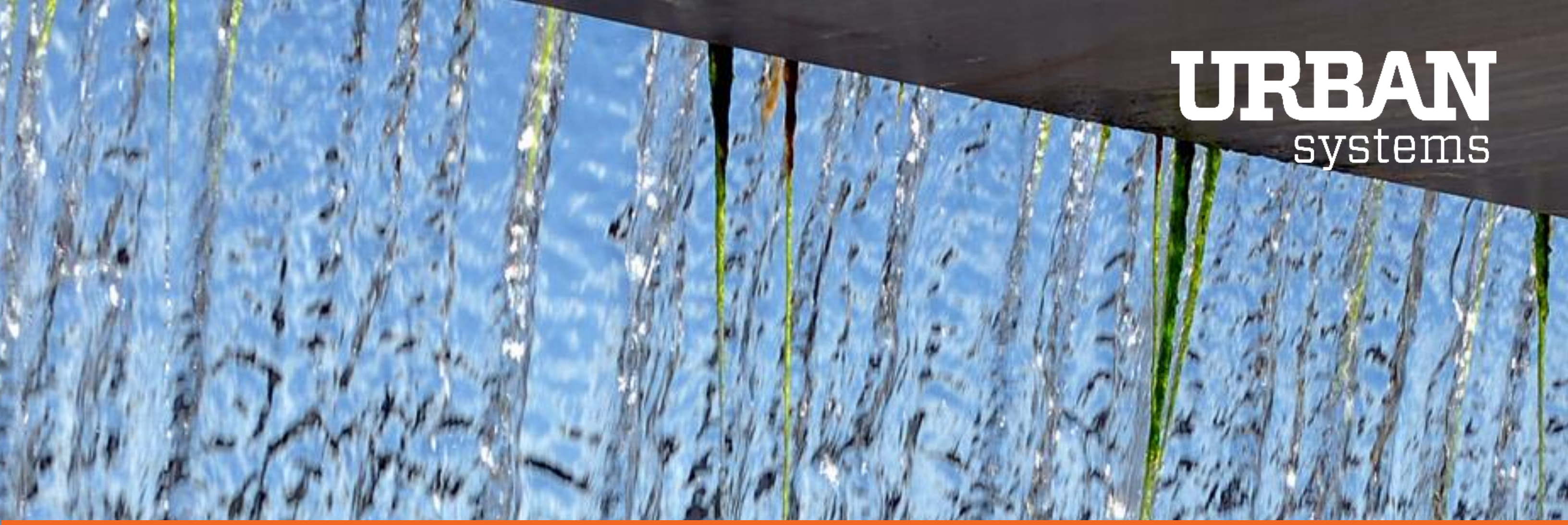
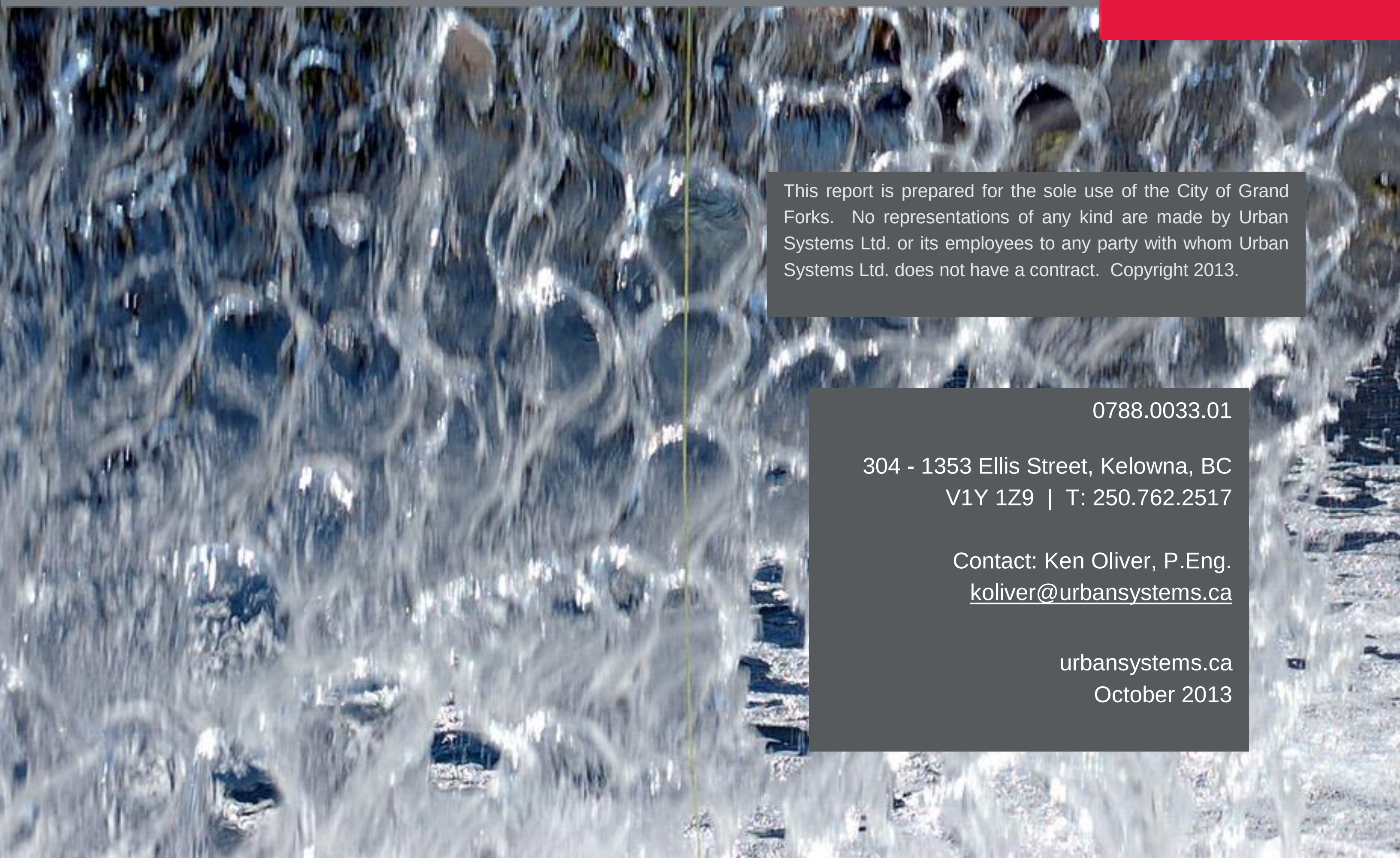


City of Grand Forks

Water Supply Plan – Final Draft



0788.0033.01

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Contact: Ken Oliver, P.Eng.
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October 2013

URBAN systems

December 04, 2013 File: 0788.0033.01

City of Grand Forks
Box 220 – 6350 2nd Street
Grand Forks, BC V0H 1H0

Attention: Sasha Bird, Manager of Development and Engineering

RE: CITY OF GRAND FORKS – WATER SUPPLY PLAN – FINAL DRAFT REPORT

Sasha,

Enclosed with this letter is the final draft report copy of the “City of Grand Forks Water Supply Plan”. We trust you will find all review comments are reflected in this final version of the document.

Thank you for your assistance and input and we trust this document will service the community as a blueprint for your water supply program well into the future.

Sincerely,

URBAN SYSTEMS LTD.

Ken Oliver, P.Eng.
Project Engineer

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Executive Summary

Since 2012, after Urban Systems investigated alternatives to the proposed Westside Reservoir, critical new information has surfaced that differs from the information available and known during development of that earlier 2012 report. More specifically, well outputs and well longevity are less than believed previously and the available reservoir storage in the water system is some 22% less than what the earlier literature suggested.

This Water Supply Plan revisits the findings, conclusions and recommendations contained in the 2012 report and examines their validity in light of the more recent and more accurate information and data. The planning horizon for the Plan is 20 years.

The Water Supply Plan evaluates two approaches to both meeting the City's domestic water demands and providing fire flow rates at a level acceptable to the Fire Underwriters Survey (FUS) organization. The FUS rating for a municipal water system ultimately impacts insurance rates within the community.

Option 1 provides for one additional well rated at 53 Lps and an increase in the volume of reservoir storage by some 500 cubic meters. Preliminary estimates peg the cost of this option at $1,248,000. This particular option could be partially funded by Borrowing Bylaw 1922-- the Emergency Water Supply for Fire Protection bylaw —in an amount of $655,000. In addition, the reservoir expansion could be staged, realizing a short term reduction in cost of $219,000. Even with this reduction, however, some $374,000 of additional funding will be required to complete the initial stage of the project.

Option 2 sees the installation of two new 54 Lps wells with attendant pumps, controls and piping. The estimated cost of this option is $1,405,000. The uncommitted funds currently available in Bylaw 1922 total $940,000, all of which could be applied to this alternative, leaving a need for an additional $465,000 of funding for this option.

Both options do reflect a 20% reduction in Maximum Day Water demands in the next five years along with decommissioning two of the existing City wells and scaling back of output from the remaining three wells by 33% of present output. These latter conditions are outlined in a recent report prepared for the City by their groundwater hydrologist.

A suggested modification to **Option 2** provides greater flexibility in terms of phasing than does **Option 1**. Installation in the near future of a new 71 Lps well, at a cost of approximately $615,000, will provide sufficient domestic and fire protection for the City until year 2024, based on an annual growth rate of 1%. Further, this entire cost of $615,000 can be funded by Bylaw 1922, which has already been approved by the electorate of the City of Grand Forks. Within the next decade, the City can then plan and arrange for the funding needed to accommodate growth driven infrastructure that rounds out the latter stages of either Option 1 or Option 2.

This Water Supply Plan document provides a series of recommended steps to implement the Plan over the life of the 20 year planning horizon.

