VILLAGE OF TELKWA

WATER SUPPLY STUDY

FEBRUARY, 2000

DAYTON & KNIGHT LTD.
Consulting Engineers

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CONTENTS

CONTENTS (cont'd.)

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1.0 INTRODUCTION

1.1 Background

The Village of Telkwa is supplied with water from a production well located north of the Village offices and an infiltration gallery from the Bulkley River located immediately adjacent to the Village Offices. The infiltration gallery is a new installation having a capacity of approximately 19 L/s and replaces a direct intake from the Bulkley River. The production well is frequently used as the sole supply of water to the Village when suspended sediments and debris in the Bulkley River prevented use of the water from the intake due to aesthetic and health concerns. The village also owns the former Forest Nursery or "Chadsey" well which is located approximately 200 m north of the Village's production well. The "Chadsey" well is not currently connected to the Village's distribution system.

The Village currently has a 909,000 L (200,000 Igal) reservoir located on Morris Hill south of the Bulkley River and outside the Village boundary.

The distribution system in Telkwa consists of pipes of different diameters, materials and ages. Some system deficiencies have been identified in terms of maintaining adequate pressures in the system during fire flows and some additions to the distribution system are required to loop the system to improve reliability and pressure.

The Village is concerned with the quality and quantity of water supplied from the two existing sources, as well as future source development. During peak demands there are indications that the existing supplies are operating near to capacity, both the well and infiltration gallery had to run continuously during peak day conditions during the summer of 1999. Quality is a concern with suspended sediment in water from the infiltration gallery and potentially with slightly elevated manganese and hardness in the well water.

Storage for fire flows, peak demands and emergency supply is also of concern, and has been addressed in previous reports by McElhanney Engineering Services Ltd. and Dayton & Knight Ltd.

1.2 Terms of Reference

The overall objective of this study is to evaluate the adequacy of the Village's existing water sources and distribution and storage system. Future strategies for improving supply quality and quantity are reviewed and alternatives considered. The findings of the previous water model and reservoir feasibility study are consolidated with an assessment of water source issues.

A proposal outlining the terms of reference for this study was submitted to the Village in August 1997. Subsequently, a preliminary report on supply options was submitted to the Village in September 1998.

In summary the scope of work is as follows:

1. Review previous reports and investigations.
2. Evaluate present and future water demands.
3. Reassess the present and long term capacity of the existing sources and estimate the ability of these sources to meet present and future demands.
4. Address groundwater quality issues and the treatment options to remedy these quality problems.
5. Investigate alternative sources.
6. Analyze the existing distribution system and storage reservoirs and make recommendations for upgrading to remedy existing deficiencies and provide for future development requirements.
7. Preparation of a draft and then final report.

2.0 REVIEW OF PREVIOUS REPORTS AND INVESTIGATIONS

Numerous reports, test results and other correspondence were reviewed to obtain background information on the existing water sources and supply system. The discussions and recommendations of the recent reports by Dayton & Knight Ltd. are incorporated elsewhere in this report and are not considered in this section. A summary of our observations follows:

Please note that these observations are comments and conclusions made by the relevant authors and do not necessarily express the opinions and advice of Dayton & Knight Ltd.

2.1 A Campbell, Consultant, September 1977, Report on a Seismic Refraction Survey in Telkwa, British Columbia

- Seismic refraction exploration for possible groundwater well sites in Telkwa.
  - Northernmost area of Telkwa appeared most promising.
  - Some other areas appeared to have limited potential.

2.2 A Campbell, Consultant, December 1977, Geological Report on Ground Water Exploration in Telkwa, B.C., 1977

- Three exploration wells drilled in Telkwa west of the Bulkley River.
  - One well developed, acceptable water quality, low capacity.
- Wells near existing water mains thought to offer limited capacity.
- Fan formation in Skillhorne road area appeared promising, not test drilled.

2.3 Aquaterre Consultants, December 1985, Water Well Drilling and Testing Program, for the Village of Telkwa

- Carried out a ground water potential study for the Village.
- Two areas identified for potential groundwater development.
  - Near the Telkwa airfield (vicinity of A. Campbell test wells).
    - aquifer found to be of low capacity when test well drilled.
    - high sodium and iron content.
  - Near Highway 16 by the Forestry Nursery.
    - identified but not tested at that time.

2.4 Aquaterre Consultants, December 1986, Water Well Drilling and Testing Program, Highway 16 Site, for the Village of Telkwa

- Observed drilling of Ministry of Forests Nursery well (now known as Chadsey Well) and felt there was good potential for the Village to also develop well on the same aquifer.
- Test well drilled
  - Similar stratigraphy to Nursery well.
  - Capacity at that time thought to be 15.2 L/s.
  - Manganese and sodium levels slightly elevated.
- Recommended that the well be put in operation and monitored. This well subsequently became the current production well.

2.5 KLM Engineering, August 1987, Village of Telkwa, Water System Study.

- Reviewed the Village's water supply and distribution system
- Three major conclusions of the study:
  - Highway 16 well water suitable for use without treatment.
  - Elevated reservoir needed in east bench area for fire protection in downtown and east bench area.

- New 200 mm diameter watermain needed from Highway 16 well to B street.

- Further conclusions and recommendations of the study were:
  - Existing supplies were marginal for maximum day demands.
  - Develop an additional supply well.
  - There were no indications of major leaks in the distribution system.
  - Fireflows east of the Bulkley River were inadequate.

2.6 Pacific Hydrology Consultants Ltd., May 1990, Evaluation of the Capacity of the Telkwa "Airfield" Aquifer Complex

- Summit Nursery Well pump tested (near airport).
  - identified limited capacity in "Airfield" aquifer.
  - long term supply to Village not possible on that aquifer.
  - Aquifer complex is confined with limited recharge ability.

2.7 McElhanney Engineering Services Ltd., December 1995, The Village of Telkwa Water Study.

- Identified several shortcomings in Telkwa's water system:
  - Water storage inadequate for fire protection.
  - Inadequate water supply for peak draws in summer months.
- Recommended:
  - Water metering to encourage conservation.
  - Installation of pressure reducing valves.
  - A leak detection program.
  - 390,000 Litre expandable reservoir for east side of Bulkley River.
  - Filtration of Bulkley River water prior to disinfection.

2.8 Report Review Summary

The previous reports have generally agreed that there is not potential for aquifer development on the west side of the Bulkley River near the airport. There is a concern with the water quality of the existing production well (Highway 16 well) with respect to elevated levels of Iron and Manganese.

Where mentioned in the reports, the original river intake was identified as a potential health risk due to the high load of fine suspended sediment that could be introduced to the distribution system. This high suspended sediment load would interfere with disinfection and if allowed to settle in the distribution system the sediments would provide an environment that could allow pathogens to flourish.

