REGIONAL DISTRICT OF OKANAGAN SIMILKAMEEN

SAGE MESA WATER SUPPLY STUDY

June 2012





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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Scope of Work 1
2.0 WATER SYSTEM DESIGN CRITERIA 2
2.1 Source 2
2.2 Water Demands 2
2.3 Water Treatment 2
2.4 Pumping Systems 2
2.5 Distribution System and Pressure Zones 3
2.6 Reservoir Capacity 3
2.7 Fire Flows/Storage 3
3.0 POPULATION AND DEMANDS 4
3.1 Populations 4
3.2 Water Demands 4
4.0 EXISTING SYSTEM ANALYSIS AND UPGRADING REQUIREMENTS 6
4.1 Supply Source 6
4.2 Lake Intake 7
4.3 Pumping Capacities 7
4.4 Reservoir Capacity 8
4.5 Distribution System 10
4.6 Water Treatment 10
4.7 Required Upgrades 11
5.0 WATER SYSTEM UPGRADES 12
5.1 Common Upgrades 12
5.2 Option 1 – Upgrade Existing Supply 13
5.3 Option 2 – New Supply System 15
5.4 Summary of Upgrades 17
6.0 PROJECT COSTS 18
7.0 CONCLUSIONS AND RECOMMENDATIONS 19

APPENDIX A – DETAILED BREAKDOWN OF COSTS

List of Tables –

Table 2.1 – Fire Flows from RDOS Bylaw #2000
Table 4.2 – MOE Listing of Water Licenses
Table 5.1 – Summary of Upgrade Options
Table 6.1 – Estimated Capital Costs

List of Figures –

Figure 1 – Existing Water System
Figure 2 – Water System Schematic
Figure 3 – Chlorine Contact Time
Figure 4 – Water Supply Upgrade – Option 1
Figure 5 – Water Supply Upgrade – Option 2

1.0 INTRODUCTION

The Sage Mesa/Hisula Highlands (SM) area is serviced by a water system that draws water from an intake in Okanagan Lake. Water is chlorinated and then pumped to a reservoir in Sage Mesa. Water is then distributed to the residents of Sage Mesa. From the Sage Mesa Reservoir, water is pumped to an upper reservoir in the Hisula Highlands area. This reservoir supplies the residents of Hisula Highlands. **Figure 1** provides a layout of the existing Sage Mesa/Hisula Highlands water supply system.

As noted, the only water treatment that the SM water system receives is disinfection with chlorine. Contact time is achieved in the supply main from the lake intake pump station to the Sage Mesa residents. It does not appear that the minimum 20 minutes of contact time is achieved during peak demands prior to the first user.

In an effort to plan for future upgrades to the SM water supply system to meet current water treatment requirements of the Interior Health Authority (IHA) Drinking Water Objective, the Regional District of Okanagan Similkameen (RDOS) retained Focus Corporation to complete a study of the SM water system. The objective of this study is to produce stand alone options for upgrading the SM system to meet the IHA 4-3-2-1-0 Drinking Water Objective. There are other options available to Sage Mesa for upgrades that include a combined system with West Bench Irrigation District (now part of RDOS) or supply from the City of Penticton. These are, however, not part of this study.

1.1 Scope of Work

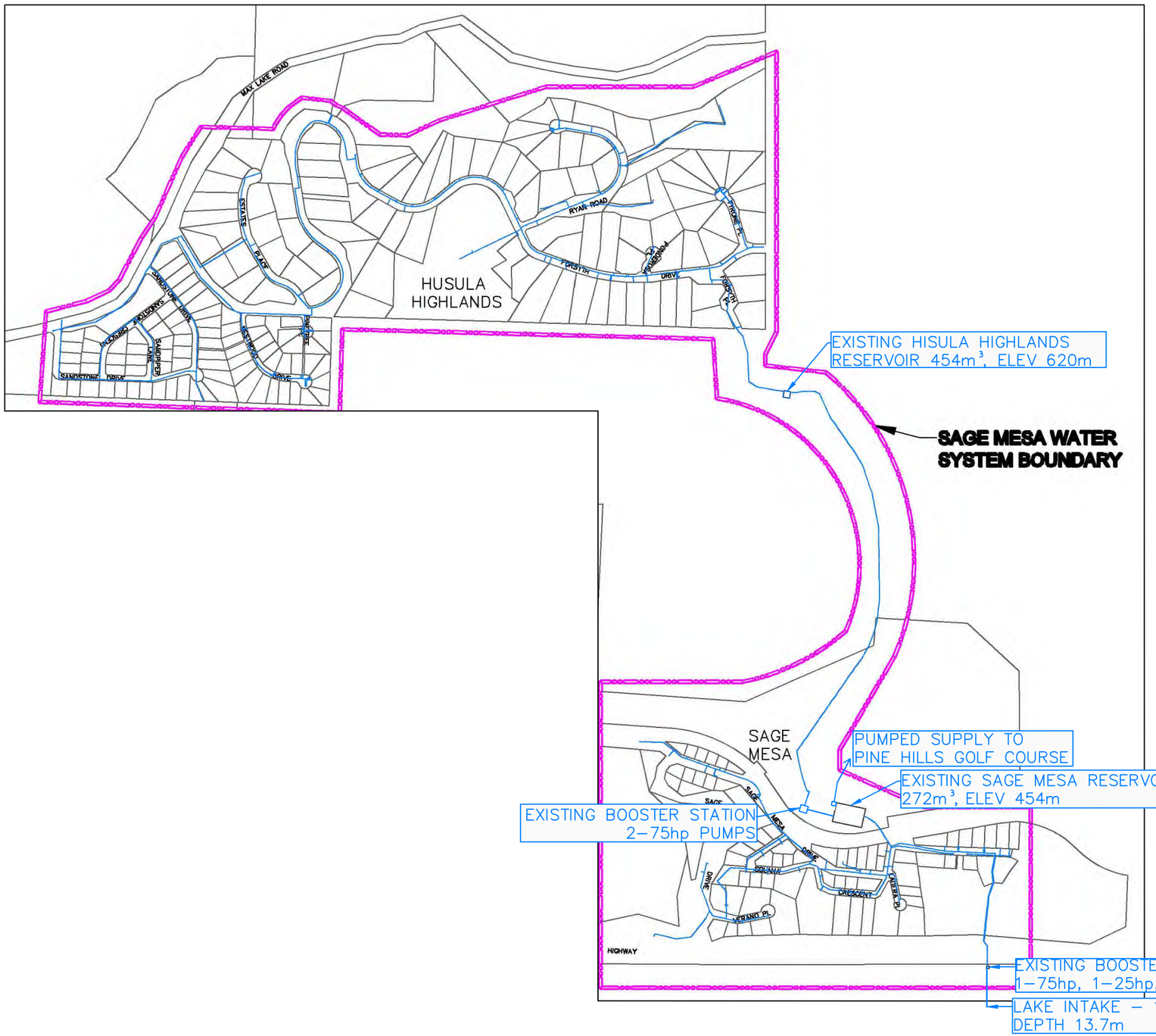
The scope of work for this project as defined in our proposal dated August 24, 2011 includes the following Tasks. The scope is to generate two water supply options, one using the existing intake, one using a new intake. Tasks to be completed were:

Task 1 – Project Initiation: Obtain information from RDOS for the study. Visit the site to review the existing lake intake pump station and investigate sites for treatment plants. Review the project with IHA.

Task 2 – Design Criteria/Water Demands: Using information from previous reports, current water demands and RDOS bylaws, confirm design criteria and water demands for Sage Mesa. These will be the basis for generating options for system upgrades.

Task 3 – Water Supply Upgrade Options: Generate two new water supply upgrade options for upgrades that will help SM meet IHA's 4-3-2-1-0 rule (assuming filtration deferral). Conceptual design drawings will be created, as well as an opinion of probable cost for capital improvements, plus annual operating costs. Present worth calculations not included at this time.

Task 4 – Report Preparation: Findings of the study will be summarized into a draft report. Three copies of the report will be submitted to RDOS for review. We will meet with RDOS to discuss comments/input to the project and then prepare three copies of a final report.



J:\Engineering\Projects\061500005 RDOS – Sage Mesa Water Supply\05 Design\05-01 Drawings\061500005 Base.dwg Plotted 4 May 2012

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DATE APRIL 2012
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REGIONAL DISTRICT OKANAGAN SIMILKAMEEN
SAGE MESA WATER SYSTEM
EXISTING WATER SYSTEM

REV. No. 1
OFFICE No.
DRAWING No. 1

2.0 WATER SYSTEM DESIGN CRITERIA

In order to evaluate the water system, design criteria must be established for each system component. These criteria are then used to evaluate the capacity of the water system. In previous studies, the criteria were established based on typical engineering standards for water districts of this size and existing bylaws. The following section outlines the recommended design standards.

2.1 Source

The supply source must be capable of supplying the total community demands throughout the year. Communities with surface sources require adequate licensing of the supply source.

2.2 Water Demands

Water demands from the RDOS Subdivision Servicing Bylaw are as follows. Sage Mesa does not have any specific bylaws for water demands.

Maximum Daily Domestic Flow (MDD)	8,000 l/single family unit/day
Peak Hour Demand (PHD)	13,600 l/single family unit/day

An analysis of water demands and calculation of Maximum Day Demands are completed in a later section of this report. The demands noted above are reasonable for a water system of this size. There are, however, flow records available for comparison to design criteria.

2.3 Water Treatment

Interior Health Authority has set objectives for all purveyors to work towards. This includes filtration of all surface water sources and meeting the 4-3-2-1-0 Drinking Water Objective. The 4-3-2-1-0 objective refers to:

4-log inactivation of viruses
3-log removal or inactivation of parasites, such as Giardia and Cryptosporidium
2 treatment process for all surface water sources
1 refers to maintaining turbidity of less than 1.0 NTU
0 refers to zero bacterial contamination of either Fecal Coliform or E. Coli bacteria

There is the potential to apply for a deferral of filtration for surface waters if the criteria established by IHA can be achieved. The deferral criteria include preparing a plan to achieve 4-3-2-1-0; submitting a proposal demonstrating that the current water quality meets the Canadian Drinking Water Guidelines; undertaking a specific water quality monitoring program, and being prepared to implement filtration should problems arise with water quality.

2.4 Pumping Systems

Typical standards for surface water sources state supply pumps must be capable of meeting maximum day demands with the largest pump out of service and balancing storage on line. If no balancing storage is available, pumps must meet peak hour demand with the largest pump out of service. Standby power must be available, as well as additional pumps sized to provide fire flows.

2.5 Distribution System and Pressure Zones

The distribution system must be capable of conveying the maximum day demand, plus fire flow or peak hour demand, whichever is greater, and still maintain the system pressures above specified minimums. Velocities of the water in pipelines should be kept to less than 2.0 meters per second except near a fire. Velocities near fires should be less than 4.0 meters per second. Mains should be looped wherever possible.

The service pressures in each zone should normally be maintained between 275 kpa (40 psi) and 690 kpa (100 psi), although they may drop as low as 135 kpa (20 psi) at a fire site during a maximum day. Areas of pressures greater than 100 psi may be acceptable but must be less than 150 psi.

2.6 Reservoir Capacity

There must be sufficient reservoir capacity to store the peak hour demands, plus the total fire flow requirements. A volume of 25 percent of the domestic maximum day demand has been used for peak hour storage. Irrigation flows for golf courses are relatively constant and, therefore, not included in the storage calculation. Fire storage requirements are typically defined by Fire Underwriter Survey Guidelines as noted in the following section. In some municipalities, emergency storage equal to 25% of the sum of the peak hour storage and fire storage is also required. For the purpose of this study, we have not included the 25% emergency storage.

2.7 Fire Flows/Storage

In addition to meeting normal system demands, reservoir storage facilities and distribution mains must be capable of meeting possible fire demands. In the past, there was a wide variation in standards set by various agencies and municipalities for duration and volume of the fire flows. The Fire Underwriters Survey (FUS) prepared by the Insurance Advisory Organization is now used by most municipalities and is noted in the RDOS Subdivision Bylaw. A summary of minimum standards listed in the RDOS Subdivision Bylaw 2000 are provided in Table 2.1.

DEVELOPMENT TYPE	FIRE FLOW (l/s)	DURATION (hrs)
Single Family Residential	60 l/s (min)	1.5
Apartments/Townhouses	150 l/s (min)	2.0
Commercial/Industrial	230 l/s – 260 l/s	3.5
Institutional	85 l/s	1.75

Table 2.1 - Fire Flows from RDOS Bylaw #2000

The fire flows noted are minimum standards. For the purpose of this report, we have used 75 l/s as a fire flow for the residential development in SM. There is no multifamily, apartment, commercial or institutional development in SM.

3.0 POPULATION AND DEMANDS

Population data and water demands are used to evaluate the water supply system capacities. The following sections outline existing populations, projected growth within the community and an analysis of water demands.

3.1 Populations

There is no specific population data available for Sage Mesa from Census Canada. We completed a count of the legal lots and came up with a total of 257 lots and 2 golf courses. There were 183 in the upper zone (Hisula Highlands) and 74 in the lower zone (Sage Mesa). Previous studies identified a total of 265 lots with 175 in the upper zone and 90 in the lower zone. The upper zone lots are stated to be metered with the lower zone not metered. For the purpose of this study, we will use a total of 260 lots with 185 in the upper and 75 in the lower.

An estimate of population in SM using 3 persons per lot would be approximately 780. There is some growth potential for the area through development of adjacent lands; however, for the purpose of this study, we have evaluated system capacities based on the current population/development.

3.2 Water Demands

The demand for water within a utility varies hourly, daily, weekly, monthly and seasonally. It is dependent upon the type of properties serviced and the water requirements for each type of use. The primary water use within Sage Mesa is for domestic purposes. Domestic use includes water utilized within the home for day-to-day needs, as well as lawn sprinkling. Typically, domestic demand remains relatively constant in non-irrigation seasons, then peaks during summer months as the amount of water use increases dramatically due to watering of lawns and gardens. The other primary users of water within Sage Mesa are the two golf courses. These two customers are significant water users in the community.

Typical domestic demand patterns are:

- Demands are relatively constant through fall, winter and spring months (October to April) as water use is primarily domestic in home use.
- Significantly higher demands occur in May to September due to outdoor water uses.
- Demands peak in July and August due to lawn and garden sprinkling. Peak days occur during summer months when long, dry spells occur. Water use will drop when rain occurs.
- During peak summer days, water use varies throughout the day. Typically, two peaks occur; one in the morning between 4:00 a.m. and 7:00 a.m. when automatic sprinkler systems come on, and the second during the evening hours when manual lawn watering occurs. Water restrictions can impact these peaks (odd/even watering, restricted hours of operation).

Irrigation demands for the golf courses are typically relatively constant throughout the irrigation season (May to end of September). The golf courses irrigation system normally come on in late evening and water through the night.

As noted in the previous section, the number of connections is estimated to be a total of 260 with 185 in the upper zone and 75 in the lower. Both golf courses are located in the lower zone. Using the number of connections and your subdivision bylaw standards, the Maximum Day Demand (MDD) for the residential use would be 2,080 m^3 (8,000 x 260 ÷ 1,000). Golf course irrigation would be in addition to this amount. In previous studies, residential MDD was predicted to be 2,250 m^3/day (Associated Engineering and True Consulting). Golf course irrigation was estimated to be 550 m^3/day. The total MDD was estimated to be 2,800 m^3/day (2,250 + 550). The Associated Engineering report (September 2007) used 2,500 m^3/day and 500 m^3/day as a design demand for their study.

We undertook a review of flow records provided by RDOS for 2009 to 2011. Information available is as follows:

- **August 2009**: Week of August 1 to August 8 – 3,467,000 imperial gallons were pumped from the lake or an average of 495,000 per day (2,250 m^3/day). As this is an average, a peak day during this period may be 15% above this or 2,580 m^3/day.
- **July 18, 2010**: Maximum day measured for 2010. Total flow was 2,137 m^3.
- **July 13, 2011**: Maximum day measured for 2011. Total flow was 2,121 m^3.

These records are total flows, including the golf courses (are total flow from the lake pump house). Available flow records from the golf courses for 2008 and 2009 indicated monthly total flows in the order of 3,100,000 imperial gallons. Converting this to cubic meters per day, the flows are approximately 450 m^3/day. This compares favorably with the predicted flows of 500 m^3/day from previous reports.

Deducting the golf course flow of 450 m^3/day from the total measured flows (using the estimated flow from August 2009), the maximum day domestic demand would be 2,130 m^3/day (2,580 – 450). This value also compares favorably with the previous study estimates for domestic demand (2,250 m^3/day) and the value calculated from your subdivision bylaw of 2,080 m^3/day. Demands in 2010 and 2011 are less than these values, possibly as a result of water conservation efforts by the District.

The MDD we will use for evaluation of system capacities and designs will, therefore, be:

MDD Domestic	2,250 m^3/day	
MDD Golf Courses	450 m^3/day	
TOTAL MDD	2,700 m^3/day	(31.3 l/s)

The maximum day demand per residential connection is 0.12 l/s.

4.0 EXISTING SYSTEM ANALYSIS AND UPGRADING REQUIREMENTS

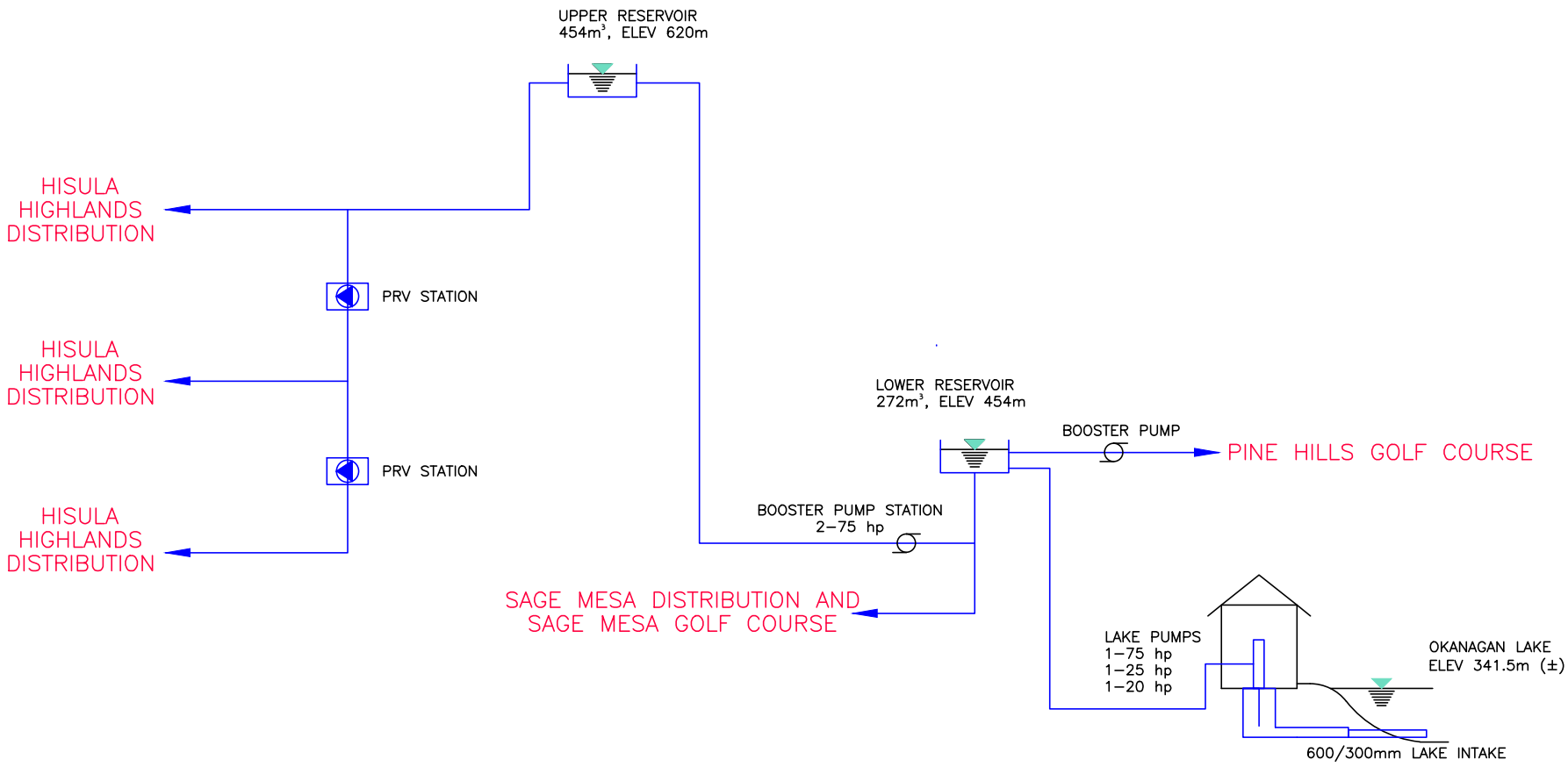
The following section analyzes the capacity of each system component based on the design criteria established in Section 2 and water demands in Section 3. A schematic of the water system is provided in **Figure 2**. An overall plan of the District and the water distribution system is provided in **Figure 1.**

4.1 Supply Source

Okanagan Lake is the source of supply for Sage Mesa. Sage Mesa holds a number of Conditional Water Licenses which allows them to divert water from Okanagan Lake for domestic and irrigation purposes. Annual water use for2010 was 218,121 m^3. Table 4.1 provides a listing of the water licenses as found on the Ministry of Environment website.

CONDITIONAL WATER LICENSE	DATE	DIVERSION AMOUNT	COMMENTS
30606	January 1966	31,000 gal/day	Initial phase of construction for Sage Mesa lots.
52739	September 1979	18,000 gal/day	Addition for CPCN. Construction of booster station and upper reservoir.
58922	June 1983	10,500 gal/day	Addition of CPCN.
59060	July 1983	1,500 gal/day	Addition of CPCN.
61571	November 1984	4,000 gal/day	Addition of CPCN.
64196	November 1986	1,500 gal/day	Addition of CPCN, maximum annual diversion 182,500.
104081	May 1992	30 acre feet/year	Addition for Golf Course – water use Apr. to Sept. Supplies Pine Hills.
104082	May 1992	44.57 acre feet/year	Addition of Golf Course – water use Apr. to Sept. Supplies Sage Mesa Course. Additional 500 gallons per day for club house.
107735	April 1996	61,500 gal/day	Addition of CPCN, maximum annual use of 8,482,500 gallons.

Table 4.1 - MOE Listing of Water Licenses



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SAGE MESA WATER SYSTEM

WATER SYSTEM SCHEMATIC

FIGURE 2

RDOS OKANAGAN-SIMILKAMEEN

Adding up the water available from these licenses, we arrive at a total of approximately 143,000 m^3 for domestic purposes and 92,000 m^3 for golf course irrigation. Comparing the licensed amount to actual water use (2010 value), the total licensed amount is 235,000 m^3 versus 218,000 m^3 utilized. The golf course irrigation component of the 218,000 m^3 assuming 450 m^3/day for 6 months is approximately 82,000 m^3. It is unlikely that the golf courses utilize this much water which would indicate that the domestic use may be exceeding the licensed volumes.

Using average day demand of 3,200 l per household per day (8,000 ÷ 2.5), the annual domestic demand is 304,000 m^3. Using the City of Penticton's bylaw average annual demand of 700 l/c/day, the annual water use would be 199,000 m^3/year. Based on these calculations, it would appear that the domestic use exceeds the licensed amount; however, the overall volume used, including golf course irrigation, is less than the licensed volume.

4.2 Lake Intake

There is limited information available on the existing lake intake. According to the Associated Engineering (AE) report, the intake is 152 meters long. It consists of 120 meters of 300 mm pipe and 32 m of 600 mm corrugated steel pipe. There is no indication what material the 300 mm pipe is. The intake extends to a depth of 13.7 m below average lake level. AE states "the intake was replaced in 2005 and remains in good condition. The screen meets the current MoE standards for screen size."

The capacity of the intake is determined from the head loss and velocity at peak flows. With a maximum day demand of 31.3 l/s, the head loss in the intake is approximately 0.2m (assuming steel or HDPE pipe for the 300 mm). The velocity in the 300 mm pipe is 0.5 m/sec. Design drawings of the pump station are not available; however, we do not anticipate that this amount of head loss will impact the pump capacity other than possibly the submersible pump in the wet well as its intake will be well above the floor of the wet well. Further extension of the intake pipe will have to consider head loss in the wet well and water levels over pump intakes.

4.3 Pumping Capacities

The capacity of the lake pump station is as follows:

75 hp vertical turbine 28 l/s	(445 USgpm)
25 hp vertical turbine 10.5 l/s	(167 USgpm)
20 hp submersible 10.5 l/s	(166 USgpm)

The total capacity of the station is, therefore, 49 l/s (778 USgpm) with all three pumps operating. Using the design criteria of the pumps meeting MDD with the largest pump out of service indicates the station's capacity is only 21 l/s. This is less than the MDD of 31.3 l/s.

Therefore, based on the design criteria, the pump station is lacking in capacity and should have one of the pumps replaced. The existing 25 hp vertical turbine should be replaced with a 75 hp pump with similar capacity to the existing 75 hp pump (or slightly more capacity to meet MDD of 31.3 l/s).

The capacity of the booster station:

2 - 75 hp vertical turbines 22 l/s (350 USgpm)

The water use in the upper zone is not metered at the pump station. We understand there are meters on the water connections but do not believe there is any data available on water use. Using the bylaw demand of 8,000 l/lot/day, the MDD would be 17 l/s (185 x 8,000 ÷ 86,400). Utilizing the predicted MDD flow per residence of 0.12 l/s, the estimated MDD for the upper zone would be 22.2 l/s. Based on this calculation and the design criteria, the booster pumps have adequate capacity.

There is a third pumping station in the utility. This pump supplies the Pine View Golf Course and club house. This is a single pump, size and capacity not available. It is not clear whether this pump is to be maintained by RDOS or not. Its capacity must be suitable for current demands; however, there is no standby pumping available. For the purpose of this report, we have assumed this pump is not the responsibility of the District to maintain.

4.4 Reservoir Capacity

There are two reservoirs in Sage Mesa. Their volumes and elevations are as follows:

Sage Mesa (lower) – Elevation 454 m, Volume 272 m^3
Hisula Highlands (upper) – Elevation 620 m, Volume 454 m^3

The lake pump station pumps to the Sage Mesa (lower) reservoir, the booster station draws water from the Sage Mesa reservoir and pumps it to the Hisula Highlands (upper) reservoir. There is currently no connection available to allow water from the upper reservoir to cascade to the lower reservoir.

Reservoirs are sized for two criteria – peak hour storage and fire storage. Peak hour storage is based on the demand in each zone and is estimated as follows. Peak hour storage is based on domestic demand only (no storage for irrigation – golf course – demand).

Lower Zone

MDD domestic 75 x 0.12 = 9 l/s
Storage is 25% of MDD
Storage equals 0.25 x 9 x 86,400 ÷ 1,000 = 194 m^3

Upper Zone

MDD domestic 185 x 0.12 = 22.2 l/s
Storage is 25% of MDD
Storage equals 0.25 x 22.2 x 86,400 ÷ 1,000 = 479 m^3 (480 m^3)

Fire storage is to be provided in accordance with the FUS. The fire flow we would recommend for this area would be a minimum of 75 l/s (1200 USgpm). Fire storage required for a flow of 75 l/s is:

$$75 \times 3{,}600 \times 1.5 \div 1{,}000 = 405 \text{ m}^3$$

As there is no interconnection between reservoirs to allow water to cascade from the upper reservoir to the lower, fire storage is required in each zone. Therefore, the required storage volumes for each zone are:

Lower Zone	
Peak Hour Storage	194
Fire Storage	405
TOTAL	**599** m^3
Upper Zone	
Peak Hour Storage	480
Fire Storage	405
TOTAL	**885** m^3

Based on the design criteria, there are significant shortfalls in each reservoir; 327 m^3 in the lower reservoir, 431 m^3 in the upper reservoir. There is the potential to reduce the required storage for the District by providing a Cascade Valve to allow water from the upper reservoir to flow to the lower reservoir during a fire. This would remove the requirement for providing fire storage in each reservoir. Required storage volumes for each reservoir would, therefore, be:

Lower Zone	
Peak Hour Storage only	194 m^3
Upper Zone	
Peak Hour Storage	480
Fire Storage	405
TOTAL	**885** m^3

Using this calculation, there is only a shortfall of 431 m^3 in the upper reservoir. This would, however, require the installation of a control valve to allow water to flow from the upper reservoir to the lower zone in case of an emergency. The piping system is in place in the booster station to install a control valve either in parallel with the existing pressure relief valve or by upgrading the valve by adding a solenoid control. Installing the cascade valve and adding to the reservoir storage in the upper zone would be the most cost effective way to upgrade the District's reservoir capacity to meet the design criteria. It should be noted that the design criteria does not include emergency storage included by many municipalities. This would also add another 200 m^3 to the upper zone storage requirements. The lower zone would still be adequate.

