of service by AQUATERA to its customers howsoever caused.

AQUATERA shall not be liable for damages:

(a) Caused by the break of any water main, service, meter, private service, attachment or for the breaching of any ditch.

(b) Caused by the interference or cessation of water supply necessary in connection with the repair or proper maintenance of the water work system including the fire flow network.

(c) Generally for any accident due to the operation of the water works system including the fire flow network.

11.1.6 Construction and Rehabilitation of the Fire Flow Network

AQUATERA is authorized as the water infrastructure steward of the City of Grande Prairie including the fire flow network and related infrastructure. As infrastructure steward AQUATERA will enforce a system of standards, approvals and inspections to ensure that new developments and subdivisions meet the required standard of fire flow protection.

Fire flow requirements fro new and existing developments will be calculated in accordance with the "WaterFire flow standards will be calculated in accordance with the "Water Supply for Public Fire Protection – A Guide to Recommended Practice", published by the Fire Underwriters Survey.

With regard to the construction of new developments, subdivisions or other structures the landowner must apply to AQUATERA for approval to construct any water infrastructure including, connections to the existing water network, construction of fire flow network or similar facilities. The landowner will provide AQUATERA with such plans, designs and other documents as may be required to review the water network / fire flow network application. All plans submitted to AQUATERA are required to be signed and sealed by a Professional Engineer.

As a general principle the planning, design and construction of the water system for a development area will be capable of meeting maximum day water demand for the area served and have sufficient residual water pressure at the fire hydrant to meet fire flow protection standards as may be defined by the city. Further the standards, methods of construction, specifications and materials used by the owner in constructing the water and fire flow network will be in accordance with that which may be specified by AQUATERA.

Once constructed the water and fire flow network must be opened for the inspection and approval of AQUATERA.

AQUATERA will establish a system of fees to charge developers for connections and the water and fire flow network that benefits their developments.

11.1.7 Rehabilitation and Upgrading of the Existing Fire Flow Network

AQUATERA will assess all existing areas within Grande Prairie to determine where the fire flow network meets desired levels of fire flow protection. For areas that can be upgraded in a cost effective fashion, the city will initiate a local improvement proposal to fund the construction of required fire flow infrastructure. The cost of the fire flow network improvements will be passed on to land owners within the benefiting area through the levying of a local improvement tax.

11.1.8 Ongoing Operation and Maintenance of the Fire Flow Network

AQUATERA will provide water supply for fire protection, including hydrants, so as to be capable of providing the flow and pressure of water for which they were designed. AQUATERA will maintain, inspect and repair hydrants in accordance with Alberta Fire Code guidelines.

- Hydrants shall be inspected at intervals not greater than twelve (12) months and repair deficiencies as required. If repairs are required, they shall be complete within a reasonable amount of time
- Hydrants shall be flushed at intervals not greater than twelve (12) months with the main valve and any outlet valves fully opened until the water runs clear.
- Hydrants shall be inspected at intervals not greater than six (6) months after each use
- All hydrants shall be winterized annually to avoid freezing
- Any non-working fire hydrant shall be clearly marked
- All inspections, maintenance and repairs shall be logged and kept for a minimum of two (2) years

AQUATERA will determine the costs of operating and maintaining the fire flow network and will bill hydrant rental cost to the City of Grande Prairie Fire Department. The City in turn will pass on these operating and maintenance costs to all taxpayers within the City of Grande Prairie through inclusion of costs in the development of the annual general tax levy.

11.1.9 Fire Flow Network Standards

It is the intention of AQUATERA to create, maintain and operate a fire flow network that will provide an immediate, adequate and reliable supply of water for firefighting purposes. In order to ensure an immediate, adequate and reliable supply of water AQUATERA has established water service standards. The general principle behind these standards is that a service areas shall have sufficient water network infrastructure capacity to meet the maximum day water demand for the area and still have sufficient residual water pressure at the fire hydrant to meet fire flow protection standards for developments in the area.