The recent report by McElhanney (December 1995) suggested that the water supply system was marginal for meeting peak demands during the summer months. Supply capacity would need improvement with additional wells or surface sources.

The most recent reports dealing with the water system as a whole have identified the need for increased water storage for fire protection, balancing peak demands, and emergency storage. Preferably a new reservoir would be located on the east side of the Bulkley River to improve fire flows in the downtown area and reduce dependence on the single watermain crossing of the Bulkley River. There have also been deficiencies identified with the distribution system, additional watermains and looping of the system would improve reliability and fire flows.

Where previous reports have dealt with groundwater sources all have agreed that the "airfield" aquifer does not appear promising for supplying the Village with water. Less certain is whether groundwater sources can be expanded on the "Village" aquifer to the east of the Bulkley River. If additional groundwater sources can be developed in the Village area then the Village's water demands can be met relatively easily. However,

should it turn out that there is no additional capacity on the Village aquifer alternative source development will be required.

3.0 WATER DEMAND ANALYSIS

3.1 Population

During the period 1986 to 1996 the Village of Telkwa experienced an average growth rate of 3.3%. During the period 1966 to 1996 the District of Houston had experienced a similar average growth rate of 2.7%. Based on this information a long-term average growth rate of 3% appears reasonable for the Village.

This projection does not allow for the possibility of a rapid increase in population, as would be associated with significant industrial development, for example should the proposed coal mine in the Telkwa area proceed.

Based on a 1999 population of 1286 and a continued 3% average growth, the Village's population will approach 2500 in the year 2020.

3.2 Water Demands

3.2.1 Average Day

In the previous Reservoir Feasibility Report Dayton & Knight Ltd. (D&K) analyzed the water consumption records for the Village of Telkwa. Over the years of 1993 to 1995 the average per capita consumption rate had varied between 590 and 656 L/day the average for the three years being 620 L/day per capita. In comparison, unit per capita demand values of 650 L/day for average day and 1790 L/day for maximum day demands were recommended in that report. By comparison, studies done by D& K for similar communities have shown an average day per capita demand of approximately 500 to 600

L/day and a maximum day per capita demand of 1500 L/day. An average day per capita demand of 620 L/day for Telkwa therefore appears to be high.

The majority of Telkwa's water distribution system is composed of older asbestos cement pipe. Considering this, and the high average water demands of 620 L/day per capita, it is therefore reasonable to assume that there is significant leakage in the Village's system. Determining and correcting actual water system leakage would require a leak detection investigation with measures to correct any leakage found.

Based on per capita consumption figures for a number of similar communities an average day per capita consumption of 550 L/day is reasonable. It will therefore be assumed for the purposes of this study that the balance of 70 L/day per capita is leakage.

Table 3.1 contains a summary of the per capita demands for average day, maximum day and peak hour. A summary of estimated total water demands is provided in Table 3.2.

3.2.2 Peak Demands

During the record period of 1993 to 1995 the recorded maximum day flow occurred on July 14, 1994 with a per capita flow of 1718 L/day. Subtracting the per capita leakage allowance of 70 L/day yields a maximum day per capita demand of 1648 L/day (say 1650 L/day). In comparing to the average day domestic unit demand of 550 L/day the maximum day peaking factor is 3. A maximum day peaking factor of 3 is on the high side of those normally encountered, which range from 2.5 to 3.

Peak day demands could be reduced with consumption management measures. This may include metering to encourage conservation or sprinkling restrictions during the summer months.

If consumption management measures were enacted and proved successful the maximum day peaking factor would be reduced, possibly as low as 2.5. This would significantly reduce the load placed on the Village's water supplies.

Estimated maximum day and peak hour unit demands are presented in Table 3.1. Maximum day and peak hour total flow rates are estimated in Table 3.2. For purposes of comparison, flow rates are provided both for the existing maximum day peaking factor of 3 and for a reduced maximum day peaking factor of 2.5, assuming that conservation measures proved successful. The same peak hour factor of 1.45 was employed for both cases.

TABLE 3.1
DOMESTIC PER CAPITA DEMANDS

	Average Day	Maximum Day (L/cap/day)		Peak Hour (L/cap/day)	
	(L/cap/day)	No Conservation	Conservation	No Conservation	Conservation
		PF = 3	PF = 2.5		
Domestic	550	1650	1375	2395	1995
Leakage	70	70	70	70	70
Total	620	1720	1445	2465	2065

3.2.3 Milk Plant

Water demands for the Milk Plant were assumed to be the same as those used in the Reservoir Feasibility Report. Average day demands were 0.5 L/s increasing to 0.75 L/s over time. Maximum day demands for the Milk Plant were 1.0 L/s in the short term, increasing to 1.5 L/s for the long term. Peak hour demands were estimated to be 5.0 L/s in the short term and 7.5 L/s in the long term.

3.2.4 Summary of Demands

The following table summarizes the total demands used for the purposes of this report. Average day demands are estimated to increase to 17.9 L/s by 2020. Without water conservation measures peak day demands will increase to 49.0 L/s by 2020. If

conservation measures are successfully implemented peak day demand could be reduced to 41.4 L/s in 2020. Peak hour demands in 2020 are estimated to be 75.5 L/s without conservation and 64.5 L/s with conservation. These demand estimates assume a constant population growth rate of 3% per year.

TABLE 3.2
PROJECTED WATER DEMAND SUMMARY

Year	Demands					
	Pop.	Average Day (L/s)	Peak Day (L/s)		Peak Hour (L/s)	
			No conservation	conservation	No conservation	conservation
1999	1286	9.7	26.6	22.5	41.6	35.7
2000	1324	10.0	27.3	23.1	42.7	36.6
2005	1534	11.7	32.0	27.1	51.2	44.1
2010	1778	13.5	36.9	31.2	58.1	49.9
2020	2389	17.9	49.0	41.4	75.5	64.5

(Note that calculated demands in Table 3.2 includes leakage and Milk Plant demands.)

For the purposes of this study the “no conservation” scenario demands are used for estimating required supplies and sizing of the reservoir. However, it is noted that the time period before these capacities of these components is exceeded would be extended by implementing conservation measures.

4.0 WATER SOURCES & TREATMENT OPTIONS

4.1 Existing Sources

The Village currently obtains all of its water from the existing production well, constructed in 1986, and the recently constructed (1998) infiltration gallery from the Bulkley River. These sources can operate separately or in combination. The production well is used for supply most of the time and is supplemented with the infiltration gallery when demands are high.