We note that this Plan deals entirely with the supply aspects of the water system and does not address water quality or water treatment. The City is presently working with Interior Health Authority to maintain the current levels of treatment, with the objective of precluding the need for additional treatment. Any changes to the current situation that might affect the present arrangement would warrant re-examination of the findings and conclusions of this report.

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1.0 Introduction

The City of Grand Forks (the City) owns and operates the City's municipal water system. The water system is comprised of two reservoirs, a booster station, five wells with pumping facilities and approximately 100 km of mains. **Figure 1.1** in **Appendix A** illustrates the system in a conceptual form.

The City of Grand Forks engaged Urban Systems Ltd in 2012 to examine alternatives for improving fire protection to the community. The outcome of that study was a proposal to strengthen the delivery of domestic and fire flows from the existing five wells servicing the grid, coupled with the available storage located in the existing Eastside and Valley Heights' reservoirs (1). The estimated costs for the recommended improvements totaled $320,000, reflecting:

- two new standby power units (one for Well #4 and Well #5 and a second for Well #2); and,
- a bypass piping arrangement between the Eastside reservoir and the Valley Heights reservoir to allow for transmission of flows from the upper reservoir during a major fire event.

The recommendations and conclusions contained in that study were based on information supplied by earlier engineering reports and data extracted from City of Grand Forks' pumping records. More specifically, this information reflected:

- available reservoir storage in the Eastside and Valley Heights reservoirs: 5000 m^3 (2); and,
- capacity of City wells per **Table 1-1** below (3).

Table 1-1: Understood Capacities of City Wells Prior to 2013

Well #	Capacity (Lps)
2	26
3	99
3a	33
4	10
5	108
Total	**276**

Since 2012, new information has surfaced that differs from the information provided in the reports prepared earlier for the City. These include:

1.1 Reservoir Storage

The available literature forming the basis of our 2012 report indicates that the capacity of the Eastside reservoir is 4550 m^3 and the capacity of the Valley Heights reservoir is 450 m^3, for a total of 5000 m^3. However, more recently we obtained the record drawings for the Eastside reservoir facility and completed a detailed volume calculation for the available storage. The Eastside reservoir actually has a maximum storage of 3450 m^3, some 25% lower than what the earlier literature indicated. This is a significant difference, impacting available fire protection and balancing storage.

1.2 Ground Water Supply

Subsequent to the 2012 Urban Systems report, the City engaged a groundwater hydrologist to undertake an evaluation of both the aquifer supplying the City's water system and the condition and capacity of the five existing supply wells. While the aquifer appears to have sufficient capacity in the near term and long term, the hydrologist noted for the three largest wells that the current extraction rates from the water wells exceed the recommended rate [(4)], as noted in **Table 1-2**.

Table 1-2: Current and Recommended Well Extraction Rates

Well #	Extraction Rate (Lps)	Recommended Rate (Lps)
2	26	24
3	99	71
3a	33	33
4	41	25
5	108	69
Total	**307**	**222**

Further, the groundwater specialist noted that Wells #2 and #3a are approaching their life expectancy and should ultimately be replaced with a new well (or new wells) within something in the order of 10 years' time. On the basis of that report, the City has decided not to invest in a new standby power unit for Well #2, instead electing to invest the available funding in new works that are aligned with the recommendations of this Water Supply Plan.

1.3 Water Metering

City council recently committed to installation of water meters throughout the residential portion of the community. Currently less than 25% of all water demands throughout the City are metered.

An earlier 2000 study completed for the City [(5)] suggests universal water metering could result in demand reductions in the order of 25-50%. This same study suggested a reduction in consumption of 20% was a conservative and achievable target for the City of Grand Forks.

1.4 Summary

The above noted changes to the parameters used as the basis for the 2012 Urban Systems study suggest the original recommendations be re-examined, with the following objectives:

- Develop recommended maximum fire flow rates.
- Determine long term reservoir requirements.
- Confirm the short term and long term plan for the existing five wells.
- Determine the need for, timing of and required capacity of a new well source.

The remainder of this report addresses the above objectives.

2.0 Criteria

A number of variables are at play in terms of the planning and operation of a community water system. They are:

- Current Maximum Day Demand (MDD)
- Current Peak Hour Demands (PHD)
- Desired fire flow rates (FF) and duration of same
- Fire storage requirements
- Equalization storage requirements
- Emergency storage requirements
- Projected demands and design horizon
- Source capacity and resiliency
- Treatment requirements
- Capacity of the distribution and transmission grid

Each of these variables is discussed to some degree in the following sections of this report.

2.1 Current MDD

Maximum Day Demand (MDD) data for the City of Grand Forks is derived from their records and is summarized in **Table 2-1.**

Table 2-1: Recorded MDD

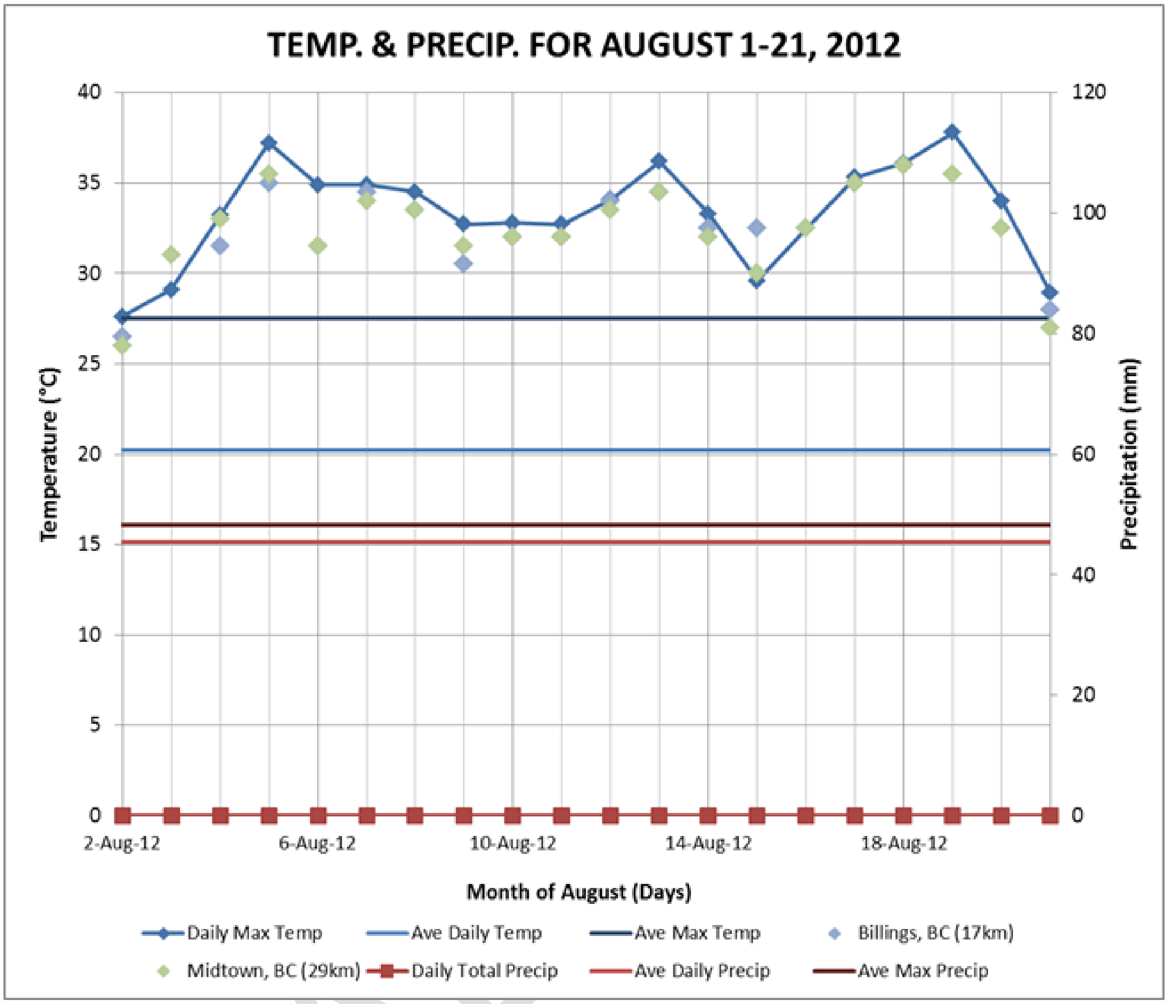
YEAR	MDD (m^3 per day)
2008	14,373
2009	14,264
2010	Data not reliable
2011	Data not available
2012	13,000

*Source: City of Grand Forks SCADA

While the data is not entirely complete, it appears that MDD for the City of Grand Forks is trending downward. This may be a function of weather, population decrease, conservation measures or, perhaps, all or some of these factors. We note that the City's water system computer model uses an MDD of 13,700 m^3 per day. The model was developed in 2008, about the same time that the City was experiencing MDD values greater than 14,000 m^3 per day.

We examined some climactic data for the month of August 2012 and, more specifically, the date of August 14, 2012, the date of the recorded MDD for that year [6].

Figure 2-1: Climactic Data for August, 2012



We note the following:

- Most of the daily temperatures are well above the average maximum daily temperature for August – hotter than normal for the period.
- The temperature for August 14, 2012 is within five (5) degrees of the maximum recorded temperature in August (near 39°C).
- There was no rainfall during August – so conditions were dry.

We also note the daily demand records for August indicate, for the five days following August 14, 2012, daily demands exceeded 12,500 m³ per day.

The conclusion we draw from our evaluation of the data here is that 13,000 m³ per day would reflect an accurate and current MDD value for the purposes of projecting forward in time. The weather information reflects the conditions that would create a high demand situation.

2.2 Future MDD

Future MDD will be affected by several factors, such as:

- design horizon;
- projected rates of growth for the community; and,
- impacts of water conservation measures.

Generally speaking, infrastructure planning relies on a 20 year time horizon, as most Official Community Plans reflect that time period. In addition, borrowing bylaws for municipal infrastructure are based on a 20-25 year amortization period. For the purpose of this report, we have adopted a 20 year planning horizon.