For developers of any new developments, subdivisions or other structures the landowner must ensure that water and fire flow network plans, design and construction comply with City standards. Where a landowner fails to comply with the requirements of the City in the planning, design or construction of water and fire flow network, the City may make such changes to the services as may be necessary for compliance and the cost of making such changes will be charged to the landowner.

11.1.10 Access to the Fire Flow Network

AQUATERA is responsible for the administration and enforcement of the system of water works and water services including requirements for the creation, maintenance and operation of the water and fire flow network. AQUATERA as owner of the water and fire flow network prohibits connection to the water and fire flow network or the use of the fire flow network except by parties authorized by AQUATERA as may be outlined in this policy.

Where a property owner wishes to provide fire protection by means of sprinkler heads, fire hydrants, outlets for hose racks, or some other manner, the owner shall make application for a combined line or fire line to the City. The property owner will comply with all requirements and conditions set out by the City before the service may be constructed including design standards, methods of construction, specifications and materials to be used by the owner in construction and other requirements as may be established from time to time by the City. Where a property owner provides fire protection to multiple housing, apartments, industrial or commercial buildings by means of a fire line, the property owner shall ensure the fire protection system conforms to the current Alberta Safety Codes, Alberta Building Code, and Alberta Fire Code in addition to requirements established by the City.

Any person who wishes to have a fire hydrant relocated which is owned by Aquatera may request in writing to AQUATERA that the hydrant be relocated, or raised or lowered in elevation. If AQUATERA considers it feasible to relocate the hydrant, the property owner shall pay the estimated cost of relocation as calculated by AQUATERA.

No person shall use water supplied through a hydrant, public or private, except as necessary for fire fighting, testing or maintenance, unless expressly authorized in writing by AQUATERA. Water may be taken from a fire hydrant on a temporary basis where AQUATERA authorizes such use. AQUATERA may establish a system of approvals or permits for the temporary use of water from a fire hydrant. AQUATERA will establish a system of fees and charges for such access.

Where water supply is provided to building sprinkler, standpipe or other fire protection systems, no person shall use such water supply for any purpose except as necessary for fire fighting, testing or maintenance, unless expressly authorized in writing by AQUATERA.

No person or persons shall wilfully open or close any hydrant or water valve or obstruct the free access to any hydrant or water valve or valve chamber by placing on it any building material, rubbish or other obstruction. Any person found to be in violation of this section shall remove any obstruction as directed by an Enforcement Officer of AQUATERA or the City of Grande Prairie. Failure to comply with the directions of AQUATERA or an Enforcement Officer of the City of Grande Prairie may result in the obstruction being removed at the expense of the person in default.

11.2. Recommended Fire Flow

The recommended fire flow for various types of land use are shown in Table 11.2.1.

LAND USE	FIRE FLOW (L/s)
Low Density Residential	95
Townhouse/Local Commercial/Mobile Home Park	150
Walk up Apartment/Medium Density Residential/Transitional Residential	185
Industrial/High Density Residential/Highway Commercial	225
Institutional public services	250

11.3 Fire Flow Policy for Existing Fire Flow Deficiency Areas

11.3.1 Capital Costs Related to Existing Development

Aquatera will likely incur fire flow infrastructure costs for existing development areas that have substandard fire flow protection or do not have fire flow protection. Recovery of these costs may be through the City's general tax levy, which is shared by all property owners in the City, or through local improvement taxes, which share infrastructure costs among those areas that directly benefit from it.

Division 7 of the Municipal Government Act outlines the particulars of local improvement taxes. Salient sections of Division 7 as they may relate to the recovery of fire flow infrastructure costs for existing development are outlined as follows: Section 391 states, "In this Division, "local improvement" means a project (a) that the council considers to be of greater benefit to an area of the municipality than to the whole municipality, and (b) that is to be paid for in whole or in part by a tax imposed under this Division." Section 393 states, "A council may on its own initiative propose a local improvement." Section 400 state, "The person liable to pay the tax imposed in accordance with a local improvement tax bylaw is the owner of the parcel of land in respect of which the tax is imposed."