4.5 Distribution System

It was not part of the scope of work for this project to prepare a hydraulic model of the distribution system and analyze the capability of the distribution system to supply peak hour or maximum day plus fire demands to each part of the water district. A review of the pipe sizes and looping was completed and it appears that the distribution system would be capable of providing peak hour flows with only a few of the homes at the upper elevations possibly seeing pressures close to criteria minimums. Similarly, there may be areas within the District that will receive marginal fire flows on peak days. There are some sections of 150 mm pipes that are not looped, some areas with 100 mm pipelines, and Verano Place appears to be serviced with a 50 mm service. Previous studies had recommended a new supply main be installed along Highway 97 from the pump house to Sage Mesa Drive, and then from Sage Mesa Drive to Solana Crescent and up to the reservoir site. This would replace the existing supply main and improve water supply to Verano Place and Solana Crescent.

Prior to implementing any system improvements for SM, we recommend a hydraulic model be prepared for the distribution system. An analysis should be done on the ability of the distribution system to meet peak hour and maximum day plus fire demands. Any upgrading requirements would be identified. The current 50 mm supply main to Verona Place must be upgraded to provide fire flows to this area.

Another project proposed for the piping system was to install an overflow pipeline for the lower reservoir. There has been some problems with reservoir overflowing and causing damage to downstream properties. A report was done by McElhanney Consulting in 2010 which reviewed options for eliminating the problems with the overflow. The two options McElhanney stated that provided the best solutions were:

- provide an overflow pipe to offsite storage in in a depression on the CPR right-of-way; and
- provide an overflow pipeline to a ditch on Sage Mesa Drive north.

There was no preferred option identified. Both options were approximately the same cost. Further discussion of this overflow is provided in a later section of this report.

4.6 Water Treatment

As noted, the only treatment provided for the Sage Mesa residents is disinfection with chlorine. A sodium hypochlorite system is provided at the intake pump station next to Okanagan Lake. Liquid chlorine is injected to the wet well from a single dosing pump. The dosing pump is manually controlled. There is a residual analyzer in the pump house and a turbidity meter; however, these are only recording levels, no control is provided.

Contact time for disinfection is provided in the supply pipeline to Sage Mesa. With the 75 hp and 20 hp pumps running, the flow in the pipeline would be approximately 38 l/s. In order to achieve a minimum of 20 minutes of contact time, a length of 1450 meters of 200 mm pipe is required. The length of 200 mm pipe from the pump house to the first user is between 250 and 300 meters, so they are receiving only slightly more than four minutes of contact time if the 75 hp and 20 hp pumps are operational. With the 75 hp pump alone, the contact time is just under six minutes. We have attached **Figure 3** which provides an illustration of the contact time in the supply mains. We have also provided an indication of the number of lots that may not receive the 20 minutes of contact time. It is difficult to accurately predict contact time once into the distribution system as time of travel is dependent upon demands which will vary significantly. Contact time also depends upon whether the pumps are operating or if supply is from the reservoir.

There are, however, a number of homes that will definitely not be receiving 20 minutes of contact time and upgrades are required.

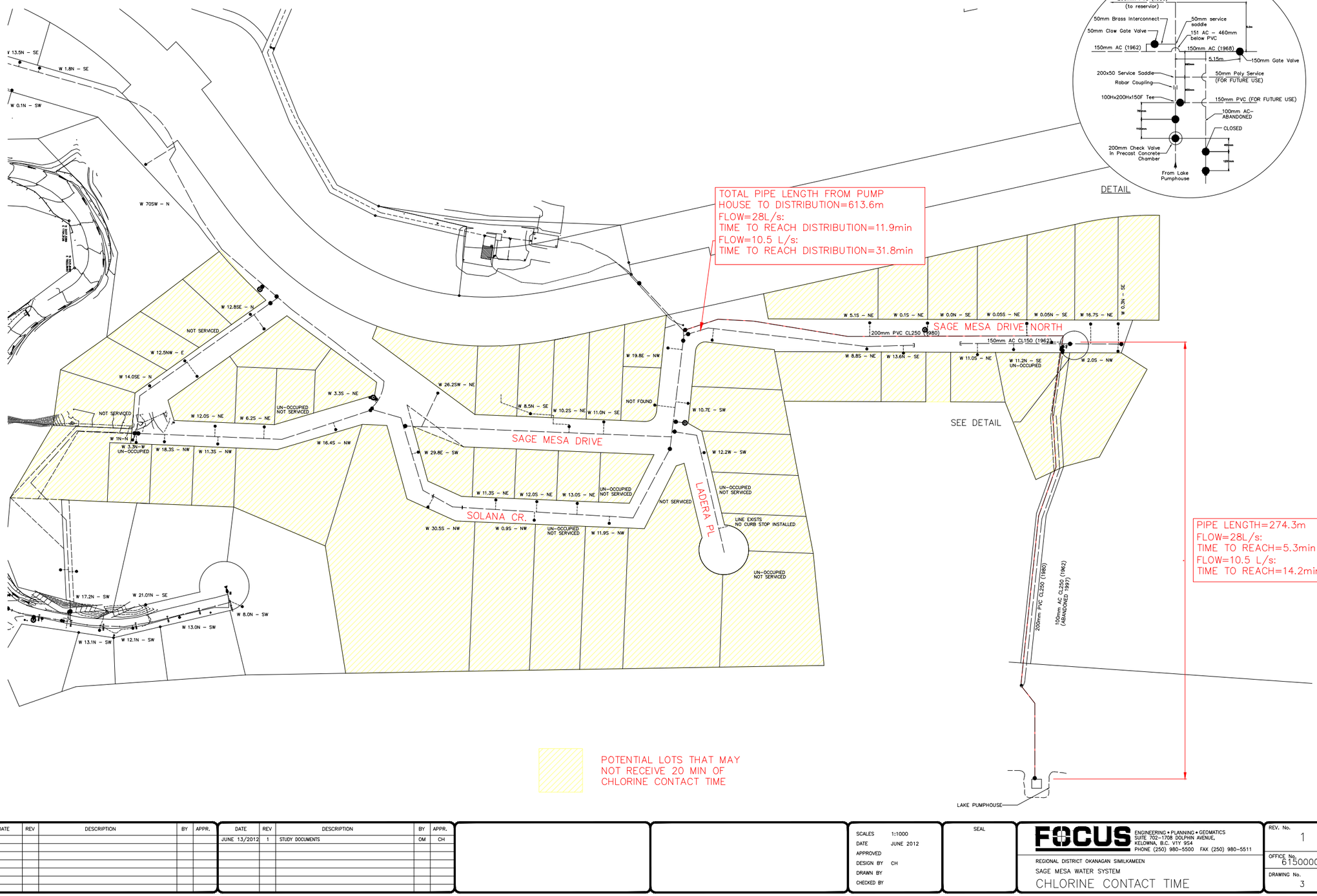
Therefore, the current treatment system does not meet any of the IHA 4-3-2-1-0 criteria other than turbidity is typically less than 1.0 (annual average 0.5± NTU). During the month of June, it increases to close to 1.0 (average) with some readings exceeding 1.0. There have been some instances where total coliforms and ecoli were present in samples taken (September 2010). It was not determined if the positive results were from sampling issues or from the water supply. Subsequent sampling did not indicate any coliform or ecoli.

Upgrades are, therefore, required to the treatment system. These include improvements to the current disinfection system through automation and providing backup systems, addition of ultraviolet light (UV) disinfection, increasing chlorine contact time, and, ultimately, filtration may be required (interim solution is to apply for filtration deferral).

4.7 Required Upgrades

Based on the above analysis, we have listed the items that require upgrading to meet listed design criteria. These include:

- Source Capacity – Modify water licenses to suit current uses.
- Lake Intake Extension – Required to improve water quality, particularly for future treatment upgrades.
- Lake Pump Station Upgrade – Replace 25 hp vertical turbine pump with a 75 hp vertical turbine.
- Reservoirs – Add 430(±) m^3 cell to upper reservoir, install cascade valve in booster station.
- Distribution System – No specific upgrades to distribution identified at this time other than to replace the 50 mm line to Verano Place. Install overflow for reservoir.
- Water Treatment – Provide automation and backup for chlorination system, provide adequate contact time, provide UV disinfection, apply for filtration deferral.



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SCALES 1:1000
DATE JUNE 2012
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REGIONAL DISTRICT OKANAGAN SIMILKAMEEN

SAGE MESA WATER SYSTEM

CHLORINE CONTACT TIME

REV. No. 1
OFFICE No. 61500005
DRAWING No. 3

J:\engineering\Projects\06\1500005 RDOS – Sage Mesa Water Supply\05 Design\05-01 Drawings\5 – SAGE MESA lower.dwg Plotted 28 June 2012

5.0 WATER SYSTEM UPGRADES

The following section provides a description of how the water system can be upgraded to meet the deficiencies identified in Section 4. We have identified two options for upgrading the supply source, as well as items common to both options. The two options for upgrading the supply source include improvements to water treatment to meet the 4-3-2-1-0 (with filtration deferral). Options are designed such that filtration can be added in the future. Option one uses the existing supply system, the second option uses a new intake and pumping system.

5.1 Common Upgrades

The following upgrades are required for either supply option selected. As noted, we have not included any upgrades to the distribution system other than the lower reservoir overflow/drain and the supply main to Verano Place.

- Water Licenses

  The District should apply for a change in the water licenses to more accurately reflect the water uses within the District. There should be no change in the total volume of water required, just in the actual uses.

- Reservoir Addition

  A cell should be added to the upper reservoir. The volume of storage required is 431 m^3. We would recommend a cell of at least 454 m^3 (twin of existing reservoir) be constructed to allow for some growth in the District.

  In order to allow water to cascade from the upper zone to the lower zone, a control valve will be installed in the booster pump house. Level monitoring in the reservoirs will control the operation of this valve. Given the high drop in head across this valve, orifice plates or a second valve may be required. This will be determined at the predesign stage.

  An overflow system upgrade for the lower reservoir has been reviewed in previous reports and should be included in any future upgrades. A new pipeline would be installed from the lower reservoir to a ditch in Sage Mesa Drive north.

- Distribution System

  Based on drawings we have available, there is a 50 mm main that supplies water to Verona Place from Solana Crescent. This main is not sized to provide fire flows and should be replaced. The distribution system has been previously upgraded to provide for a new main from Sage Mesa Drive through to Solana Crescent. This main should be installed. It will, however, require an easement from property owners.

5.2 Option 1 – Upgrade Existing Supply

This Option upgrades the existing supply and treatment system to meet the IHA 4-3-2-1-0 requirement. As filtration is not included, an approval for deferral will be required from IHA. If deferral is received, the water quality is expected to meet all requirements of 4-3-2-1-0. Components of this upgrade include the following items; a schematic is provided in **Figure 4**.

- Lake Intake Extension

  The current intake is approximately 150 meters long and extends to a depth of 13.7 meters. In order to improve the water quality, the intake should be extended to a depth of 23 to 25 meters. This requires an extension of approximately 600 m. The size of the intake pipe should be at least 300 mm internal diameter. The available head loss in the pump station will need to be reviewed to confirm final pipe diameter.

- Pump Station Upgrade

  The existing pump station should have the 25 hp vertical turbine pump replaced with a 75 hp vertical turbine. The chlorination system should be upgraded to a dual pumping system controlled by a flow meter and residual analyzer. This will require installation of a new electronic flow meter.

- Supply Main to Sage Mesa Reservoir

  The 200 mm supply main to the existing reservoir has a number of connections on it once it reaches Sage Mesa Drive north. A new main will, therefore, need to be installed from this point to the UV treatment system/reservoir so that there is a dedicated supply from the lake to the treatment plant. Chlorination would still be provided at the lake with the dedicated supply main providing contact time. Initial calculations indicate the main extension would be a 300 mm pipeline; this would need to be confirmed at the predesign stage to ensure 20 minutes of contact time is provided.

- UV Treatment Facility

  The dedicated main would be routed through a new treatment building located between the existing booster station and the Sage Mesa reservoir (demolition of a small concrete storage room would be required). Low pressure high intensity ultra violet light disinfection units would be installed in a concrete block type building. There would be two units, one operating, one standby, each sized to treat the flow from two lake pumps (40± l/s). Flow meters would be required for each unit, as well as control valves for alternating units.

WEST BENCH IRRIGATION DISTRICT

SAGE MESA BOUNDARY

TOSH DRIVE

PINE HILLS DRIVE

SAGE MESA

TO HISULA HIGHLANDS UPPER RESERVOIR
ADD 454m³ CELL TO RESERVOIR

NEW UV TREATMENT FACILITY
C/W RECHLORINATION

PUMPED SUPPLY TO
PINE HILLS GOLF COURSE

EXISTING LOWER RESERVOIR
272m³, ELEV 454m
ADD DIVIDER WALL TO RESERVOIR

SAGE MESA DRIVE

EXISTING BOOSTER STATION
ADD CASCADE VALVE

NEW OVERFLOW/DRAIN

NEW DEDICATED SUPPLY MAIN

NEW WATERMAIN

SOLANA DRIVE

SOLANA CRESCENT

LADERA PL

VERANO PL

PS2

OKANAGAN HIGHWAY

UPGRADE EXISTING PUMP SYSTEM
–NEW 75 hp PUMP
–NEW CL_2 SYSTEM
–NEW FLOW METER

EXISTING LAKE PUMP HOUSE

EXISTING INTAKE – 150M LONG

EXTEND LAKE INTAKE – 600m(±)
DEPTH 25m

OKANAGAN LAKE

DATE	REV	DESCRIPTION	BY	APPR.

DATE	REV	DESCRIPTION	BY	APPR.
May 4/2012	1	STUDY DOCUMENTS	OM	CH

mm 0 20 40 60 80 100 120 140 160
1:2000

SCALES 1:2000 (A1 SIZE)
DATE APRIL 2012
APPROVED
DESIGN BY CH
DRAWN BY NR
CHECKED BY

SEAL

FOCUS ENGINEERING • PLANNING • GEOMATICS
SUITE 702–1708 DOLPHIN AVENUE,
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REGIONAL DISTRICT OKANAGAN SIMILKAMEEN
SAGE MESA WATER SYSTEM
WATER SUPPLY UPGRADE OPTION 1

REV. No. 1
OFFICE No. 61500005
DRAWING No. 3

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A rechlorination unit would also be included in the treatment building to top up chlorine levels as required (UV disinfection will remove some of the residual chlorine). From the UV treatment facility, treated water would be routed to the Sage Mesa reservoir. The addition of the UV facility is expected to have minimal impact on the lake pumps as the head loss across the UV units would be offset by the reduced head loss in the dedicated supply main. This would need to be confirmed at predesign.

It should be noted that with this Option, as well as Option 2, golf course irrigation water will be treated with UV disinfection. Although there is no requirement for this to occur, the size of the UV units is not significantly impacted by the additional flow for the golf courses. However, if filtration or further treatment is planned, then the golf course sources should be separated from the domestic supply. This could be accomplished by:

- For Pine Hills, a tee would be installed prior to the UV treatment building and a pipeline routed to a small tank (50± m^3) that would act as a reservoir for a booster pump for irrigation water. A control system would be required to start the lake pumps to provide water supply when the domestic system is not calling for water. A domestic water service (either from the upper zone or on a separate pump station) would also be required for the club house.
- The supply for the Sage Mesa golf course would be connected to the same small storage tank as the Pine Hills booster pump. A new supply main would be routed from the tank to the golf course. The existing service could be used for part of this supply main after the last domestic user on the line; however, a new domestic service for the golf course would also be required.

At this stage, we have not included for these improvements as they would be fairly expensive and only marginally reduce the cost of the UV treatment facility.

- <u>Sage Mesa Reservoir</u>

  It is our understanding the Sage Mesa reservoir is a single cell. This will make cleaning of the reservoir difficult to do (pumps would have to be deadheaded). As part of this project, we would recommend a divider wall be installed to separate the reservoir into two cells. The location of the inlet/outlet piping systems, overflows and drains would need to be reviewed to determine the most efficient method for completing this work. There will be a new pipeline from the UV treatment facility that can be split/valved for the two cells. The existing inlet/outlet will become an outlet only so would need to be modified for the second cell.

- Future Filtration

  If, in the future, filtration is required, the inlet piping to the UV treatment building would be rerouted to a filtration plant. There appears to be available land in the general area of the existing booster station/lower reservoir; however, this likely would have to be purchased from the golf course. The Kettle Valley Rail ROW is adjacent to the lower reservoir; however, it is unlikely this land will be available. Depending upon the location and elevation of the treatment plant, the lake pumps may need to be upgraded to supply sufficient head for the filters. Water would then be pumped to the Sage Mesa reservoir for distribution.

5.3 Option 2 – New Supply System

This Option provides a new supply system for the Sage Mesa utility to replace the existing lake intake, pump house and supply main to the lower reservoir. The treatment system (UV and chlorine disinfection) does not change from Option 1. The treatment system would meet the IHA 4-3-2-1-0 requirement if filtration deferral is provided. Components of this option include the following items; a schematic is provided in **Figure 5**.

- New Lake Intake

  A new intake pipe would be installed into Okanagan Lake to a depth of approximately 25 meters. The intake would be installed opposite the current Highway 97 pull-out below Verano Place. The intake would be installed by directional drilling the first section (200± m) under the highway and out to a depth in the lake where the intake pipe can be laid on the lake bed. At a depth of approximately 10 meters, a submersible pump header consisting of three separate pipelines with 40 hp – 16 l/s submersible pumps would be installed in the intake pipe. The pumps are sized to pump MDD of 31.3 l/s with one pump out of service.

  The pump header consists of three branches of 300 mm pipe, isolated by valves, with a submersible pump installed in each branch. Pumps can be installed/removed by unbolting flanges/couplings on the pipe branch and removing the branch/pump as one component. Divers are required to do this; however, the requirement to remove the pumps for servicing is years apart. The cost of this type of installation is significantly cheaper than constructing a traditional wet well, intake and pump house as the requirement for a deep wet well and intake pipeline is eliminated. There is no requirement for a large pump house – only a small building or kiosk is required to house chlorination equipment, electrical and controls. The only drawback to the system is the limited access to the pumps (divers only).

WEST BENCH IRRIGATION DISTRICT

SAGE MESA BOUNDARY

SAGE MESA

TOSH DRIVE

PINE HILLS DRIVE

TO HISULA HIGHLANDS UPPER RESERVOIR
ADD 454m³ CELL TO RESERVOIR

NEW UV TREATMENT FACILITY C/W RECHLORINATION

PUMPED SUPPLY TO PINE HILLS GOLF COURSE

EXISTING LOWER RESERVOIR 272m³, ELEV 454m
ADD DIVIDER WALL TO RESERVOIR

EXISTING BOOSTER STATION
ADD CASCADE VALVE

NEW OVERFLOW/DRAIN

NEW WATERMAIN

SAGE MESA DRIVE

SOLANA CRESCENT

LADERA PL

VERANO PL

NEW DEDICATED SUPPLY MAIN

NEW CHLORINE AND ELECTRICAL BUILDING

EXISTING LAKE PUMP HOUSE

EXISTING INTAKE – 150M LONG

NEW PUMP HEADER (SEE DETAIL)

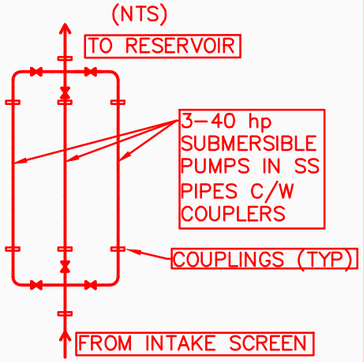
NEW LAKE INTAKE AND SCREEN – 750m, DEPTH 25m

PS2

OKANAGAN HIGHWAY

OKANAGAN LAKE

PUMP HEADER DETAIL
(NTS)



DATE	REV	DESCRIPTION	BY	APPR.

DATE	REV	DESCRIPTION	BY	APPR.
MAY4/2012	1	STUDY DOCUMENTS	OM	CH

mm 0 20 40 60 80 100 120 140 160
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CH
SAGE MESA WATER SYSTEM
WATER SUPPLY UPGRADE OPTION 2

REV. No. 1
OFFICE No. 61500005
DRAWING No. 4

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In order to achieve contact times for chlorine disinfection, chlorine would be injected into the supply pipeline from the intake. A small block building (5± m x 3± m) would be constructed in the highway pull-out area. The building would house the chlorination equipment (dual metering pump station c/w residual analyzer and flow meter), as well as the electrical/controls for pumps. Electrical cables to the pumps would be installed in conduits directional drilled into the lake. The pumps would run on soft starts to reduce water hammer during operation.

- Water Supply Line

  From the lake intake, a 300 mm dedicated pipeline would be routed along Sage Mesa Drive, through a right-of-way and then along the KVR (or private lands) to the upper reservoir site. Easements would be required in a few locations. The pipeline would provide the required 20 minutes of contact time.

- Water Treatment

  Water treatment, consisting of UV disinfection and rechlorination, will be provided at a facility located between the existing lower reservoir and the booster station. Treatment system would be the same as Option 1. Upgrades proposed for the lower reservoir (divider wall) would also be undertaken. There is no plan for separation of the domestic and irrigation supply at this time (similar to Option 1). Filtration can also be added in the future, similar to Option 1.

5.4 Summary of Upgrades

A summary of the upgrades for both options are provided in the following Table 5.1.

Option 1	Option 2
Update water licenses.	Update water licenses.
Upgrade existing lake pumps. Install new chlorination system and flow meter.	Install new submersible pumps in lake header, construct electrical/control building c/w chlorination system.
Install new section of dedicated supply main Sage Mesa Drive north to UV treatment plant.	Install new dedicated supply main from the lake intake to the UV treatment facility.
Construct new UV treatment facility incl. rechlorination equipment. Install supply line to lower reservoir.	Construct new UV treatment facility incl. rechlorination equipment. Install supply line to lower reservoir.
Install divider wall in lower (Sage Mesa) reservoir. Upgrade reservoir piping to suit two cells.	Install divider wall in lower (Sage Mesa) reservoir. Upgrade reservoir piping to suit two cells.
Install cascade valve in existing booster station.	Install cascade valve in existing booster station.
Install watermain from Sage Mesa Drive to Solano Crescent to replace existing 50 mm supply to Verano Place.	Install watermain from Sage Mesa Drive to Solano Crescent to replace existing 50 mm supply to Verano Place.
Install overflow for lower (Sage Mesa) reservoir.	Install overflow for lower (Sage Mesa) reservoir.
Add 454 m^3 cell to upper (Hisula Highlands) reservoir.	Add 454 m^3 cell to upper (Hisula Highlands) reservoir.

Table 5.1 - Summary of Upgrade Options

6.0 PROJECT COSTS

The following section outlines our opinion of probable cost for the various improvements identified. Actual cost will only be known once the design is complete and project tendered. We have provided a capital cost estimate (numbers rounded) which includes a 35% allowance for contingencies and engineering. We have not included allowances for land costs for right-of-ways required for pipelines or other facilities, financing costs or HST. A detailed breakdown of the costs is provided in Appendix A. A summary of the costs is provided in Table 6.1.

Item	Option 1	Option 2
1. Update water licenses	$ -	$ -
2. Extend lake intake, upgrade lake pumps, CL_2 and flow meter	628,000	-
3. New lake intake submersible pumps, CL_2 and electrical building	-	1,267,000
4. Dedicated supply main	341,000	451,000
5. UV treatment facility	737,000	737,000
6. Lower reservoir divider wall/piping, cascade valve booster station	150,000	150,000
7. Distribution upgrades	238,000	238,000
8. Add 454 m^3 cell to upper reservoir	368,000	368,000
TOTAL CAPITAL COST	**$2,462,000**	**$3,211,000**

Table 6.1 – Estimated Capital Costs

Operation costs for the upgraded facility will not increase significantly for either of the two options. The only expected increase would be for the UV treatment facility. Additional operation costs for this would be:

Building light/heat	$ 1,200
UV power consumption	6,000
UV bulb replacement	3,000
Chlorine	500
Operator (2 hours per week)	5,000
TOTAL	**$15,700**

Costs for pumping and maintenance of the existing facilities should remain equal to current operation costs. There would potentially be an increase in maintenance cost of the upper reservoir as there is an additional cell to maintain. This could be $2,000 - $3,000 per year.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, we offer the following conclusions and recommendations:

Conclusions:

- The District has sufficient water licenses to cover the total amount of water used annually; however, the domestic use appears to be more than the licensed volume. This should be reviewed in detail and modifications applied for if necessary.

- The water quality from Okanagan Lake is good with average turbidity levels approximately 0.5 NTU. During spring freshet, levels do approach 1.0 NTU with some samples exceeding 1.0.

- Chlorine disinfection is the only method of treatment. There is not adequate contact time to the first users in the utility. This needs to be corrected.

- The Chlorine disinfection system is run manually and has a single pump system. The system should be automated and have a standby pump system installed.

- The lake intake is relatively shallow (13.7 m). Consideration should be given to extending the lake intake.

- The lake pump station capacity does not meet the design criteria standards of supplying MDD with the largest pump out of service. A new 75 hp pump should be installed to replace the existing 25 hp.

- Treatment levels do not meet IHA's 4-3-2-1-0 requirement. In order to work towards meeting this requirement, UV disinfection should be installed, as well as increased chlorine contact time provided. Filtration deferral will also be required.

- The reservoir storage capacity does not meet design criteria standards. A second cell of 454 m^3 should be constructed at the upper reservoir site. A cascade valve should be installed in the booster station to allow water from the upper reservoir to cascade to the lower reservoir.

- A hydraulic simulation model should be prepared for the distribution system to determine if pipelines are adequately sized for MDD, plus fire flows.

- The 50 mm pipeline that supplies Verano Place should be replaced with a 200 mm pipeline.

- An overflow pipeline should be installed from the lower reservoir.

- There are two options investigated in this report for upgrading the water supply system on a standalone basis. The most economical of the two options is to upgrade the existing supply system. The cost of this upgrade, plus the other items noted above, is $2,462,000, plus HST, land acquisition and financing costs. Upgrades proposed within this cost will meet the IHA 4-3-2-1-0 requirement if filtration deferral is approved. The option of providing a new lake intake/pump station has a capital cost of $3,211,000, or about $750,000 more than upgrading the existing system. It does, however, replace existing infrastructure that is aging and will eventually need to be replaced.

- The operating cost for either of the upgraded options is expected to rise approximately $16,000 per year for either option from current operation cost.

Recommendations:

- The chlorine contact time needs to be resolved as soon as possible. As a temporary measure, the injection pipe could be extended into the lake intake; however, the system must then be automated.

- The District should compare the costs for these upgrades to costs developed for other alternatives previously considered for a combined Sage Mesa and West Bench water system. The supply could either come from Okanagan Lake or the City of Penticton.

- Public meetings should be held with the residents of Sage Mesa to review options and costs.

- If either of these options is selected, grants from the Provincial Government should be applied for.