The projected rate of growth is discussed in our 2012 report (1). The accepted rate, as discussed with the City at the time, is 1% per annum.

We note in Section 1.3 above that the City is looking to reduce overall water consumption by a minimum of 20% with the introduction of a universal metering program. Interestingly enough, that target corresponds very well with the anticipated increase in MDD due to population growth over the 20 year design period – approximately 22%. Hence, the projected MDD for year 2033 is 12,700 m^3 per day, a slight decrease in the current MDD of 13,000 m^3 per day.

2.3 Peak Hour Demands (PHD)

Throughout the day, system demands during peak usage periods will exceed the ability of the water source to meet those demands. Most water utilities provide sufficient storage in their reservoirs to supply those peak hour periods, replenishing the storage during the lower demand periods of the diurnal cycle. Ideally, the source is capable of delivering MDD with the reservoir storage supplementing that average supply rate during peak hour demand periods.

The ratio between PHD and MDD will vary amongst water systems depending upon patterns of use. For instance, agricultural irrigation operating over a 24-hour period will tend to moderate peaks in usage. In a more urban setting, the peak uses in the early morning and evenings can increase the ratio. The recorded information available to us (3) indicates the PHD\MDD ratio for the Grand Forks water system is approximately 1.5. This is not inconsistent with the ratio associated with other water systems operating in arid and semi-arid environments with a predominantly urban service area.

Peak hour demands impact the ability of the transmission and distribution systems to deliver water at or above a minimum service pressure. For Grand Forks, this minimum pressure is 300 kPa or about 45 psi.

In addition to developing this water supply plan, Urban Systems will be completing computerized modeling of the transmission and distribution network under both the MDD + FF scenario and the PHD scenario.

2.4 Fire Flows (FF)

The following is extracted from the 2012 Urban Systems report entitled "*An Evaluation of Fire Protection Alternatives".*

The Fire Underwriters Survey (FUS) completed a fire grading survey of the City in 2004. Details of the survey are provided in ***Appendix A.***

The grading survey determines recommended fire flow rates at a specific location within the community, based upon the type and construction of one or more of the buildings within the immediate vicinity of the selected location. The table below outlines the range of recommended fire flow rates based upon the type of land use that was included in the 2004 fire grading survey.

Table: Minimum Fire Flow Rate Per Land Use

Type of District	***Required Fire Flow Range (L/min)***	***Required Fire Flow Range (L/sec***
Single Family Residential	*3,637 to 6,819*	*60.6to 114.7*
Multi Family	*10,001 to 11,365*	*166.7-189.4*
Commercial	*11,365 to 12,274*	*189.4-205.5*
Industrial/Institutional	*10,001 to 15,911*	*166.7-265.2*

The 2004 FUS report established a Basic Fire Flow of 2,700 Igpm (205 L/s, 12,300L/min) for the fire insurance grading analysis of the water distribution system - which should not be confused with the maximum required fire flow.

The reservoir sizing analysis in this report utilizes the maximum fire flow rate of 15,911 L/min (265 L/s) as outlined in the FUS report."

At the time our previous report was completed, both the City of Grand Forks and Urban Systems relied upon earlier work completed by third parties relative to the available reservoir capacity in the Eastside and Valley Heights reservoirs (5000 m^3). That apparent volume of storage allowed us to utilize a Required Fire Flow of 265 L/s for our earlier analysis. As we note in Section 1.2 above, we now know the 5000 m^3 figure is incorrect-- the combined available capacity of the two reservoirs is only 3900 m^3, confirmed from record drawings and field measurements.

This dramatic change in available storage has raised the question "What Required Fire Flow rate should be applied so as not to trigger an increase in insurance rates for the community?"

The FUS rating for the water system accounts for only 30% of the overall insurance grading classification for the community (7). The overall classification is used for establishing insurance premiums within the community. Other considerations, and their respective weightings, are:

- Fire Department (40%)
- Fire Prevention and Fire Safety Control (20%)
- Emergency Communications Systems (10%)

In terms of the water supply storage and delivery, the major areas considered by FUS to determine adequacy for fire-suppression purposes include:

- water source reliability;
- volume of stored water;
- capacity to deliver required fire flows simultaneously with Maximum Daily Demand;
- redundancy of all major components of system;
- looping and distribution system design;
- single point failure analysis; and,
- hydrant distribution, maintenance, and condition.

A flow of 205 Lps (12,300 L/min) is the minimum Basic Fire Flow rate FUS established in their 2004 report for Grand Forks. The Basic Fire Flow, as we understand things from FUS, is an amalgam of desired fire flow rates for the community. It does not represent the Required Fire Flow rate, which will be site specific and depends upon the location, type of construction and a variety of other considerations related to a particular building. For industrial/institutional uses, the Required Fire Flow rates will vary with location and will range from 166.7 L/s to 265.2 L/s, according to FUS.

Obviously constructing infrastructure to provide a rate of 265.2 L/s is desirable. However, for the City of Grand Forks, a community faced with a multitude of infrastructure renewal priorities, 'desirable' must be examined in the light of 'affordable'. In other words, would some rate less than 265.2 L/s meet the needs of the community without impacting insurance premiums? We looked to FUS for an answer to this question. FUS advises that even with a 10-20% decrease in the Basic Fire Flow rate, the overall insurance rating for Grand Forks would not be affected.

Therefore, we suggest that the City utilize the Basic Fire Flow rate of 205 Lps as a criterion for long term design and planning of its water system in terms of storage and delivery. FUS specifies a desired minimum duration of 2.5 hours for this rate of fire flow. For shorter term planning, where funds are limited and future upgrading can be accomplished with "add ons", a lower level of service may be desirable. Alternatively, where building water related infrastructure incrementally is not possible, then the higher level of service should likely apply. As an example, any future transmission main upgrades would be sized for the Required Fire Flow value of 265 Lps. Incrementally upsizing a water main, once installed, is obviously not realistic. However, reservoir upgrades could potentially be deferred on the basis of a lower level of service, until such time as funding allows for the upgrades, thereby permitting a higher level of service in future.

The following sections of this report utilize the Basic Fire Flow of 205 Lps for the purposes of developing a long term plan for the community's water system.

2.5 Equalization and Emergency Storage Requirements

2.5.1 Equalization Storage

Equalization storage is temporary storage in the reservoir that provides for system demands exceeding the ability of the source to them. Historically, equalization storage has been taken as 25% of MDD. This value can vary from community to community, depending on demand patterns. A review of demand records for 2012 provided by the City indicates that staff operate the Eastside Reservoir between about 98% and 80% full and between 70% and 98% full in the Valley Heights Reservoir, which represents 28% of available storage and 9% of current MDD. This means that currently peak hour demands are largely met with surplus pumping capacity from the well system rather than from reservoir storage. However, as we note in Section 1.0, that surplus will change over time as Wells #2 and #3a ultimately reach their useful life and output from the remaining three wells is dialed back in accordance with the groundwater specialist's recommendations.

Ultimately, we suggest that the system incorporate 20% of MDD as equalization storage. This value is in line with previous recommendations [1, 2].

2.5.2 Emergency Storage

The volume of emergency storage is usually a function of the reliability of the water system – how susceptible is the system to a situation where the supply of water is in jeopardy. In the case of Grand Forks, the supply is from a series of groundwater wells and the pumps supplying the system will ultimately be supported by standby power units. From a practical sense, the need for emergency storage appears to be an unnecessary expense. For the purposes of our work here, we have not made allowances for emergency storage for the following additional reasons:

- With five wells contributing to the system, risk of failure of the source - meaning all five wells - is minimal.
- Power failure events will be covered off by standby power units.
- The system does not contain long pipelines (potential points of failure) between the source and the reservoir.

2.5.3 TREATMENT REQUIREMENTS

The City of Grand Forks currently provides chlorination at each well source. No other form of treatment, such as Ultra Violet disinfection, is in place. The chlorination systems at the well sources are intended to provide chlorine residuals in the distribution system, as opposed to providing a barrier to bacteria and viruses found at source. To our knowledge, the water quality - from a bacteriological standpoint - is not an issue. In the recent past, the City has intensified testing frequency at each well source with the objective of developing sufficient data to support their desire to avoid additional levels of treatment.

This water supply plan is based upon the premise that chlorination will continue as the only form of water treatment for the community. Any changes that might affect that assumption would warrant re-examination of the findings and conclusions of this report.

3.0 Going Forward

Within a 20 year planning horizon, the impacts of water conservation will generally offset the impacts of growth. This is illustrated in **Figure 3-1**.

However, the limited reservoir storage and reduced capacity of the well system in the future requires a re-evaluation of how Grand Forks will manage MDD, PHD, and fire demands going forward.

3.1 Meeting MDD

As we look ahead – with the future decommissioning of Wells #2 and #3a and the reduced output from Wells #3, #4 and #5 – things look quite differently than they do today, with a future net loss of capacity exceeding 100 Lps, as outlined in **Table 3-1**.