The local improvement tax approach however provides an outlet to property owners to quash an improvement initiative. Section 396 (1) and (3) state, "when a local improvement plan has been prepared the municipality must send a notice to the persons who will be liable to pay the local improvement tax. (3) Subject to subsection (3.1), if a petition objecting to the local improvement is filed with the chief administrative officer within 30 days of the notices' being sent under subsection (1) and the chief administrative officer declares the petition to be sufficient, the council must not proceed with the local improvement."

Based on the forgoing it may be most appropriate to allocate the cost of retrofit fire flow capital infrastructure costs to those areas that will directly benefit from it. It is our view that the City of Grande Prairie should consider cost recovery of existing development's fire flow infrastructure costs through a local improvement tax levied on benefiting property owners.

12.0 Best Practices Investigation

The purpose of this section is to provide Aquatera a summary of water system best practices obtained from a literature review to assist Aquatera in the formulation of the policy for the water system. A review of Aquatera's current practice is beyond the scope of work for this assignment.

12.1 Leading Utility Practices

Most efficient and effective organizations have adopted a continuous improvement strategy around their operations. A critical element of this improvement strategy is to gain traction from the experiences of other industry partners to identify and adopt leading industry practices.

Aquatera wants to ensure at the outset of its operation that the leading practices of other water and wastewater utilities have been considered. This section of the report outlines a number of leading practices that have been gathered through review of various Canadian and U.S. utilities, as well as management studies of utilities and similar industries. Topics include:

- Good Governance in Water Utilities
- Reducing the Impact of Variations in Financial Plans
- Adoption of Strategic Planning Framework
- Best Practices in Minimizing Water Loss
- Creating a Water Smart Community
- Lessons Learned from Walkerton
- Strategies for competitive advantage.
- Best Practices for Maintenance Work Orders

Each topic area is discussed more fully below.

12.2 Good Governance in Water Utilities

Good governance is about achieving the desired results in the right way. The importance of good governance is widely accepted yet in many utilities the principles of governance are not clearly articulated and the relationship between utility stakeholders is unclear. Good governance is characterized by a set of ranked principles that guide decision-making processes and management practices. Principles of good governance and the prioritization of each principle may vary between organizations and jurisdictions. As part of the Walkerton Inquiry, Justice O'Connor offered the following governance principles:

- Public safety is the paramount principle.
- Public accountability for decisions related to the water system.
- Effective exercise of owner's oversight responsibilities.
- Competence and effectiveness in the management and operation of the system.
- Full transparency in decision-making.

Some of the most frequently occurring good governance principles in water management include:

- Protection of public health and safety.
- Environmental protection.
- Accountability for stewardship and performance.
- Transparency.
- User participation.
- Balancing equity, efficiency and effectiveness in performance.
- Financial sustainability.

12.3 Reducing the Impact of Variations in Financial Plans

The financial planning process for utilities, particularly water and wastewater utilities, can vary significantly from the actual results.

- Extremes in wet or dry weather can have a dramatic impact on residential and some commercial customers water consumption habits and utility revenues.
- Over heated development growth can expedite capital infrastructure plans.

- Regulatory changes can result in new infrastructure, rehabilitation or operational requirements.
- Capital project variances can result in unforeseen demands or surpluses.

The development and maintenance of various reserve funds can provide the continuity for these unpredicted events. Several reserve funds that should be considered by a Utility include:

- Rate Stabilization Fund – The rate stabilization fund is used to minimize the rate impact of extraordinary cost increases such as large increases in debt borrowings or related interest rates. Normally the rate stabilization fund is drawn upon when rate increase requirements exceed defined hurdle rate percentage. Typically rate stabilization funds are replenished, up to a defined limit, through an allocation of a part of any annual operating surpluses. Aggressive management and utilization of the fund permits development and adoption of long-range rate strategies and avoids the political tension associated with short range rate planning.
- Operating Reserve Fund – The operating reserve fund is used as a point of fall back for any years operating losses that may occur as a result of temporary customer consumption drops and the like. The fund is established and replenished when operating surpluses arise. The fund typically is set marginally greater than the largest history loss position providing support for a single catastrophic operating year and multiple years where operations are marginally below predictions.
- Insurance Reserve Fund – Most utilities are self-insured. This fund is used to pay for ordinary losses incurred through operations etc. that are a result of accident, theft and usual liability claims (Note extra-ordinary claims are usually covered through insurance held with private insurance companies). This fund is created and replenished though self applied insurance premiums levied annually as part of operating budgets. The fund is typically set according to long term claims history with reserve adjustments made through period review of the asset base being insured.
- Renewal and Replacement Reserve – This fund is established to replace and rehabilitate existing infrastructure when the asset has reached the end of its

useful life. The reserve is established and replenished through depreciation charges in the annual operating budget and through special requisitions to budget that recognize that replacement assets may have escalated from the time they were originally booked. Reserve funds are usually earmarked for use through the annual capital budget process. The creation and use of these funds are also important to the development and adoption of long range financial plans and rate strategies.

12.4 Adoption of a Strategic Planning Framework

A strategic planning framework involves establishing a set of linked cyclical management processes, which together form a planning, implementing and measurement tool set to satisfy both long term as well as short term needs. The following illustration shows typical strategic plan elements.

12.5 Best Practices in Minimizing Water Loss

Water use and loss from the potable, water distribution systems are significant factors impacting the ultimate cost of water for a Utility. Best practices include concepts developed by the International Water Association and the American Water Works Association regarding strategic elements required to allow for the proper creation of a water audit. The following are strategies to identify and help reduce water loss.

- Metering.
- Leak detection and repair.
- Water efficiency and conservation programs.
- Valve maintenance programs.
- Pressure management.
- Infrastructure renewal programs.
- Effective water rate pricing.
- Bylaw enforcement and system inspection programs.
- Establishing zone metering and district metered areas.
- Designing standards for construction methods and materials.
- A supervisory control and data acquisition system (SCADA).
- Nighttime flow analysis.
- Distribution system modeling.
- Speed and quality of repairs.

12.6 Creating a Water Smart Community

Community prosperity and well-being are directly dependent upon a sufficient supply of clean water. Management of freshwater resources to accommodate growing communities has traditionally focused on supply side projects. However the costs of obtaining and treating new sources of water have steadily risen making demand side option economically attractive. The following are some examples of best management practice strategies to utilize in striving for water efficiency.

- Introduction of conservation / efficiency rate structures.
- Reduction of system leaks.
- Wasting water bylaws.
- Landscape water use audits.
- Home and business audits and retrofit.

- Public education programs.
- Water efficient landscaping.

12.7 Lessons Learned from Walkerton

This section is to apprise Aquatera of evolving drinking water safety standards, methods, policies and regulations and to reflect on how Aquatera might best position itself for potential future changes.

In the aftermath of the water-borne outbreak in Walkerton, the Government of Ontario established a public inquiry that was in part directed to recommend changes that would ensure the safety of drinking water in Ontario. In Ontario over 80% of residents are served by municipally owned water systems. The provision of water in Alberta is similar to that of Ontario. The most significant recommendations of the Walkerton report therefore are directed at municipal water system management and operation. The following is a synopsis of significant recommendations:

- Promote Accountability - One of the principle recommendations of the Walkerton report focuses the accountability for water system management and operation within municipalities. In this regard it is recommended that the persons charged with management and operations of municipal water systems be held to a "statutory standard of care" for the safety of water, similar to the duty of a director of a corporation. In these instances the conduct or operation of the corporation is inseparable from its directors—and directors are liable for the actions or inaction of their corporation.
- Mandatory Accreditation - To address the need for quality management, the Walkerton report recommends mandatory accreditation. Accreditation will be designed to insure that municipalities have in place systems that will enable them to deliver safe water.

  As a minimum all accredited municipal water providers in Ontario must have continuous inline monitoring of turbidity, disinfectant residual and pressure treatment at the treatment plant, together will alarms that signal immediately when any regulatory parameter is exceeded. In addition the disinfection residual should be continuously or frequently measured in the distribution system and where needed, automatic shutoff mechanisms should accompany alarms.