APPENDIX A

Detailed Breakdown of Costs

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
OPTION 1 UPGRADE EXISTING SUPPLY SYSTEM
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
LAKE INTAKE EXTENSION/ PUMPSTATION UPGRADE -- OPTION 1					
A. General Conditions					
1	Mobilization and demobilization	LS	1	$3,000.00	$3,000.00
2	Bonding and Insurance	LS	1	$10,000.00	$10,000.00
3	Surveys and Layout	LS	1	$1,000.00	$1,000.00
4	Traffic Management	LS	1	$3,000.00	$3,000.00
5	General Requirements	LS	1	$10,000.00	$10,000.00
6	Erosion and Sediment Control	LS	1	$3,000.00	$3,000.00
	SUBTOTAL GENERAL REQUIREMENTS				**$30,000.00**
B. Lake Intake Extension					
1.0	Intake Pipe Extension (300mm HDPE DR 21)	lin.m	600	$400.00	$240,000.00
2.0	Concrete Anchor Weights	each	120	$300.00	$36,000.00
3.0	Intake Screen Relocation	LS	1	$3,000.00	$3,000.00
4.0	Tie to Existing Intake	lin.m	1	$5,000.00	$5,000.00
5.0	Divers Installation	LS	1	$20,000.00	$20,000.00
	SUBTOTAL LAKE INTAKE				**$304,000.00**
Section 5000 - 9000 Lake Pumpstation Upgrades					
1	Pump - Vertical Turbine 75 hp	each	1	$42,000.00	$42,000.00
2	BF Valve	each	1	$1,500.00	$1,500.00
3	Check Valves	each	1	$3,500.00	$3,500.00
4	Flow Meter	each	1	$8,000.00	$8,000.00
5	Piping	lin.m	5	$1,000.00	$5,000.00
6	Bends / Fittings	each	4	$1,000.00	$4,000.00
7	Air Valves	each	1	$400.00	$400.00
8	Chlorine System	LS	1	$17,000.00	$17,000.00
9	Install Labour	LS	1	$25,000.00	$25,000.00
10	Electrical / Controls	LS	1	$25,000.00	$25,000.00
	SUBTOTAL LAKE PUMPSTATION UPGRADES				**$131,400.00**
	SUB TOTAL LAKE INTAKE / PUMPSTATION - OPTION 1				**$465,400.00**
	35% CONTINGENCIES AND ENGINEERING				**$162,890.00**
	TOTAL LAKE INTAKE / PUMPSTATION - OPTION 1				**$628,290.00**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
OPTION 2 NEW LAKE SUPPLY FOR SAGE MESA
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
LAKE INTAKE / PUMPSTATION -- OPTION 2					
A. General Conditions					
1	Mobilization and demobilization	LS	1	$5,000.00	$5,000.00
2	Bonding and Insurance	LS	1	$20,000.00	$20,000.00
3	Surveys and Layout	LS	1	$3,000.00	$3,000.00
4	Traffic Management	LS	1	$5,000.00	$5,000.00
5	General Requirements	LS	1	$15,000.00	$15,000.00
6	Erosion and Sediment Control	LS	1	$5,000.00	$5,000.00
	SUBTOTAL GENERAL REQUIREMENTS				**$53,000.00**
B. Lake Intake					
1.0	Intake Pipe Laid on Lake Bed(300mm HDPE DR 21)	lin.m	550	$400.00	$220,000.00
2.0	Concrete Anchor Weights	each	110	$300.00	$33,000.00
3.0	Intake Screen	LS	1	$12,000.00	$12,000.00
4.0	Foreshore Directional Drilling including Electrical Conduits	lin.m	200	$700.00	$140,000.00
5.0	Highway Casing Pipe	lin.m	35	$1,200.00	$42,000.00
6.0	300mm Land Intake Pipe	lin.m	50	$300.00	$15,000.00
7.0	Divers Installation	LS	1	$25,000.00	$25,000.00
8.0	Pavement Removal / Replacement	m^2	50	$65.00	$3,250.00
	SUBTOTAL LAKE INTAKE				**$490,250.00**
Section 5000 - 9000 Lake Pumpstation - Submersible Pumps in Lake Header					
1	Electrical Control Cl2 Building (6m x 3m)	m^2	18	$2,500.00	$45,000.00
2	Building Mechanical	LS	1	$5,000.00	$5,000.00
3	Pumps - Submersible 40 hp	each	3	$15,000.00	$45,000.00
4	Check Valves	each	3	$3,500.00	$10,500.00
5	SS Pump Header, Supply and Install	each	1	$120,000.00	$120,000.00
6	Flow Meter in Manhole	each	1	$15,000.00	$15,000.00
7	Bends / Fittings	each	4	$1,000.00	$4,000.00
8	Air Valves	each	1	$4,000.00	$4,000.00
9	Electrical / Controls	LS	1	$110,000.00	$110,000.00
10	Electrical Supply	LS	1	$20,000.00	$20,000.00
11	Chlorine System	LS	1	$17,000.00	$17,000.00
	SUBTOTAL LAKE PUMPSTATION				**$395,500.00**
	SUB TOTAL LAKE INTAKE / PUMPSTATION - OPTION 2				**$938,750.00**
	35% CONTINGENCIES AND ENGINEERING				**$328,562.50**
	TOTAL LAKE INTAKE / PUMPSTATION - OPTION 2				**$1,267,312.50**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
OPTION 1 DEDICATED SUPPLY MAIN
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
Sage Mesa Drive N. to UV Building, UV Building to Lower Reservoir					
4. General Conditions					
1	Mobilization and demobilization	LS	1	$2,000.00	$2,000.00
2	Bonding and Insurance	LS	1	$4,000.00	$4,000.00
3	Surveys and Layout	LS	1	$2,000.00	$2,000.00
4	Traffic Management	LS	1	$1,000.00	$1,000.00
5	General Requirements	LS	1	$4,000.00	$4,000.00
6	Erosion and Sediment Control	LS	1	$1,000.00	$1,000.00
7	Clear and Grub	LS	1	$1,000.00	$1,000.00
	SUBTOTAL GENERAL REQUIREMENTS				**$15,000.00**
Section 02224- Roadworks,Excavation,Embankment, Compaction					
02224.1	Gravel shoulder restoration	l.m	250	$6.00	$1,500.00
02224.2	Sawcut Asphalt	l.m	250	$10.00	$2,500.00
02224.3	Asphalt Removal and disposal	sq.m	750	$3.00	$2,250.00
02224.4	Subgrade Preparation	sq.m	750	$2.00	$1,500.00
02224.5	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal- as directed	cu.m	50	$30.00	$1,500.00
Section 02233 - Granular Base					
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	750	$8.00	$6,000.00
02233.2	Granular driveways - 25 mm minus crushed gravel - 100 mm thick, removal, disposal of existing	sq.m		$10.00	$0.00
Section 02234 - Granular Sub Base					
02234.1	Granular sub-base,150mm minus pit run gravel (300mm thick),removal, disposal of existing	sq.m	750	$10.00	$7,500.00
Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	50	$30.00	$1,500.00
Section 02512 - Hot Mix Asphalt Paving					
02512.1	Asphalt (Roadway) - 50 mm thick	sq.m	750	$20.00	$15,000.00
02512.2	Asphalt Driveways - 50mm thick,	sq.m		$22.00	$0.00
02512.3	Asphalt Curb	lin.m		$35.00	$0.00
Section 02523 - Concrete Walks, Curbs and Gutters					
02523.1	Miscellaneous Concrete- 100mm thick, 100mm base, removal, disposal-driveways etc as directed	sq.m.	0		$0.00
	SUBTOTAL ROADS				**$39,250.00**
Section 02666 - Waterworks					
02666.1	Watermains-All depths , Native backfill				
	300mm CL 150 C900 PVC	lin.m	400	$220.00	$88,000.00
	300mm Hillside Installation	lin.m	200	$400.00	$80,000.00
02666.2	Gate Valves				
	a) 300mm	each	2	$2,500.00	$5,000.00
02666.3	Bends c/w TB	each	13	$1,200.00	$15,600.00
02666.4	End Caps c/w TB	each			$0.00
02666.5	Tie ins	each	2	$2,500.00	$5,000.00
02666.7	Air Release Valves	each	1	$4,000.00	$4,000.00
	SUBTOTAL WATER				**$197,600.00**
Section 02921, 02934 - topsoil, hydroseeding					
02921.1	Hydroseeding - Highways mix as directed by Engineer	sq.m.	1000	$0.50	$500.00
02921.2	Sod Replacement of disturbed areas as directed by Engineer	sq.m.		$15.00	$0.00
	SUBTOTAL LANDSCAPING				**$500.00**
	SUB TOTAL DEDICATED SUPPLY MAIN OPTION 1				**$252,350.00**
	35% CONTINGENCIES AND ENGINEERING				**$88,322.50**
	TOTAL DEDICATED SUPPLY MAIN OPTION 1				**$340,672.50**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
OPTION 2 WATER SUPPLY MAIN
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
LAKE INTAKE BUILDING TO LOWER RESERVOIR - OPTION 2					
4. General Conditions					
1	Mobilization and demobilization	LS	1	$3,000.00	$3,000.00
2	Bonding and Insurance	LS	1	$6,000.00	$6,000.00
3	Surveys and Layout	LS	1	$2,000.00	$2,000.00
4	Traffic Management	LS	1	$3,000.00	$3,000.00
5	General Requirements	LS	1	$5,000.00	$5,000.00
6	Erosion and Sediment Control	LS	1	$2,000.00	$2,000.00
7	Clear and Grub	LS	1	$1,000.00	$1,000.00
	SUBTOTAL GENERAL REQUIREMENTS				**$22,000.00**
Section 02224- Roadworks,Excavation,Embankment, Compaction					
02224.1	Gravel shoulder restoration	l.m	300	$6.00	$1,800.00
02224.2	Sawcut Asphalt	l.m	300	$10.00	$3,000.00
02224.3	Asphalt Removal and disposal	sq.m	1000	$3.00	$3,000.00
02224.4	Subgrade Preparation	sq.m	1000	$2.00	$2,000.00
02224.5	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal- as directed	cu.m	80	$30.00	$2,400.00
Section 02233 - Granular Base					
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	1000	$8.00	$8,000.00
02233.2	Granular driveways - 25 mm minus crushed gravel - 100 mm thick, removal, disposal of existing	sq.m		$10.00	$0.00
Section 02234 - Granular Sub Base					
02234.1	Granular sub-base,150mm minus pit run gravel (300mm thick),removal, disposal of existing	sq.m	1000	$10.00	$10,000.00
Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	100	$30.00	$3,000.00
Section 02512 - Hot Mix Asphalt Paving					
02512.1	Asphalt (Roadway) - 50 mm thick	sq.m	1000	$20.00	$20,000.00
02512.2	Asphalt Driveways - 50mm thick,	sq.m		$22.00	$0.00
02512.3	Asphalt Curb	lin.m		$35.00	$0.00
Section 02523 - Concrete Walks, Curbs and Gutters					
02523.1	Miscellaneous Concrete- 100mm thick, 100mm base, removal, disposal-driveways etc as directed	sq.m.	0		$0.00
	SUBTOTAL ROADS				**$53,200.00**
Section 02666 - Waterworks					
02666.1	Watermains-All depths , Native backfill				
	300mm CL 150 C900 PVC	lin.m	570	$220.00	$125,400.00
	300mm Hillside	lin.m	220	$400.00	$88,000.00
02666.2	Gate Valves				
	a) 300mm	each	3	$2,500.00	$7,500.00
02666.3	Bends c/w TB	each	20	$1,200.00	$24,000.00
02666.4	End Caps c/w TB	each			$0.00
02666.5	Tie ins	each	2	$2,500.00	$5,000.00
02666.7	Air Release Valves	each	2	$4,000.00	$8,000.00
	SUBTOTAL WATER				**$257,900.00**
Section 02921, 02934 - topsoil, hydroseeding					
02921.1	Hydroseeding - Highways mix as directed by Engineer	sq.m.	2000	$0.50	$1,000.00
02921.2	Sod Replacement of disturbed areas as directed by Engineer	sq.m.		$15.00	$0.00
	SUBTOTAL LANDSCAPING				**$1,000.00**
	SUB TOTAL LAKE INTAKE BUILDING TO LOWER RESERVOIR - OPTION 2				**$334,100.00**
	35% CONTINGENCIES AND ENGINEERING				**$116,935.00**
	TOTAL LAKE INTAKE BUILDING TO LOWER RESERVOIR - OPTION 2				**$451,035.00**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
UV TREATMENT FACILITY -- OPTIONS 1 AND 2
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
UV TREATMENT FACILITY					
4. General Conditions					
1	Mobilization and demobilization	LS	1	$4,000.00	$4,000.00
2	Bonding and Insurance	LS	1	$10,000.00	$10,000.00
3	Surveys and Layout	LS	1	$1,000.00	$1,000.00
4	Traffic Management	LS	1		$0.00
5	General Requirements	LS	1	$12,000.00	$12,000.00
6	Erosion and Sediment Control	LS	1		$0.00
7	Clear and Grub	LS	1		$0.00
	SUBTOTAL GENERAL REQUIREMENTS				**$27,000.00**
Section 02224- Roadworks,Excavation,Embankment, Compaction					
02224.1	Gravel shoulders	l.m		$6.00	$0.00
02224.2	Sawcut Asphalt	l.m		$10.00	$0.00
02224.3	Asphalt Removal and disposal	sq.m		$3.00	$0.00
02224.4	Subgrade Preparation	sq.m	100	$2.00	$200.00
02224.5	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal- as directed	cu.m		$30.00	$0.00
02224.6	Common Excavation	cu.m	50	$10.00	$500.00
Section 02233 - Granular Base					$0.00
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	100	$8.00	$800.00
					$0.00
Section 02234 - Granular Sub Base					$0.00
02234.1	Granular sub-base,150mm minus pit run gravel (300mm thick),removal, disposal of existing	sq.m	100	$10.00	$1,000.00
					$0.00
Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator					$0.00
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m		$30.00	$0.00
Section 02512 - Hot Mix Asphalt Paving					$0.00
02512.1	Asphalt (Roadway) - 50 mm thick	sq.m	100	$25.00	$2,500.00
	SUBTOTAL ROADS				**$5,000.00**
Section 02921, 02934 - topsoil, hydroseeding					$0.00
02921.1	Hydroseeding - Highways mix as directed by Engineer	sq.m.	200	$0.50	$100.00
	SUBTOTAL LANDSCAPING				**$100.00**
Section 5000 to 9000 - UV Treatment					
1	Building (8m x 5m)	m^2	40	$2,500.00	$100,000.00
2	Building Mechanical	LS	1	$5,000.00	$5,000.00
3	UV Disinfection Units -- Low Pressure, High Intensity	each	2	$90,000.00	$180,000.00
4	Butterfly Valves c/w control	each	4	$5,000.00	$20,000.00
5	Flow Meter	each	2	$8,000.00	$16,000.00
6	Piping	lin.m	30	$600.00	$18,000.00
7	Bends / Fittings	each	9	$1,000.00	$9,000.00
8	Air Valves	each	2	$500.00	$1,000.00
9	Misc. Equipment/analysers	LS	1	$15,000.00	$15,000.00
10	Install Labour	LS	1	$25,000.00	$25,000.00
11	Electrical / Controls	LS	1	$80,000.00	$80,000.00
12	Electrical Supply	LS	1	$20,000.00	$20,000.00
13	Chlorine System	LS	1	$17,000.00	$17,000.00
14	Gate Valves	each	2	$2,500.00	$5,000.00
15	Tees	each	2	$1,500.00	$3,000.00
	SUBTOTAL UV TREATMENT				**$514,000.00**
	SUB TOTAL UV TREATMENT FACILITY				**$546,100.00**
	35% CONTINGENCIES AND ENGINEERING				**$191,135.00**
	TOTAL UV TREATMENT FACILITY				**$737,235.00**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
LOWER RESERVOIR AND BOOSTER STATION UPGRADES
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
RESERVOIR AND BOOSTER STATION UPGRADES					
4. General Conditions					
1	Mobilization and demobilization	LS	1	$1,000.00	$1,000.00
2	Bonding and Insurance	LS	1	$2,000.00	$2,000.00
3	Surveys and Layout	LS	1		$0.00
4	Traffic Management	LS	1		$0.00
5	General Requirements	LS	1	$4,000.00	$4,000.00
6	Clear and Grub	LS	1		$0.00
	SUBTOTAL GENERAL REQUIREMENTS				**$7,000.00**
Section 0300 to 01100 - Reservoir Divider Wall					
1	Concrete Walls	m^3	20	$1,000.00	$20,000.00
2	Mechanical				
	a) Piping	lin.m	20	$500.00	$10,000.00
	b) Valves	each	4	$1,500.00	$6,000.00
	c) Check Valves	each		$2,500.00	$0.00
	d) Bends / Fittings	each	6	$1,200.00	$7,200.00
	e) Install Labour	LS	1	$15,000.00	$15,000.00
3	Electrical / Controls	LS	1	$5,000.00	$5,000.00
	SUBTOTAL RESERVOIR CONSTRUCTION				**$63,200.00**
Section 01100 - Cascade Valve in Booster station					
1	Mechanical				
	a) Piping	lin.m	10	$500.00	$5,000.00
	b) Valves	each	2	$3,000.00	$6,000.00
	c) Control Valves	each	1	$7,000.00	$7,000.00
	d) Bends / Fittings	each	4	$1,500.00	$6,000.00
	e) Install Labour	LS	1	$7,000.00	$7,000.00
2	Electrical / Controls	LS	1	$10,000.00	$10,000.00
	SUBTOTAL CASCADE VALVE				**$41,000.00**
	SUB TOTAL LOWER RESERVOIR AND BOOSTER STATION UPGRADES				**$111,200.00**
	35% CONTINGENCIES AND ENGINEERING				**$38,920.00**
	TOTAL LOWER RESERVOIR AND BOOSTER STATION UPGRADES				**$150,120.00**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
DISTRIBUTION SYSTEM UPGRADES
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
NEW WATER MAIN TO SUPPLY VERANO PLACE					
A. General Conditions					
1	Mobilization and demobilization	LS	1	$2,000.00	$2,000.00
2	Bonding and Insurance	LS	1	$4,000.00	$4,000.00
3	Surveys and Layout	LS	1	$1,500.00	$1,500.00
4	Traffic Management	LS	1	$3,000.00	$3,000.00
5	General Requirements	LS	1	$4,000.00	$4,000.00
6	Erosion and Sediment Control	LS	1	$500.00	$500.00
	SUBTOTAL GENERAL REQUIREMENTS				**$15,000.00**
Section 02224- Roadworks,Excavation,Embankment, Compaction					
02224.1	Sawcut Asphalt	l.m	30	$10.00	$300.00
02224.2	Asphalt Removal and disposal	sq.m	100	$5.00	$500.00
02224.3	Subgrade Preparation	sq.m	100	$3.00	$300.00
02224.4	Replace unsuitable subgrade with 150mm minus, compaction in place, disposal	cu.m	20	$30.00	$600.00
Section 02233 - Granular Base					
02233.1	Granular base - 25 mm minus crushed gravel - 150 mm thick, removal, disposal of existing	sq.m	100	$10.00	$1,000.00
02233.2	Granular shoulders	lin.m	20	$10.00	$200.00
Section 02234 - Granular Sub Base					
02234.1	Granular sub-base,150mm minus pit run gravel (400mm thick),removal, disposal of existing	sq.m	100	$10.00	$1,000.00
Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	20	$35.00	$700.00
Section 02512 - Hot Mix Asphalt Paving					
02512.1	Asphalt (Roadway) - 50mm thick	sq.m	100	$35.00	$3,500.00
	SUBTOTAL ROADS				**$8,100.00**
Section 02666 - Waterworks					
02666.1	Watermains-All depths , Native backfill				
	200mm CL 150 C900 PVC Hillside	lin.m	100	$400.00	$40,000.00
02666.2	200 mm Gate Valves	each	2	$1,500.00	$3,000.00
02666.3	Bends c/w TB	each	10	$700.00	$7,000.00
02666.4	Air Release Valves	each	1	$4,000.00	$4,000.00
02666.5	Tie to existing				
	a) Connect to existing 150mm Solana Cres.,	each	1	$2,000.00	$2,000.00
	b) Connect to existing 250mm watermain at Sage Mesa Drive South,	each	1	$2,500.00	$2,500.00
	SUBTOTAL WATER				**$58,500.00**
Section 02921, 02934 - Landscaping					
02921.1	Landscaping Rehab	LS	1	$5,000.00	$5,000.00
OVERFLOW PIPING FOR LOWER RESERVOIR					**$5,000.00**
From McElhanney report					
1	Estimated cost	LS	1	$90,000.00	$90,000.00
	SUBTOTAL OVERFLOW PIPE				**$90,000.00**
	SUB - TOTAL DISTRIBUTION UPGRADES				**$176,600.00**
	35% CONTINGENCIES AND ENGINEERING				**$61,810.00**
	TOTAL DISTRIBUTION UPGRADES				**$238,410.00**

FOCUS

SAGE MESA WATER SUPPLY OPTIONS
UPPER ZONE RESERVOIR UPGRADES
MAY 2012
OPINION OF PROBABLE COST

	DESCRIPTION	UNIT OF MEAS	QTY	UNIT PRICE	CONTRACT AMOUNT
RESERVOIR UPGRADES 454 cm at UPPER RESERVOIR SITE					
A. General Conditions					
1	Mobilization and demobilization	LS	1	$3,000.00	$3,000.00
2	Bonding and Insurance	LS	1	$8,000.00	$8,000.00
3	Surveys and Layout	LS	1	$1,000.00	$1,000.00
4	Traffic Management	LS	1	$0.00	$0.00
5	General Requirements	LS	1	$8,000.00	$8,000.00
6	Clear and Grub	LS	1	$2,000.00	$2,000.00
	SUBTOTAL GENERAL REQUIREMENTS				**$22,000.00**
Section 02224- Roadworks,Excavation,Embankment, Compaction					
02224.1	Subgrade Preparation	sq.m	50	$2.00	$100.00
02224.2	Replace unsuitable subgrade with 150mm minus	cu.m		$30.00	$0.00
Section 02233 - Granular Base					
02233.1	Granular driveways - 25 mm minus crushed gravel - 100 mm thick, removal, disposal of existing	sq.m	50	$10.00	$500.00
Section 02234 - Granular Sub Base					
02234.1	Granular sub-base,150mm minus pit run gravel (300mm thick),removal, disposal of existing	sq.m	50	$10.00	$500.00
Section 02235 - Unsuitable Trench Material- only as directed/authorised by Contract Administrator					
02235.1	Removal, disposal, replacement with pitrun gravel (150mm minus)	cu.m	20	$30.00	$600.00
	SUBTOTAL ROADS				**$1,700.00**
Section 02666 - Buried Waterworks and Drainage					
02666.1	Watermains-All depths , Native backfill				
	200mm CL 150 C900 PVC	lin.m	20	$300.00	$6,000.00
	300mm CL 150 C900 PVC	lin.m		$300.00	$0.00
02666.2	Gate Valves	each			$0.00
02666.3	Tees c/w TB	each	0		$0.00
02666.4	End Caps c/w TB	each	0		$0.00
02666.5	Bends c/w TB	each	2	$1,500.00	$3,000.00
02666.6	Drain Piping	lin.m	20	$200.00	$4,000.00
02666.7	Manhole	LS		$3,000.00	$0.00
02666.8	Tie to existing				
	a) Connect to existing 200mm watermain.	each	1	$3,000.00	$3,000.00
	b) Connect to existing 150mm	each	1	$3,000.00	$3,000.00
	SUBTOTAL BURIED WATERWORKS AND DRAINAGE				**$19,000.00**
Section 02921, 02934 - topsoil, hydroseeding					
02921.1	Hydroseeding - Highways mix as directed by Engineer	sq.m.	500	$0.50	$250.00
	SUBTOTAL LANDSCAPING				**$250.00**
Section 0300 to 01100 - Reservoir Construction					
1	Excavation / Backfill	LS	1	$20,000.00	$20,000.00
2	Concrete Walls	m^3	100	$800.00	$80,000.00
3	Concrete Floor	m^3	25	$600.00	$15,000.00
4	Concrete Roof Slab	m^3	27	$1,000.00	$27,000.00
5	Concrete Valve Chamber	m^3	30	$800.00	$24,000.00
6	Mechanical				
	a) Piping	lin.m	30	$500.00	$15,000.00
	b) Valves	each	6	$1,500.00	$9,000.00
	c) Check Valves	each	2	$2,500.00	$5,000.00
	d) Bends / Fittings	each	10	$1,200.00	$12,000.00
	e) Install Labour	LS	1	$15,000.00	$15,000.00
7	Electrical / Controls	LS	1	$5,000.00	$5,000.00
8	Electrical Supply	LS	1	$2,500.00	$2,500.00
	SUBTOTAL RESERVOIR CONSTRUCTION				**$229,500.00**
	SUB TOTAL RESERVOIR UPGRADES				**$272,450.00**
	35% CONTINGENCIES AND ENGINEERING				**$95,357.50**
	TOTAL RESERVOIR UPGRADES OPTION 3 AND 5				**$367,807.50**

SAGE MESA
WATER AND PUBLIC SERVICE COMPANY

ASSESSMENT REPORT

Prepared for:

Regional District of Okanagan-Similkameen

Prepared by:

TRUE Consulting Group

January 2000

TRUE
CONSULTING GROUP

January 18, 2000 Our Ref: 383-061

Regional District of Okanagan-Similkameen
101 Martin Street
Penticton, B.C.
V2A 5J9

Attention: Mr. Karl Newholm, Special Projects Manager

Dear Sir:

RE: ***Assessment Report –***
Sage Mesa Water and Public Service Co. Ltd.

We submit herewith our final report presenting an assessment of the Sage Mesa Area Water System. Consistent with your Terms of Reference, the report assesses financial, legal and functional (technical) issues relative to the water system. The report includes a series of appendices containing regulatory information, applicable to the water system.

We hope that the assessment report will be of assistance to the Regional District in a decision process which may result in the Regional District assuming ownership of the system. Should clarification of any aspect of the report be required, please contact the undersigned.

Yours truly,

T.R. Underwood, P. Eng.

TRU/cab

attach.

CB\TRU\RDOS-Newholm-Sage Mesa Final Rpt.doc

SAGE MESA
WATER AND PUBLIC SERVICE COMPANY

ASSESSMENT REPORT

TABLE OF CONTENTS

PAGE #

EXECUTIVE SUMMARY

SECTION 1.0: INTRODUCTION AND STUDY OBJECTIVES 1.1

1.1 INTRODUCTION 1.1
1.2 STUDY OBJECTIVES 1.1

SECTION 2.0: SYSTEM DESCRIPTION AND SERVICE AREA 2.1

SECTION 3.0: ADMINISTRATION 3.1

3.1 CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY (CPCN) . 3.1
3.2 WATER LICENCES 3.2
3.3 STATUTORY RIGHTS OF WAY 3.4
3.4 MINISTRY OF HEALTH 3.7

SECTION 4.0: WATER SYSTEM ASSESSMENT CRITERIA 4.1

4.1 WATERWORKS DESIGN CRITERIA 4.1
4.2 WATER DEMAND CRITERIA 4.2
4.3 DISINFECTION 4.4

SECTION 5.0: WATER SYSTEM ASSESSMENT 5.1

5.1 GENERAL 5.1

5.2 LOWER (1490) PRESSURE ZONE 5.1
5.2.1 LAKE INTAKE 5.1
5.2.2 LAKE PUMPHOUSE 5.3
5.2.3 DISINFECTION SYSTEM 5.5
5.2.4 SUPPLY MAIN-LAKE PUMPHOUSE TO LOWER PRESSURE ... 5.6
5.2.5 LOWER ZONE (1490) RESERVOIR 5.7
5.2.6 LOWER ZONE DISTRIBUTION SYSTEM 5.9

TABLE OF CONTENTS

PAGE #

5.3 UPPER PRESSURE ZONE 5.10
5.3.1 BOOSTER STATION 5.10
5.3.2 WATER SUPPLY MAIN 5.11
5.3.3 RESERVOIR 5.12
5.3.4 DISTRIBUTION SYSTEM 5.13

5.4 UPGRADING AND IMPROVEMENT PLAN 5.14
5.4.1 GENERAL 5.14
5.4.2 OPERATION AND MAINTENANCE 5.15
5.4.3 CAPITAL IMPROVEMENTS 5.16
5.4.4 FIVE YEAR CAPITAL PLAN 5.23

5.5 FINANCIAL 5.24
5.5.1 FINANCIAL STATEMENTS 5.24
5.5.2 WATER RATE STRUCTURE 5.26
5.5.3 RDOS PRO FORMA BUDGET 5.28

5.6 LEGAL 5.30
5.6.1 SERVICE AREA 5.30
5.6.2 PENDING LEGAL ACTION 5.31

APPENDIX 'A' – WATER SYSTEM SERVICE AREA – TRUE DRAWING 383-041-00

APPENDIX 'B' - CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY (CPCN)

APPENDIX 'C' - WATER LICENCES
- PERMITS AUTHORIZING THE OCCUPATION OF CROWN LAND UNDER THE WATER ACT

APPENDIX 'D' – PERMIT TO OPERATE ISSUED BY MINISTRY OF HEALTH

APPENDIX 'E' – WATER UTILITY ACT – WATER TARIFF NO. 5 RATES AND RULES

APPENDIX 'F' – FINANCIAL STATEMENTS – NOVEMBER 30, 1998 PREPARED BY KEMP, HARVEY, LISTER, INC.

APPENDIX 'G' – CORRESPONDENCE RELATED TO SERVICE LOWER PRESSURE ZONE

Introduction and System Description

The Sage Mesa water system services 250 residential lots and two golf courses in the Sage Mesa area 2 km northwest of the City of Penticton. The water system comprises two pressure zones designated upper and lower with pressure established in each by a reservoir of reinforced concrete construction. Water is supplied from an intake into Okanagan Lake.

Initial phases of the water system were constructed in 1962 to service residential development in the Sage Mesa area located east and below the Kettle Valley Railway Right of Way. In 1977, the system was extended into the upper pressure area to service development in the Forsyth Road area. Distribution system extensions were constructed in the upper pressure zone in 1981, 1994 and 1997.

Operational Status

The Sage Mesa water system is a private utility owned by the Sage Mesa Water and Public Service Co. Ltd. and authorized by a Certificate of Public Convenience and Necessity first issued in 1965 pursuant to the Water Utilities Act. By "order of seizure" dated June 27, 1990, the Comptroller of Water Rights assumed responsibility for operation and maintenance of the utility. The seizure was issued because of failure by the utility owner to make prescribed deposits to reserve accounts and failure to install and operate disinfection equipment. In the period June 27, 1990 to date, the water system has been managed by the Comptroller of Water Rights with operation and maintenance contracted to a local (Penticton area) firm.