Table 3-1: Well Capacities – Current, Recommended, and Following Decommissioning of Wells 2 and 3a

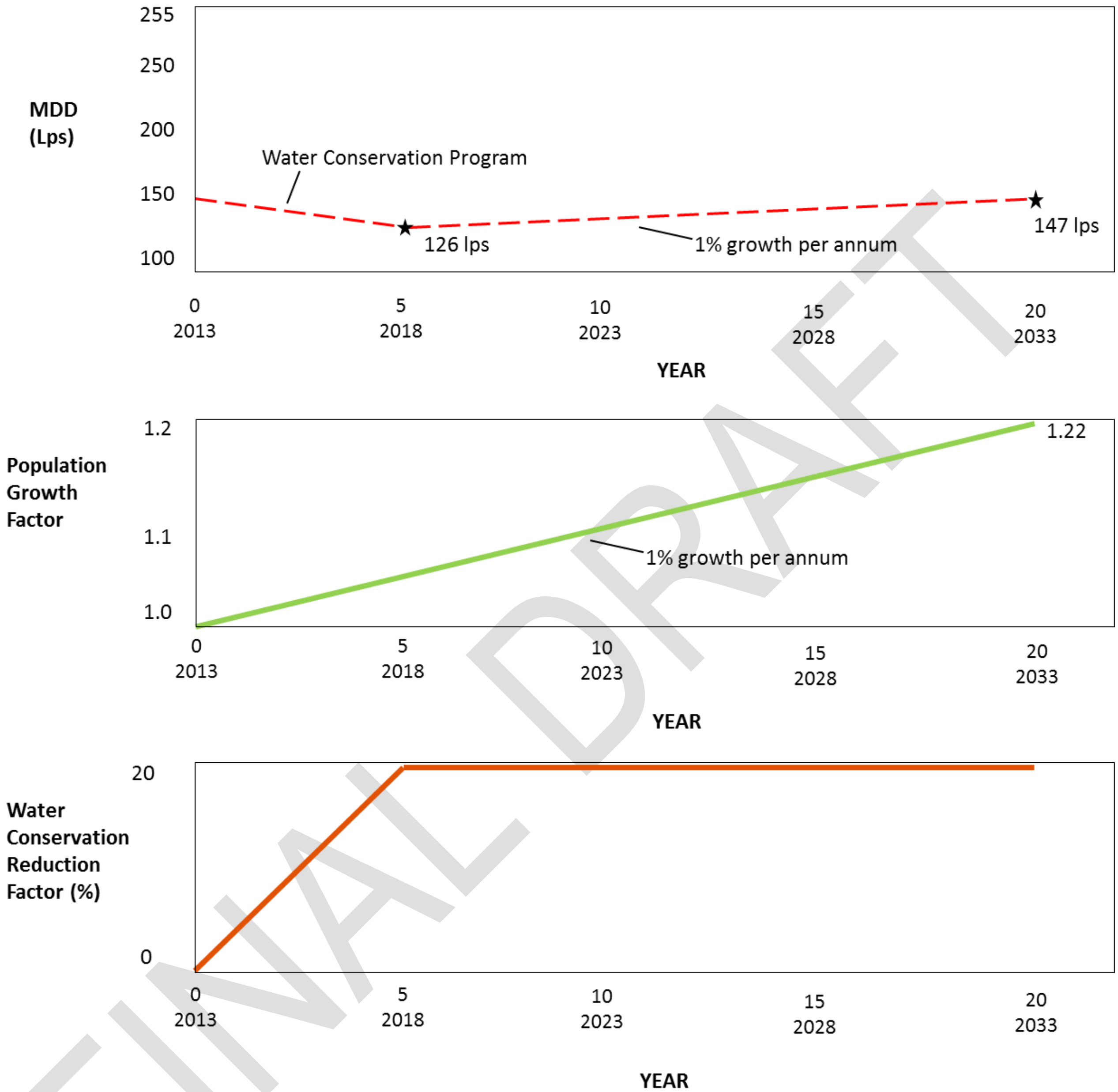
Well #	Current Rate (Lps)	Recommended Rate (Lps)	Projected Supply (Lps)
2	26	24	Nil
3	99	71	71
3a	33	33	Nil
4	41	25	25
5	108	69	69
Total	**276**	**222**	**165**

In addition, standard engineering practice suggests that the supply system must be able to meet MDD with the largest pump out of service, thereby reducing the available confirmed supply rate to 94 Lps with Well #5 out of service. With an MDD of 12,700 m^3 per day – which translates to some 147 Lps – Grand Forks will need to look for, at minimum, an additional 53 Lps in order to meet its future MDD requirements (147 Lps minus 94 Lps). **Table 3-2** reflects this new arrangement.

Table 3-2: Capacities Required to Meeting Year 2033 MDD

Well #	Recommended Rate (Lps)	Future with Largest Well Out of Service (Lps)
3	71	Out of Service
4	25	25
5	69	69
New Well (future)	53	53
Total	**218**	**147**

Figure 3-1: 20 Year Planning Horizon



3.2 Meeting Future (2033) MDD and Fire Flows (MDD + FF)

Two options are available here to meet this operational condition. **Option 1** reflects a system where all fire flows are delivered from elevated storage. **Option 2** involves provision of some fire flow from existing elevated storage, with the remainder delivered from well sources, over and above those flows that must be provided from the wells for MDD. In other words, for Option 2, the confirmed supply from wells would need to exceed 147 Lps (MDD).

Both options are discussed below.

3.2.1 Option 1 – Additional Elevated Storage without Wells Supplementing Fire Flows

Currently, the City's water system can provide some 3900 m^3 of elevated storage. However, some 20% of future MDD (20% x 12,700 m^3/day, or 2540 m^3), must be accommodated in the reservoirs for equalization storage, as discussed above in Section 2.5.1 (Equalization Storage).

The Basic Fire Flow of 205 Lps for a duration of 2.5 hours translates to an additional 1845 m^3 of required storage. **Table 3-3** summarizes this information.

Table 3-3: Reservoir Storage Requirements for Year 2033

Future Storage Requirements	Volume (m^3)
Equalization storage	2540
Fire storage	1845
Total	4385
Available in Eastside and Valley Heights	3900
Shortfall	**485=>500**

As **Table 3-3** demonstrates, the existing reservoir storage is inadequate for future needs by some 500 m^3.

Preliminary cost estimates for Option 1 are provided in Section 3.3. Estimated costs are provided for a reinforced concrete reservoir. We investigated the option of a bolted steel tank but found little difference in cost since the height of the tank is limited by the inlet and outlet elevations of the existing Eastside reservoir, a difference of about 3.5M. The economies associated with a steel tank come with the ability to create a smaller footprint by creating a much higher structure.

The proposed location of a new reservoir is provided in **Figure 3.2,** located in **Appendix A**.

3.2.2 Option 2 – Existing Elevated Storage with Wells Supplementing Fire Flows

As noted above, the City's water system can currently provide some 3900 m^3 of elevated storage. However, **Table 3-3** identifies that an additional 500m^3 of water will be needed in future to meet the desired fire flow rate of 205 Lps for 2.5 hours plus accommodating the required equalization storage.

That volume of water (500 m^3) could conceivably be delivered from the aquifer by means of additional well and pumping capacity. This approach formed the basis of the concept outlined in our 2012 report (1) which offered an alternative to the proposed Westside Reservoir.

For a fire with duration of 2.5 hours, a well source capable of delivering 54 Lps would be required to complement the available storage of 3900 m^3. This rate of 54 Lps would be in addition to the 53 Lps required to meet future MDD, as discussed in Section 3.1 of this report. A single well with a capacity of 107 Lps (54 Lps + 53 Lps) would be a substantial facility and would not be particularly efficient for supplementing MDD flows, given that 50% of the pumping power would only be needed during a fire situation. In addition, a well with an output of 107 Lps could not be included in the confirmed system capacity in the event of an emergency, given that it would be the largest well in the City's system and hence would be considered "out of service" in an emergency situation.

Two new wells, each capable of about 54 Lps, would be a more logical approach. **Table 3-4** summarizes the approach here.

Table 3-4: Option 2 Well Requirements

Well #	Future Rate (Lps)	Future with Largest Well out of service (Lps)
3	71	Out of Service
4	25	25
5	69	69
2a (future)	54	54
6(future)	54	54
Total	**273**	**201 = 147 MDD + 54 FF**

Any new well with the following characteristics will trigger an Environmental Assessment (EA) process under British Columbia legislation:

- an output equal to or greater than 75 Lps; or,
- an output greater that 35% of the current rate of extraction (227 Lps) from the aquifer.

Two new wells with a combined capacity of 108 Lps (2X54 Lps) will undoubtedly raise the question of whether an Environmental Assessment is required prior to design and construction of any new well facilities.

Based upon on our most recent experience, the cost of the EA process is in the order of $200,000 and would take approximately two years to complete. This sum of $200K does not include any physical work, such as drilling an exploratory or production well – it merely reflects the cost of the EA process itself.

However, we do note that *future* extraction rates from the aquifer will actually be more or less the same as *current* rates once the water conservation program is in place. The case could be made that construction of two new wells, coupled with both decommissioning of Wells #2 and #3a and the reduced output from Wells #3, #4 and #5, would actually impact the aquifer less than the EA criteria. MDD rates of extraction would remain unchanged. The highest rate of extraction would only occur under a major fire condition for a period of 2.5 hours. **Table 3-5** summarizes this comparison.

Table 3-5: Current and Future Aquifer Extraction Rates

Current MDD (2013) (13,000 m^3/ day)	Future MDD (2033) (12,700 m^3/ day)	Future MDD + FF
150 Lps (average over 24 hours)	147 Lps (average over 24 hours)	202 Lps (for 2.5 hours)

In terms of *annual* extraction from the aquifer, one could expect a 20% decrease from today's annual volume as a result of pending water conservation measures. Hopefully, with a downward trend in overall consumption from the aquifer, the EA process could potentially be waived, irrespective of the short term future MDD + FF rate of extraction for some 2.5 hours.

3.3 Preliminary Costs

Tables 3-6 and **3-7** provide preliminary costs for Options 1 and 2.

Figures 3.3 and 3.4, located in **Appendix A,** identify the proposed locations for proposed new wells. Future Well #2a would be installed in what is currently an undeveloped road right-of-way, near the present location of Well #2. Connecting to both the existing electrical system and distribution grid would be straight forward. Future Well #6 would be located about 300 m away from the existing distribution system.

Figure 3.5, outlines a concept level outline for a building housing the metering, controls, electrical, and chlorination equipment at the new well sites. We have assumed the well pumps will be submersible units.