- *Operational Plans* - As part of the water quality management approach each municipality will be required to have an operational plan for its water system. As part of is operational plan, every municipal water provider would be responsible for developing an adequate sampling and continuous measurement plan. Sampling plans will provide sampling under conditions that are most challenging to the water system such as after heavy rainfalls or spring floods.
- *Emergency Response Plan* - A further essential element of operational planning will be the development of a generic emergency response plan including associated procedures, training and periodic testing of the emergency response plan.
- *Assessment of Management and Operating Staff Abilities* - Municipalities will be required to formally review the management and operating structure of their water system to ensure it is capable of providing safe drinking water. Mandatory certification will be required for individual operators, who must demonstrate their knowledge and experience by passing an examination. In Ontario the Minister of Environment has been charged with the development of an appropriate curriculum for operator training that specifically emphasizes water quality and safety issues.
- *Financial Plan* - The cost of regulatory compliance will be addressed before accreditation approvals will be granted. Municipalities will be required to submit a financial plan for their water systems as a condition of license for their water systems. As a general principle municipality's plans must demonstrate that adequate financial resources for water systems can be derived from local revenue sources. Provincial agents will be required to refuse operating approval of water systems that are not economically viable to ensure water safety.
- *Customer Reports* – Water providers should also consider provision of customer reports on minimum, maximum and average value tests of E.coli, Cryptosporidium and Giardia in delivered water together with any exceedances of regulatory values specified by regulation in a reporting period. In this regard bi-annual bill stuffers and public web sites are considered as appropriate information forums.

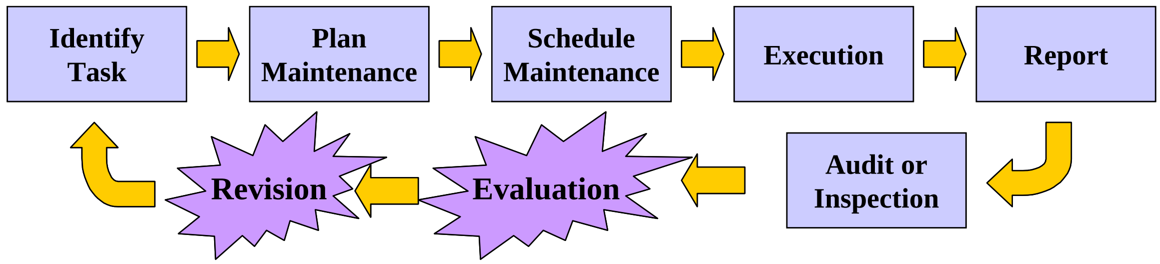
In light of the magnitude of changes that are required to take place it is envisioned that many municipal water system operations, particularly those in smaller or remote centers, will be unable to garner either the management and or operational expertise, the water infrastructure and facilities and or the financial resources to support these. In this regard the Ontario government is advocating that municipalities consider different approaches to managing and operating water systems including rationalization or consolidation with other municipalities and contracting with external operating agencies.

12.8 Strategies for Competitive Advantage

Deregulation of the utility environment and with it the added pressures of opened market competition places greater and greater emphasis on those actions that can have immediate positive impact on the bottom line. The maintenance and reliability of utility operations is coming under minute scrutiny. Modern tools and systems have created maintenance and operational opportunities that were not possible in the past. The following is a listing and explanation of some of the identified maintenance "best practices" being used in the utility industry.

- Benchmarking – One tool used effectively today by many utilities is that of benchmarking. The process of benchmarking can take many forms. On method of benchmarking is to compare oneself to a single leading utility. Using indicative data from operations and maintenance differences are highlighted for potential opportunity. This approach also has the appeal of allowing key management and staff to visit the maintenance and operations of the benchmark utility to understand first hand cultural and environmental factors that play a vital role in achieving a highly efficient operation. Another approach is to use an outside firm to provide comparison data across many utility operations so that standards can be developed and anomalies from these standards highlight. This approach has the advantage of quickly highlighting quickly potential target areas.
- Work Flow Control – Workflow control involves flow-charting, measurement, analysis and assessment and standardization of the steps involved in typical maintenance and operational activities. These activities might include what transpires in maintenance callouts for emergency items or routine maintenance activities like sewer flushing or hydrant testing.