Assessment Study Objectives

Representation has been made by property owners in the Sage Mesa area to the Regional District to take over and assume ownership of the Sage Mesa Water System. This study assesses technical, financial and legal status issues related to the Sage Mesa water system and is intended to assist the Regional District in a decision which may result in the assumption of ownership of the system.

Assessment Study Summary

(1) Administrative and Legal

- ❒ the water utility has all necessary operational certificates from the Ministry of Health and water licences issued by the Ministry of Environment.
- ❒ all components of the water system which are not located within public road rights of way are covered by statutory rights of way in favour of the utility.
- ❒ the CPCN has not been updated since 1985 and does not therefore specifically reference properties currently serviced by the utility in the upper pressure zone developed after 1985.
- ❒ according to Ministry of Environment staff, there is no outstanding or pending legal action against the utility.
- ❒ from the perspective of the Ministry of Environment, the utility has no outstanding commitments for service. Appendix G of the report contains correspondence from ARA Holdings owned by Mr. Richard Chapman that presents the position that there is an outstanding service commitment by the utility to service proposed development in the lower pressure area.
- ❒ the utility has appropriate rate and regulatory documents registered with the Comptroller of Water Rights.

(2) Technical (Engineering)

- ❒ an assessment of all components of the water system concludes that there are no significant deficiencies which directly impact the utility's ability to provide service.
- ❒ a five year capital improvement plan is derived which comprises supply and distribution system improvements, components of which the utility has initiated construction with the capital resources available to it. The capital plan comprises:

Component	*Objective*	*Estimated Capital Cost*
Supply Main Improvements Lake Pumphouse to Solana Cres.	Addresses reliability concerns, provides adequate chlorine contact time and provides fire flow to Verano Place	$198,000
Supply Main – Solana Cres. to Low Zone Reservoir	Completes supply to reservoir, and resolves reliability concerns	$102,000
Lower Zone Reservoir Overflow	Resolves deficiency and addresses soil stability risks which may result from an overflow event.	$69,000
Lake Pumphouse Capacity Upgrading	Upgrade electrical service and provide standby supply capacity consistent with regulatory guidelines.	$181,000
Water Service Replacements – Lower Pressure Zone	Replace water services which may be subject to corrosion.	$78,000
	TOTAL	**$628,000**

(3) Financial

- ❒ the utility's rate structure provides adequate revenue for operation and maintenance of the system. The rate structure will provide adequate revenue for estimated operation and maintenance costs under Regional District ownership.
- ❒ financial statements confirm contributions to reserve accounts consistent with the utility's tariff. To November 30, 1998, the utility had reserves totaling $32,339.
- ❒ the utility has no outstanding capital debt.

Assumption of Ownership Issues

Should the Regional District of Okanagan-Similkameen decide to proceed with the objective of possibly assuming ownership of the Sage Mesa water system, following are listed issues that should be raised with the Provincial Government and the Utility's owner.

- eligibility of the Capital Improvement Program for Infrastructure Assistance from the Province.
- update of the CPCN and authorized service area.
- confirmation that there is no legal action pending against the utility and that there are no outstanding service commitments.
- the "mechanics" of the assumption of ownership, including but not limited to:
  - does the Regional District purchase (for a nominal or other sum) the Sage Mesa Water and Public Service Co. Ltd.
  - are all assets of the utility, i.e., water system, reserve accounts, licences, etc. transferred with the purchase of the Sage Mesa Water and Public Service Co. Ltd.
  - following assumption, the procedures for dissolving the utility as a corporation and operation as a Local Service Area.

1.1 Introduction

The Sage Mesa Water and Public Service Company water system is located approximately 2 km north west of the City of Penticton and services residential development and two golf courses in the West Bench Area. Drawing 383-041-00 illustrates the service area of the utility.

The water system comprises two separate pressure zones designated the upper and lower pressure zones. Components comprising the lower pressure zone were constructed in 1962 associated with residential development in this area. The system was extended to provide service in the upper pressure zone area in 1977. Distribution system extensions were constructed in the upper pressure zone in 1981, 1994 and 1997 to service single family residential development in this area.

In the period 1962 to 1990 the Sage Mesa Water and Public Service Company was owned and operated by persons and companies associated with land development projects in the water system service area. In 1990, by Order of Seizure issued pursuant to the Water Utility Act and the Utilities Commission Act, administrative and operational responsibilities of the water system were taken over by the Comptroller of Water Rights. Since June 1990, the water system has been managed and operated by the Water Management Branch of the Ministry of Environment.

The Sage Mesa Water System is located within Electoral Area F of the Regional District of Okanagan Similkameen. The Regional District of Okanagan Similkameen (RDOS) regulates zoning and development standards within the water system service area. With the RDOS being the local government having land use and development jurisdiction in the water system service area, representation has been made on several occasions since 1990 by property owners in the Sage Mesa area related the RDOS assuming operational jurisdiction for the water system. To respond to these requests, this study is prepared as a functional and administrative assessment to assist the RDOS in a decision to assume ownership of the Sage Mesa Water and Public Service Co. Ltd. Water system.

1.2 Study Objectives

This assessment study has been prepared in accordance with Terms of Reference compiled by the Regional District of Okanagan Similkameen. These terms of reference are intended to provide an assessment of all legal, financial, and engineering (technical) aspects of the water utility. Principal components of the terms of reference are summarized following:

Legal:

A. Define legal boundaries of the utility.
B. Determine whether the utility provides service to areas outside its legal boundaries
C. Determine whether there is any legal action pending against the utility.
D. Compile an inventory of regulatory and rate bylaws.

Financial:

A. Assess the utility's most recent financial statement.
B. Review financial statements and identify any financial exposure concerns.
C. Analyze current loan authorization and security issuing bylaws.
D. Assess RDOS staffing implications and develop pro forma budget for first year of operation.
E. Conduct equity analysis of rate bylaws.
F. Analyze reserve funds and enabling authority.
G. Identify and prioritize five year capital expenditure requirements.
H. Provide an opinion as to where any capital improvements would rate within the Provincial government's evaluation matrix for infrastructure grants.

Engineering:

A. Assess system efficiency, identify operational deficiencies and associated hazard land risks.
B. Prioritize 5 year capital upgrade requirements.
C. Confirm all water system components are "covered" by appropriate rights of way or comparable approvals.
D. Assess status of "as built drawings".

As described in Section 1, the Sage Mesa water system comprises two pressure zones, designated upper and lower with the service area illustrated on drawing 383-041-00. Using this drawing as a key plan, a composite plan of the lower pressure zone is presented on drawing 383-041-01 and the upper pressure zone on drawings 383-041-02 to 05 inclusive. The water system composite drawings numbered 383-041-01 to 05 have been prepared on the basis of:

- as built and record drawings as provided by the utility. These drawings relate generally to all waterworks components constructed prior to 1990.

- *TRUE* Consulting Group as constructed drawings for projects that the firm has assisted the utility with. All of these projects are located in the lower pressure zone, and were constructed in the period 1991 to 1999. Examples in this regard include the reconstruction of the 1490 Booster Station, supply main on Sage Mesa Drive and distribution system replacement on Verano Drive.

- repair and maintenance records as provided by the utility's operation and maintenance contractor.

The composite plans of the water system comprising drawings 383-041-01 to 05 inclusive have been reviewed for accuracy by the system's operation and maintenance contractor, Mr. Al Lister. Mr. Lister has provided operation and maintenance services to the utility since 1990 and therefore has knowledge of all components of the water system.

Referring to drawing 383-041-01, the lower pressure zone comprises:

- 200 mm supply main approximately 300 m in length from the Lake pumphouse to Sage Mesa Drive North.

- distribution system comprising 50 mm PVC and galvanized iron, 100 mm and 150 mm asbestos cement and 100 mm to 250 mm PVC pipe. All galvanized iron and asbestos cement distribution mains represent the initial components of the system constructed in 1962. PVC pipe has been used for all upgrading and extensions in the lower pressure zone constructed after 1980.

- a 272 m^3 (60,000 Igal) reservoir of cast in place concrete construction located on the west side of the former Kettle Valley Railway Right of Way.

Where information is available, the year of construction of all components of the lower pressure zone is provided on drawing 383-041-01.

PLAN 42983

50mm BLOWOFF/DRAIN (GROUND LEVEL)

200mm DIAMETER IRON SUPPLY MAIN TO UPPER ZONE RESERVOIR

LOT A PLAN 40762

R/W PLAN 12586

BOUNDARY R/W PLAN 42983

UPPER ZONE BOOSTER STATION

PLAN A10065

LOWER ZONE RESERVOIR 60,000 L gd FWL 1490 FEET

200mm AC (1962)

ELECTRICAL SERVICE TO BOOSTER STATION

DETAIL D

PAVEMENT
GOLF COURSE BOOSTER STATION
APPROXIMATE LOCATION EXISTING 75mm SUPPLY TO GOLF COURSE
ABANDONED BOOSTER STATION
EXISTING 200mm D.I. SUPPLY MAIN
200mm Gate Valve (Normally Closed)
GATE VALVE (NORMALLY CLOSED)
RESERVOIR
BOOSTER STATION (1927)
200mm D.I.
200mm AC SUPPLY MAIN FROM LAKE INTAKE
200mm GATE VALVE
RESERVE AREA FOR FUTURE RESERVOIR EXPANSION
200mm PVC C900 CL150 (1997)
250Hx250Hx200H TEE c/w END CAP
250mm PVC CL150 (1997)

SAGE MESA DR.

SEE DETAIL A

SAGE MESA DR. NORTH

SEE DETAIL B

SEE DETAIL E

SOLANA CR.

LADERA PL.

VERANO PLACE

LOT A PLAN 16910

LOT 1 PLAN 21078

R/W PLAN A2740

1 13161
2 13161 (W 33.61E – S)
3 13161
4 13161
5 13161
6 13161
7 13161 (W 1.8H – SE)
8 13161
9 13161
10 13161
11 13161
12 13161 R/W PLAN A2740 (W 4.7E – SW)
13 13161
14 13161
16 13161 (W 12.85E – N)
17 13161 NOT SERVICED
18 13161 (W 12.5NW – E)
19 13161 (W 14.05E – N)
20 13161 NOT SERVICED
21 13161
22 13161 (W 3.3N – W UN–OCCUPIED)
23 13161 (W 16.3S – NW)
24 13161 (W 11.3S – NW)
25 13161
26 13161
27 13161 (W 12.0S – NE)
28 13161 (W 6.2S – NE)
29 13161 UN–OCCUPIED NOT SERVICED
30 13161 (W 3.3S – NE)
31 13161 (W 26.3SW – NE)
32 13161
33 13161 (W 8.5N – SE)
34 13161 (W 10.2S – NE)
35 13161 (W 11.0N – SE)
36 13161 (W 19.8E – NW)
37 13161 NOT FOUND
38 13161 R/W PLAN A2740 (W 29.8E – SW)
39 13161 (W 11.3S – NE)
40 13161
41 13161 (W 13.0S – NE)
42 13161 UN–OCCUPIED NOT SERVICED
43 13161
44 13161 (W 10.7E – SW)
45 13161 (W 12.2W – SW)
46 13161 UN–OCCUPIED NOT SERVICED
47 13161 LINE EXISTS NO CURB STOP INSTALLED
48 13161 UN–OCCUPIED NOT SERVICED
49 13161
50 13161
51 13161
52 13161
53 13161
54 13161
55 13161
57 13161
58 13161
59 13161
60 13161
61 13161
62 13161

1 20001
2 20001 (W 5.1S – NE)
3 20001 (W 0.0N – SE)
4 20001 (W 0.05S – NE)
5 20001 (W 0.05N – SE)
6 20001 (W 16.7S – NE)
8 20001 (W 8.8S – NE)
9 20001 (W 13.6N – SE)
10 20001 (W 11.0S – NE)
11 20001 (W 11.2N – SE UN–OCCUPIED)
12 20001

150mm PVC CL150 (1984)
150mm PVC CL150 (1998)
100mm AC CL150 (1962)
150mm AC CL150 (1962)
200mm PVC CL250 (1980)
150mm AC (1968)
RWAY PLAN A12565
RWAY PLAN A12564
250mm PVC DR18 (1998)
250mm PVC DR14 (1998)
100mm PVC (1998)
150mm PVC (1998) (Sage Mesa Dr. to Hydrant)
SERVICES to LOT 55 to 61 – 19mm PEX 1998
LOTS 1 & 57 – 25mm PEX 1998 (NOT CONNECTED TO EXISTING)
25mm SERVICE to LOT 62 (1998)
END CAP AND THRUST BLOCK
250mm END CAP (1998)
250mm GATE VALVE (LOCATION APPROX.)

DETAIL C

200mm D.I. to PVC supply
1006mm To Sage Mesa Drive
100mm AC
WKP.POLE
1000mm VALVE CLOSED
27.7m of 600mm CMP CULVERT
INV. 342.7m
31.7m OF 600mm CMP CULVERT
3–3" FRE DUCTS WITH 300 MCM CU. CONDUCTORS
INV. 342.7m
TOP OF RIP RAP
19.05m
100mm PVC DRAIN TO R.P.
DOOR SILL EL. 343.73m
PUMPHOUSE
32.6m of 600mm CMP INTAKE LINE
CONC. ANCHORS AT EACH JOINT
200mm PVC CL250 (1980)
100mm AC CL250 (1962) (ABANDONED 1997)
BLK B D.L. 2497
HIGHWAY 97
200mm D.I. (60m from pumphouse to connection to PVC)
LAKE PUMPHOUSE

DETAIL E

FIRE HYDRANT
CURBSTOP
150mm GATE VALVE
150mmx100mm REDUCER
100mm GATE VALVE
150x150x100mm TEE

DETAIL A

Underground cable to booster (600V) (1997)
Power pole and main switch for booster pump house
200mm AC (to reservoir)
200mm Gate Valve
200mm PVC (1980)
200Hx200Hx200F Tee
200Hx150Hx150F Tee
150mm AC (1962)
150mm Gate Valve

DETAIL B

200mm PVC (1980) (to reservior)
50mm Brass Interconnect
50mm Clow Gate Valve
150mm AC (1962)
50mm service saddle
151 AC – 460mm below PVC
150mm AC (1968)
150mm Gate Valve
200x50 Service Saddle
Robar Coupling
50mm Poly Service (FOR FUTURE USE)
100Hx200Hx150F Tee
150mm PVC (FOR FUTURE USE)
100mm AC– ABANDONED
CLOSED
200mm Check Valve in Precast Concrete Chamber
From Lake Pumphouse

No.	DATE	DESCRIPTION	BY	APP'D
9				
8				
7				
6				
5				
4				
3	NOV 30/98	REVISED TO REFLECT UTILITY COMMENTS	VW	TRUE
2	SEPT 21/98	LEGAL DESCRIPTION UPDATE	VW	TRUE
1	DEC 21/98	FINAL REVISIONS	DL	TRUE

ISSUES / REVISIONS

SCALE NTS
DESIGN BY TRUE
DRAWN BY TRUE/DL
DATE JUNE 1998
CHKD. BY: TRUE
DATE

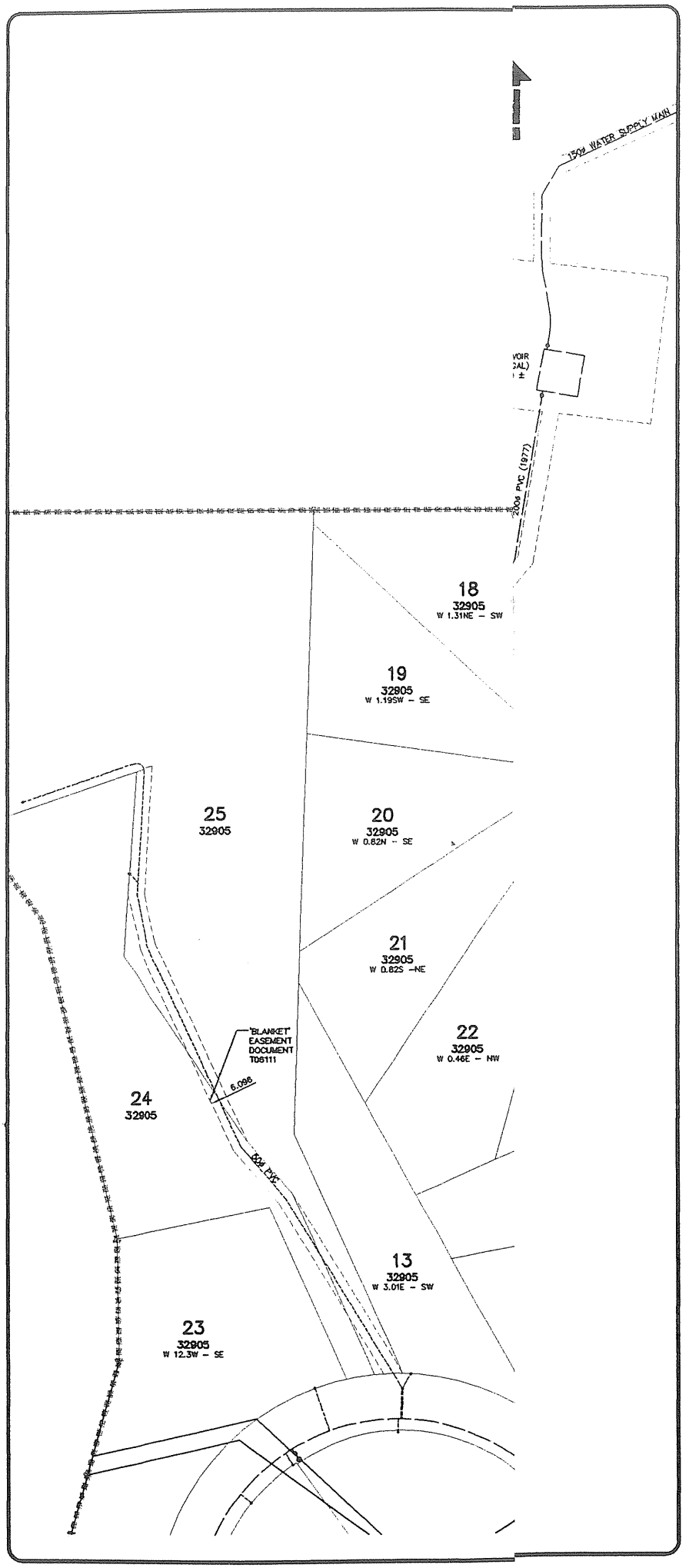
TRUE CONSULTING GROUP

SAGE MESA WATER AND SERVICE CO. LTD

COMPOSITE PLAN OF 1490 (LOWER PRESSURE ZONE)

SHEET No. OF
DRAWING NO: 383-041-01
ISSUED/REV. 3

ACAD FILENAME: 383-041.DWG



No.	DATE	DESCRIPTION	BY	APP'D
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8				
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1	NOV 30/99	REVISED TO REFLECT UTILITY COMMENTS	VW	TRU

ISSUES / REVISIONS

SCALE	NTS
DESIGN BY	TRU
DRAWN BY	VW
DATE	APRIL 1999
CHK. BY:	
DATE	

TRUE CONSULTING GROUP

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.

WATER SYSTEM COMPOSITE

UPPER PRESSURE ZONE N FORSYTH DR, FORSYTH PLACE AND TYRONE PL

SHEET No.	OF
DRAWING NO: 383-041-02	ISSUED/REV. 1

ACAD FILENAME 38304123.DWG



No.	DATE	DESCRIPTION	BY	APP'D
9				
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2				
1	NOV 30/99	REVISED TO REFLECT UTILITY COMMENTS	VW	TRU

ISSUES / REVISIONS

SCALE NTS
DESIGN BY TRU
DRAWN BY VW
DATE APRIL 1999
CHK. BY:
DATE

TRUE
CONSULTING GROUP

SAGE MESA
WATER & PUBLIC
SERVICE CO. LTD.

WATER
SYSTEM
COMPOSITE

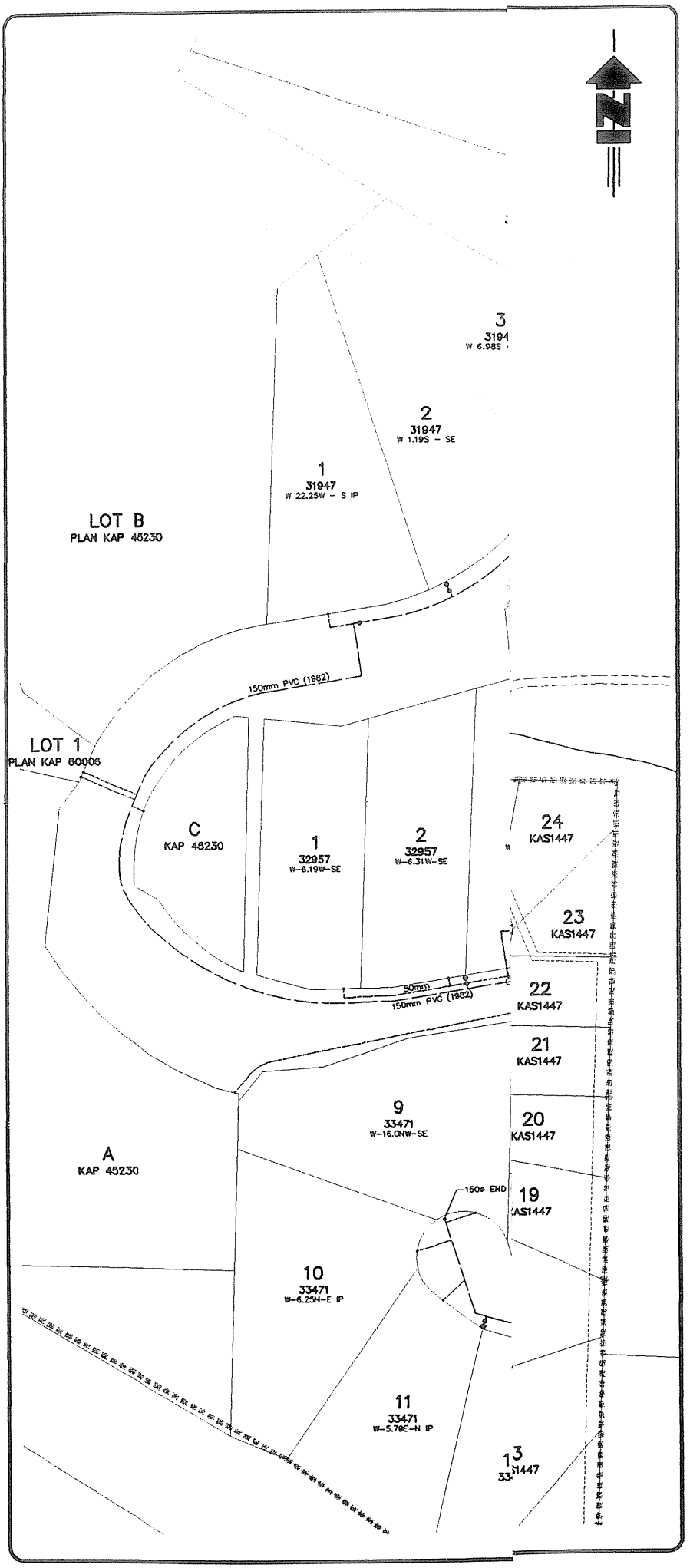
UPPER
PRESSURE ZONE
FORSYTH DRIVE
AND
RYAN ROAD

SHEET No. OF

DRAWING NO: 383-041-03

ISSUES/REV. 1

ACAD FILENAME. 38304123.DWG



No.	DATE	DESCRIPTION	BY	APP'D
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1	NOV 30/99	REVISED TO REFLECT UTILITY COMMENTS	VW	TRUE

ISSUES / REVISIONS

SCALE	NTS
DESIGN BY	WBJ
DRAWN BY	WBJ
DATE	APRIL 1999
CHK. BY:	
DATE	

TRUE CONSULTING GROUP

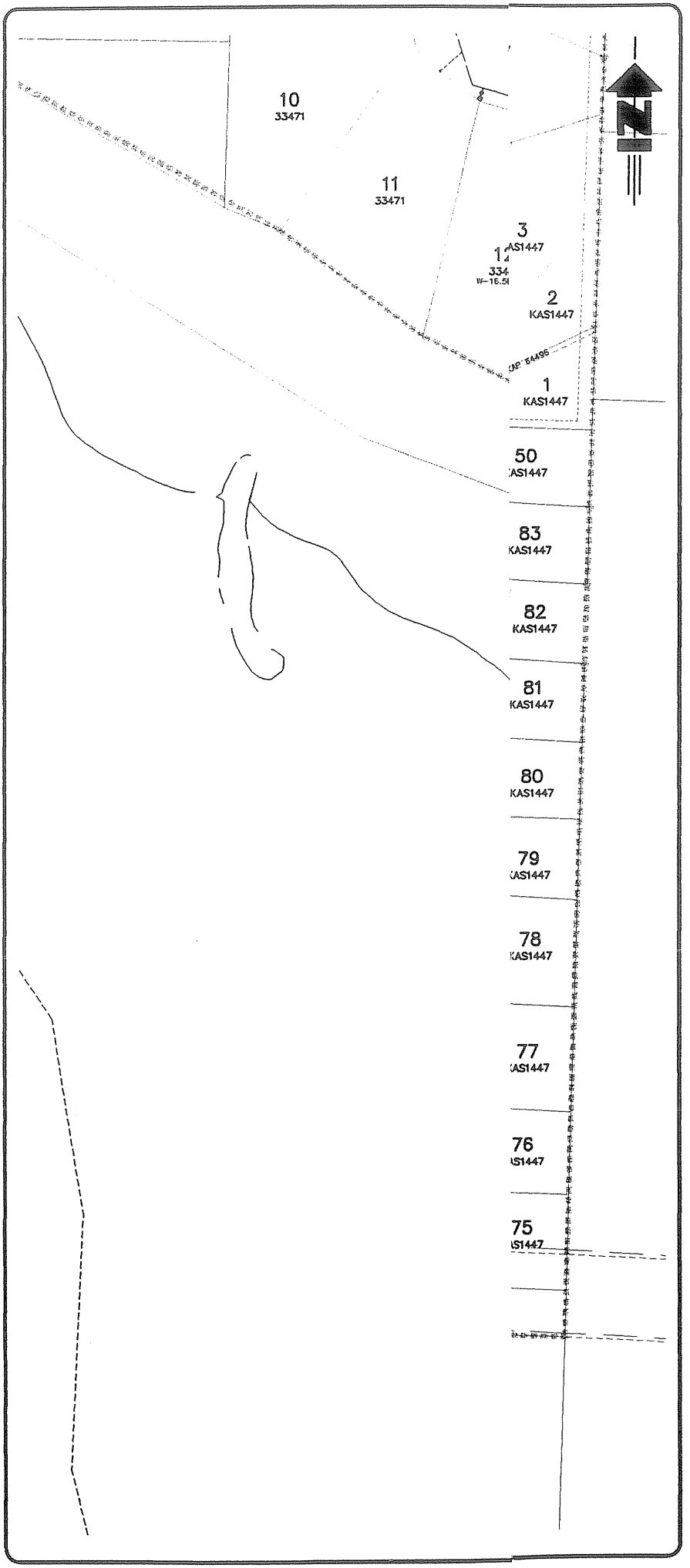
SAGE MESA WATER & PUBLIC SERVICE CO. LTD.

WATER SYSTEM COMPOSITE

UPPER PRESSURE ZONE SOUTH FORSYTH DRIVE AND WESTWOOD DRIVE

SHEET No.	OF	
DRAWING NO: 383-041-04		ISSUES/REV. 1

ACAD FILENAME 38304123.DWG



No.	DATE	DESCRIPTION	BY	APP'D
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1	NOV 30/99	REVISED TO REFLECT UTILITY COMMENTS	VW	TRU

ISSUES / REVISIONS

SCALE	NTS
DESIGN BY	TRU
DRAWN BY	VW
DATE	APRIL 1999
CHK. BY:	
DATE	

TRUE CONSULTING GROUP

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.

WATER SYSTEM COMPOSITE

WATER PRESSURE ZONE SANDSTONE DRIVE

SHEET No.	OF	
DRAWING NO:	383-041-05	ISSUES/REV. 1

ACAD FILENAME 38304123.DWG

Water is pumped from the lower to the upper pressure zone by a booster station (designated 1490 booster station) located south and adjacent to the lower pressure zone reservoir. Piping appurtenance to the booster station is illustrated on an insert detail on drawing 383-041-01. Referring to the overall water system service area drawing (383-041-00), the supply main between the upper and lower pressure zones comprises:

- 600 m of 200 mm ductile iron CL250 pipe starting at the 1490 booster station; and
- 650 m of 150 mm ductile iron CL250 pipe terminating at the upper pressure zone reservoir.

Record drawings suggest that the supply system between the upper and lower pressure zones was constructed in 1977.