The distribution and transmission systems were both examined under PHD and under MDD + FF conditions for both options. Neither option triggered system upgrades for the transmission system, although a number of smaller local mains will need upsizing, regardless of which supply option is selected. The analysis of the distribution and transmission system is the subject of a separate and parallel study now being completed for the City of Grand Forks.

Table 3-6: Option 1 – Preliminary Cost Estimates

Item	Unit	Estimated Quantity	Unit Price	Extension
(A) Well #2a-53 Lps				
Test well	Lump Sum	1	$15,000	$15,000
Production Well	Lump Sum	1	$80,000	$80,000
Pump, Motor, Check Valve and Wire	Lump Sum	1	$36,000	$36,000
150 mm Schedule 40 Drop pipe	Lineal Metres	60	$175	$10,500
Pitless	Lump Sum	1	$26,000	$26,000
150 mm Sched 10 SS Piping	Lineal Meters	15	$900	$13,500
Valves (buried gate and air release)	Lump Sum	1	$5,000	$5,000
Building	Square Metres	21	$2,200	$46,200
Electrical and controls	Lump Sum	1	$95,000	$95,000
Standby power	Lump Sum	1	$40,000	$40,000
Power supply	Lump Sum	1	$25,000	$25,000
Chlorination	Lump Sum	1	$25,000	$25,000
Containment system	Lump Sum	1	$5,000	$5,000
Chlorine analyzer	Lump Sum	1	$7,500	$7,500
Emergency shower, hot water tank, water service	Lump Sum	1	$7,500	$7,500
100 mm sanitary service	Lump Sum	1	$2,500	$2,500
250 mm watermain	Lineal Metres	22	$250	$5,500
Tie-in to existing water system	Lump Sum	1	$1,000	$1,000
Fencing	Lump Sum	1	$5,000	$5,000
Gravel parking	Lump Sum	1	$2,800	$2,800
			Subtotal (A)	**$454,000**
(B) 500 m^3 reinforced concrete reservoir				
Earthworks	Cubic Metre	1000	$15	$15,000
Reinforced concrete	Cubic Metre	183	$1,500	$274,500
Piping, valving, and tie-ins	Lump Sum	1	$77,000	$77,000
Hatches, ladders, vents	Lump Sum	1	$24,000	$24,000
Site fencing and parking	Lump Sum	1	$5,000	$5,000
Controls and SCADA	Lump Sum	1	$15,000	$15,000
Miscellaneous	Lump Sum	1	$5,500	$5,500
			Subtotal (B)	**$416,000**
			Subtotal (A) + (B)	**$870,00**
			Hydro-geologist	**$40,000**
			Engineering	**$130,000**
			Construction Contingency Allowance	**$208,000**
			Total	**$1,248,000**

Table 3-7: Option 2 – Preliminary Cost Estimates

Item	Unit	Estimated Quantity	Unit Price	Extension
A) Well #2a --54 Lps				
Test well	Lump Sum	1	$15,000	$15,000
Production well	Lump Sum	1	$80,000	$80,000
Pump, motor, check valve, and wire	Lump Sum	1	$36,000	$36,000
150 mm Schedule 40 drop pipe	Lineal Metres	60	$175	$10,500
Pitless unit	Lump Sum	1	$26,000	$26,000
150 mm Schedule 10 SS piping	Lineal Metres	15	$900	$13,500
Valves (buried gate and air release)	Lump Sum	1	$5,000	$5,000
Building	Square Metres	21	$2,200	$46,200
Electrical and controls	Lump Sum	1	$95,000	$95,000
Standby power	Lump Sum	1	$40,000	$40,000
Power supply	Lump Sum	1	$25,000	$25,000
Chlorination	Lump Sum	1	$25,000	$25,000
Containment System	Lump Sum	1	$5,000	$5,000
Chlorine Analyzer	Lump Sum	1	$7,500	$7,500
Emergency shower, hot water tank, water service	Lump Sum	1	$7,500	$7,500
100 mm sanitary service	Lump Sum	1	$2,500	$2,500
250 mm watermain	Lineal Metres	22	$250	$5,500
Tie-in to existing water system	Lump Sum	1	$1,000	$1,000
Fencing	Lump Sum	1	$5,000	$5,000
Gravel parking	Lump Sum	1	$2,800	$2,800
			Subtotal (A)	**$454,000**
B) Well #6-- 54 lps				
Test well	Lump Sum	1	$15,000	$15,000
Production well	Lump Sum	1	$80,000	$80,000
Pump, motor, check valve, and wire	Lump Sum	1	$36,000	$36,000
150 mm Schedule 40 drop pipe	Lineal Metres	60	$175	$10,500
Pitless unit	Lump Sum	1	$26,000	$26,000
150 mm Schedule 10 SS piping	Lineal Metres	15	$900	$13,500
Valves (buried gate and air release)	Lump Sum	1	$5,000	$5,000
Building	Square Metres	21	$2,200	$46,200
Electrical and controls	Lump Sum	1	$95,000	$95,000
Standby power	Lump Sum	1	$40,000	$40,000
Power supply	Lump Sum	1	$35,000	$35,000
Chlorination	Lump Sum	1	$25,000	$25,000
Containment System	Lump Sum	1	$5,000	$5,000
Chlorine Analyzer	Lump Sum	1	$7,500	$7,500
Emergency shower, hot water tank, water service	Lump Sum	1	$7,500	$7,500
Holding Tank	Lump Sum	1	$5,000	$5,000
Drain (daylight o/s bldg and include heat trace)	Lump Sum	1	$3,000	$3,000
250 mm watermain	Lineal Metres	310	$200	$62,000
Tie-in to existing water system	Lump Sum	1	$1,000	$1,000
Fencing	Lump Sum	1	$5,000	$5,000
Gravel Parking	Lump Sum	1	$2,800	$2,800

Subtotal (B)	**$526,000**
Subtotal (A) + (B)	**$980,000**
Hydro-geologist	**$80,000**
Engineering	**$145,000**
Construction Contingency Allowance	**$200,000**
Total	**$1,405,000**

Note that none of the above options reflect the cost of an Environmental Assessment, pegged at about $200,000, if required. We note in Section 3.4.2 of this report that this assessment can potentially be avoided, based on the knowledge that demands on the aquifer will not be increased in the future.

3.4 The Effects of Growth

We note in Section 2.2 that within the 20 year planning horizon the effects of a 1% rate of growth will increase Maximum Day Demands by some 22%. Section 3.0 of this report examined options and costs associated with meeting the water demands associated with that magnitude of growth.

This section of the report (Section, 3.4) examines what "no growth" means in terms of the sizing and costing implications of growth. This section makes all of the same assumptions about decommissioning Wells #2 and #3a and reducing output from the remaining three wells, as outlined in Section 3.1. In addition, assumptions about reducing MDD by some 20% through a water conservation program prevail in this "zero growth" scenario as well.

The overall objective here is to allow the City to understand the impacts on sizing, staging and cost of infrastructure as a function of growth.

Without growth and with an effective water conservation plan, MDD will theoretically decline from 13,000 m^3 to 80% of that value -- namely 10,400 m^3 per day. This translates to an average rate of flow of 120 Lps. **Table 3-8** indicates how that demand of 120 Lps will be met.

Table 3-8: Well Capacities Required to Meet MDD (without Growth)

Well #	Future Rate (Lps)	Future Rate with Largest Well Out of Service (Lps)
3	71	0 (out of service)
4	25	25
5	69	69
2a (future)	26	26
Total	**191**	**120**

Note that the overall required output for new Well #2a is some 50% of the required capacity for this same Well #2a under the 1% growth scenario. (Reference **Table 3.2**)

As noted above, MDD will drop to 10, 400 m^3 per day without growth, **Table 3-9** indicates the required reservoir storage for that level of MMD, as well as for a desired fire flow of 205 Lps for 2.5 hours. The table also identifies the shortfall in available storage.

Table 3-9: Reservoir Storage Requirements for Zero Growth Scenario

Future Storage Requirements	Volume (m^3)
Equalization (20% of MDD)	2080
Fire	1845
Total	3925
Available in Eastside and Valley Heights	3900
Shortfall	**25**

This relatively minor volume of 25m^3 could easily be accommodated by increasing the output from new Well #2a (26 Lps) to some 30 Lps, thereby eliminating the need for additional reservoir storage. What this tells us is that *with an effective water conservation plan, the City does not need to increase reservoir storage to meet the needs of its current population*. For the current population, one new well, rated for 30 Lps, will handle MDD demands once the water conservation plan takes effect and, in addition, provides for lost output arising from a reduction in the capacity of the existing wells.

Without that conservation plan, with a current MDD of 13,000 m^3, the reservoir shortfall would be:

Table 3-10: Year 2033 Storage Requirements without Water Conservation

Storage Requirements	Volume (m^3)
Equalization (20% of MDD)	2600
Fire	1845
Total	4445
Available in Eastside and Valley Heights	3900
Shortfall	545

And what is the situation today? At the moment, with standby power installed on Wells #3, #3a, #4 and #5, total confirmed well output, without the recommended reductions in output, is as follows:

Table 3-11: Year 2013 Well Outputs

Well #	Current Rate (Lps)	Current rates with Largest well out of service (Lps)
3	99	99
3a	33	33
4	41	41
5	108	Out of service
Sub Total	281	173
Less MDD	150	150
Surplus	131	23

This surplus capacity of 23 Lps translates to an available volume for fire protection, over a 2.5 hour period, of some 207 m^3 , leaving an overall reservoir storage shortfall of $(545\text{-}207)m^3$ or approximately 350 m^3 . What this means is that the City cannot currently meet its desired service levels even by over pumping the existing wells.

Note that Well #2 does not have a standby power unit nor does the City plan to add one, given the limited expected life of this well.

4.0 Making It Work

4.1 Commentary

The dynamics affecting the future of the Grand Forks water system are complex, in that a number of parameters impacting the system performance will be changing over time. More specifically, these include:

- increasing need for reservoir storage
- community growth
- impacts of water conservation
- decreasing output from the existing wells and pumps

The challenge here is to provide a plan that allows the City to integrate these changes in a manageable and cost effective manner.