A controlled maintenance work stream should involve the



- Preventive Maintenance – Everyone has a preventative maintenance program however most programs are over burdened with wants versus needs. The result is that the preventative program may not be applied to the "right" facilities and infrastructure, preventative maintenance routines are not being fulfilled because of "higher priority" needs, preventative strategies have not be kept current and scheduled down time is viewed as intrusive rather than a planned outage. In most instances preventive maintenance routines have to be pared and non-effective tasks removed and other tasks added.
- Operations Responsibilities – Maintenance of operating equipment in a treatment plant etc. is an operating responsibility. The degree to which equipment or a facility is maintained is determined and approved by operations. The expertise and capabilities of the maintenance force and its management determine the quality and quantity of work performed. In many cases in today's competitive market operators are used to perform basic maintenance tasks where skill is not a factor.
- Materials Management – The most efficient plants recognize that management of the materials used in the performance of maintenance is a definite best practice. Practice considerations include locating maintenance inventory relative to the work areas, spare part delivery schemes, vendor managed inventories etc.
- Diagnostics – Establish the use of diagnostics with follow-up corrective actions associated with prior notification of failure leads to improved reliability and bottom line performance.
- Training – Aging workforces, unaccustomed to change are finding their skills are deficient in providing the level of repair and diagnostics needed for today's plant equipment.

12.9 Best Practices for Maintenance Work Orders

There is an aversion to developing and using standard procedures for maintenance tasks. Arguments are presented that the workforce is mature, performing the same tasks for an number of years "successfully" and as such there is no compelling reason to have detailed procedures. However the inefficiencies that existing within and surrounding the every day maintenance work order offer many improvement opportunities. The following are some best practices surrounding maintenance work orders.

- The Risks and Benefits of an Aging Workforce – Most utility organizations have a very experienced maintenance workforce. This experience workforce does not required maintenance procedures or protocols to handle many of the utilities critical infrastructure, plant systems and equipment maintenance requirements. Because of this ready availability of experience and knowledge it is important that maintenance procedures and protocols be document and preserved now. Human resource studies have shown that a large knowledge drain will occur in the work place as baby boomers exit the workforce. Utilities are not immune from the experience drain and as such establishing robust maintenance procedures and methods now will lessen the impact of the loss of knowledge and experience that is occurring.
- Safety Considered On Every Work Order – Primary information required for every maintenance task or work order is the safety issues associated with completion of the task. Safety worksheets should be provided and linked to every work order to ensure that maintenance staff, regardless of experience level, fully understands how to accomplish the maintenance task in a safe manner.
- Linkage of Tools, Materials and Equipment on Every Work Order – Studies have shown that a typical maintenance worker only spends 24% of their workday performing maintenance work. A good portion residual time is spent waiting for or lost due as tools, materials and equipment is not readily available for the task at hand. Discussions with maintenance workers will highlight simple tasks that can be undertaken to dramatically improve productivity.
- Acceptance Criteria – Many work order procedures already define how and inspection should be performed as well as how to perform it safely the most commonly missing information however is an acceptable range of results that

advises a maintenance worker when a task may not be required or when the job is functionally complete.

- Mean-time-to-repair – Maintenance work order descriptions should also include the standard hours the task typically requires to complete. This information is not only essential for effective task planning and scheduling but can assist workers to maintain pace or to document situations where abnormal maintenance efforts may be required.