Referring to drawings 383-041-02 to 05, components of the upper pressure zone comprise:

- 450 m^3 (100,000 Igal) reservoir located east of Forsythe Place.
- distribution system comprising 100 mm to 200 mm PVC pipe. Consistent with the drawing for the lower pressure, dates of construction is provided where information is available.
- two pressure reducing stations

From operation statistics provided by the utility for June 1999 and system composite drawings, the utility currently services the following in the upper and lower pressure zones.

- *Lower Pressure Zone:*
  - 65 Residential Connections (Lots)
  - 3 Vacant-Serviced Residential Lots
  - 5 Not Serviced Lots
  - Pine Hills Golf Course
  - Sage Mesa Golf Course

  Total 68 Residential Lots and 2 Golf Courses

❒ *Upper Pressure Zone:*

- 151 Residential Connections (Lots)
- 31 Vacant-Serviced Residential Lots

Total 182 Residential

3.1 Certificate of Public Convenience and Necessity (CPCN)

The construction and operation of a Water Utility to service the Sage Mesa area was authorized by a Certificate of Public Convenience and Necessity issued to the Sunnyview Development Co. Ltd. on June 18th, 1965. In the period 1965 to date, the CPCN has been amended on several occasions to change the Utility name and authorize expansion of the service area.

Principal amendments to the CPCN are summarized following: (copies included in *Appendix B*)

Certificate No. 552 - Nov. 19th, 1984 - Consolidation of Areas authorized to be serviced by the Utility

The present service area of the Sage Mesa Water and Public Service Co. Ltd. water utility is illustrated on drawing 383-041-00 contained in *Appendix A*. The Utility's Certificate of Public Convenience and Necessity has not been amended since 1984 and referring to *Appendix B*, does not make reference to any subdivision or development plans after Plan 33471. All development currently serviced by the utility having Land Titles Plan numbers higher than 33471 are not therefore referenced in the CPCN. The majority of the development now serviced by the utility having plan numbers higher than 33471 is located in the southern portion of the upper pressure zone. Ministry of Environment staff recognize that an amendment to the utility's CPCN is necessary to reflect development since 1984 currently serviced by the utility.

By *"order of seizure"* issued pursuant to the Water Utilities Act and the Utilities Commission Act dated June 27, 1990, the Comptroller of Water Rights took possession and assumed responsibility for the operation and maintenance of the Water Utility. The *Order* (refer to *Appendix B* for copy of *Seizure Order 1378*) makes reference to previous orders which the Utility owner failed to comply with as the basis for the *Seizure Order*. Items specifically described are:

(1) Deposit $11,983.71 into the Lower Area Replacement Reserve Trust Fund, being the calculated balance owing to the fund as at April 30, 1990, and as shown on Appendix A to Order No. 1366;

(2) Deposit $6,581.83 into the Upper Area Replacement Reserve Trust Fund, being the calculated balance owing to the fund as at April 30, 1990, and as shown on Appendix B to Order No. 1366;

(3) Install and place into operation disinfection equipment as required by the Minister of Health in his order of June 19, 1989.

The Sage Mesa Water and Service Company Ltd. to November 1999 is being operated and maintained by the Comptroller of Water Rights pursuant to the *Order of Seizure* dated June 27, 1990.

3.2 Water Licences

The Sage Mesa Water and Public Service Company Ltd. holds nine (9) water licences and three (3) permits issued appurtenant to water licences authorizing the occupation of Crown Lands. Copies of all water licences and permits are contained in *Appendix C*. The water licences and permits issued to the Utility are tabulated following.

Conditional Licence No.	*Date of Issue*	*Diversion Quantity*	*Comments*
C 30606	17 January 1966	31,000 Igal/day	waterworks purposes to service 62 lots in lower pressure zone
C 52739	6 September 1979	18,000 Igal/day	waterworks purposes to service Phase 1 of development in upper pressure zone
C 58922	15 June 1983	10,500 Igal/day	waterworks purposes to service development in upper pressure zone
C 59060	15 July 1983	1,500 Igal/day	waterworks purposes to service development in upper pressure zone
C 61571	14 November 1984	4,000 Igal/day	waterworks purposes to service development in upper pressure zone
C 64196	21 November 1986	182,500 Igal/year	waterworks purposes for one dwelling unit
C 104081	25 May 1992	30 acre feet	irrigation of Lot A Plan 40262 (Pine Hills Golf Course)
C 104082	25 May 1992	44.67 ac-feet and 500 Igpd	irrigation of portion of Lot 5076 (Sage Mesa Golf Course) and waterworks for clubhouse
C 107735	29 April 1996	61,500 Igpd	Waterworks purposes

The nine (9) water licences listed above authorize a total withdrawal from Okanagan Lake for waterworks (domestic) purposes of 127,500 Igallons per day. Licences for waterworks purposes are generally allocated on the basis of an average of 500 Igallons/day/dwelling unit. The total

licenced quantity of 127,500 Igallons/day would, therefore, equate to a total of 255 dwelling unit or equivalent single family residential lots. The development within the service area of the Sage Mesa Water System currently comprises a total of 255 single family lots (182 lots in the upper pressure zone and 73 lots in the lower pressure zone). The Utility, therefore, has adequate licenced quantity for waterworks purposes.

The Utility has water licences authorizing the withdrawal from Okanagan Lake for irrigation purposes of a total of 74.67 acre feet per annum. The irrigation licences authorize irrigation of up to 30 acres on the Sage Mesa Golf Course and up to 20 acres on the Pine Hills Golf Course. Water consumption data provided by the Utility for the irrigation users for the period April 01 to September 30, 1998 are:

Pine Hills	-	total metered usage	-	16 ac.-ft.
Sage Mesa	-	total metered usage	-	36 ac.-ft.
		Total Irrigation		**52 ac.-ft.**

Assuming the actual consumption by Pine Hills and Sage Mesa Golf Courses in 1998 is representative of average operations, licenced quantities for irrigation purposes appear adequate.

The Water Utility holds three (3) permits to occupy Crown Land for waterworks appurtenant to Conditional Water Licences. These permits are tabulated following. Copies of the permits are included in *Appendix C.*

Permit #	*Date Issued*	*Authorization*
15781	February 10, 1987	Occupation of Okanagan Lake foreshore for intake and pumphouse with the area dimensions being 400 feet long by 15 feet wide representing a total area of 0.14 acres.
20187	May 25, 1992	Occupation of Okanagan Lake foreshore for intake and pumphouse with the area dimensions being 400 feet long by 15 feet wide representing a total area of 0.14 acres.
20184	May 25, 1992	Occupation of Okanagan Lake foreshore for intake and pumphouse with the area dimensions being 400 feet long by 15 feet wide representing a total area of 0.14 acres.

All of the above permits relate to the same foreshore area on Okanagan Lake but are apportioned to different water licences.

3.3 Statutory Rights of Way

From composite drawings 383-041-01 to 383-041-05 inclusive, all areas where water mains and/or water services are not located within road rights of way were identified and searches were undertaken at the Land Titles office to determine that the waterworks were "covered" by a statutory right of way in favour of the utility. Table 3.1 lists all locations where waterworks are not located within public road rights of way and provides statutory right of way plan and document numbers over the listed private properties.

In the upper pressure zone, the utility has a 2 m wide statutory right of way over Strata Lot 2 Strata Plan KAS 1447 for the purposes of supply under emergency conditions to the West Bench Irrigation District Reservoir. The right of way ends (as illustrated on drawing 383-041-05) at the east boundary of Strata Plan KAS 1447. Whether appropriate rights of way are in place between the West Bench Irrigation District Reservoir and the east boundary of the Sage Mesa Water and Public Service Right of Way as shown on Plan KAP 64496 has not been assessed.

Assessments related to statutory rights of way confirm that appropriate rights of way are registered in favour of the utility for all waterworks not located within dedicated public roads. Whether or not all waterworks are actually within various rights of way has not been confirmed.

Table 3.1 provides information for the width of all rights of way containing waterworks operated by the utility. The accepted standard width for a right of way for a water distribution main is 6m. Referring to Table 3.1, all rights of way comply with this accepted standard except for:

Low Zone (4) Water Service to Lots 13 and 14 – Right of Way A2740 – 3m
Referring to drawing 383-041-01, this right of way is for a water service to Lots 13 and 14 Plan 13181 and is relatively short, approximately 30m. The width is not a significant concern recognizing that Lots 13 and 14 could be serviced from Sage Mesa Drive should the right of way width represent a future constraint.

Low Zone (5) 50 mm Distribution Main to Verano Place – Right of Way A2740 min. 3m
As will be addressed in a subsequent section of this report, the utility is in the process of constructing improvements which will result in the abandonment of this line. Accordingly, the right of way width of 3m minimum is not a concern from the perspective of long term accessibility for operation and maintenance.

Upper Zone (8) Emergency Supply to WBID Reservoir – 2m Width

This right of way is intended to enclose an emergency supply pipeline to the WBID reservoir. Under normal operation, the line is valved closed on Sandstone Drive and is therefore not under pressure. The width that the utility could obtain was constrained by lot size and available building area on each lot adjoining the right of way. While the width is less than accepted standards, the right of way does not represent a significant long range concern recognizing that its function is to enclose an emergency connection to the WBID system.

TABLE 3.1

STATUTORY RIGHTS OF WAY FOR WATERWORKS

LOWER PRESSURE ZONE

	WATERWORKS	R/W PLAN #	DOCUMENT	PROPERTIES	R/W WIDTH
(1)	Water Supply Main, Intake to Sage Mesa Drive North	A12565	KD042979	Lots 11 and 12 Plan 20001	6 m
(2)	Water Supply Main, Intake to Sage Mesa Drive North	A12564		Block B DL 2497	6 m
(3)	150 mm Distribution Main	A2740		Lot 38 Plan 13181	varies triangular shape
(4)	50 mm Distribution Main - Solana Drive to Verano Place	A2740		Lots 21, 56 and 57 Plan 13181	varies min 3 m
(5)	Water Services to Lots 13 and 14 Plan 13181	A2740		Lots 11, 12 and 13, Plan 13181	3 m
(6)	Lower Zone Reservoir and Upper Zone Booster Sta.	A42983	KD042979	Lot A Plan 40762	0.425 ha
(7)	Access to Lower Zone Reservoir and Upper Zone Booster Sta.	A42983	KD042979	Lot A Plan 40762	6.096 m

UPPER PRESSURE ZONE

	WATERWORKS	R/W PLAN #	DOCUMENT	PROPERTIES	R/W WIDTH
(1)	200 mm Water Supply Main - Lower Pressure Zone to Upper Pressure Zone Reservoir	A12566	KD042979	Lot A Plan 40762	6 m
(2)	150 mm Water Supply Main Lower Pressure Zone to Upper Pressure Zone Reservoir	C14341		DL 4701	6 m – pipeline 0.34 ha - reservoir
(3)	Water Service	Blanket Easement	T6111	Lots 24 and 25 Plan 32905	blanket easement
(4)	Water Service	Blanket Easement	T6111	Lots 12 and 11 Plan 32905	blanket easement
(5)	Water Service to Lot 7 and 8 Plan 32905	A16615	T6111	Lot 8 Plan 32905	triangular shape
(6)	Water Service to Lot 9 Plan 32905	A16615	T6111	Lot 10 Plan 32906	triangular shape
(7)	150 mm Water Distribution Main	A17274	T60123	Lots 15 to 18 Plan 33471	varies 9.6 to 12.0 m
(8)	Emergency Supply to West Bench Irrigation District	KAP 64496		Strata Lot 2 Plan KAS 1447	2 m

3.4 Ministry of Health

The Sage Mesa Water and Public Service Co. Ltd. operation is authorized by a *"Permit to Operate"* issued by the Ministry of Health dated September 01, 1994. The Permit to Operate references a water system with 15 to 300 connections located in the Sage Mesa Area. The water purveyor is identified as the Deputy Comptroller of Water Rights. A copy of the Permit to Operate is contained herein in *Appendix D.*

4.1 Waterworks Design Criteria

As described in Section 1.2, the terms of reference as prepared by the Regional District of Okanagan Similkameen describe the requirements for a technical assessment of the water system. The technical assessment is generally undertaken in relation to design guidelines and standards of government agencies having regulatory jurisdiction. Standards which are applicable to the technical assessment of the water utility are:

- "Design Guidelines for Rural Residential Community Water Services" dated 1998 prepared by the Utility Regulation section of the Water Management Branch, B.C. Ministry of Environment.
- "Subdivision Servicing Bylaw #1567-1995" of the Regional District of Okanagan Similkameen.

Both of the above referenced documents describe design criteria for community water systems for domestic (day to day service) and fire protection. In general, the Water Management guidelines present design criteria for water systems intended to service rural subdivisions and therefore include provisions which recognize operation by part time staff and possible remote location. On the other hand, the waterworks standards contained in RDOS bylaw #1567-1995 represent accepted municipal standards. As shown by the following comparison of the two standards, the provisions of RDOS bylaw #1567-1995 require a higher design standard than the "Design Guidelines for Rural Community Water Systems".

Criteria	*"Design Guidelines for Rural Community Water Systems"*	*RDOS Bylaw #1567-1995*
Per Lot (Dwelling Unit) Maximum Day Demand	metered 6.4m^3/unit unmetered 8.2m^3/unit	8.0m^3/unit
Fire Flow	30 L/sec for 1 hour	75 L/sec for 1.75 hrs. (38 L/sec for 1.0 hr. will be considered for rural areas where fire fighting equipment is limited)
Service Pressures	min. at peak hour – 265 Kpa (40 psi) maximum – 700 Kpa (100 psi)	min. at peak hour – 265 Kpa (40 psi) maximum – 620 Kpa (90 psi) or 865 Kpa (125 psi) with individual PRV's

Criteria	*"Design Guidelines for Rural Community Water Systems"*	*RDOS Bylaw #1567-1995*
Minimum Watermain Size	150 mm	150 mm
Fire Hydrant Spacing	300 m	250 m
Pumping Stations	Minimum 2 pumps each capable of delivering maximum day demand	Acceptable to Approving Officer
Reservoirs	Balancing Storage – 25% of Maximum Day Demand (plus) Emergency Storage – 25% of Maximum Day Demand (plus) Fire Storage – 25% of Maximum Day Demand	No Standards

For the purposes of the technical assessments of this study, the "Design Guidelines for Rural Residential Community Water Systems" as prepared by the Water Management Branch have been utilized. These standards contain provisions which relate to all components of the Sage Mesa Water System and the system has been generally designed and constructed in relation to these standards.

4.2 Water Demand Criteria

The water utility maintains records of the total quantity pumped at the Okanagan Lake water intake/pumphouse and the 1490 booster station supplying the upper pressure zone. In addition, approximately 125 domestic connections in the upper pressure zone and the two golf course services in the lower pressure zone are individually metered. Water demand criteria are therefore appropriately derived on the basis of the extensive historical usage data as provided by the utility.

Maximum day demand are typically experienced during the summer months (July and/or August) when lawn and irrigation is taking place. Summer climate and weather conditions directly affect lawn and garden irrigation usage. Within the last 5 year period, there were extended periods of hot and dry weather during the summer of 1998. Total water usage in the summer of 1998 was recorded as being 10 to 20% above average by several irrigation systems in the south Okanagan area.

Water consumption data for the Sage Mesa system as provided by the utility for July and August 1998 and 1999 is presented in Table 4.1. Consistent with the observation of other water utilities in the south Okanagan area, the Sage Mesa total monthly and maximum daily usage for 1998 is significantly higher than the comparable period in 1999. Using the summer 1998 water

TABLE 4.1
Sage Mesa Water and Public Service Co. Ltd.
Historical Water Usage Data
July & August 1998

	July						August					
	Upper Zone Booster			Lake Intake			Upper Zone Booster			Lake Intake		
	Pumps Hrs.	Igal x 1000	m^3	Pumps Hrs.	Igal x 1000	m^3	Pumps Hrs.	Igal x 1000	m^3	Pumps Hrs.	Igal x 1000	m^3
1	8.55	164.2	746	10 est.	346.9	1577	20.7	397.4	1807	21.9	759.6	3453
2	9.35	179.5	816	8.6	298.3	1356	6.95	133.4	607	6.35	220.2	1001
3	9.35	179.5	816	8.6	298.3	1356	6.95	133.4	607	6.35	220.2	1001
4	7.57	145.3	661	5.97	207.1	941	11.7	224.6	1021	11.4	395.4	1797
5	7.57	145.3	661	5.97	207.1	941	13.5	259.2	1178	13.3	461.3	2097
6	7.57	145.3	661	5.97	207.1	941	15.4	295.7	1344	14.4	499.5	2270
7	9.85	189.1	860	9.4	326.0	1482	10.8	207.4	943	12.3	426.6	1939
8	9.85	189.1	860	9.4	326.0	1482	12.55	241.0	1095	12	416.2	1892
9	8.85	169.9	772	9.4	326.0	1482	12.55	241.0	1095	12	416.2	1892
10	8.85	169.9	772	9.4	326.0	1482	13.4	257.3	1169	13.1	454.4	2065
11	10.23	196.4	893	9.1	315.6	1435	12.5	240.0	1091	12.2	423.2	1923
12	10.23	196.4	893	9.1	315.6	1435	12.7	243.8	1108	12.3	426.6	1939
13	10.23	196.4	893	9.1	315.6	1435	12.6	241.9	1100	11.5	398.9	1813
14	9.45	181.4	825	9.7	336.4	1529	14.9	286.1	1300	13.7	475.2	2160
15	9.45	181.4	825	9.7	336.4	1529	14.9	286.1	1300	13.7	475.2	2160
16	9.1	174.7	794	9.2	319.1	1450	11.45	219.8	999	9.15	317.4	1443
17	9.1	174.7	794	9.2	319.1	1450	11.45	219.8	999	9.15	317.4	1443
18	7.23	138.8	631	11.37	394.4	1793	11.9	228.5	1039	11.3	391.9	1782
19	7.23	138.8	631	11.37	394.4	1793	11.9	228.5	1039	11.3	391.9	1782
20	7.23	138.8	631	11.37	394.4	1793	(2) 19.95	383.0	1741	14.9	516.8	2349
21	12.1	232.3	1056	11.8	409.3	1860	(2) 19.95	383.0	1741	14.9	516.8	2349
22	12.1	232.3	1056	11.8	409.3	1860	7.6	145.9	663	7.9	274.0	1246
23	16	307.2	1396	15.7	544.6	2475	8.2	157.4	716	8.9	308.7	1403
24	(1) N/A			N/A			8.2	157.4	716	8.9	308.7	1403
25	(1) N/A			N/A			8	153.6	698	9.45	327.8	1490
26	15.3	293.8	1335	13.4	464.8	2113	8	153.6	698	9.45	327.8	1490
27	7.5	144.0	655	7.9	274.0	1246	12.7	243.8	1108	14.85	515.1	2341
28	8.6	165.1	751	10.9	378.1	1718	12.7	243.8	1108	14.85	515.1	2341
29	14.2	272.6	1239	13.3	461.3	2097	12.5	240.0	1091	7.83	271.6	1234
30	13.5	259.2	1178	13.1	454.4	2065	12.5	240.0	1091	7.83	271.6	1234
31	17	326.4	1484	15.2	527.2	2396	12.5	240.0	1091	7.83	271.6	1234
TOTALS		**5628.3**	**25583**		**10232.8**	**46513**		**7326.7**	**33303**		**12312.8**	**55967**

(1) Upper Zone Reservoir Overflow - Data Not Applicable
(2) Emergency Supply to West Bench Improvement District

TABLE 4.1 (continued)
Sage Mesa Water and Public Service Co. Ltd.
Historical Water Usage Data
July & August 1999

	July						August					
	Upper Zone Booster			Lake Intake						Lake Intake		
	Pumps Hrs.	Igal x 1000	m^3	Pumps Hrs.	Igal x 1000	m^3	Pumps Hrs.	Igal x 1000	m^3	Pumps Hrs.	Igal x 1000	m^3
1	5.7	109.4	497	6	208.1	946	11	211.2	960	12.15	421.4	1916
2	5.7	109.4	497	6	208.1	946	11	211.2	960	12.15	421.4	1916
3	5.85	112.3	511	5.67	196.7	894	10.25	196.8	895	11.5	398.9	1813
4	5.85	112.3	511	5.67	196.7	894	10.25	196.8	895	11.5	398.9	1813
5	5.85	112.3	511	5.67	196.7	894	10.27	197.2	896	11.2	388.5	1766
6	5.85	112.3	511	5.67	196.7	894	10.27	197.2	896	11.2	388.5	1766
7	9.33	179.1	814	5.67	196.7	894	10.27	197.2	896	11.2	388.5	1766
8	9.33	179.1	814	5.67	196.7	894	3.25	62.4	284	5.45	189.0	859
9	9.33	179.1	814	5.67	196.7	894	3.25	62.4	284	5.45	189.0	859
10	9.2	176.6	803	9.73	337.5	1534	3.25	62.4	284	5.45	189.0	859
11	9.2	176.6	803	9.73	337.5	1534	3.25	62.4	284	5.45	189.0	859
12	9.2	176.6	803	9.73	337.5	1534	10.35	198.7	903	13.6	471.7	2144
13	9.55	183.4	833	9.65	334.7	1521	10.35	198.7	903	13.6	471.7	2144
14	9.55	183.4	833	9.65	334.7	1521	5.3	101.8	463	4.5	156.1	709
15	6.65	127.7	580	7.05	244.5	1111	5.3	101.8	463	4.5	156.1	709
16	6.65	127.7	580	7.05	244.5	1111	5.3	101.8	463	4.5	156.1	709
17	10	192.0	873	10.67	370.1	1682	15.5	297.6	1353	5.6	194.2	883
18	10	192.0	873	10.67	370.1	1682	15.5	297.6	1353	5.6	194.2	883
19	10	192.0	873	10.67	370.1	1682	23.8	457.0	2077	8.25	286.2	1301
20	9.6	184.3	838	10.5	364.2	1655	23.8	457.0	2077	8.25	286.2	1301
21	9.6	184.3	838	10.5	364.2	1655	11.47	220.2	1001	9.6	333.0	1514
22	7.8	149.8	681	6.8	235.9	1072	11.47	220.2	1001	9.6	333.0	1514
23	7.8	149.8	681	6.8	235.9	1072	11.47	220.2	1001	9.6	333.0	1514
24	9.57	183.7	835	9.97	345.8	1572	11.47	220.2	1001	9.6	333.0	1514
25	9.57	183.7	835	9.97	345.8	1572	13.1	251.5	1143	10.03	347.9	1581
26	9.57	183.7	835	9.97	345.8	1572	13.1	251.5	1143	10.03	347.9	1581
27	9.9	190.1	864	10.75	372.9	1695	13.1	251.5	1143	10.03	347.9	1581
28	9.9	190.1	864	10.75	372.9	1695	8.5	163.2	742	8.28	287.2	1305
29	9.77	187.6	853	11.33	393.0	1786	8.5	163.2	742	8.28	287.2	1305
30	9.77	187.6	853	11.33	393.0	1786	8.5	163.2	742	8.28	287.2	1305
31	9.77	187.6	853	11.33	393.0	1786	8.5	163.2	742	8.28	287.2	1305
TOTALS		**5095.9**	**23163**		**9236.3**	**41983**		**6157.2**	**27987**		**9458.9**	**42995**

consumption data, maximum day water demand criteria for the Sage Mesa water system is derived following:

Upper Pressure Zone:

Maximum Day Demand – 15 hrs pump operation x 87.2 m^3/hr. = 1308 m^3

* July 26, Aug. 5, Aug. 14, Aug. 15, 1998

Total Connections – July/August 1998 – 142

Maximum Day Demand/Connections (Lot) = 1308/142 = 9.2 m^3/Lot

Lower Pressure Zone:

Overall System Maximum Day Demand –		2270 m^3/day
*	Aug. 5, Aug. 14, Aug. 15, Aug. 28, 1998	
(less)	Upper Pressure Zone -	1308 m^3/day
	Maximum day Lower Zone	
	(residential and golf courses)	962 m^3/day
(less)	Metered Golf Courses -	550 m^3/day
	Net Lower Zone Max. Day Residential	412 m^3/day

Total Connections – July/August 1998 – 65

Maximum Day Demand/Connection (Lot) = 6.4 m^3/day/lot

Upper pressure zone maximum day water demand is derived to be 9.2 m^3/connection (lot). This per connection demand is modestly higher but consistent with demand criteria presented in Section 4.1. The maximum day demand in the lower pressure zone is calculated to be 6.4 m^3/day/ connection which is approximately 68% of the comparable demand for the upper zone. Lower maximum day water demands on a per lot basis in the lower pressure zone are anticipated recognizing that lot sizes are generally smaller in the lower pressure zone and that the lower pressure zone is essentially entirely located on silt soil types. The stability of the silt soils in the lower pressure zone area can be compromised by saturation from lawn and garden watering therefore the lower maximum day water demands in lower pressure zone area likely reflect cautionary irrigation practices by homeowners. In comparison, soil types in the upper pressure zone area are granular.

Ministry of Environment staff indicate that their calculations of the maximum day residential demand in the lower pressure zone results in a per lot demand approximately 70% of the 6.4 m^3/day per lot derived herein. The difference is attributable to the use of the average monthly metered golf course irrigation usage in the demand calculation. Under maximum day demand conditions it is reasonable to assume that golf course irrigation usage will be higher than monthly averages. Without daily records of golf course irrigation usage, it is not possible to accurately define what the ratio is between average monthly and maximum daily golf course irrigation

usage. The 6.4 m^3/day/lot maximum day demand for the lower pressure zone derived herein is therefore conservative.

For purposes of a technical assessment of water supply components of the Sage Mesa Water Systems, maximum day demand criteria of 9.2 m^3/residential lot for the upper pressure zone and 6.4 m^3/residential unit for the lower pressure zone are utilized. Using these per lot maximum day demand criteria and serviced lot data from Section 2.0, the resultant maximum day supply requirements for the upper and lower pressure zones are:

Maximum Day Demand – Upper Pressure (Supply from 1490 Booster Station)

- 182 residential lots x 9.2 m^3/day/lot = 1674 m^3/day
  or 19.4 L/sec

Maximum Day Demand – Lower Pressure Zone (Supply from Okanagan Lake Intake)

➢ Upper Pressure Zone (from above) -		1674 m^3/day
➢ Lower Zone – Golf Courses -	550 m^3/day	
– Residential 68x6.4m^3/lot	435 m^3/day	
Lower Zone Total	985 m^3/day	985 m^3/day
Total Overall System		2660 m^3/day
		or 30.8 L/sec

With adequate balancing storage, the maximum day demand of the upper zone would be adequately supplied by a 1490 booster station capacity of 19.4 L/sec and the system as a whole, by a pumping capacity at the Okanagan Lake Intake of 30.8 L/sec.

4.3 Disinfection

Water system design standards related to disinfection are the jurisdiction of the Ministry of Health. Where disinfection is to be provided by chlorination, the Ministry requires:

- a minimum chlorine contact time of 20 minutes measured from the point of chlorination to the first service connection.
- maintenance of a measurable free chlorine residual at all points of the distribution system.

The Ministry of Health Standard for drinking water specifies 0 (zero) total and/or fecal coliforms where testing is undertaken on a monthly basis.

5.1 General

As described in Section 1 and 2, the Sage Mesa Water and Public Service Co. Ltd. water system was initially constructed in 1962, expanded to the upper pressure zone in 1977 and the service area expanded in the upper pressure zone in the period 1977 to 1999. Sections following provide a detailed description and a capacity/operational assessment of each component of the water system. These assessments are presented separately for the upper and lower zones. Composite drawings 383-041-01 and 05 inclusive may be referred to for the location of all components of the water system.

5.2 Lower (1490) Pressure Zone

5.2.1 Lake Intake

Description:
On the basis of as-constructed drawing 86-7-1 prepared by JE Falkenbury Ltd. dated June 1987, the intake system into Okanagan Lake comprises:

- a cylindrical shaped screen 0.9 m in diameter and 0.9 m in length supported approximately 0.8 m off of the lake bottom.
- from the screen, approximately 120 m (400 feet) of 300 mm (12 inch) diameter PVC DR 35 pipe and 32.6 m (107 feet) of 600 mm (24 inch) diameter corrugated steel pipe ending at the pumphouse wet well.

The intake screen and 300 mm PVC intake pipe were installed in Okanagan Lake in 1980. These components represented an upgrading of intake components originally constructed in 1962. The 32.6 m section of 600 mm CSP intake pipe was constructed in 1987 associated with the widening and upgrading of Highway 97.

The as-constructed drawings indicate that the intake is located at elevation 330 m in Okanagan Lake which represents a submergence of about 13.7 m (45 feet) in relation to the average elevation of Okanagan Lake.