Predicting the future is not without some risk. However, we offer the following timelines in an effort to provide a reasonable and conservative approach to incorporating the changes facing the City:

1. Water Conservation

We suggest that, with the implementation of the metering program, the City can hopefully reap the benefits of the program within the next five years. This timeline assumes that the program is instituted immediately.

2. Decreasing Output from Existing Wells and Pump

Ideally, the reduced output from the wells would be gradually implemented over about the same five year period as the water conservation program is taking hold and unit consumption decreases. Realistically, changing the pumps in Wells #3, #4 and #5 need not happen immediately, as long as the City recognizes that continuing to operate at the existing rates of extraction does mean that the margin of safety is narrowed accordingly. The objective, of course, is to work toward achieving the reduced outputs in a timely fashion while making provisions for replacing the needed capacity. That objective, at Year 5 (2018) would look like this:

Table 4-1: Year 2018 Well Capacities

Well #	Rate (Lps)	
	Option 1	Option 2
3	Out of Service (71)	Out of Service (71)
4	25	25
5	69	69
2a	54	54
6	Not required	54
Total	**148 w/o Well #3**	**202 w/o Well #3**

4.2 Evaluating the options

Section 3.3 of this report identifies that the cost difference between **Option 1** (Additional Elevated Storage without Wells) and **Option 2** (Existing Elevated Storage with Wells Supplementing Fire Flow) is some $157,000.

So what are the pros and cons of each alternative, other than costs? We've summarized these in Table 4-2 and discuss some of the key points following **Table 4-2**.

Table 4-2: Comparison of Options

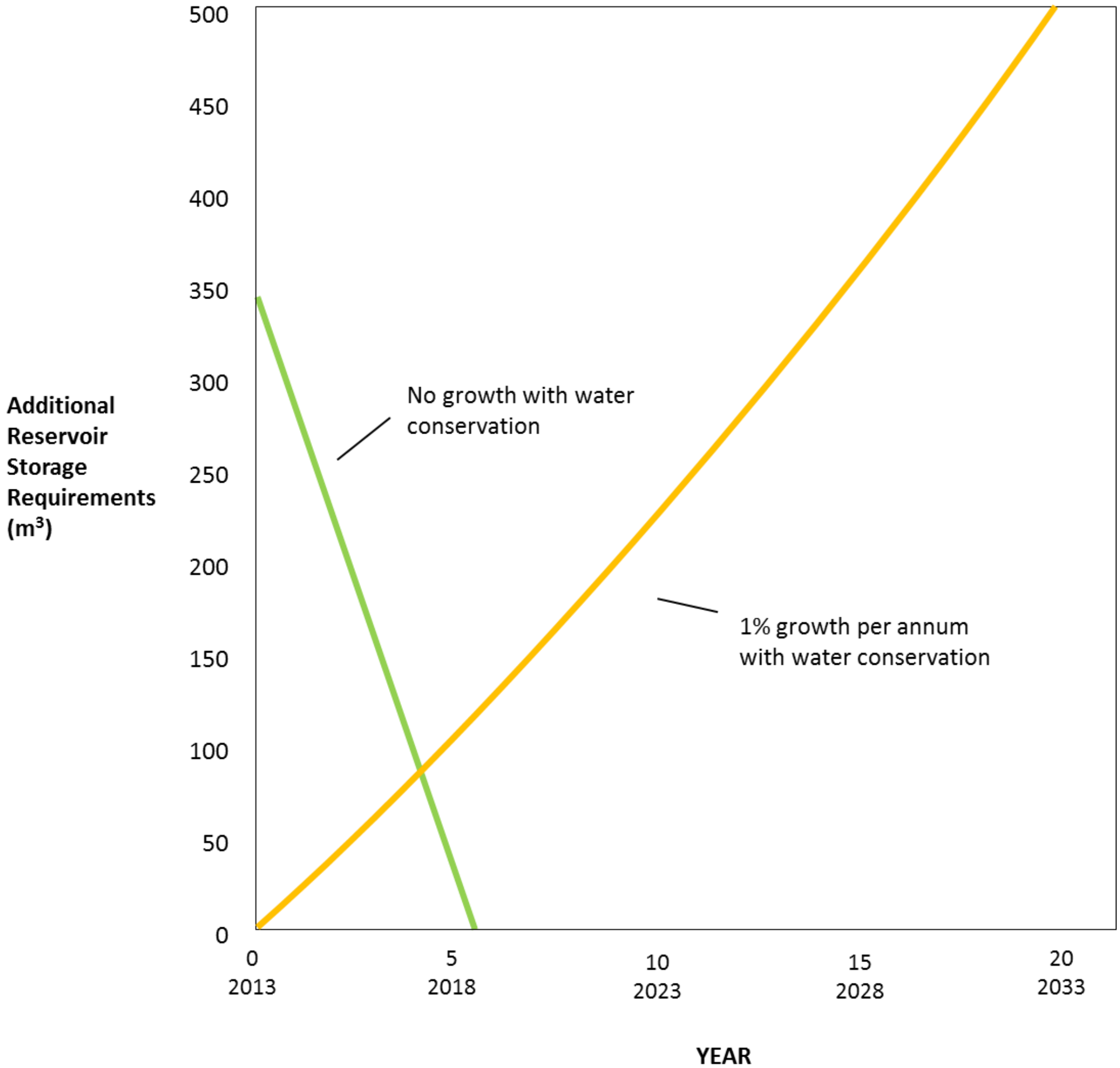
Option	Estimated Costs	Pros	Cons
1	$1,248,000	• Reservoir expansion could be phased • EA not required	• Slightly lower capital cost • Only partial access to funding under bylaw 1922: ±($660,000) • Managing water quality in reservoirs
2	$1,405,000	• Full remaining amount of bylaw applicable ($940,000) • Slightly higher overall capital cost	• Potential for EA needs addressing • Increased O/M with more mechanical components

4.2.1 Option 1-Commentary

The City might consider constructing one cell of the reservoir, with an estimated cost reduction of $219,000, thereby dropping the initial cost of **Option 1** to $1,029,000. If growth does not occur as expected, then this investment of $219,000 would be wasted, as it would if the entire 500 m^3 of storage is built at once. **Figure 4-1** on the following page illustrates what this might look like. Note that all of the 500 m^3 of storage to meet year 2033 needs are entirely attributable to growth.

We also note that, based on our interpretation of the two recent borrowing bylaws, neither allow for financing the cost of reservoir expansion.[8][9] Only about $655,000 of the **Option 1** costs could be recovered through the $1.3 Million Emergency Water Suppy Bylaw #1922. To date, some $360,000 of that Bylaw amount has been committed for new works. Hence, even to proceed with a reduced reservoir expansion of 250 m^3, **Option 1** would require $374,000 of funding from a source other than Bylaw #1922.

Figure 4-1: Reservoir Construction Timeline



4.2.2 Option 2-Commentary

The amount of borrowing capacity remaining in the Emergency Water Supply Bylaw #1922 is approximately $940,000, all of which could be applied to implementing **Option 2**. An additional $465,000 would be needed if **Option 2** proceeds in order to meet both MDD and fire flow demands for year 2033.

There is also some risk associated with the need for an Environmental Assessment for two 54 LPS wells. This risk is not associated with Option 1.

4.3 The Plan

Section 4 of this report identifies that installation of a new 30 Lps well will provide the City with sufficient well and storage capacity to manage their water demands for their existing population *with implementation of an effective water conservation program over the next five years*. Cost of such an installation would be in the order of $655,000.

However, in order to manage year 2033 demands, either a new 53 Lps well plus a 500 m3 reservoir expansion (Option 1), will be needed or, alternatively, two new 54 Lps wells will be required (Option 2). The cost differences between the two options is $157,000 with Option 1 the least costly at $1,248,000.

However, we suggest factors other than overall costs should be considered, one of which is the flexibility of each option to accommodate future growth.

We considered the impact of increasing the capacity of proposed new Well #2a to 71 Lps from the 53 Lps required for the first stage of either Option 1 or Option 2, as noted above. A well of 71 Lps capacity would have the same output as Well # 3 once the output from Well #3 is aligned with the groundwater hydrologist's recommendation. Available output, with the largest well out of service, would then look like:

Table 4-1: Years 2013- 2024 Proposed Well Outputs

Well #	Rated Output (Lps)	With Largest Well out of Service (Lps)
2a	71	0 (out of service)
3	71	71
4	25	25
5	69	69
TOTAL	**236**	**165**

Without any increase in reservoir capacity from what is available today, a confirmed output of 165 Lps would address MDD and fire flow rates up to the end of year 11(2024) based on a 1% growth rate and a 20% reduction from 2013 MDD levels. The marginal cost to increase the output of Well #2a, from 53 Lps to 71Lps, is in the order of $35,000. Table 4.3 itemizes the cost for this approach.