4.1.1 Capacity

The existing production well was placed in operation in 1986, and is located on an aquifer that lies under the main village area of Telkwa east of the Bulkley River. At the time that it was placed in operation its capacity was reported to be 15 L/s. The pump in the production well is reported to have a capacity of 11.5 L/s at a TDH of 90.0 m.

In September, 1999, AGRA Earth & Environmental conducted pumping tests on the existing production well and the Village owned former Chadsey well. The AGRA report is enclosed in Appendix A. The general conclusions arising from AGRA's investigation were:

1. Interference between the two wells occurs. The main well is more heavily interfered with by the Chadsey well than vice versa.

2. The Chadsey well may be imposing a low flow boundary on the production well.

3. The static water level in the aquifer has dropped by 3.7 metres since the wells were first installed. The time period over which this has occurred is not known.

4. Static water levels in the aquifer were 6.7 metres below the level of the Bulkley River, this indicates that there is low permeability sediments between the river and the well which prevents direct recharge of the well by the river.

5. AGRA feels that the aquifer has been over pumped by the production well.

6. The recommended sustained capacities of the production well and Chadsey well are 5.4 and 10.0 L/s respectively. This is significantly less than their original reported capacities and in the case of the production well below the capacity of the installed pump.

In summary, the testing shows that the sustainable rates at which the two wells can be pumped are considerably less than that reported when they were originally drilled.

The infiltration gallery from the Bulkley River is of recent construction and replaces an older gallery and direct intake. The new gallery was pump tested in the spring of 1999 and found to have a capacity of approximately 19 L/s during high Bulkley River levels. Assuming that peak demands during the summer coincide with high Bulkley River levels, the peak capacity of the infiltration gallery should be available during these periods. The infiltration gallery capacity may depend on the levels in the Bulkley River and its capacity in the fall and winter may be lower than that measured so far. Seasonal variation in the capacity of the infiltration gallery due to varying river levels is not known, but it is believed to be considerably less than peak capacity during the fall and winter.

4.1.2 Quality

Water quality from the production well has reportedly been a concern. Elevated maganese levels, up to 0.16 mg/L, have been reported. The Aesthetic Objective (AO)

upper limit in the Guidelines for Canadian Drinking Water Quality (GCDWQ) is 0.05 mg/L. Hardness levels up to 128 mg/L as $CaCO_3$ have been reported in the well water. The GCDWQ recommend hardness levels between 80 to 100 mg/L as $CaCO_3$ and the well water therefore is slightly hard. Treatment options for the Village's groundwater supplies are discussed in Section 4.3.

The manganese concentrations and hardness are primarily an aesthetic concern and are not believed to have any health impacts. Manganese can cause staining of fixtures and laundry, while elevated hardness levels can lead to encrustation of pipes and fixtures and increased soap use for laundry.

Sodium levels in Telkwa's well water were reported to be 26.0 mg/L. This is slightly above the level at which health officials should be notified (20.0 mg/L) but well below the Aesthetic Objective level of 200 mg/L. Sodium in water supplies can be a concern for those on sodium restricted diets, and must be taken into account by health professionals. The sodium levels in the Telkwa wells are only slightly elevated and treatment for sodium removal is not considered necessary.

Pathogenic organisms are not currently a concern with the groundwater source.

Water quality from the new infiltration gallery is somewhat improved over that from the original installation. There is not currently any turbidity data for raw water in the Bulkley River or for water drawn from the infiltration gallery during spring freshet or other high turbidity periods. However, fine sediments can still be drawn into the distribution system. These fine sediments interfere with disinfection and can settle in the distribution system, providing a media in which pathogenic organisms can establish themselves. Treatment options for the infiltration gallery source are discussed in section 4.3.

The operation of the Village's water system is potentially of concern. Water from the infiltration gallery is disinfected with sodium hypochlorite, while the well water is not disinfected. When both sources are being used the two waters mix in the distribution

system and the sodium hypochlorite added to the gallery water is diluted, thereby compromising disinfection.

4.2 Proposed Sources

4.2.1 Capacity

The Village has purchased the former Forest Nursery or Chadsey Well. This well was reported to have a capacity of 22 L/s. This well draws from the same aquifer as the current production well and is located approximately 175 metres north of it. The well still contains a 15 Hp pump and could be made operational by connecting electrical power, as was done for the recent pumping test by AGRA Earth & Environmental (AGRA). However, the well does not currently connect to the Village's water distribution system. The rated head of the Chadsey well pump is not known, so it was not possible to evaluate how it would operate when tied into the Village system.

As a result of the pump testing carried out in September 1999, AGRA have estimated that the sustainable pumping rate (with simultaneous operation of the existing production well) would be approximately 10 L/s. This is less than half the capacity reported when the Chadsey well was first drilled.

AGRA also noted that any additional groundwater development should be at least 300 metres from the existing wells so that it would be outside their zone of influence. Further successful development of wells on the Village aquifer is uncertain and a more rigorous hydro-geological investigation would be required prior to the development of additional wells.

Subsequent to the well pumping tests, AGRA has recommended a two part investigation of the Telkwa aquifer to determine the potential for expanding the groundwater supply to Telkwa. AGRA proposes an initial investigation to drill three test wells and monitor water levels and sample for water quality in the aquifer. These wells would be monitored

for interference while operating the Main and Chadsey Wells. If the results of the initial investigation justified it, two of the wells would be screened and yield tested. Each part of AGRA's proposed investigation would cost approximately $20,000, for a total of $40,000. A copy of this recommendation from AGRA is enclosed in Appendix B.

If a hydro-geological investigation proved successful, the conceptual estimated cost for developing an addition well is approximately $1,303,000 (GST included). This estimate includes the hydro-geological investigation, the well and pump, an assumed 2 km dedicated supply main to the Trail Avenue Reservoir site (longer for Trobaks Hill, and dependant on actual well siting) and controls and electrical. This item is detailed in Section 6. In view of the high risk of the exploration program not being successful and the resulting high cost of developing a future hydrogeological source, Dayton & Knight Ltd. does not recommend any further hydrogeological exploration.

The only readily apparent additional surface water source would be the construction of a new infiltration gallery on the Bulkley River to supplement (or replace) the existing gallery. A new gallery would be similar in design to the existing gallery. Additional pumps and a tie in to the distribution system would be required for the new gallery.

Tyhee Lake has a drainage area of approximately 32 square kilometers. This area would likely provide a sufficient base flow to satisfy Telkwa's water needs. However, Tyhee Lake is used as a recreational water body during the summer months, and many homes with septic systems are located in its vicinity. Little is known of Tyhee Lake water quality but a level of treatment equivalent to that for the Bulkley River would likely be required. In addition a supply main at least one kilometer long would be required, as would a pump station. The Bulkley River infiltration gallery is closer to Telkwa and already has much of the required infrastructure in place, as such it is preferable as a surface water source. In view of this, Tyhee Lake is not considered further.