The intake pipe connects to the pumphouse wet well at elevation 339.15 m (centre line of pipe elevation). Functionally, the capacity of the intake is determined by the elevation difference between the intake pipe connection at the pumphouse wet well and low water

elevations in Okanagan Lake. From as-constructed drawings, these elevations (available head) are as follows:

In relation to "Normal Low Water"			
	Okanagan Lake Elevation	-	341.3 m
(less)	Top of Intake Pipe	-	339.4 m
	Submergence	-	1.9 m
In relation to "Drought Lake Level"			
	Okanagan Lake Elevation	-	340.40 m
(less)	Top of Intake Pipe	-	339.40 m
	Submergence		1.0 m

Assessment:

Hydraulically, the present service commitments of the utility require the intake capacity to be at least 31 L/sec. Friction calculations indicate that flows in the intake system of the order of 75 L/sec would result in head losses of 1.0 m, which equates to the available submergence (head) at drought Okanagan Lake level. Theoretically, the intake pipe system to the pumphouse wet well has adequate hydraulic capacity to supply a total system demand 40% greater than the estimated maximum day demand of existing service commitments of the utility.

Operationally, the water system maintenance contractor indicates that no problems have been experienced with the intake system in terms of supply to the intake wet well and supply pumps.

In April of 1999, an inspection of the 300 mm PVC pipe intake section and intake screen assembly was undertaken by Diving Dynamics of Kelowna. The inspection included a video tape which indicates:

- the 300 mm pipe appears to be in good condition with no evidence of joint separation. The section of 600mm CSP intake pipe is reported to be covered and therefore was not inspected.
- concrete anchors referred to on the as-constructed drawings have broken and settled into the lake bottom sediments. In only two location is there a portion of the anchor in place. The as-constructed drawings do not provide sufficient detail to determine how many concrete collar type anchors were originally placed to stabilize the PVC pipe on the bottom of the lake.

- the screen assembly is adequately supported off of the bottom of the lake and appeared to be partially "clogged" with what is assumed to be organic material. The inspection personnel easily cleared the screens with their hands which exposed several holes, 25 mm to 37 mm in diameter in the actual screen. The diving contractor indicates that the screen assembly has deteriorated to the point that it requires replacement.

On the basis of the video record of the inspection by Diving Dynamics, additional concrete anchors should be placed over the 300 mm PVC intake pipe section and the intake screen assembly "replaced". This work is relatively modest in scope and completely consistent for a system which has been in service for 20 years. It is anticipated that the suggested intake pipe and screen repairs would be accommodated within the utility's operation and maintenance budget.

The inspection by Diving Dynamics in April 1999 did not include the CSP intake pipe section installed in 1987. Accordingly, no discussion is presented herein related to the condition of this pipe. Should the Regional District proceed with negotiations to assume ownership of the system, an underwater inspection of the CSP section of the intake pipe is suggested.

In the course of reviews of preliminary drafts of this report, the question was raised as to whether the depth of the intake complies with standards or guidelines of the Ministry of Health for intakes in Okanagan Lake. Discussions with Ministry of Health representatives indicate that intake depths in Okanagan Lake of 18 m or deeper are preferred to insure that the intake is located below the lake's thermocline. The winds from the north can however result in mixing of warmer water normally above the thermocline at depths greater than 18 m at the south end of Okanagan Lake. As a result, the potential benefits of a deeper intake at Sage Mesa are uncertain. Provided that the existing intake depth does not represent a bacteriological concern, the Ministry will not require the utility to extend the intake to deeper water. Should the utility however, propose capacity improvements to the intake, the Ministry will require assessment of opportunities for siting at depths greater than 18 m.

5.2.2 Lake Pumphouse

Description:

Associated with the widening and reconstruction of the Highway #97, the lake pumphouse was reconstructed in 1987. According to as-constructed drawings numbered 86-7-3 prepared by JE Falkenburg Ltd. dated June 1987, the pumphouse comprises:

- 1.8 m dia. precast concrete wet well having an overall length of 6.0 m. The base slab of the wet well is 1.40 m below or lower than the centreline of the 600 mm CSP intake pipe from the lake.

- a pumphouse building of masonry construction measuring 5.5 m by 6.1 m. Separate rooms are provided in the pumphouse for chlorination and electrical equipment.

- two vertical turbine pumps;
  - 4 stage 150 mm Byron Jackson Model MG-L pump driven by a 75 HP Vertical Electric Motor operating at 3500 RPM.
  - 8 stage Johnson 100 mm (model unknown) pump driven by a 25 HP electric motor operating at 3500 RPM.

- 150 mm discharge piping and appurtenances including check valves, butterfly isolation valve and pressure relief valve and turbine type water meter.

Adequate space is provided in the lake pumphouse to theoretically accommodate a third vertical turbine pump. It is however more probable that future upgrading would include removal of the existing 25 HP pump to provide additional space for increased pump capacity.

The electrical service to the lake pumphouse is 230 volt 3 phase and is supplied by an underground service from a connection to West Kootenay Power located on the west side of H97. An assessment by Unit Electrical Engineering in the spring of 1999 suggests that the existing 230V electrical service is fully committed. Any upgrading of the intake pump capacity will therefore require upgrading of the electrical service to 600 volts.

Assessment:
The utility's operator indicates that the 75 HP and 25 HP are operated together during the summer months (peak period) and the 75 HP separately during the winter. From operating records, the combined capacity of the 75 HP and 25 HP pumps is 43.8 L/sec against a total dynamic head of about 120 m (169 psi). The individual pump capacities are 36 L/sec for the 75 HP pump and 10 to 12 L/sec for the 25 HP pump.

With adequate balancing storage, the existing supply capacity of 43. 8 L/sec at the lake pumphouse is adequate to supply the maximum day demand of present service commitments of 31 L/sec as derived in Section 2.0. For reliability, Ministry of Environment guidelines for Rural Residential Water Systems require a minimum of two

supply pumps, each capable of supplying the system maximum day demand. There is therefore a pump capacity deficiency in relation to the Rural Residential Water System Guidelines related to standby pump capacity. The utility does however have an emergency supply agreement with the adjacent West Bench Irrigation District and a long range plan to upgrade the lake pumphouse supply capacity, i.e., installation of additional larger pumps to be implemented as the service area expands in the upper pressure. In this manner capital contributions will be received from developers to assist with the upgrading of the lake pumphouse capacity.

From discussions with the water system operation and maintenance contractor reliability has not been a concern with the lake pumphouse since 1990. The 75 HP vertical turbine pump and electric motor were reconditioned by the utility in 1994. The 25 HP pump, according to the operator, is "original equipment" and has not to his knowledge, been removed for overhaul and maintenance. The 25 HP is used during the summer months only and represents a standby unit for the remainder of the year.

5.2.3 Disinfection System

Description:

Disinfection equipment at the lake pumphouse comprises a chlorine solution pump (hypochlorination system) and diffuser located in pumphouse wet well. The chlorine solution pump is controlled by the start-stop control system for the vertical turbine pumps. The utility operation adjusts the chlorine solution pump rate in relation to the operating mode of the supply pumps.

A similar hypochlorination system is located in the 1490 booster station. Rechlorination at this location is practiced to assist in the maintenance of a disinfection system throughout the utility's service area.

Chlorine contact time is provided in the water supply main comprising approximately 280m of 200mm pipeline between the lake pumphouse and the lower zone distribution system on Sage Mesa Drive North. The supply main provides a total of 9.1 m^3 of chlorine contact volume.

Assessment:

The 9.1 m^3 of chlorine contact volume in the water supply main equates to the following chlorine contact times:

Summer (75 HP and 25 HP Pump Operating)	-	3.5 minutes
Winter (75 HP Pump Operating)	-	5.0 minutes

These chlorine contact times are significantly less (approximately 20 to 25%) of the Ministry of Health standard of a minimum 20 minute chlorine contact time.

Staff of the Okanagan-Similkameen Health Region take samples on a monthly basis within the utility's service area for bacteriological analysis. For the period January 1998 to October 1999 (total of 22 tests), all bacteriological test results were satisfactory with total and fecal coliform values consistently being <1. While the chlorine contact time is significantly less than Ministry of Health Standards, bacteriological standards for fecal and total coliform are being consistently complied with.

5.2.4 Supply Main – Lake Pumphouse to Lower Pressure

Description:

As illustrated on drawing 383-041-01, the supply main from the lake pumphouse to the lower pressure zone at Sage Mesa Drive North comprises approximately 280m of 200mm watermain. Approximately 50m of the supply main is located within the H97 right of way and consists of ductile iron pipe in a 600mm CMP casing. From the west side of H97, the supply main is 200mm PVC CL200 pipe constructed in 1980. Drawing 383-041-01 also illustrates a 100mm AC supply main located parallel to the 200mm main. The 100mm AC supply main was a component of the original system constructed in 1962 and was abandoned in 1997.

Assessment:

Hydraulically, the 200mm supply main to the lower pressure zone has adequate capacity for the present service area of the utility. The supply main is located in an intermittent drainage course and along its complete length is within the bench silt materials. The supply main is essentially inaccessible for maintenance and the utility operator reports several sink holes in the vicinity of the pipeline. Stability and resultant reliability therefore represent concerns with the water supply main from the lake intake to the lower pressure zone.

To address access and reliability concerns with the existing supply main, the utility adopted, in 1998, a long range plan to replace the supply main. The replacement will comprise:

- approximately 800m of 250mm main along the west side of H97 from the lake pumphouse south to Sage Mesa Drive.

- approximately 300m of 250mm main on Sage Mesa Drive from H97 to a point south of Solana Crescent.

- approximately 110m of 250mm main from Sage Mesa Drive, up the silt bank to a connection to distribution mains on Solana Crescent.

As illustrated on drawing 383-041-01, 270m of the supply main was installed by the utility on Sage Mesa Drive in 1998 concurrent with a road reconstruction project by the Ministry of Transportation and Highways. The supply main reconstruction has direct road access for maintenance along 90% of its length and will result in a significant increase in chlorine contact time.

5.2.5 Lower Zone (1490) Reservoir

Description:

Storage in the lower pressure zone is provided by a cast in place reinforced concrete reservoir located on the west side of the former Kettle Valley Railway right of way. The reservoir was constructed in 1962 and has a reported capacity of 272 m^3 (60,000 Igallons) with the full water elevation being 1490 feet (454m). Drawing 383-041-01 accurately illustrates the location of the reservoir and piping system appurtenant to the reservoir on the basis of site surveys undertaken associated with reconstruction of the upper pressure zone booster station.

The lower zone reservoir does not have drain or overflow piping. The water system operator indicates that in an overflow event, water flows out of the access hatch. The lack of a drain, which is used principally during cleaning operations at 3 to 5 year intervals, is overcome by the operator by simply allowing usage in the lower pressure zone to lower the reservoir level to the greatest extent practical. Residual water in the reservoir is then removed by portable pumps.

Assessment:

From an operational perspective, the lack of a drain and overflow at the lower pressure zone reservoir represent deficiencies with the overflow being more significant. The lower pressure zone reservoir control system does however include a high level alarm with the operator being advised of the condition through a telephone dialer in the upper zone booster station control panel.

In relation to the Ministry of Environment design guidelines for rural residential water systems, the storage requirements for the lower pressure zone are derived as follows:

- ❒ Fire Storage – 30 L/sec x 1 hour = 180 m^3
- ❒ Balancing Storage
  – 25% x Max. Day Demand (985m^3/day from Section 4.2) = 246 m^3
- ❒ Emergency Storage
  – 25% x Max. Day Demand = 246 m^3

Total **672 m^3**

The reservoir capacity of 272 m^3 provided in the lower zone reservoir is approximately 40% of the capacity requirement derived to comply with the Design Guidelines for Rural Community Water Systems.

The utility operator indicates difficulty in maintaining adequate levels in the low zone reservoir during maximum day demand conditions when the upper zone booster station is operating and both golf courses are irrigating. This problem is partially addressed by the operation of both supply pumps at the lake pumphouse during the summer months.

Increased storage capacity in the lower zone and the provision of a reservoir overflow represent necessary future capital improvements. To 1999, the lack of an overflow at the low zone reservoir and the storage deficiency in relation to the Ministry of Environment design guidelines have not negatively impacted the level or reliability of water service. Compliance with the provisions of the design guidelines for emergency storage is not considered essential recognizing:

- ❒ utility has a dialer system to operator to alarm conditions as they occur.
- ❒ water can, under emergency conditions, be supplied to the lower zone from the upper zone reservoir.
- ❒ the utility has an emergency supply reciprocal arrangement with the West Bench Irrigation District.

Future upgrading requirements could appropriately be based on balancing and fire storage criteria.

5.2.6 Lower Zone Distribution System

Description:
As illustrated on Drawing 383-041-01, the lower pressure zone water distribution system comprises:

- 345m – 100mm AC CL150 (constructed 1962)
- 650m – 150mm AC CL150 (constructed 1962)
- 120m – 100mm PVC CL150 (constructed 1998)
- 410m – 150mm PVC CL150 (constructed 1984 to 1998)
- 240m – 200mm PVC CL250 (constructed 1980)
- 165m – 50mm PVC or Galvanized Iron

Hydrant and isolation valves are provided consistent with accepted standards.

Water service locations are illustrated on drawing 383-041-01 with offset information referenced to a property pin provided as a descriptor on each serviced lot. All water service locations and descriptor data were confirmed by the utility's operator in 1997 and 1998. Water service piping is primarily copper tubing with the exception of Verano Place where services are PEX tubing.

Assessment:
The lower zone water distribution system comprising mains, valves, and hydrants generally complies with accepted design standards and the Ministry of Environment Design Guidelines for Rural Residential Community Water Systems. The principal exception is the 50mm main from Solana Crescent to Verano Place approximately 156m in length located on Lots 21, and 57 Plan 13181. The location of this main is illustrated schematically and the piping material is unknown. The utility intends to connect the 250mm PVC main on Sage Mesa Drive adjacent to Lot 62 Plan 13181to Solana Crescent in the short term future. When this connection is completed, Verano Place will be supplied by the 250mm PVC main on Sage Mesa Drive and the 50mm line will be abandoned. Construction of the 250mm main to Solana Crescent is anticipated to proceed following processing by BC Lands of an application by the utility for a statutory right of way over Lot 20 Plan 13181.

The utility has experienced leakage problems in water services as a result of corrosion of galvanized iron fittings used as connections between copper tubing and brass curb and corporation stops. Table 4.2 provides a tabulation of all water services in the lower pressure zone with approximate year of construction and repair and/or replacement data based on as-constructed drawings of improvements undertaken after 1990 and the operator's diary for the period 1990 to 1999. Out of a total of 67 services in the lower pressure zone, approximately 25 (37%) have been inspected, repaired or replaced in the period 1990 to 1999.

The utility has no information as to the extent that galvanized iron fittings were used for water service construction in the lower zone. Where galvanized iron fittings were used, the water service is subject to corrosion due to the connection of dissimilar metals and represents a risk of a leak developing. Service leaks represent a significant concern recognizing that the lower pressure zone area is principally located on silt soil types.

The utility's operator utilizes acoustic leak detection equipment to check for service leaks in the lower pressure zone area. All services in the lower pressure zone are checked in this manner two or three times per year. Any indication of a leak is immediately responded to.

Water service repair and maintenance costs have to 1999 been adequately covered by repair and maintenance provisions in the utility's annual budget.

5.3 Upper Pressure Zone

5.3.1 Booster Station

Description:

Associated with an extension of service to development comprising Westwood Drive and Sandstone Drive in the upper pressure zone, the upper zone booster station was reconstructed by the utility in 1997. Referring to drawing 383-041-01, the upper pressure zone booster station is located south of the 1390 reservoir and comprises:

- 6.0m x 7.5m pumphouse structure of precast concrete construction (walls and roof).
- 250mm suction and 200mm discharge piping to accommodate a total of three pumps. Two "canned" 6 stage Gould Model 7CLC vertical turbine pumps with 75HP 3500 RPM electric motors are currently provided in the booster station.

Table 4.2
Sage Mesa Water and Public Service Co. Ltd.
Lower Zone Water Services

Lot	Plan	Address	Constructed	Repair
1	Plan 13181	Sage Mesa Drive	1984	Curb & Corp Stops Replaced - June 1998
2	Plan 13181	Sage Mesa Drive	1984	Curb & Corp Stops Replaced - June 1998
3	Plan 13181	Sage Mesa Drive	1984	
4	Plan 13181	Sage Mesa Drive	1984	
5	Plan 13181	Sage Mesa Drive	1984	
6	Plan 13181	Sage Mesa Drive	1984	
7	Plan 13181	Sage Mesa Drive	1984	Service Replaced - July 1997
8	Plan 13181	Sage Mesa Drive	1984	
9	Plan 13181	Sage Mesa Drive	1984	
10	Plan 13181	Sage Mesa Drive	1984	
11	Plan 13181	Sage Mesa Drive	1984	
12	Plan 13181	Sage Mesa Drive	1984	
13	Plan 13181	Sage Mesa Drive	1984	
14	Plan 13181	Sage Mesa Drive	1984	
A	Plan 16819	Sage Mesa Drive	1984	
16	Plan 13181	Solana Crescent	1962	
17	Plan 13181	Solana Crescent	1962	
18	Plan 13181	Solana Crescent	1962	
19	Plan 13181	Solana Crescent	1962	
20	Plan 13181	Solana Crescent	Not Serviced	
21	Plan 13181	Solana Crescent	1962	Corp Inspected May 1995
22	Plan 13181	Solana Crescent	1962	
23	Plan 13181	Solana Crescent	1962	
24	Plan 13181	Solana Crescent	1962	Corp & Saddle Replaced December 1997
25	Plan 13181	Solana Crescent	1962	
26	Plan 13181	Solana Crescent	1962	
27	Plan 13181	Solana Crescent	1962	Corp & Saddle Replaced December 1997
28	Plan 13181	Solana Crescent	1962	
29	Plan 13181	Solana Crescent	1962	
30	Plan 13181	Solana Crescent	1962	
31	Plan 13181	Sage Mesa Drive	1962	
32	Plan 13181	Sage Mesa Drive	1962	
33	Plan 13181	Sage Mesa Drive	1962	
34	Plan 13181	Sage Mesa Drive	1962	
35	Plan 13181	Sage Mesa Drive	1962	
36	Plan 13181	Sage Mesa Drive	1962	
37	Plan 13181	Sage Mesa Drive	1962	
38	Plan 13181	Solana Crescent	1962	
39	Plan 13181	Solana Crescent	1962	
40	Plan 13181	Solana Crescent	1962	Curb Stop Replaced, Corp Stop Insp. Sept. '91
41	Plan 13181	Solana Crescent	1962	
42	Plan 13181	Solana Crescent	Not Serviced	
43	Plan 13181	Sage Mesa Drive North	1962	
44	Plan 13181	Sage Mesa Drive North	1962	
45	Plan 13181	Ladera Place	1962	Service Replaced - June 1992
46	Plan 13181	Ladera Place	Not Serviced	
47	Plan 13181	Ladera Place	Not Serviced	
48	Plan 13181	Ladera Place	Not Serviced	
49	Plan 13181	Ladera Place	Not Serviced	

Table 4.2 (continued)
Sage Mesa Water and Public Service Co. Ltd.
Lower Zone Water Services

Lot	Plan	Address	Constructed	Repair
50	Plan 13181	Solana Crescent	1962	
51	Plan 13181	Solana Crescent	Not Serviced	
52	Plan 13181	Solana Crescent	1962	Corp Inspected - September 1991
53	Plan 13181	Solana Crescent	1962	Reconstructed - 1991
54	Plan 13181	Verano Place	1962	Reconstructed - 1998
55	Plan 13181	Verano Place	1962	Reconstructed - 1998
1	Plan 21078	Verano Place	1962	New Service 1998 - not connected
57	Plan 13181	Verano Place	1962	New Service 1998 - not connected
58	Plan 13181	Verano Place	1962	Reconstructed - 1998
59	Plan 13181	Verano Place	1962	Reconstructed - 1998
60	Plan 13181	Verano Place	1962	Reconstructed - 1998
61	Plan 13181	Verano Place	1962	Reconstructed - 1998
62	Plan 13181	Sage Mesa Drive	1962	Reconstructed 1998
1	Plan 20001	Sage Mesa Drive North	1962	Reconstructed 1980
2	Plan 20001	Sage Mesa Drive North	1962	Reconstructed 1980
3	Plan 20001	Sage Mesa Drive North	1962	Reconstructed 1980
4	Plan 20001	Sage Mesa Drive North	1962	Reconstructed 1980
5	Plan 20001	Sage Mesa Drive North	1962	Reconstructed 1980
6	Plan 20001	Sage Mesa Drive North	1968	
7	Plan 20001	Sage Mesa Drive North	1968	Reconstructed May 1992
8	Plan 20001	Sage Mesa Drive North	1962	
9	Plan 20001	Sage Mesa Drive North	1962	
10	Plan 20001	Sage Mesa Drive North	1962	
11	Plan 20001	Sage Mesa Drive North	1962	
12	Plan 20001	Sage Mesa Drive North	1968	

- ❒ appurtenances including surge relief valve and piping, magnetic flow meter and re-chlorination equipment.
- ❒ control and alarm panel for all system pumps and reservoirs.

As illustrated on drawing 383-041-01, the point of electrical service from West Kootenay Power is located on Sage Mesa Drive North adjacent to Lot 30 Plan 13181. From this point of service, the utility owns and is responsible for maintenance of an underground electrical cable, approximately 150m in length to the booster station. This electrical service arrangement was made necessary by West Kootenay Power's lack of appropriate rights of way to the booster station/reservoir site area.

Assessment:

Operational records maintained by the utility indicate that the upper pressure zone each have a capacity of 24.2 L/sec (384 USgpm) operating against static lift of 166m (544 feet). From section 4.2, water service commitments by the utility in the upper pressure zone represent a projected maximum day demand of 1674 m^3/day which equates to a supply pump capacity requirement of 19.4 L/sec. The upper zone booster station is therefore concluded to have adequate capacity for the utility's service commitments in the upper pressure zone with 100% standby capacity in compliance with the Design Guidelines for Rural Residential Community Water Systems.

5.3.2 Water Supply Main

Description:

On the basis of as-constructed drawings prepared by Alan R. Colby Associates dated 1977, the supply main to the upper pressure zone comprises:

- ➢ approximately 600m of 200mm ductile iron CL250 pipe starting at the upper zone (1490) booster station; and
- ➢ approximately 650m of 150mm ductile iron CL250 pipe terminating at the upper zone water reservoir.

The overall length of the supply main is therefore approximately 1250m. Concurrent with the construction of the supply main, a "telemetry" cable was installed between the upper zone reservoir and the booster station for pump start-stop control.

Assessment:

Section 5.3.1 concludes that water service commitments in the upper pressure can be adequately supplied by the existing supply works comprising the 1490 booster station and supply main described herein. Upgrading of the supply main may be considered by

the utility as option to provide increased capacity to the upper pressure as may be required by future development proposals.

The telemetry cable installed in 1977 between the upper zone reservoir and the 1490 booster station has represented concerns to the operator from a reliability perspective. As a result of a failure of the telemetry system in October 1999, the utility is proceeding with arrangements for a leased telemetry circuit from Telus.

5.3.3 Reservoir

Description:
The upper zone reservoir was constructed in 1977 and on the basis of as-built drawing no. 76-2-3 prepared by Alan R. Colby Associates, the reservoir;

- is of reinforced concrete construction and 16m (52 feet) square;
- has an overall wall height of 2.4 m^2 with the maximum water depth being 2.27 m (7.5 feet) measured from the floor to the overflow pipe;
- is supplied by a 150mm pipe from the 1490 booster station entering the north wall and supplies the upper pressure zone area by a 200mm pipe exiting the south wall (refer to drawing 383-041-02); and
- has drain and overflow piping which discharge onto the ground adjacent to the reservoir.

The operating capacity of the upper zone reservoir is 450 m^3 (100,000 Igallons) with the full water elevation being 620 m (2034 feet) approximately.

When initially constructed, the reservoir had a wood frame roof system. Deterioration of the wooden roof system resulted in replacement with a precast concrete panel system prior to 1990.

Assessment:
Operationally, there are no significant deficiencies associated with the upper zone water reservoir.

In a manner similar to the lower zone reservoir presented in section 5.2.5, the upper zone storage requirements derived on the basis of the Ministry of Environment Design Guidelines for Rural Community Water Systems is presented following.

- ❒ Fire Storage – 30 L/sec x 1 hour = 180 m^3
- ❒ Balancing Storage
  – 25% x Max. Day Demand (1674m^3/day from Section 4.2) = 420 m^3
- ❒ Emergency Storage
  – 25% x Max. Day Demand = 420 m^3

Total **1020m^3**

As was the case with the lower zone reservoir, the upper zone reservoir capacity is approximately 40% of the requirement to fully comply with the Design Guidelines. Emergency storage provisions may be considered as not warranted based on the anticipated quick response by maintenance staff and availability of emergency supply from the West Bench Irrigation District. Discounting emergency requirements, the total storage provided in the upper pressure zone of 454 m^3 is reasonably consistent with the fire and balancing requirements of the Design Guidelines.

5.3.4 Distribution System

Description:
Referring to drawings 383-041-02 to 05 inclusive, the upper pressure zone water distribution system comprises 150mm and 200mm PVC series 160 and C900 CL150 pipe. All series 160 PVC pipe was installed at the north end of the system in 1977. The distribution system by year of construction is tabulated as follows:

Year of Construction	*150 mm*	*200 mm*
1977	925 m	260 m
1981	485 m	
1982	1410 m	
1994	765 m	330 m
1997	775 m	370 m
Totals	**4360 m**	**960 m**

Hydrants and isolation valves are provided consistent with accepted standards.

Water services in the upper pressure zone according to the utility operation contractor are copper. There are a total of 181 service connections of which 151 are to be developed (non-vacant lots). Of these 151 services, 126 services are metered.

Assessment:

The upper pressure zone water distribution system comprising mains, valves, and hydrants generally complies with accepted design standards and the Ministry of Environment Design Guidelines for Rural Residential Community Water Systems. If, at some future date, the water system is extended to service development southwest of Max Lake Road, fire flow deficiencies may result which would be resolved by upgrading existing supply mains on Forsyth Drive to the upper zone reservoir. It is assumed that future supply main improvements would be a development related approval condition.

The utility's operator reports no operation and maintenance concerns with the upper pressure zone water distribution system.

5.4 Upgrading and Improvement Plan

5.4.1 General

On the basis of the technical and operational assessments of all components of the water system as presented in sections 5.2 and 5.3, upgrading requirements can be defined. Upgrading requirements are presented in two categories, operation and maintenance and capital improvements. Items in the operation and maintenance classification would generally be undertaken utilizing operation and maintenance provisions of the utility's annual budget. Typical examples of projects which would be classified as operation and maintenance improvements include water service replacements, intake pipe repairs, etc.

The second category is capital improvements which includes projects of a significant cost representing a replacement or upgrading of primary supply components of the system. Examples in this regard include the low zone water supply main replacement as described in section 5.2.4 and capacity upgrading of the lake pumphouse. These projects would normally be undertaken utilizing the utilities reserve accounts and/or capacity contributions from developers requesting an extension of service from the utility. Under municipal or regional district "ownership" projects in the capital improvement category would generally qualify for assistance under infrastructure construction grant programmes of the senior government.

Consistent with these two categories, an upgrading and improvement plan for the Sage Mesa water system is presented in sections following.

5.4.2 Operation and Maintenance

Improvements anticipated to be necessary in the short to mid term which would be undertaken as operation and maintenance projects are:

- *Intake Pipe and Screen Maintenance*

  From the inspection video by Diving Dynamics, the utility should anticipate having to replace "missing" concrete weights on the intake pipe and replace the intake screen assembly. Concrete weights could be precast on shore and lowered into place, with the assistance of a diver, from a boat. Diving Dynamics in their inspection report to the utility have provided an estimate of $5000 to fabricate and install a replacement intake screen assembly. Combined, the intake screen and concrete weights represent a cost of the order of $10,000.

- *Lower Zone Water Services*

  From Section 5.2.6, the utility has experienced corrosion related water service leaks in the lower pressure zone. The corrosion affects galvanized iron fittings connecting curb stops and corporation stops to the service pipe. No information is available which may assist in an assessment of the number of services which may ultimately fail or leak as a result of corrosion. In the period 1990 to 1999, the utility has had to respond to an average of one corrosion related water service leak per year.

  The corrosion related problems with water services in the lower zone should be recognized as an ongoing operation and maintenance concern. From Table 4.1, there remains approximately 42 water services in the lower zone, which have no record of maintenance repair or inspection and therefore represent the potential of a corrosion related problem. Operation and maintenance costs related to water services appear to have been adequately covered by present budget provisions. Assuming the rate of failure does not increase, present budget provisions for operation and maintenance should be adequate for water service related repair activities.

  Alternatively, the water services in the lower pressure zone could be addressed by a capital project in which case all 42 services would simply be replaced. Recognizing the potential damage to private property which could result in the silt soils there is valid justification for replacing all previously uninspected or upgraded water services in the lower pressure zone by a capital improvement program.