13.0 Conclusions

The study has the following conclusions:

- The assessment concluded that the majority of the current design standards are still applicable. The new design standards are:
  - Water Demand
    - Highway commercial developments = 26,000 L/ha/day
    - General commercial developments = 20,000 L/ha/day
    - Light industrial developments = 10,000 L/ha/day
    - Heavy industrial developments = 20,000L/ha/day
    - School = 20,000 L/ha/day
    - Hospital = 30,000 L/ha/day
  - Fire Flow
    - Institutional = 250 L/s
  - Hydrant spacing
    - Residential = 150m (measured radially)
    - All other land use = 90m

- The WaterCAD software is the most suitable model for the City of Grande Prairie because it has a better support and training program and a lower cost.

- The population projection for the water demand calculation was based on an annual growth rate of 3.5% for the next three years because it is anticipated that the City will carry on the same annual growth rate for a period of time. From 2007, the annual growth rate will be reduced to 2.5%.

- The model for the existing system was calibrated with nine fire flow tests and provide reasonably good results. The model can be refined by conducting tests to determine the roughness coefficient of the existing watermains and validate the database.

- The study identified there are seven areas in Zone 1 and one area in Zone 2 as well as five areas in Zone 3 that have insufficient fire flows in accordance with the new fire flow standards. The deficiency in these areas can be rectified by replacing undersized watermains and construction of new watermains as well as pressure reducing valve stations.

- To accommodate future developments, improvements for the water distribution system will be required.

  The improvements required in the immediate future would consist of the following components.
  - Expand the capacity of the Airport reservoir by the construction of a 2.5ML capacity reservoir and construct a 300mm Ø watermain to connect the reservoir to the existing water distribution system as discussed in the EXH report.
  - Expand the Zone 3 reservoir by an amount of 5.0 ML for the development of the County North Industrial area.
  - The 250mm watermains from the Lakeland subdivision to the intersection of 132 Avenue and 97B Street.

  The improvements required by 2008 would consists of the following components:
  - Construct a 500mm Ø dedicated trunk watermain to supply water from the Zone 1 reservoir to the Zone 3 reservoir.

  The improvements required sometimes after 2018 would consists of the following components:
  - Expand Zone 1 pumphouse to have a pumping capacity to be defined at that time.
- In accordance with the Municipal Government Act, Aquatera will not be required to upgrade the existing water distribution system in areas where there are insufficient fire flow. However, the City should advise the residents in those areas about the condition so that Aquatera can be protected from being negligent.

For areas of the City that can be upgraded in a cost effective fashion, the City will initiate a local improvement proposal to fund the construction of required fire flow.

For areas of the City where the fire flow network cannot be brought up to desired standards in a cost effective fashion, Aquatera will maintain an inventory of deficient areas and periodically assess improvement opportunities.

- The service connection rates for water ($646.42 single family rate) and sewer ($869.06 single family rate) will fully recover water and sewer new growth area infrastructure investments in 60 to 80 years which is unreasonable.

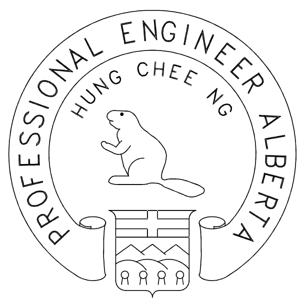
14.0 Recommendations

The study has the following recommendations:

- Adopt the recommended design standards as new design standards for the water distribution system.
- Refine the WaterCAD model by carrying out tests to determine the roughness coefficient of the existing watermains and validate the size of the watermain and node elevation in the database.
- Carry out improvements to rectify deficient fire flow in areas where improvements can be carried out cost effectively.
- Carry out improvements to accommodate future developments in stages as recommended.
- Maintain an inventory of deficient areas where they cannot be upgraded cost effectively and periodically assess improvement opportunities.
- Aquatera should consider service connection fees that are closer to the minimum ($2,300.00) and maximum $3,000.00).

Corporate Authorization

This document entitled "City of Grande Prairie, Water Distribution System Master Plan" was prepared by Infrastructure Systems Ltd.



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The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Appendix A

Water Distribution Models Web Based Information

Appendix B

Population and Land Use Projections

Appendix C

WaterCAD Model

Appendix D

Digital Report Files