Dayton & Knight Ltd. has reviewed topographic maps of the Telkwa area. There are no other watersheds or stream courses that appear promising as an alternate surface water source to the Bulkley River.

4.2.2 Quality

The water quality issues from both a new groundwater source or increased infiltration gallery capacity would be expected to be similar to those encountered with the existing sources. Increased infiltration gallery capacity would require an expansion of any treatment process that is provided for the existing infiltration gallery or new gallery at a different site.

4.3 Water Treatment Options

Contamination from the infiltration gallery poses a risk to the health of Village residents and to ensure a safe potable water supply, it is recommended that the water from the infiltration gallery be treated. The groundwater sources (Production and Chadsey Wells) have water quality issues that are more of an aesthetic concern than a health concern.

4.3.1 Surface Water

Water withdrawn from the Bulkley River through the infiltration gallery experiences high turbidity during the freshet period. High turbidity interferes with disinfection by shielding pathogenic organisms from the disinfectant, thereby allowing waterborne diseases to enter the distribution system. Further, the turbidity itself can settle out in quiet areas of a distribution system and provide an environment where pathogenic organisms can take hold. Even when waterborne diseases are not present, turbidity is aesthetically undesirable for water users.

For conceptual design purposes it was estimated that during the freshet the Bulkley River turbidity would run as high as 50 NTU during peak periods. Monitoring of Bulkley River

water quality should be undertaken prior to actual selection and design of treatment units for the Village. Because of space limitations at the existing infiltration gallery site it is assumed in the cost estimates that a new site, including a new infiltration gallery, is required.

Depending upon turbidity levels realized from the infiltration gallery, it may be possible to utilize package direct filtration units for water treatment. If turbidity levels exceed 40 NTU then settling/clarification would be required prior to filtration. To match the current capacity of the infiltration gallery (300 USgpm) the cost of package treatment is estimated to be approximately $1,550,000 (GST included) with pre-clarification and $1,532,000 (GST included) without pre-clarification.

4.3.2 Groundwater

Water from the Production well, and by inference from the Chadsey well, has been identified as being high in manganese and hardness. Neither of these elements is believed to pose a health threat at the levels found in the Village's groundwater supply. They are potentially an aesthetic nuisance due to the effect of manganese discoloring laundry and water fixtures and hardness encrusting pipes and fixtures.

Manganese removal can be accomplished by several different processes. The removal process generally consists of oxidation followed by liquid/precipitate separation. The effectiveness of each option is difficult to predict and varies with the specific properties of the subject water. A pilot study is normally required to assess which approach is most applicable to a given water source. Possible treatment options include; chlorine oxidation and filtration, potassium permanganate oxidation and filtration, birm filtration and ion exchange softening. While the AO limit of 0.05 mg/L of manganese is exceeded by Telkwa's ground water supply (0.15 mg/L), the manganese concentration is still relatively low. Water treatment for manganese removal should be initiated if there are consumer complaints of discoloration problems.

A variant of the chlorine oxidation approach may provide a simple means for treating the Village's water supply if groundwater is to be the main source. If a dedicated water main from the wells to the new reservoir were implemented (most viable for the Trail Avenue site), the water could be chlorinated at the wells and the precipitate of manganese allowed to settle out at the reservoir, before entering the distribution system. This would involve additional water main construction.

Hardness removal from Telkwa's groundwater could be accomplished by the addition of lime to remove the desired amount of calcium carbonate hardness. The precipitate of calcium carbonate would then be settled in a clarifier or filtered and the pH of the water adjusted. In Telkwa's case the hardness of the groundwater sources exceeds the desirable range of 80-100 mg/L as Calcium Carbonate by only 20 mg/L. It is unlikely that this small quantity of excess hardness presents any major problems, therefore the cost of hardness adjustment on the existing groundwater supply is probably not justified.

4.4 Discussion

Comparison of the existing supply sources, the production well and infiltration gallery, with estimated maximum day demands (see Table 4.1) indicates that the currently utilized supplies are marginal at this time. Currently, the available supplies are 24.4 L/s as compared to an estimated maximum day demand on the order of 26 L/s. Bringing the Chadsey well on line would make available a supply of 34.4 L/s. This would provide adequate supplies until at least the year 2005, depending upon population growth and demand trends. If conservation measures were successfully enacted the three sources combined would be adequate for maximum day until the year 2010, allowing further source development to be delayed by up to five years. Table 4.1 provides a summary of the projected demands and existing and proposed short term supply options for the Village:

TABLE 4.1
PROJECTED DEMANDS AND SHORT TERM SUPPLIES

Year	Demands				Supply			Summary			
	Pop.	Average Day	Peak Day		Production (Existing)	Chadsey Well (Assumed Connected)	Infiltration Gallery (Assumes used only with Treatment)	Wells Only (Assumed no use of Infiltration Gallery)		Wells and Infiltration Gallery	
			Summer (No conservation)	Winter				Total Supply	Shortfall (Summer)	Total Supply	Shortfall (Summer)
		(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)
2000	1325	10	27	18	5	10	19	15	12	34	-
2005	1550	12	32	22	5	10	19	15	17	34	-
2010	1800	14	37	25	5	10	19	15	22	34	3
2020	2400	18	49	32	5	10	19	15	34	34	15

The Chadsey well should be connected to the Village water system immediately. The existing pump will need to be replaced and connected to the distribution system. The Chadsey well would also have to be tied into the control system that operates the production well. The estimated capital cost of bringing the Chadsey well into operation is $160,500 (GST included). It should be noted that the Chadsey well was estimated by AGRA to have a higher sustainable capacity (10 L/s) than the current production well (5.4 L/s)

The demand analysis indicates that there is insufficient water for peak day conditions with the current population. Additional water demands (i.e. residential or commercial development) on the system should be avoided until the Chadsey well is in production.

The two wells operating together would have sufficient estimated capacity (15.4 L/s) to satisfy average day demands until at least 2010. Alternatively the infiltration gallery has sufficient estimated capacity to satisfy average day demands until 2020, but requires treatment.

To meet peak day demands, either the infiltration gallery must remain in use, with appropriate treatment, or additional groundwater sources identified and brought into production.

Without additional investigations, it is not possible to determine with certainty the potential for further ground water development in the Village area. AGRA recommends

a two part investigation for a total cost of approximately $40,000. There is no guarantee of successfully developing additional groundwater supplies for the Village. There is a high risk that such an investigation would be unsuccessful. Dayton & Knight Ltd. does not recommend any further groundwater exploration.