5.4.3 Capital Improvements

➢ *Water Supply Main – Lake Pumphouse to Solana Crescent*

The utility has initiated a phased programme to construct a supply main from the Lake Pumphouse to Solana Crescent to replace the existing 200mm main located at the north end of the lower zone. From section 3.2.4 the existing supply main represents reliability concerns related to soil stability and is essentially inaccessible for maintenance. In 1998, the utility constructed 270m of this supply main on Sage Mesa Drive concurrent with a road improvement programme by the Ministry of Transportation and Highways.

Referring to Figure 5.1, Table 5.1 presents a preliminary capital estimate to complete the construction of the supply main from the Lake Pumphouse to Solana Crescent. The capital cost estimate is based on the assumption that the construction would be tendered on a material supply and install basis with the contractor providing surety consistent with the Master Municipal Contract Document (MMCD). In Table 5.1, the unit price for estimating purposes for the 250mm supply main parallel to Highway 97 is $110.00/m.

Table 5.1
Lake Pumphouse to Solana Crescent
Water Supply Main – Preliminary Capital Cost Estimate

Part 1 – End Existing Sage Mesa Drive to Solana Crescent

1.1	Tie to Existing on Sage Mesa Drive complete with bends & thrust blocks		$4,000
1.2	250mm Insulated/Heat Traced Watermain	40 m	$32,000
1.3	250mm Watermain on Lot 20 Plan 13181	50 m	$5,000
1.4	Tie to Existing on Solana Crescent complete with valves & fittings		$6,000
1.5	Right of Way Survey & Registration	allow	$2,000
		Subtotal Part 1	**$49,000**

Part 2 – Lake Pumphouse to End Existing Sage Mesa Drive

2.1	Tie to Existing 200mm Supply Main		$5,000
2.2	250mm C900 CL200 Watermain	800 m	$88,000
2.3	Allowance for Bends and Fittings and Valves		$5,000
		Subtotal Part 2	**$98,000**
		Total Construction	**$147,000**
		Contingencies, Engineering & Net GST (allow 28%)	**$41,000**
		TOTAL	**$198,000**

SAGE MESA WATER AND SERVICE CO. LTD.

CONCEPT PLAN OF LOWER ZONE CAPITAL IMPROVEMENTS

DSGN BY:	TRU
DATE:	
SCALE:	1:2000
DWG. NO.:	FIGURE 5.1
REV.:	
DWN. BY:	TDU/DL/VW
DATE:	NOV 1999

TRUE CONSULTING GROUP

LOT A PLAN 40762

LOT A PLAN 16819

LOT 1 PLAN 21078

PLAN A10065

PLAN 42983

R/W PLAN 12566

R/W PLAN A2740

BOUNDARY R/W PLAN 42983

50mm BLOWOFF/DRAIN (GROUND LEVEL)

200ø DUCTILE MAIN SUPPLY MAIN TO UPPER ZONE RESERVOIR

UPPER ZONE BOOSTER STATION

LOWER ZONE RESERVOIR 60,000 L cpl FWL 1890 FEET

OVERFLOW CONNECTS TO RESERVOIR

ELECTRICAL SERVICE TO BOOSTER STATION

200mm AC (1962)

PROPOSED OVERFLOW 250ø PVC

SAGE MESA DR.

SAGE MESA DR. NORTH

FUTURE SUPPLY MAIN SOLANA CRES TO RESERVOIR

150mm PVC CL150 (1984)

150mm AC CL150 (1962)

200mm PVC CL250 (1980)

150mm AC (1968)

100mm AC CL150 (1962)

100mm PVC (1998)

250mm PVC DR18 (1998)

200ø PVC DR 14 (1998)

250mm END CAP (1998)

PART 1 100m OF 250ø SUPPLY MAIN

CONNECT TO EXISTING

25mm SERVICE to LOT 62 (1998)

SERVICES to LOT 55 to 61 – 19mm PEX 1998
LOTS 1 & 57 – 25mm PEX 1998
(NOT CONNECTED TO EXISTING)

SOLANA CR.

VERANO PLACE

LADERA PL.

LINE EXISTS NO CURB STOP INSTALLED

UN-OCCUPIED NOT SERVICED

NOT SERVICED

NOT FOUND

CONNECT TO EXISTING 200ø SUPPLY MAIN

RWAY PLAN A12565

BLK B D.L. 2497

100mm AC CL250 (1962) (ABANDONED 1997))

HIGHWAY 97

PART 2 – 800m OF 250mm SUPPLY MAIN

200mm D.I. (60m from pumphouse to connection to PVC)

LAKE PUMPHOUSE

END CAP AND THRUST BLOCK

CONNECT TO EXISTING

The utility has in the past undertaken construction on the basis of installation only of material supplied by the utility and reduced surety requirements in relation to accepted municipal standards. This approach reduces the contract amount thereby making the project of interest to a larger number of contractors and reduces costs for contractor margins for material, overhead, carrying costs, etc. For comparison the utility's costs using this construction tendering approach for the 250mm watermain on Sage Mesa Drive in 1998 was approximately $70 per meter.

The supply main upgrading will result in a significant increase in chlorine contact time measured from the point of chlorine addition in the lake pumphouse to the first water service in the lower pressure zone. The improvement in chlorine contact time with a comparison to the present system from section 5.2.3 is summarized as follows:

	Present	*With Supply Main Upgrading*
Pipeline	280m – 200mm	50m-200mm and 940m-250mm
Contact Volume	9.1 m^3	48 m^3
Contact time (Summer – 75HP & 25HP pumps operating)	3.5 min	18.5 min
Contact time (Sept to June Inclusive – 75HP pump operating)	5.0 min	22.2 min

Currently the contact time is significantly deficient in relation to the Ministry of Health Standard of 20 minutes minimum. The supply main upgrading project will result in chlorine contact times consistent with the Ministry of Health Standards. The calculated chlorine contact times do not include provisions for contact time provided in the lake pumphouse wet well.

In the predesign phase of Part 2 (Section Parallel to Highway 97) of the supply main upgrading project, the long range expansion potential of the utility should be assessed and the ultimate lake intake design pumping capacity determined. This capacity requirement should then be utilized to determine whether Ministry of Health chlorine contact time requirements can be achieved in the supply main to the lower pressure zone. This assessment may conclude that the section of supply main parallel to H97 (part 2 of Table 5.1) is more appropriately sized as 300mm or larger to achieve compliance with chlorine contact time standards.

With completion of the supply main from the Lake Pumphouse to Solana Crescent, the existing 50mm distribution line to Verano Place through Lots 21 and 56 Plan 13181 would be abandoned.

➢ *Supply Main – Solana Crescent to Reservoir*

The segment of supply main from the Lake Pumphouse to Solana Crescent represents a project of significant priority to resolve reliability concerns, chlorine contact time deficiencies and provide fire protection to Verano Place. Consistent with the format of the terms of reference, it is anticipated that the supply main to Solana Crescent would be completed as a component of a 5 year capital budget.

As illustrated conceptually in Figure 5.1, the long range objective is to complete the supply main construction to the Lower Zone Reservoir. Several alignment options are available to the utility, one of which is illustrated on Figure 5.1 involving construction on Solana Crescent and the former KVR Right of Way. Whether or not approval to construct within the KVR right of way can be obtained remains to be determined.

Table 5.2 provides a preliminary capital cost estimate for the supply main completion from the Solana Crescent to the reservoir. The estimate is preliminary recognizing that no pre-design engineering or alignment feasibility assessments have to date been undertaken. Bedrock is anticipated to represent a constraint and a cost for the segment of the supply main within the former KVR right of way.

At such time as the supply main is completed to the reservoir as shown in Figure 5.1, the existing 200mm supply main could be abandoned.

Table 5.2
Water Supply Main – Solana Crescent to Reservoir
Preliminary Capital Cost Estimate

Item	*Description*		*Estimated Cost*
1.	250mm Supply Main – Solana Crescent	130m	$13,000
2.	Water Service Replacements – Solana Crescent	5 ea.	$5,000
3.	Pavement and Boulevard Restoration	allow	$6,000
4.	Tie to Existing on Sage Mesa Drive complete with valves		$5,000
5.	Sage Mesa Drive to KVR c/w Restrained Joints	50m	$7,500
6.	KVR to Reservoir	210m	$21,000
7.	Connection at Reservoir	allow	$3,000
8.	Trench Rock	250m^3 @ $60	$15,000
9.	Fittings and Appurtenances		$4,000
		Total Construction	**$79,500**
		Contingencies, Engineering & Net GST	**$22,500**
		TOTAL	**$102,000**

➢ *Lower Zone Reservoir Overflow*

The description of the lower zone reservoir and related appurtenances presented in section 5.2.5 indicates that the reservoir does not have a piped overflow or drain. The lack of a piped drain does not represent a significant functional deficiency recognizing that the drain is used only when the reservoir is cleaned, 3 to 5 year intervals. The lack of a piped overflow represents a more significant deficiency as overflow events can occur relatively frequently as a result of a malfunction or failure of the pump control system.

The utility has previously assessed options for providing a piped overflow with a suitable point of discharge being a significant constraint. All soils in the lower zone service area below the reservoir are hazard rated silts therefore discharge from a reservoir overflow pipe onto lands in the immediate vicinity of the reservoir would represent the risk of compromising soil stability anywhere "downstream" of the point of discharge.

Following completion of the lower zone supply main summarized in Tables 5.1 and 5.2, the present 200mm supply main represents a piping system which could be utilized for an overflow system. Referring to drawing Figure 5.1, works to utilize this existing supply main as an overflow would include:

- ❒ 100m of 250mm gravity sewer from the Reservoir to Sage Mesa Drive North adjacent to Lot 43 Plan 13181 following the alignment of the existing 200mm supply main.
- ❒ 250m of 250mm gravity sewer on Sage Mesa Drive North connecting to the existing 200mm supply main adjacent to Lot 11 Plan 20001.

While the overflow system is described herein in conceptual detail, the objective is to illustrate that there is an opportunity at some future date to resolve the present overflow deficiency without compromising soil stability in the service area. The system as illustrated in Figure 5.1 would result in an overflow discharging adjacent to Highway 97 where it is assumed existing storm drainage works would convey flow to Okanagan Lake. A preliminary capital cost estimate for the overflow system is presented in Table 5.3.

A fundamental assumption of the overflow upgrading plan described herein is that there will be sufficient retention time in the drainage ditch on the west side of H97 to "dissipate" chlorine residuals. Accordingly, discussions with the Ministry of Transportation and Highways and the Department of Fisheries and Oceans are essential in the preliminary phases of the project implementation. Table 5.3 includes allowances to undertake improvements in the H97 roadside ditches to provide retention.

Table 5.3
Lower Zone Reservoir Overflow
Preliminary Capital Cost Estimate

Item	*Description*		*Estimated Cost*
1.	Connect to Reservoir complete with fittings		$3,000
2.	250mm PVC DR35 – Reservoir to Sage Mesa Drive North	100m	$8,000
3.	250mm PVC DR35 – Sage Mesa Drive North	250m	$20,000
4.	Connection to Existing 200mm Supply Main		$5,000
5.	Allowance for Pavement and Boulevard Restoration		$8,000
6.	H97 Ditch Upgrading for Flow Retention – allow		$10,000
	Total Construction		**$54,000**
	Contingencies, Engineering & Net GST (allow 28%)		**$15,000**
	TOTAL		**$69,000**

➢ *Lake Pumphouse Capacity Upgrading*

From Section 5.2.2 the lake pumphouse is deficient in supply capacity in relation to provisions of the Ministry of Environment Guidelines for Rural Residential Water Systems which requires a minimum of two supply pumps each having a capacity equivalent to the maximum day water demands of the utility's service area. In the period 1990 to 1999, the utility has however not experienced pump failure or other pump related problems which resulted in an interruption in service.

The objective of the utility should be capacity upgrading at the lake pumphouse to fully comply with MoE Design Guidelines. Upgrading of the lake pumphouse to fully comply with MoE Guidelines would comprise:

- ❒ installation of a 100 HP vertical turbine pump to replace the existing 25 HP unit. Available space in the pumphouse is limited and complete removal of the existing 25 HP pump would appear appropriate.
- ❒ upgrading of the existing discharge piping in the pumphouse from 150 mm to 200 mm or 250 mm including a pressure relief valve and flow meter.
- ❒ upgrade pumphouse ventilation and provide standby chlorination system.
- ❒ upgrade the electrical service to the pumphouse to 600 volts including transformer, supply conductor upgrading, motor control centre replacement and motor rewinding.
- ❒ provide switching and a receptacle for power supply from a standby generator.

A preliminary capital cost estimate for capacity improvements at the lake pumphouse is presented in Table 5.4. The capital cost estimate represents an update of preliminary estimates prepared for the utility in 1992 and an assessment by Unit Electrical Engineering for the utility in 1999.

Table 5.4
Lake Pumphouse Capacity Improvements
Preliminary Capital Cost Estimate

Item	*Description*		*Estimated Cost*
1.	Supply and install 100 HP Vertical Turbine Pump		$28,000
2.	Upgrade Pump Discharge Piping to 200mm or 250mm and 250 lb. rating complete with flow meter and pressure relief		$35,000
3.	Ventilation and chlorination system upgrading	allow	$8,000
4.	Electrical Service Upgrading, conversion to 600 volt, motor rewinding, etc.		$60,000
5.	Switch and Receptacle for power supply from a standby generator.	allow	$10,000
	Total Construction		**$141,000**
	Contingencies, Engineering & Net GST (allow 28%)		**$40,000**
	TOTAL		**$181,000**

➢ *Lower Zone Water Service Replacements*

Section 5.4.2 describes corrosion related problems related to water services in the lower pressure zone. In the period 1990 to 1999, the utility has upgraded, replaced or inspected 25 of 67 water services in the lower pressure zone. No information is available from which to determine how many of the remaining 42 water services may be subject to failure as a result of corrosion of galvanized iron components. Recognizing the sensitivity of the silt soils in the lower pressure zone area to water, replacement of the 42 water services not to date inspected and/or upgraded may be undertaken as a capital project.

Referring to *Figure 5.1* and Table 5.2, four of the 42 original water services would be replaced concurrent with the construction of the proposed water supply main on Solana Crescent. The water service replacement upgrading project would therefore comprise a total of 38 water services. A preliminary capital cost estimate for the water service replacement program in the lower pressure zone is presented in Table 5.5.

Table 5.5

Lower Pressure Zone Water Service Replacement Program

Preliminary Capital Cost Estimate

Item	*Description*		*Estimated Cost*
1.	Excavate Service Connection at Main, Replace Saddle & Corp Stop	38 @ $400	$15,200
2.	Supply and Install 20 mm Water Service	450 m @ $40	$18,000
3.	Replace Curb Stop, Service Box and Connect to Existing	38 @ $300	$11,400
4.	Asphalt Repair	800 m^2 @ $20	$16,000
		Total Construction	**$60,600**
		Contingencies, Engineering & Net GST (allow 28%)	**$17,400**
		TOTAL	**$78,000**

5.4.4 Five Year Capital Plan

Capital projects described in Section 5.3 are summarized as follows:

≫ Supply Main – Lake Pumphouse to Solana Cres. (Table 5.1) -	$198,000
≫ Supply Main – Solana Cres. to Lower Zone Reservoir (Table 5.2) -	$102,000
≫ Lower Zone Reservoir Overflow (Table 5.3) -	$ 69,000
≫ Lake Pumphouse Capacity Upgrading (Table 5.4) -	$181,000
≫ Lower Zone Water Service Replacement (Table 5.5) -	$ 78,000
Total	$628,000

The ability of the utility to undertake capital improvements is presently constrained by reserve account amounts and the inability of the utility to finance improvements by debenture.

If the Regional District were to assume ownership of the utility, the Regional District would be in the position of being able to make application for Infrastructure Assistance Grants from senior governments for the projects. The provincial Infrastructure Implementation programme currently provides up to 50% assistance grants.

The Ministry of Municipal Affairs has a rating system for waterworks projects to assist in determining priority for funding. Related to major water projects, the Ministry's rating values are:

Public Health Protection	1
Environmental Protection	2
Necessary Renewal, Age & Condition	4
Increase Reliability & Fire Flows	7
Increase Capacity for Existing Development	8
Increase Capacity for Future Development	9

The capital works program derived herein for the Sage Mesa water system will address and resolve public health and age and condition concerns which have high priority rating values. It therefore appears reasonable to assume that the Capital Improvement Program would qualify for capital cost assistance from the Ministry of Municipal Affairs.

5.5 Financial

5.5.1 Financial Statements

The annual financial statements for the Sage Mesa Water and Public Service Co. Ltd. are prepared by Kemp Harvey Lister Inc., certified General Accountants of Penticton. The year end for the utility is the end of November. *Appendix F* contains the utility's financial statements for the period ending November 30, 1998. The financial status from the Utility's balance sheet is summarized following:

	1998	*1997*
Assets		
Cash	$14,065	$23,264
Accounts Receivable & Prepaids	$ 9,826	$ 9,342
	$23,921	$32,606
Liabilities		
Accounts Payable	$7,646	$12,567
Due to Reserve Funds	$2,946	
	$10,592	$12,567
Reserves		
Maintenance Reserve	$18,800	$18,800
Upper Area Replacement Reserve	$15,801	$26,680
Lower Area Replacement Reserve	($12,745)	$32,880
Deferred Capacity Reserve	$10,492	$15,146
Reserve Totals	$32,339	$93,506

As noted in earlier sections of this report, the utility completed construction of a water supply main on Sage Mesa Drive, distribution main replacement on Verano Place and other maintenance/replace repair projects. These improvements were financed from reserve accounts and are reflected in a decrease of total reserve account amount from $93,506 at November 30, 1997 to $32,339 at November 30, 1998. All expenditures from reserve accounts appear to be appropriately described in the 1998 financial statements summarized as follows:

	Upper Area Replacement Reserve	
	Balance at November 30, 1997	$26,680
(plus)	Additions and Interest	$8,860
(minus)	Expenditures – Water Supply Main Replacement	$14,669
	– Reservoir Inlet Pipe Replacement	$4,048
	– Reservoir Hatch	$1,022
	Net at End of Year	**$15,801**

	Lower Area Replacement Reserve		
	Balance at November 30, 1997		$32,880
(plus)	Additions and Interest		$8,292
(minus)	Expenditures	– Water Supply Main Replacement	$31,429
		– Verano Place Distribution Main	$14,669
		– Service Connection Replacement	$4,890
		– Replace Curb Stops	$1,121
		– Replace Gate Valves	$1,817
	Net at End of Year		**$(12,754)**

On the basis of the Utility's financial statement, the Utility has no long term debt. All capital improvements in the period 1990 to 1999 have been undertaken through agreements for service with developers requesting an extension of service and/or reserve accounts.

5.5.2 Water Rate Structure

The Sage Mesa Water and Public Service Co. Ltd. regulations related to the water system use, connection procedures, etc. and rate schedule are contained in the form of "Water Tariff No. 5. Rates and Rules for Water Service" dated June 01, 1998. This document is equivalent to a municipal water connection and regulation bylaw. Because the utility is a limited company, the rates and rules of service are prepared in the format of a Water Tariff which is reviewed and formally approved by the Comptroller of Water Rights. A copy of "Water Tariff No. 5" is contained in *Appendix E.* From the tariff, the rate structure is summarized following:

The Utility's Water Rate Structure is established by Water Tariff No. 5 contained in *Appendix E.* From the tariff, the rate structure is summarized following:

➢ *Domestic Flat Rate Service*
Lower Pressure Zone –
- $96.00/quarter for domestic use
- $48.00/quarter for suites in houses

➢ *Domestic Metered Rates*
Upper Pressure Zone –
- $96.00/quarter for first 3000 cu.ft. of consumption plus $0.25 for each 100 cu.ft. consumed

➢ *Non Domestic Meter Rates*
Pine Hills Golf Course - $415/mo. for 1st 100,000 Imperial gallons plus $0.20 per 1000 gallons used thereafter
Sage Mesa Golf Course - $830/mo. for 1st 200,000 Imperial gallons plus $0.20 per 1000 gallons used thereafter

➢ *Availability of Service Charge*
All lots not receiving water service - $164.00/annum

➢ *Contribution in Aid of Future Construction*
For each unit qualifying as authorized premise - $2000/unit

The rate schedule summarized above includes provisions for Utility's Replacement Reserve Accounts. The tariff defines the following amounts included in the rate schedule as contribution to Reserve Funds.

➢ *Lower Area Replacement Reserve Trust Funds*
- ❒ $25.50 per quarter per unit
- ❒ $12.25 per quarter per suite
- ❒ $85.00 per month for Pine Hills Golf Course
- ❒ $170.00 per month for Sage Mesa Golf Course

➢ *Upper Area Replacement Reserve Trust Fund*
- ❒ $15.00 per quarter per unit

Any charges levied pursuant to the "Aid of Future Construction" provisions of the Tariff are deposited in a separate reserve account identified as "Deferred Capacity Trust Fund". The tariff provides for a 10% discount of all service charges (both metered and flat rate) if the payment is received by the utility within 21 days of the date of billing.

Water utility rate structures should generate sufficient revenue for annual operation, maintenance and administration costs and capital and repair reserve accounts. From the utility's financial statements for 1997 and 1998, total revenue and total annual costs including provisions for reserves are summarized following:

Year	*1998*	*1997*	*1996*	*1995*
Total Annual Revenue	$101,504	$87,760	$80,132	$80,225
Total Expenses including Reserves	$110,207	$84,532	$73,293	$77,751
Net	**($8,703)**	**$3,228**	**$6,839**	**$2,474**

With the exception of 1998, the utility's revenue exceeded its overall annual expenses in the period 1995 to 1997 by an amount ranging between 3% and 8.5% of its total annual revenue. In 1998, the utility undertook significant capital improvements which are reflected in a 50% increase in repair and maintenance costs as compared to 1997 ($40,751 – 1998 compared to $28,400 – 1997). In addition, the summer of 1998 was dryer than average and resulted in above average demands. The utility's power costs in 1998 were $18,858 compared to $11,739 in 1997. Power costs are directly proportional to water consumption.

Overall it may be concluded that the utility's water rate structure appears reasonable in relation to the utility's annual expenses.

5.5.3 RDOS Pro Forma Budget

Consistent with the terms of reference, this section derives a pro forma budget for the RDOS assuming that the Regional District assumes ownership of the water utility. Using the Utility's Statement of Income from its financial statement as a budget format, the pro forma budget is presented in Table 5.6.

Whether or not the system is operated by the RDOS, several categories of expenses will remain comparable to historical costs. These items include licences and fees, power, water treatment supplies, and telephone. Assumption of ownership by the Regional District will however potentially impact several of the utility's principal operating cost categories as follows:

- billing and office – currently contracted by the utility to Kemp, Harvey, Lister Inc.
- contract labour – general operation and maintenance currently contracted by the utility to Al Lister.
- repairs and maintenance – currently contracted by the utility with management by Al Lister and MoE.

In consultation with RDOS administrative staff, pro forma budget estimates for the above listed expense categories are presented in Table 5.6.

Table 5.6
Pro Forma Budget – RDOS Ownership

Existing – 1998 Actual				*RDOS Ownership*	
				Contracted Maintenance	*Maintenance by Own Staff*
Income/Revenue	$95,579			$92,000	$92,000
Expenses:		*Expenses:*			
Accounting & Legal	$1,210	4120	Administration	$3,000	$3,000
Bad Debts	$1,116	4840	Contracted Maintenance	$10,632*	
Bank Charges & Interest	$8	5310	Education	$300	$300
Billing and Office	$12,860	5500	Hydrant Maintenance	$4,000	$4,000
Contract Labour	$10,632	5600	GST Expense	$1,500	$1,500
Insurance	$1,800	5700	Property Insurance	$600	$600
Legal	$0	5710	Insurance General Liability	$1,200	$1,200
Licences & Dues	$1,135	6020	Legal/Survey/Engineering	$3,000	$3,000
Power	$18,858	6030	Licences & Permits	$1,200	$1,200
Repairs & Maintenance	$40,751	7395	Supplies & Chlorination	$3,000	$3,000
Telephone	$1,873	7410	Operations & Repairs	$27,500	$27,500
Water Treatment Supplies	$2,870	8070	Safety	$300	$300
Workers' Compensation	$1,249	8190	Travel Leasing	$200	$700
		8810	Utility's Power	$15,000	$15,000
Total Expense:	**$94,362**	8815	Utility's Telephone	$2,000	$2,000
			Wages & Benefits-Staff	$5,000	$16,000
			Total Expenses:	**$78,432**	**$79,300**

*Preliminary: Operation, Maintenance and Inspections schedule subject to detailed assessment by R.D.O.S. Public Works Manager

Table 5.6 suggests that the R.D.O.S. could assume operational jurisdiction of the water system with the present rate structure providing adequate revenue for anticipated operation and maintenance expenses. The current rate structure generates approximately $17,000 annually for reserve accounts which is not included in the revenue projections presented in Table 5.6.

The pro forma budget as presented in Table 5.6 does not include provisions for a capital program derived in sections 5.4.3 and 5.4.4. The impact of the capital program on benefiting properties in the Sage Mesa water system service area depends to a significant degree on capital assistance which may be provided by senior government. If the Regional District were successful in obtaining 50% assistance for the capital program, the impact on property owners in the service area is derived following:

	Total Capital Program (from Section 5.4.4)	-	$628,000
(minus)	Infrastructure Capital Assistance (assume 50%)	-	$314,000
	Net Capital Cost to Utility	-	$314,000
	Amortization - $314,000 @ 8% for 20 years	-	$27,000 annually
(less)	Contribution from Current Revenue Account		
	Levy - assume	-	$10,000
	Net Additional Cost		$17,000

The net additional cost of $17,000 derived above would represent an increase in rates of approximately $20.00 per quarter ($80.00 per year) applicable to both upper and lower pressure zones.

5.6 Legal

5.6.1 Service Area

The terms of reference require an assessment of the Utility's actual service area in relation to its "legal" service area boundary with the purpose of defining whether there are serviced properties outside of the legal boundary. The utility's service area boundary enclosing properties actual provided water service is illustrated on drawing 383-041-00 in *Appendix A*. The legal service area boundary of the utility is determined from the CPCN contained in *Appendix B*. As described in Section 3.1, the CPCN was last amended in 1984 and all development subsequent to this date is not referenced in this CPCN. Water Management Branch staff recognize that an amendment to the utility's CPCN is required to update the authorized service area consistent with drawing 383-041-00. It is therefore assumed that the CPCN for the utility would be appropriately amended prior to any assumption of ownership by the Regional District.

Within the authorized service area, Mr. D. Chapman, owner of Lot A Plan 407682 (Pine Hills Golf Course) is of the opinion that there is an outstanding commitment by the utility to provide service to 57 undeveloped single family equivalent units on his property. This alleged commitment by the utility to provide service with no capacity related capital contributions by Mr. Chapman or his development corporation is described in a letter prepared by Mr. Chapman's legal council, Berge and Company, dated December 30, 1996. A copy of this letter is contained in *Appendix G*. Mr. Berge in this letter states that when the water utility was acquired by Mr. Chapman from the original developer, ARA Holdings, in 1968, and the water system was adequately sized for second phase of development in lower pressure zone area comprising 61 single family lots. The position of Mr. Chapman is that this capacity commitment by the utility remains outstanding.

In 1998, ARA Holdings (development company owned by Mr. Chapman) proceeded with a subdivision proposal of Parcel B DL 2497 which would create 7 single family lots located at the north end of Sage Mesa Drive North. The developer's position of an outstanding commitment for service by the utility was restated by Mr. Reinhart Burke, solicitor for Mr. Chapman, in a letter dated June 01, 1998 to the Ministry of Environment (copy presented in *Appendix G*). The response dated June 18, 1998 from the Deputy Comptroller of Water Rights (please refer to *Appendix G*) appears to suggest that there is no outstanding commitment by the utility to provide service to properties owned by Mr. Chapman.

Should the Regional District decide to consider assumption of ownership of the Sage Mesa Water and Public Service Co. Ltd., the issue of service commitments to potentially developable properties in the lower pressure zone owned by Mr. Chapman warrant assessment.

5.6.2 Pending Legal Action

On the basis of a meeting on November 12, 1999 with Ministry of Environment staff having administrative responsibility for the water utility, the writer was advised that there are no outstanding legal actions against or involving the water utility.

APPENDIX A

Water System Service Area

TRUE Drawing 383-041-00



No.	DATE	DESCRIPTION	BY	APP'D
9				
8				
7				
6				
5				
4				
3				
2				
1	NOV 30/99	REVISED TO REFLECT UTILITY COMMENTS	VW	TRUE

ISSUES / REVISIONS

SCALE	NTS
DESIGN BY	TRUE
DRAWN BY	VW
DATE	AUG 1999
CHK. BY	
DATE	

TRUE CONSULTING GROUP

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.