Table 4-2: Capital Cost for 71 Lps Well

A) Well #2a --71 Lps				
Test well	Lump Sum	1	$15,000	$15,000
Production well	Lump Sum	1	$80,000	$80,000
Pump, motor, check valve, and wire	Lump Sum	1	$40,000	$40,000
200 mm Schedule 40 drop pipe	Lineal Metres	60	$200	$10,500
Pitless unit	Lump Sum	1	$26,000	$26,000
200 mm Schedule 10 SS piping	Lineal Metres	15	$1260	$18,000
Valves (buried gate and air release)	Lump Sum	1	$5,000	$5,000
Building	Square Metres	21	$2,200	$46,200
Electrical and controls	Lump Sum	1	$104,000	$104,000
Standby power	Lump Sum	1	$45,000	$45,000
Power supply	Lump Sum	1	$25,000	$25,000
Chlorination	Lump Sum	1	$25,000	$25,000
Containment System	Lump Sum	1	$5,000	$5,000
Chlorine Analyzer	Lump Sum	1	$7,500	$7,500
Emergency shower, hot water tank, water service	Lump Sum	1	$7,500	$7,500
100 mm sanitary service	Lump Sum	1	$2,500	$2,500
250 mm watermain	Lineal Metres	22	$250	$5,500
Tie-in to existing water system	Lump Sum	1	$1,000	$1,000
Fencing	Lump Sum	1	$5,000	$5,000
Gravel Parking	Lump Sum	1	$2,800	$2,800
			Subtotal	*$479,000*
			Hydro-geologist	$40,000
			Engineering	$75,000
			Construction Contingency Allowance	$96,000
			Total	**$690,000**

Alternatively, with Option 1, a well capable of delivering 53 Lps would require, in addition, 151m^3 of storage to address MDD demands coupled with a 205 Lps fire flow rate for year 2024, some 11 years out. In reality, the initial phase of the reservoir would be sized more in the order of 250 m^3, half of the volume required for the ultimate expansion of 500 m^3 proposed under Option 1. An initial 250 m^3 cell is estimated to cost $354,000, significantly more than the $35,000 required to incrementally upsize well #2a from 53 Lps to 71 Lps.

What the foregoing tells us is that while Option 2 may be marginally more expensive in the long term, it provides far more flexibility to the City in terms of front end funding. Furthermore, all of the costs of a 71 Lps well can be funded by Bylaw 1922, whereas all of the costs for the reservoir expansion (Option 1) would require a separate source of funding-- Bylaw 1922 does not include provisions for new reservoir construction. The relatively minor investment in the cost of growth by the City will then give the City a decade or so to address how Well #6 or, alternatively, additional reservoir storage, will be funded. We note that the need for Well #6 - or expansion of the existing reservoir - will be driven entirely by growth and development. A lead time of 11 years would provide the City with an opportunity, time wise, to collect funds through a Development Cost Charge or like mechanism to pay for either Well #6 or a reservoir expansion, in order to accommodate growth beyond year 2024.

We recommend, therefore that the City proceed with the “going forward” steps summarized in **Table 4-3**:

Table 4-3: Going Forward Steps

Element	Timing	Cost	Funding Source
Obtain decision from Ministry of Environment that EA not required for Well #2a	Immediately	$5,000	Bylaw #1922[8]
Develop New Well #2a with an output of 71 Lps following approval to proceed without EA	Immediately	$155,000	Bylaw #1922[8]
Install new Well #2a Pumping Works	Immediately following Well #2a development	$535,000	Bylaw #1922[8]
Institute Water Meter Program	Immediately	$1,217,000	Gas Tax
Decommission Wells #2 and #3a	By approximately Year 5 (2018) but depending on condition	$35,000	Utility Rates
Reduce output from Wells #3, #4 and #5	By approximately Year 5 (2018)	$40,000	Utility Rates
Develop cost recovery mechanism for Well #6 or increased reservoir storage	As soon as possible	$5,000	Planning Grant
Construct Well #6 or increase reservoir storage	By approximately year 2024 (growth related)	Well #6: $750,000 or Reservoir: $593,000	Possibly DCC or other mechanism

REFERENCES

1) “An Evaluation of Fire Protection Alternatives” prepared by Urban Systems, February 2012.

2) ”Predesign Report for the Westside Reservoir” prepared by Kerr Wood Leidal, September 2002, page 2-1 and Figure 4-1.

3) City of Grand Forks SCADA data

4) “City of Grand Forks-Management of Community Wells” prepared by Piteau Associates Engineering”, February 2013.

5) “Universal Water Metering Feasibility Assessment” prepared by Urban Systems Ltd, October, 2000.

6) http://climate.weatheroffice.gc.ca/climateData/canada_e.htm

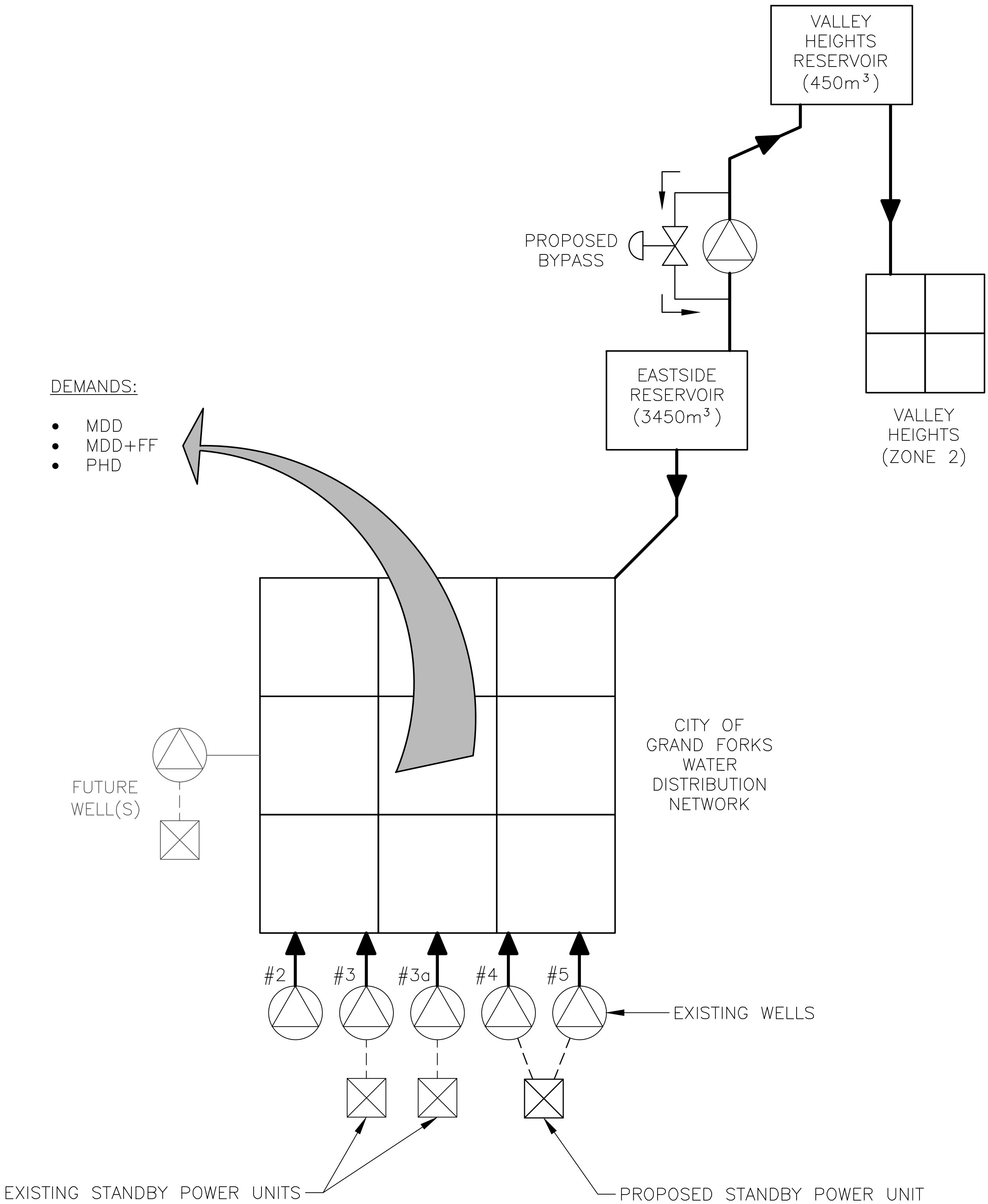
7) http://www.fireunderwriters.ca/pfpc_e.asp

8) A Bylaw to Authorize the Borrowing of up to $1.3 Million for Emergency water Supply for Fire Protection.

9) A Bylaw to Authorize the Borrowing of up to $4.2 Million for Road, Water and Sewer Capital Renewal Project