Given the high development cost of a new well, and the uncertainty of successfully locating a viable well site, the Bulkley River appears to be the preferred source.

If surface water (via an infiltration gallery) becomes the primary supply for the Village, water treatment should be provided.

Conservation measures should be implemented to defer the time at which additional sources will need to be developed.

5.0 WATER STORAGE

The Village of Telkwa currently has a single 909,000 L reservoir on Morris Hill on the opposite side of the Bulkley River from the Village center. The reservoir is connected to the main Village by a single watermain which is attached to a road bridge across the Bulkley River.

Dayton & Knight Ltd. conducted a feasibility study for a new reservoir for the Village in 1998. As part of the reservoir study D&K considered the efficiency and reliability of the distribution system, especially when conveying fire flows.

The reservoir study determined that the existing reservoir did not have sufficient capacity to meet the Village's current or future needs. Additional storage was necessary to provide adequate fire, emergency and peak period storage. In order to improve pressures in the main Village area during peak periods and fire flows, as well as to reduce dependence on the single watermain crossing of the Bulkley River, it was determined that a site on the east side of the Bulkley River, closer to the main townsite, was preferable. Several individual options, including associated watermains, and in some cases booster pump stations, were examined in the report.

Two differing criteria for determining the required total storage was used:

Total storage required = A + B + C

Or

Total storage required = A + B

Where:

A = fire fighting storage capacity

B = equalization storage capacity equal to 25% of projected maximum day demand.

C = emergency storage capacity equal to 25% of A + B. The emergency storage can be eliminated (first criteria) where system maintenance and flexibility reduces the risk of supply interruption.

There are several factors affecting the reliability of the Village of Telkwa's water supply. Both existing sources are pumped and are connected to the same power grid. Neither source is equipped with standby power at this time. Power outages can be expected to occur on a relatively frequent basis, affecting one and possibly both sources. Also affecting system reliability is the location of the existing reservoir on the east side of the Bulkley River. Even accounting for the addition of a new reservoir, a break or interruption of service in the single watermain crossing of the Bulkley River would remove a significant portion of the available storage from use in the main part of the Village area, where demands and required fire flows are greatest. The new reservoir should therefore be capable of operating completely independently of the existing. This suggests that including emergency storage in the new reservoir would be prudent.

The residential fire demand is assumed to be 60L/s for 90 minutes or 324,000 L. The commercial fire demand is assumed to be 133 L/s for a duration of 2 hours. The Village currently has four pieces of fire fighting apparatus; therefore the fire demand of 133 L/s is probably realistic for a large fire. It is assumed that future large buildings will be equipped with sprinkler systems to limit their potential fire demands. The commercial fire demand is the governing conditions for reservoir fire storage requirements.

The storage volume calculations from the reservoir feasibility study are summarized in Table 5.1. They have been revised to reflect the demand figures of this study and the year 2000 population projection. The original reservoir feasibility study was based on calculations and population projections starting from 1997.

TABLE 5.1
RESERVOIR SIZING AND STAGING

Year	Population	Maximum Day Demand (L/s)	Design Fire Flow (L/s)	Fire Storage A (L)	Equalization Storage B (L)	Emergency Storage C (L)	Total Recommended Storage (L)	Net Additional Storage Required (L)
2000	1325	27.3	133	960,000	590,000	388,000	1,938,000	1,029,000
2010	1800	36.9	133	960,000	797,000	439,000	2,196,000	1,287,000
2020	2090	49.0	133	960,000	1,059,000	505,000	2,524,000	1,615,000

Due to a revision in the projected future demands. The Village's immediate storage requirements have been revised to 1,029,000 L from the 860,000 L of the earlier feasibility study. In order to meet the Village's storage requirements to the year 2010, the new reservoir should be sized for 1,287,000 L. An ultimate reservoir size of 1,615,000 would be sufficient up to the year 2020, given current growth rates. If conservation measures prove successful the reservoir would meet the Village's requirements for a longer time horizon. Combined with the existing reservoir these volumes would provide sufficient storage for peak demand balancing, emergencies and fire demands. A 1,615,000 L reservoir would also allow for provision of the design fire flow and some equalization and emergency storage for the main Village area, even if the crossing of the Bulkley River were out of service and the existing reservoir storage unavailable.

If emergency storage is not provided, and system reliability is not deemed to be an issue, a reservoir of 641,000 L size would meet the Village's immediate needs. For the projected year 2020 population a reservoir of 1,010,000 L size would be required if emergency storage were omitted. However, given the small incremental cost of providing the emergency storage, it is recommended that the large reservoir be built.

Two separate options were identified for siting of the new reservoir. The first was a reservoir and booster pump station on Trail Avenue, east of and above the Village center. The second was a reservoir located on Trobaks Hill to the south of the Village center. The Trobaks Hill option involved a longer run of watermain, and is located outside of the Village's current boundaries. The first option, on Trail Avenue, was preferred if there was no further expansion of Village boundaries and development of the Aldermere property. If the Village boundaries were expanded

and the Aldermere property were developed, then Trobaks Hill would be preferable as some of the costs could be deferred by DCC.

The cost comparison of the two options is reproduced here in Table 5.2 for reference.

TABLE 5.2
RESERVOIR CAPITAL AND LIFE CYCLE COSTS

	Capital Cost ($) (GST inc.)	Present Worth Capital Expansion ($) (GST inc.)	Present Worth O&M ($)	Life Cycle Cost Present Worth ($)
Trail Avenue				
1,029,000 L with 586,000 L expansion	804,000	230,000	261,000	1,351,000
above including Aldermere servicing	860,000	677,000	280,000	1,827,000
1,615,000 L	1,066,000	0	261,000	1,327,000
above including Aldermere servicing	1,066,000	447,000	280,000	1,803,000
Trobaks Hill				
1,029,000 L with 586,000 L expansion	1,389,000	230,000	77,000	1,696,000
1,615,000 L	1,595,000	0	77,000	1,672,000

If the Aldermere property were developed the total cost of the reservoir and site servicing would be less for the Trobaks Hill reservoir site than for the Trail Avenue site. However, unless development of this site and expansion of Village boundaries is proceeding with certainty in the near future, the Trail Avenue site is likely to be less costly. Provision of additional storage capacity should not be significantly delayed in hopes of accommodating the Aldermere development. The Village has expressed that the Trobaks Hill option is more desirable, however if Village expansion and the Aldermere development were to be delayed significantly the Trail Avenue site would become preferable.

If the reservoir is built out to its full size (1,615,000 L) immediately at either site there is an estimated premium of $206,000 in up front costs. The net life cycle cost is slightly lower for building the reservoir to full size immediately. The Village has expressed a preference to build the reservoir at the Trobaks Hill site to full size initially.

6.0 DISTRIBUTION SYSTEM

The Village's distribution system is primarily asbestos cement pipe of 30-40 years age. Newer portions of the water distribution system are PVC pipe of less than 20 years age. Pipe diameters range from 10 inch on the main trunks to 6 inch on the distribution system loops in the main village area and on the west side of the Bulkley River. The single crossing of the Bulkley River, between the main village area and the reservoir, is a 10 inch line supported by a road bridge.

The water demand analysis of section 4 indicates that there is a significant leakage component. It is likely that this leakage is occurring mostly in the older asbestos cement sections of pipe.

As part of the earlier Reservoir Feasibility Study, required additions and improvements to the distribution system were analyzed using a computer model of Telkwa's water system. In addition to watermain extensions required to connect to the proposed reservoir sites, twinning and looping of watermains in the North Yellowhead Highway and lower Cottonwood Flats areas is required.

Twinning and looping of watermains in the North Yellowhead Highway and lower Cottonwood flats area is estimated to have a total capital cost of $1,577,000 (including GST). A portion of these costs would be recovered through DCC. It is assumed that this work would be phased.

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7.0 COST ESTIMATES

7.1 Capital Costs

7.1.1 Chadsey Well

The estimated capital cost of connecting the Chadsey well to the distribution system and making it operational is:

• New pump and pump house	$ 50,000
• Electrical and controls, including tie in to existing	25,000
• Approximately 200 m of 250 mm watermain	50,000
SUB-TOTAL	**$125,000**
• Allow 10% for Engineering	12,500
• Allow 10% for Contingencies	12,500
SUB-TOTAL	**$150,000**
• 7% GST	10,500
TOTAL	**$160,500**

7.1.2 New Infiltration Gallery with Package Treatment

The two options are dependent on peak turbidity levels in the Bulkley River.

Direct Filtration Package Treatment (capacity 19 L/S)

This is the estimated cost of purchasing and installing a package water treatment unit and new infiltration gallery, including connections and appurtenances. This option depends on peak Bulkley River turbidity levels being less than 40 NTU. It is assumed that a new

infiltration gallery site is required, as the existing site is too small to accommodate a treatment plant.

It is also assumed that purchase of new property is required.

• Property acquisition	$50,000
• Site preparation	30,000
• Design and install new infiltration gallery	80,000
• Supply and installation of package treatment unit	270,000
• Clearwell/chlorine contact tank	40,000
• Plant piping	100,000
• Building and appurtenant work	175,000
• Pump station and appurtenances	250,000
• Backwash pumps	60,000
• Power supply, electrical and controls	30,000
• Residuals handling	20,000
• Connections to distribution system	40,000
SUB-TOTAL	**$1,145,000**
• Allow 10% Engineering	114,500
• Allow 15% Contingencies	171,500
SUB-TOTAL	**$1,431,250**
• 7% GST	100,200
TOTAL WITH GST	**(Say) $1,532,000**

Upflow Clarifier and Tube Settler Package Treatment (Capacity 19 L/s)

This is the estimated cost of purchasing and installing a package water treatment unit and new infiltration gallery, including connections and appurtenances. This option would be for peak Bulkley River turbidity levels being greater than 40 NTU. This assumes a new infiltration gallery site is required, as the present site is too small to accommodate a treatment plant. It is also assumed that property purchase is necessary.

• Property Acquisition	$50,000
• Site Preparation	30,000
• Design and install second infiltration gallery	80,000
• Supply and installation of package treatment unit	300,000
• Clearwell/Chlorine Contact Tank	40,000
• Plant piping	100,000
• Building and appurtenant work	175,000
• Pump station and appurtenances	250,000
• Backwash pumps	60,000
• Power supply, electrical and controls	30,000
• Residuals handling	20,000
• Connections to distribution system	40,000
SUB-TOTAL	**$1,175,000**
• Allow 10% Engineering	117,500
• Allow 15% Contingency	176,250
SUB-TOTAL	**$1,468,750**
• 7% GST	102,813
TOTAL WITH GST	**(Say) $1,571,000**

Second Infiltration Gallery and Treatment Units and Pump Station

This item estimates the cost of expanding the Village's water supply by adding a second infiltration gallery and treatment units of equal capacity (19 L/S) to the first. This item will be necessary between the years of 2005 to 2010, depending upon population growth and the effectiveness of conservation and leakage control measures. This item assumes that a upflow clarifier and tube settling package treatment unit will be necessary.

• Design and Install Second Infiltration Gallery	$ 80,000
• Supply and Installation of package treatment unit	280,000
• Clearwell/Chlorine Contract Tank	40,000

• Plant Piping	40,000
• Building and appurtenant works	100,000
• Pump station and appurtenances	250,000
• Backwash pumps	60,000
• Power Supply, electrical and controls	30,000
• Connections to distribution system	40,000
SUB-TOTAL	**$920,000**
• Allow 10% Engineering	92,000
• Allow 15% Contingency	138,000
SUB-TOTAL	**$1,150,000**
• 7% GST	80,500
TOTAL	**(Say) $1,231,000**

7.1.3 Reservoir

Trail Avenue Reservoir Option

This item is the estimated cost for the Trail Avenue Reservoir Option that would be favoured if the Village does not expand its boundaries southward to include the Aldermere property and Trobaks Hill reservoir site. This costing assumes that the reservoir is built to full size (1,615,000 L) initially.

• Mobilization and Demobilization	$10,000
• Site Clearing and Grading	$6,000
• Booster Pump Station	$275,000
• 30m of 200 mm diameter watermain @ $200/m	$6,000
• Check valve stations	$10,000
• Combination pressure reducing /altitude valve station	$40,000
• Construct 1,615,000 L reservoir and foundation	$443,000
• Property Purchase	$40,000
SUB-TOTAL	**$830,000**

• Allow 10% engineering	83,000
• Allow 10% for Contingencies	83,000
SUB-TOTAL	**$996,000**
• 7% GST	69,720
TOTAL	**(Say) $1,066,000**

Note that a reservoir sized for immediate requirements only, without emergency storage (641,000 L) would have an estimated capital cost of $700,000 for the Trail Avenue Site. If sized and built for 2020 with no emergency storage (1,010,000 L), the reservoir would have an estimated capital cost of $840,000 for Trail Avenue.

Trobak's Hill Reservoir Option

This item is the estimated cost for the Trobak's Hill Option that would be favored if the Village expands its boundaries southward to include the Aldermere property and Trobaks Hill reservoir site. This costing assumes that the reservoir is built out to full size initially.