Appendix A

Figures



URBAN systems
urbansystems.ca

Client/Project		
CITY OF GRAND FORKS		
Scale	Date	Figure
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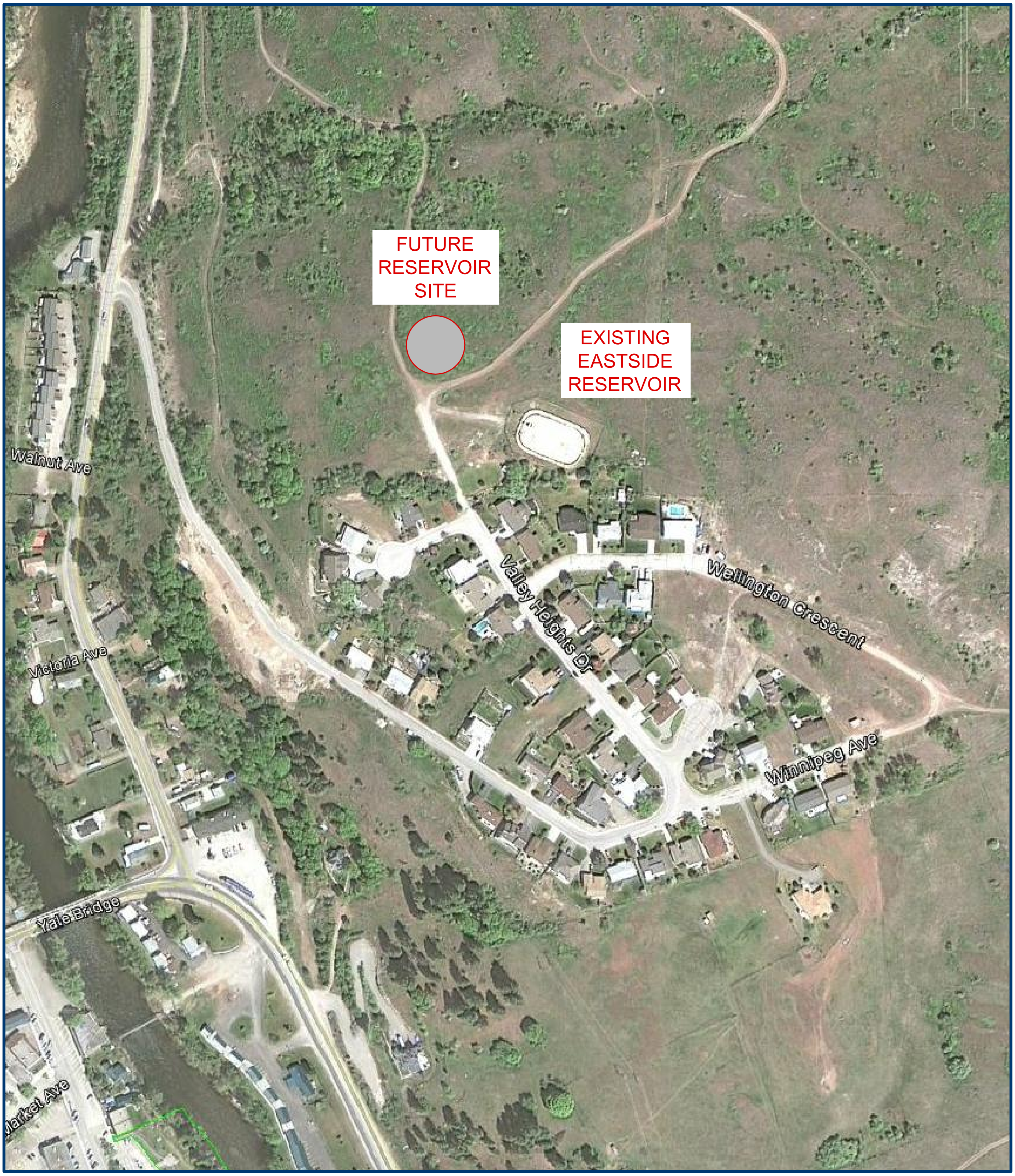
0788.0033.01		Title
GRAND FORKS WATER SYSTEM		



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Client/Project		
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FUTURE RESERVOIR SITE		

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PROPOSED WELL #2A

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Client/Project		
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Scale	Date	Figure
nts	OCTOBER 2013	3.3
0788.0033.01		Title
PROPOSED WELL #2A		

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OCTOBER 29, 2013
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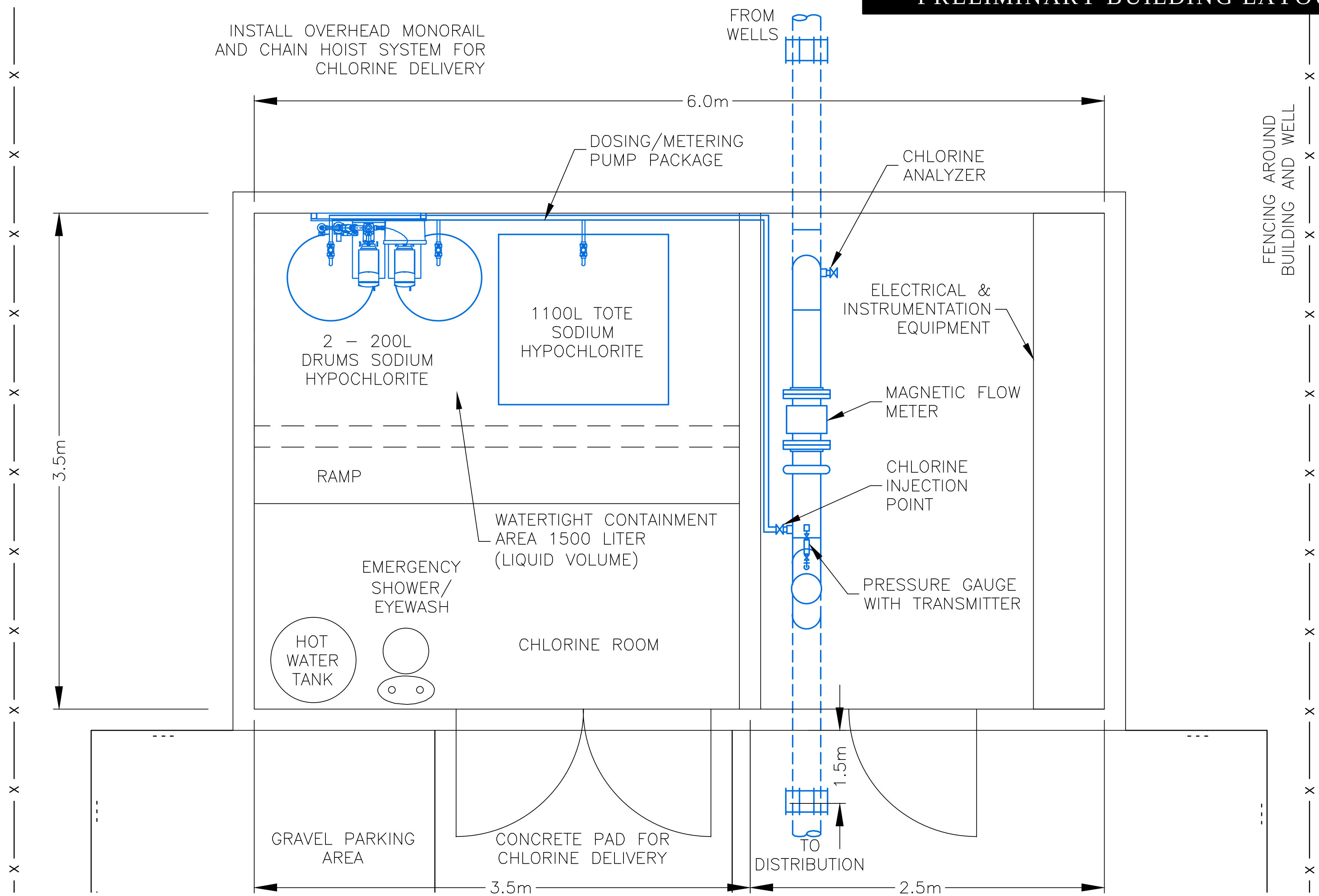
Client/Project		
CITY OF GRAND FORKS		
Scale	Date	Figure
nts	OCTOBER 2013	3.4
0788.0033.01		Title
PROPOSED WELL #6		

PRELIMINARY BUILDING LAYOUT



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ISSUED FOR INFORMATION
SEPTEMBER 20, 2013
URBAN systems

Client/Project		
CITY OF GRAND FORKS WATER SYSTEM STRATEGY		
Scale	Date	Figure
nts	13-10-29	3.5
0788.0026.02		Title

WELLS #2a & #6 PRELIMINARY CHLORINATION/METERING BUILDING LAYOUT

Appendix B

Bylaw #1922

CITY OF GRAND FORKS
BYLAW NO. 1922

A Bylaw to Authorize the Borrowing of Up to $1.3 Million for Emergency Water Supply for Fire Protection in accordance with the *Community Charter*.

WHEREAS it is deemed desirable and expedient to address the Emergency Water Supply for Fire Protection to meet the requirements of the insurance industry whose underwriters insure properties of Grand Forks residents;

AND WHEREAS the estimated cost for the planning, study, design and construction of fire flow requirements (additional well, stand-by pumps and pipe) is the sum of one million and three hundred thousand dollars ($1,300,000);

AND WHEREAS the term of the debt that may be authorized by this bylaw is twenty five (25) years;

AND WHEREAS the total debt to be created by this bylaw is not exceeding the sum of one million and three hundred thousand dollars ($1,300,000);

AND WHEREAS the approval of the Inspector of Municipalities has been obtained prior to adoption, in accordance with the *Community Charter*;

AND WHEREAS Council has provided for a referendum process in relation to the proposed Loan Authorization Bylaw;

NOW THEREFORE Council of the Corporation of the City of Grand Forks, in open meeting assembled, enacts as follows:

1. Council of the City of Grand Forks is hereby authorized to:

   a) Borrow upon the credit of the City a sum not exceeding one million and three hundred thousand ($1,300,000) for the purpose of undertaking and carrying out, or causing to be carried out, the planning, study, design and construction of works for the provision of the facilities and equipment relating to the fire flow requirements (additional well, standby pumps and pipe); and,

   b) Acquire all real property, easements, rights-of-way, leases, licenses, rights or authorities as may be requisite, or desirable for, or in connection with the construction of the fire flow requirements (additional well, standby pumps and pipe).

2. The maximum term for which debentures may be issued to secure the debt created by this bylaw is twenty five (25) years.

3. This bylaw shall take effect on the date of its adoption by Council.

4. This bylaw may be cited for all purposes as the "City of Grand Forks Emergency Water Supply For Fire Protection Loan Authorization Bylaw No 1922, 2011."

READ A **FIRST** TIME THIS 18TH DAY OF JULY, 2011

READ A **SECOND** TIME THIS 18TH DAY OF JULY, 2011

READ A **THIRD** TIME THIS 18TH DAY OF JULY, 2011

Certified a true copy of Bylaw No. 1922 as at third reading.

____
Corporate Officer

APPROVED BY THE INSPECTOR OF MUNICIPALITIES THIS 6TH DAY OF SEPT, 2011

RECEIVED THE ASSENT OF THE ELECTORS AT A REFERENDUM HELD NOVEMBER 19, 2011.

FINALLY ADOPTED THIS 16th DAY OF April, 2012

______________________________ ______________________________
MAYOR CORPORATE OFFICER

FILED with the Inspector of Municipalities this ____ day of April, 2012.

CERTIFIED CORRECT

I hereby certify the foregoing to be a true copy of Bylaw No. 1922 as adopted by the Municipal Council of the City of Grand Forks on the 16th day of April, 2012

____
Corporate Officer of the Municipal Council of the
City of Grand Forks