• Mobilization and Demobilization	$ 10,000
• Site Clearing and Grading	6,000
• 1,575 m of 350 mm diameter watermain @ $350/m	551,000
• 400 m of 300 mm diameter watermain @ $300/m	120,000
• 160 m of 200 mm diameter watermain @ $200/m	32,000
• Construct 1,615,000 L reservoir and foundation	443,000
• Altitude Valve Station at Morris Hill Reservoir	40,000
• Communications	40,000
SUB-TOTAL	**$1,242,000**
• Allow 10% engineering	124,000
• Allow 10% for contingencies	124,000
SUB-TOTAL	**$1,490,000**
• 7% GST	104,300
TOTAL	**$1,595,000**

Note that a reservoir sized for immediate requirements only, without emergency storage (641,000 L) would have an estimated capital cost of $1,222,000 for the Trobaks Hill Site. If sized and built for 2020 with no emergency storage (1,010,000 L), the reservoir would have an estimated capital cost of $1,330,000 for Trobaks Hill.

Service Area Expansion

This item is the cost to provide water service to the future commercial properties along Highway 16 south of the Village. This item would be a component of the Trobaks Hill Reservoir Option but would have to be built separately under the Trail Avenue Reservoir Option.

• 1,160 m of 300 mm diameter watermain @ $300/mm	$348,000
• Allow 10% engineering	35,000
• Allow 10% contingency	35,000
SUB-TOTAL	**$418,000**
• 7% GST	29,620
TOTAL	**(SAY) $447,000**

7.1.4 Distribution System Improvements

Watermain Twinning and Looping

These items estimate the cost to improve the distribution system to provide adequate fire flows and pressures during peak demands. Twinning of the watermain to the Yellowhead North area along Highway 16 is required, as is looping of the distribution system in the lower Cottonwood flats area. DCC item number denoted as (#). DCC item number denoted as (#).

1. 100 m of 150 mm diameter watermain @ $200/m	$ 15,000

2. 200 m of 150 mm diameter watermain @ $200/m	30,000
3. 40 m of 300 mm diameter watermain @ $200/m	12,000
4. 620 m of 300 mm diameter watermain @ $200/m	186,000
5. 350 m of 300 mm diameter watermain @ $200/m	105,000
6. 700 m of 300 mm diameter watermain @ $300/m	210,000
7. 545 m of 300 mm diameter watermain @ $200/m	164,000
8. 700 m of 300 mm diameter watermain @ $200/m	210,000
9. 200 m of 200 mm diameter watermain @ $200/m	40,000
10. 90 m of 150 mm diameter watermain @ $200/m	14,000
11. 250 m of 300 mm diameter watermain @ $300/m	75,000
12. 230 m of 300 mm diameter watermain @ $300/m	69,000
13. 650 m of 150 mm diameter watermain @ $200/m	98,000
SUB-TOTAL	**$1,228,000**
• Allow 10% for Engineering	123,000
• Allow 10% for Contingency	123,000
SUB-TOTAL	**$1,474,000**
• 7% GST	103,180
TOTAL	**(Say) $1,577,000**

7.1.5 Standby Power for Water Source

This item estimates the capital cost for providing standby power to one of the water sources. It is assumed that the water source with the greatest capacity would be provided with standby power.

• Standby Genset and enclosure (assume 50 hp)	$50,000
• Controls	10,000
• Allow 10% Engineering	6,000
• Allow 10% Contingency	6,000
SUB-TOTAL	**$72,000**
• 7% GST	5,040

TOTAL	**(Say) $77,000**

7.1.6 Groundwater Source Development

This item estimates the capital cost to identify and develop expanded groundwater supplies as an alternative to surface water sources. This estimate assumes a 2 km dedicated watermain from the new well to the Trail Avenue reservoir site. The actual watermain length would depend on the siting of a new well, and would also be longer of the Trobaks Hill option is selected. This item does not include possible treatment costs. The Village would require new groundwater sources with total capacity of 38 L/s approximately 25 L/s. Due to the uncertainty associated with this item a 30% contingency is included.

• Hydro-geological Investigation	$ 40,000
• Construct and Install new well and appurtenances	250,000
• Construct 2,000 m of 250 mm diameter watermain	500,000
• Power Supply	50,000
• Electrical and Controls	30,000
SUB-TOTAL	**$870,000**
• Allow 10% for Engineering	87,000
• Allow 30% for Contingency	261,000
SUB-TOTAL	**$1,218,000**
• 7% GST	85,260
TOTAL	**(Say) $1,303,000**

7.2 Operation and Maintenance Costs

7.2.1 Chadsey Well

The estimated annual operating cost of this well is $7,500 in power costs and $5,000 year in maintenance. For a 20 year period, assuming a 5% discount rate, the present value cost of O&M is $155,250.

7.2.2 Infiltration Gallery Water Treatment

Direct Filtration Package Treatment (capacity 19 L/S)

Cost estimates assume treatment unit works are at or near capacity throughout year. Actual operating costs will depend upon raw water quality.

The direct filtration plant has power costs for operation, chemical dosing and maintenance. The estimated power costs are $900 per year, with chemical dosing approximately $17,000/year and maintenance at $3000/year (approximately 2% of capital cost). Total yearly O&M is therefore estimated at $21,000 per year. The 20 year present value is then $262,000, at a 5% discount rate.

Upflow Clarifier & Tube Settler Package Treatment (Capacity 19 L/S)

The Upflow Clarifier and Tube Settling treatment plant has power costs for operation, chemical dosing and maintenance. The estimated power costs are $900 per year, with chemical dosing approximately $18,000/year and maintenance at $3500/year (approximately 2% of capital cost). Total yearly O&M is therefore estimated at $22,500 per year. The 20 year present value is then $280,000, at a 5% discount rate.

Second Infiltration Gallery and Treatment Units

The operating cost for the additional treatment units would be similar to those for the existing infiltration gallery. Annual operating cost would be $21,000 to $22,500 per year depending upon treatment process and water quality.

A new pump station would be required with the infiltration gallery, with an estimated operating cost of $12,000 per year.

The estimated 20 year present worth of O&M would be between $410,000 to $555,000.

7.2.3 Reservoir

Trail Avenue Reservoir Option

The Trail Avenue Reservoir Option requires that the booster pump station operate continuously. The average annual electricity cost would be $7,500. An additional $10,000 per year is anticipated for maintenance costs.

The O&M cost for the reservoir would be $2,000 per year.

The yearly O&M cost for the reservoir site would be $19,500.

One cycle of complete pump replacement would be required at ten years in a twenty year life cycle. The pump replacement would cost $30,000.

The 20 year present worth would be $261,000 at a 5% discount rate. This figure includes one pump replacement cycle after ten years.

Trobaks Hill Reservoir Option

The Trobaks Hill Reservoir option does not include a booster pump station. However, a new watermain of approximately 2,100 m length is required. At an estimated maintenance cost of $2/m the yearly O&M cost of the watermain would be $4,200.

The estimated yearly cost of reservoir maintenance would be $2000.

The 20 year present worth of O&M for the full size reservoir is estimated at $77,000.

Service Area Expansion

The O&M cost to service the commercial developments south of the Village, and the Aldermere development, in the absence of the Trobaks Hill reservoir, would be $2,300 per year for 1160 m of water main at a O&M cost of approximately $2/m. The 20 year present worth would be $29,000.

7.2.4 Watermain Twinning and Looping

Twinning and looping of the distribution system in the Yellowhead Highway North and Lower Cottonwood Flats areas would add approximately 4,675 m of watermain to the system. If all of these additions are carried out they would increase system O&M costs by approximately $9,350/year. The equivalent 20 year present worth of these costs would be $116,501 assuming a 5% discount rate.

1. 100 m @ $2/m	$200
2. 200 m @ $2/m	$400
3. 40 m @ $2/m	$80
4. 620 m @ $2/m	$1,240
5. 350 m @ $2/m	$700
6. 700 m @ $2/m	$1,400

7. 545 m @ $2/m	$1,090
8. 700 m @ $2/m	$1,400
9. 200 m @ $2/m	$400
10. 90 m @ $2/m	$180
11. 250 m @ $2/m	$500
12. 230 m @ $2/m	$460
13. 650 m @ $2/m	$1,300
TOTAL	**$9,350**
20 Year Present Worth @ 5%	$116,500

7.2.5 Standby Power for Water Source

It is assumed that the standby genset would operate occasionally and would require periodic testing and maintenance. Allow $3,000 per year for O&M for this item. The present worth for a 20 year period at 5% interest rate would be $37,000.

7.2.6 Groundwater Source Development

This item estimates the O&M cost of a new well, if a source were successfully identified and brought into production.

Based on the O&M costs of the production well the power and maintenance costs for a new well would be $7,500 and $2,000 respectively. The O&M costs for the 2000 metres of dedicated watermain would be $4,000/year based on $2/metre per year.

The total estimated O&M cost of a new groundwater source is $13,500 per year. The 20 year present worth is then $168,500 assuming a 5% discount rate.

7.3 Cost Summaries

The capital and O&M costs are summarized in Table 7-1.

TABLE 7-1
CAPITAL AND O&M COST SUMMARY

Description	Capital Cost ($) (GST inc.)	O&M ($/year)	20 Year Present Worth ($)	Total Life Cycle Cost
Chadsey Well	160,500	12,500	155,000	315,500
Infiltration Gallery Water Treatment				
• Direct filtration package treatment	1,532,000	21,000	262,000	1,794,000
• Upflow clarifier and tube settler package treatment	1,550,000	22,500	280,000	1,830,000
• Second infiltration gallery and treatment units	1,231,000	34,500	555,000	1,786,000
Reservoir				
• Trail Avenue	1,066,000	19,500	261,000	1,327,000
• Trobaks Hill	1,571,000	6,200	77,000	1,648,000
• Service Area Expansion	447,00	2,300	29,000	476,000
Watermain Twinning and Looping	1,577,000	9,350	116,500	1,693,500
Standby Power for Water Source	77,000	3,000	37,000	114,000
Groundwater Source Development No Treatment Included	1,303,000	13,500	168,500	1,471,500

8.0 RECOMMENDATIONS

Dayton & Knight Ltd. has identified a need both for a new reservoir and expanded water supplies with appropriate treatment. It is unlikely that the Village of Telkwa will be able to finance both of these projects simultaneously, with a combined capital cost of up to $3.15 million. A phased approach should therefore be adopted. It is recommended that the priorities be determined after consultation with the community and regulatory bodies.

The specific recommendations of this report are:

1. A decision should be taken regarding further hydro-geological investigations to determine the potential for further groundwater development. AGRA's proposal is included in Appendix B. Estimated cost $40,000. D&K does not recommend further hydro-geological investigations.

2. Before the next summer season, the Chadsey Well should be connected to the distribution system. In combination with the existing sources this should satisfy the Village's short term water supply requirements, but will not address quality and treatment issues. Estimated cost $160,500.

3. Water conservation and a leakage detection program should be implemented. The estimated cost of a leakage detection program is $35,000. This does not include the cost of required repairs.

4. A new infiltration gallery and water treatment plant should be constructed. The existing infiltration gallery site does not have sufficient space for a treatment unit. The new gallery and treatment plant should have equivalent capacity to the existing gallery

(19 L/s), but should be capable of providing this quantity year round. Estimated capital cost of this item is $1,571,000.

5. Construction of the new reservoir is necessary to ensure adequate storage for peak demand equalization, emergencies and fire flows. The final site selection should be made based on the likelihood of Village expansion and development of the Aldermere property proceeding in the near future. Trobaks Hill is favored if expansion occurs soon, Trail Avenue if expansion is deferred. The Village prefers the Trobaks Hill site because this will alleviate the need to maintain a pump station at the Trail Avenue site. Estimated costs $1,595,000 (Trobaks Hill), $1,066,000 (Trail Avenue). Constructing the new reservoir to full size (1,615,000 L) immediately is the most cost effective option, and is preferred by the Village. This would provide adequate equalization, fire flow and emergency storage, even if the Bulkley River crossing, and hence the use of the Morris Hill reservoir, were lost.

6. As the capacity of the existing supplies is reached further source capacity must be developed. Expanded infiltration gallery capacity with full treatment will be necessary to meet increasing demands. Estimated cost $1,231,000.

7. Distribution system improvements in the Yellowhead Highway North and Cottonwood Flats area are necessary to provide adequate peak period pressures and fire flows. These improvements could be undertaken concurrently with construction of the new reservoir or additional groundwater developments. Costs are presented in Section 7.1.4. This work would be phased.

8. At least one of the water sources should be provided with standby power to maintain some water supply during a power outage. Preferably this would be for the largest of the water sources. Estimated cost $77,000.

VILLAGE OF TELKWA
WATER SUPPLY STUDY

APPENDIX A

AGRA EARTH AND ENVIRONMENTAL LTD.
VILLAGE OF TELKWA, BRITISH COLUMBIA
WELL EVALUATION AND AQUIFER ASSESSMENT

VILLAGE OF TELKWA
WATER SUPPLY STUDY

APPENDIX B

AGRA EARTH AND ENVIRONMENTAL LTD.
PROPOSAL FOR FURTHER HYDROGEOLOGICAL INVESTIGATIONS