COMPOSITE

KEY PLAN

SHEET No. OF

DRAWING NO: 383-041-00

ISSUED/REV. 1

ACAD FILENAME: 3830412.3.DWG

APPENDIX B

Certificate of Public Convenience and Necessity (CPCN)
Sage Mesa Water and Public Service Co. Ltd.

- *Consolidation Certificate #552*
  November 19, 1984

- *Order of Seizure No. 1378*
  June 27, 1990

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

PROVINCE OF BRITISH COLUMBIA

In the Matter of the *Water Utility Act* and the *Utilities Commission Act*

and

In the Matter of Sage Mesa Water & Public Service Co. Ltd.

CERTIFICATE

OF

PUBLIC CONVENIENCE AND NECESSITY

(CONSOLIDATION)

WHEREAS Certificates of Public Convenience and Necessity (Consolidation) dated July 2, 1971, No. 257 dated April 18, 1979, No. 426 dated January 18, 1982, and No. 470 dated September 13, 1982, were granted to Sage Mesa Water & Public Service Co. Ltd. for the construction, operation and extension of its waterworks system near Penticton, British Columbia;

AND WHEREAS it is considered that the public interest requires a new Certificate to be issued pursuant to Section 53 (6) of the Utilities Commission Act in order to consolidate the legal descriptions of the areas authorized for service by the Utility;

IT IS HEREBY ORDERED THAT the Utility is authorized to operate an approved waterworks system to serve 170 lots and a Golf Course in the area described as:

Lots 1 - 14 incl.	Plan 13181
Lots 16 - 55 incl.	Plan 13181
Lots 57 - 62 incl.	Plan 13181
all of Lots 2497 and 5087, O.D.Y.D.	
Lots 1 - 12 incl.	Plan 20001
Lot 1	Plan 21078
Lot A	Plan 16819
Block B (except Plans 13181 and 20001)	
all of Lot 2497, O.D.Y.D.	
Lots 1 - 20 incl.	Plan 33471
Lots 1 - 35 incl.	Plan 29093
Lots 1 - 8 incl.	Plan 32957
Lots 1 - 3 incl.	Plan 31947
Lots 1 - 25 incl.	Plan 32905
Lots 3 & 4	Plan ~~24125~~ 24215 (Gravel Plant)
Lot 1	Plan 15612
Lot A	Plan 33715
all of Lot 4947, O.D.Y.D.	
District Lot 702, O.D.Y.D.	(Golf Course)

AND IT IS FURTHER ORDERED THAT this consolidated Certificate replaces Certificates of Public Convenience and Necessity (Consolidation) dated July 2, 1971, No. 257 dated April 18, 1979, No. 426 dated January 18, 1982, and No. 470 dated September 13, 1982.

J.E. Farrell,
Deputy *Comptroller of Water Rights*

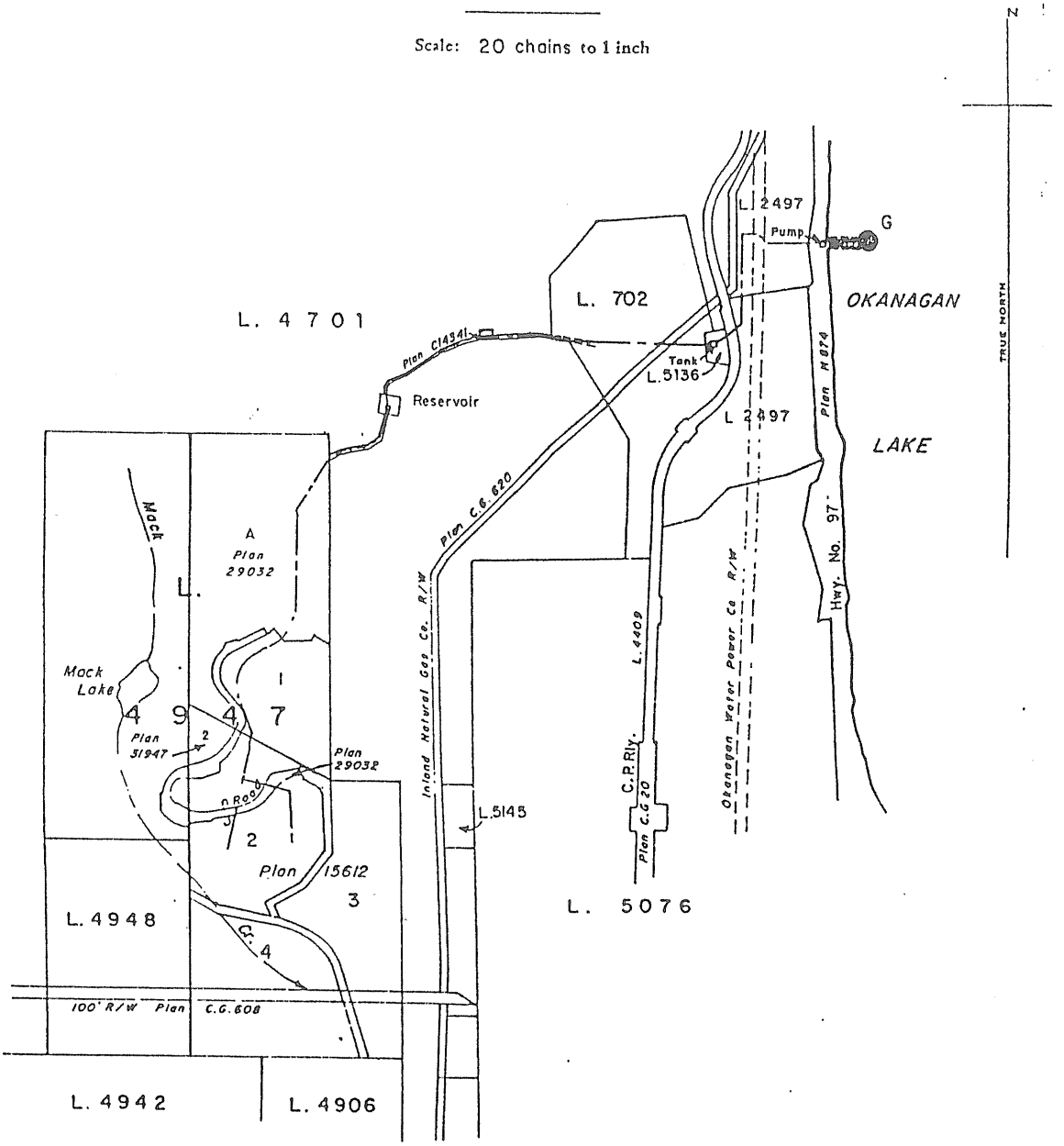
File No. 0321081 Date issued: November 19, 1984 Certificate No. 552

British Columbia

PENTICTON WATER DISTRICT

OSOYOOS DIVISION OF YALE DISTRICT

Scale: 20 chains to 1 inch



LEGEND

Point of Diversion ●
W.R. Map 1550A
Pipe — — —
Permit over Crown Land

Signature [signature]

Date 15th June 1983.

C.L. 58922
File 0369962
P.C.L. No. 13735

Penticton Precinct

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sage Mesa Water and Public Service Co. Ltd., of 264 Westminster Avenue, Penticton, B. C. V2A 1J9

is hereby authorized to divert and use water as follows:

(a) The source of the water supply is Okanagan Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 15th May, 1981.

(d) The purpose for which the water is to be used is waterworks.

(e) The maximum quantity of water which may be diverted is 1,500 gallons a day, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be used is the whole year.

(g) This licence is appurtenant to the undertaking of the licensee as set out in Certificate of Public Convenience and Necessity No. 426/1982 and any substitution thereof or amendment thereto.

(h) The works authorized to be constructed are diversion structure, pump, pipe, tank, reservoir and distribution system, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works has been completed and the water shall be beneficially used on or before the 31st day of December, 1984.

(j) The works authorized under clause (h) hereof shall be constructed to operate with a lake elevation of 1,116.8 to 1,125.6 feet.

J. E. Farrell,
Deputy Comptroller of Water Rights.

File No. 0368604 Date issued: 15th July, 1983 Conditional Licence 59060

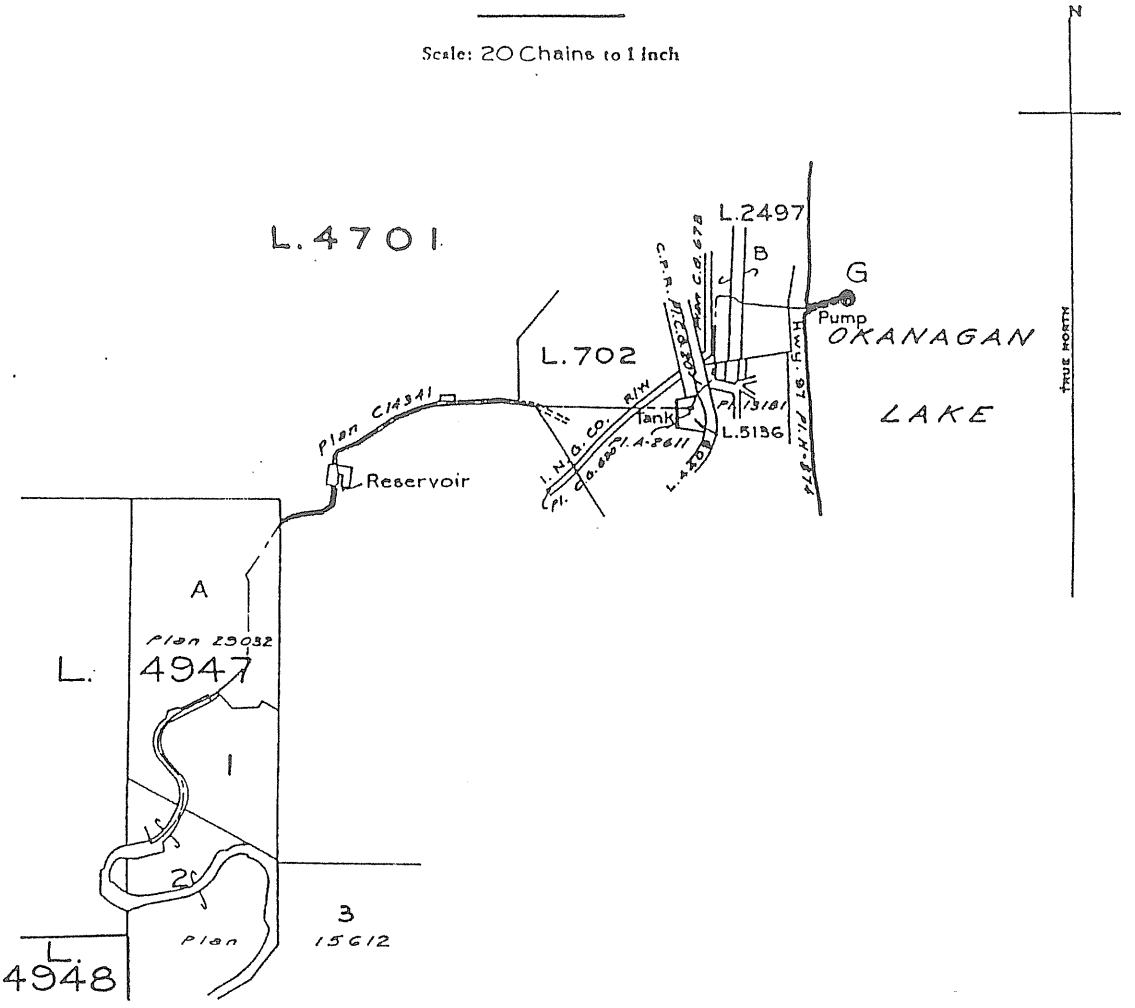
W-183

British Columbia

PENTICTON WATER DISTRICT

OSOYOOS DIVISION OF YALE DISTRICT

Scale: 20 Chains to 1 Inch



LEGEND

Point of Diversion ●

W.R. Map 1550A

Pipe

Permit over Crown Land [redacted]

Signature _____

Date 15th July 1983

C.L. 59060

File 0368604

P.C.L. No. 13774

Penticton Precinct

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sage Mesa Water and Public Service Co. Ltd., of 264 Westminster Avenue, Penticton, B. C. V2A 1J9

is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Okanagan Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 27th May, 1981.

(d) The purpose for which the water is to be used is waterworks.

(e) The maximum quantity of water which may be diverted is 4,000 gallons a day, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be used is the whole year.

(g) This licence is appurtenant to the undertaking of the licensee as set out in Certificate of Public Convenience and Necessity No. 426/1982 and the substitution thereof or amendment thereto.

(h) The works authorized to be constructed are diversion structure, pump, pipe and distribution system, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works shall be commenced on or before the 31st day of May, 1985, and shall be completed and the water beneficially used on or before the 31st day of December, 1987.

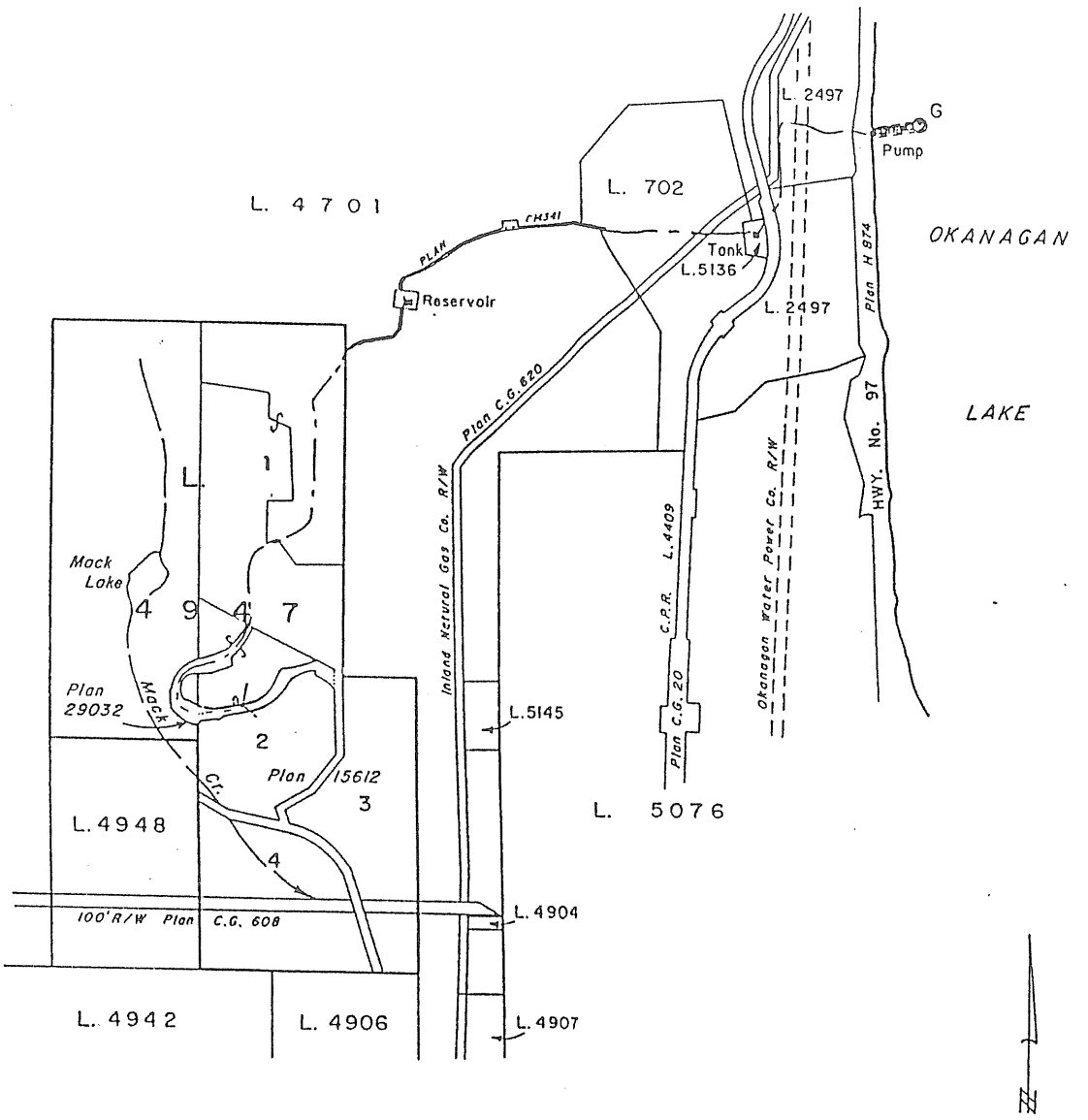
(j) The works authorized under clause (h) hereof shall be constructed to operate with a lake elevation of 1,116.8 to 1,125.8 feet.

J. E. Farrell
Deputy Comptroller of Water Rights

File No. 0368663 Date issued: NOV 14 1984 Conditional Licence 61571

W-183

Province of British Columbia



WATER DISTRICT : PENTICTON
PRECINCT : PENTICTON
LAND DISTRICT : OSOYOOS DIVISION OF YALE

LEGEND

Scale : 20 Chains to 1 Inch
Point of Diversion : ⊕
Map Number : WR 1550A
Pipe : — — —
Permit over Crown Land: ▬▬▬

Signature ...
Date NOV 14 1984

C.L. 61571
File 0368663
P.C.L. 14618

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT and Parks

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sage Mesa Water and Public Service Co. Ltd. of 264 Westminster Avenue West, Penticton, British Columbia V2A 1J9

is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Okanagan Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 28th May, 1985.

(d) The purpose for which this licence is issued is waterworks.

(e) The maximum quantity of water which may be diverted is 182,500 gallons a year, at a rate not exceeding 1,500 gallons a day.

(f) The period of the year during which the water may be used is the whole year.

(g) The land upon which the water is to be used and to which this licence is appurtenant to is the undertaking of the licensee as set out in Certificate of Public Convenience and Necessity No. 552/1984, and any substitution thereof or amendment thereto.

(h) The works authorized to be constructed are diversion structure, tank, pump, pipe and reservoir, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works shall be completed and the water beneficially used on or before the 31st day of December, 1988.

(j) This licence authorizes the use of water for domestic purpose in one dwelling located approximately as shown on the attached plan.

(k) The works authorized under clause (h) hereof shall be constructed to operate within a lake elevation of 1116.8 to 1125.6 feet.

A. Zackodnik, P.Eng.
Regional Water Manager
Southern Interior Region

File No. 8000681 Date issued NOV 21 1986 Conditional Licence 64196

182,500 G.A.Y ÷ 365 = 500 G.A.D.

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sage Mesa Water and Public Service Co. Ltd. is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Okanagan Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 7th December, 1966.

(d) The purpose for which this licence is issued is industrial (golf course).

(e) The maximum quantity of water which may be diverted is 30 acre feet per annum.

(f) The period of the year during which the water may be used is 1st April to 30th September.

(g) The land upon which the water is to be used and to which this licence is appurtenant is Lot A of Lot 702 and of Lot 5136, Osoyoos Division of Yale District, Plan 40762, of which 20 acres may be irrigated.

(h) The works authorized to be constructed are diversion structure pump, pipe, tank, and sprinkler system which shall be located approximately as shown on the attached plan.

(i) This lience is issued in substitution of Conditional Water Licence 41357 in part.

(j) The construction of the said works has been completed and the water shall be beneficially used on or before the 31st day of December, 1993.

M. D. Bancha

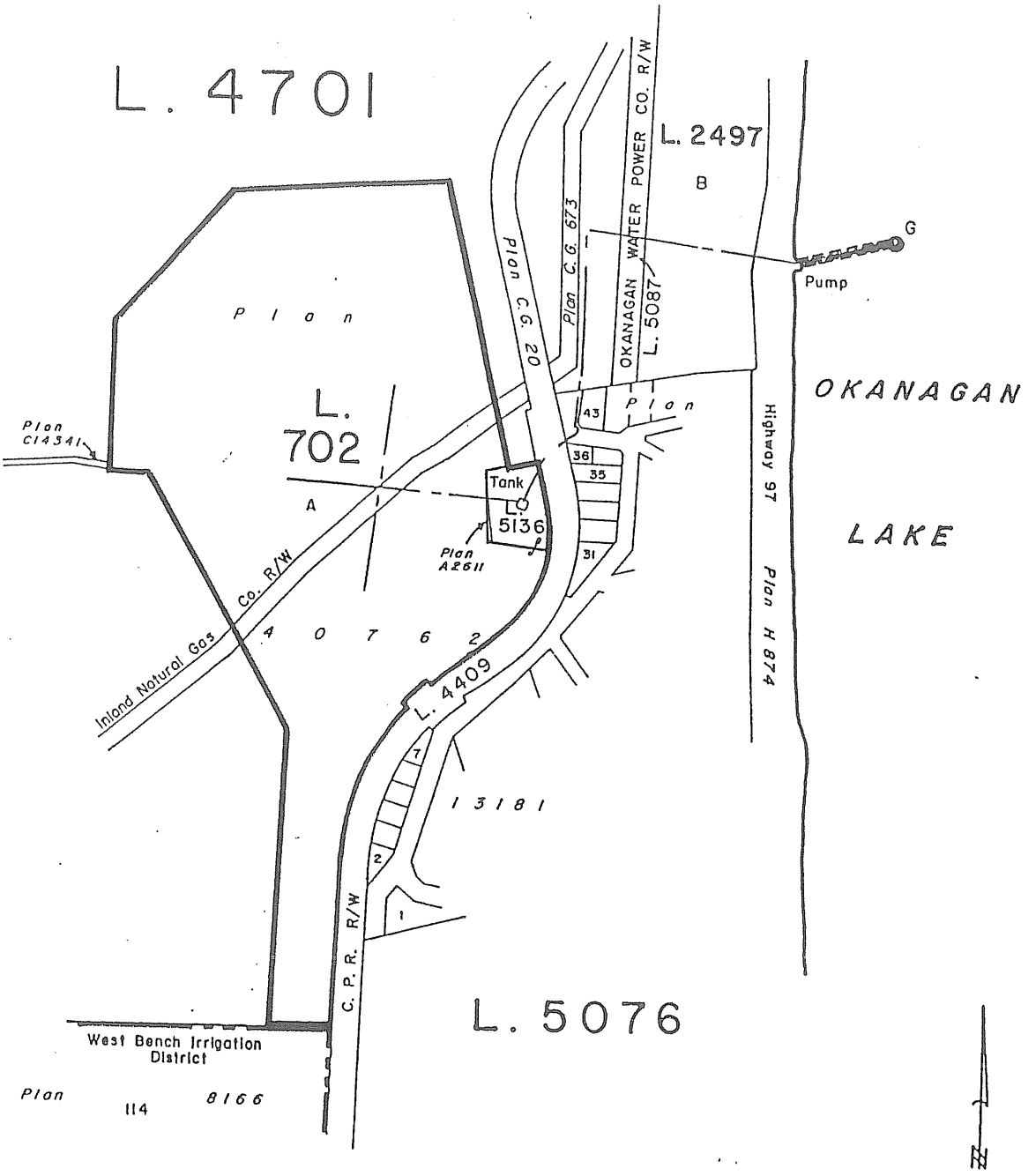
A.D. Zackodnik, P.Eng.
Regional Water Manager
Southern Interior Region

Date Issued: MAY 25 1992

File No. 0270855

Conditional Licence 104081

Province of British Columbia



WATER DISTRICT :PENTICTON
PRECINCT :PENTICTON
LAND DISTRICT :OSOYOOS DIVISION OF YALE

Signature M. G. Baulke
Date MAY 25 1992

LEGEND

Scale : 500 feet to 1 inch
Point of Diversion : ●
Map Number : WR 1550A
Pipe : — — —
Permit over Crown Land: [redacted]

C.L. 104081 for C.L. 41357, in part
File 0270855
P.C.L. 20184

The boundaries of the land to which this licence is appurtenant are shown thus: ▬▬

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sage Mesa Water and Public Service Co. Ltd., are hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Okanagan Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 7th December, 1966.

(d) The purpose for which this licence is issued is industrial (golf course) and industrial (commercial club house).

(e) The maximum quantity of water which may be diverted for industrial (golf course) purpose is 44.67 acre-feet per annum and for industrial (commercial club house) purpose is 500 gallons a day.

(f) The period of the year during which the water may be diverted for industrial (golf course) purpose is 1st of April to 30th of September, and for industrial (commercial club house) purpose is 1st April to 30th September.

(g) The land upon which the water is to be used and to which this licence is appurtenant is that portion of lot 5076, lying to the north and east of Plan 8166 and that part of Lot 5087 lying to the north and east of Plan 8166 all within Osoyoos Division of Yale District, of which 30 acres may be irrigated.

(h) The works authorized to be constructed are diversion structure, pump, pipe, tank and sprinkler system, which shall be located approximately as shown on the attached plan.

(i) This lience is issued in substitution of Conditional Water Licence 41357 in part.

(j) The construction of the said works shall be completed and the water shall be beneficially used on or before the 31st day of December, 1993.

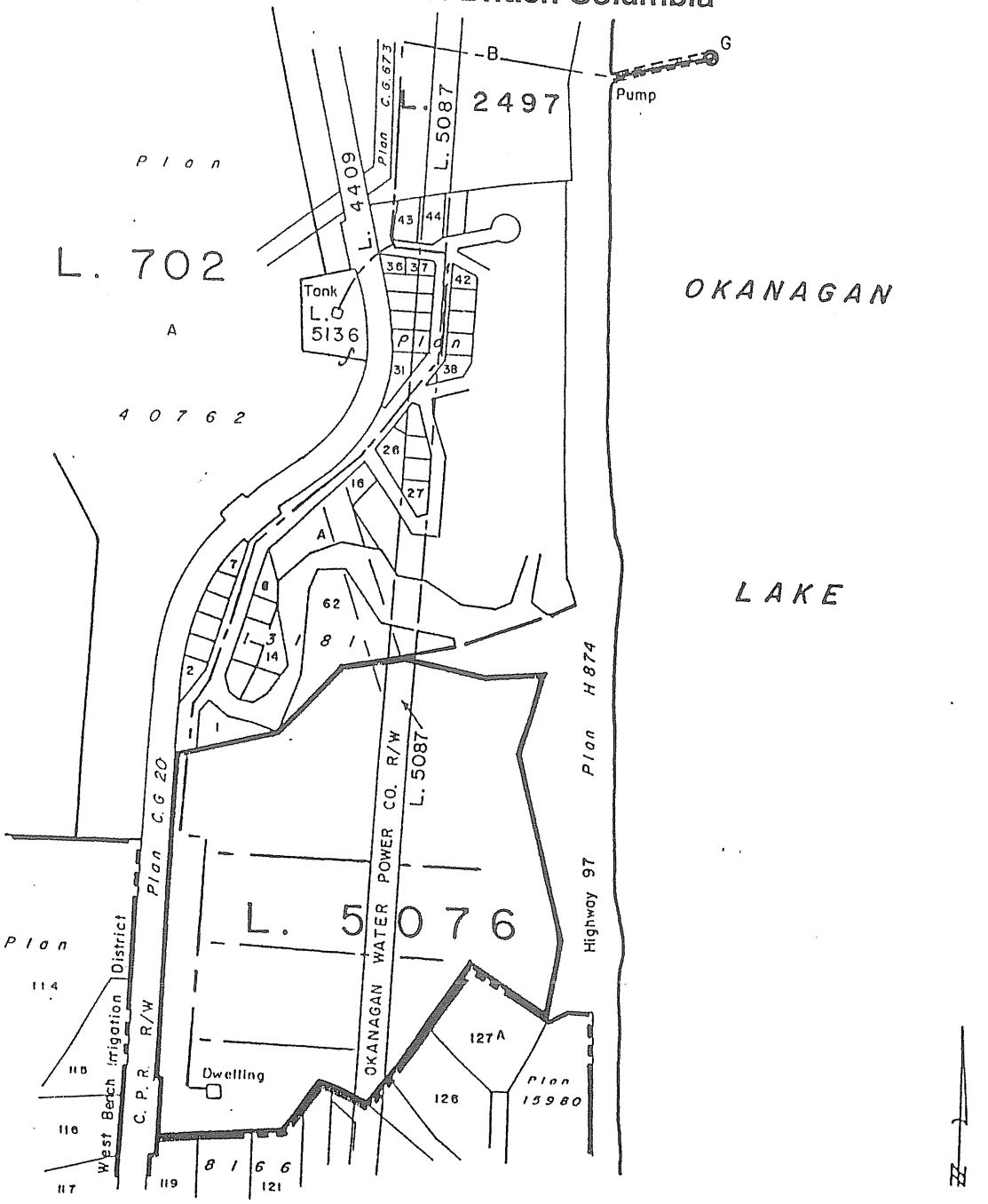
A.D. Zackodnik, P.Eng.
Regional Water Manager
Southern Interior Region

Date Issued: MAY 25 1992

File No. 8001928

Conditional Licence 104082

Province of British Columbia



WATER DISTRICT : PENTICTON
PRECINCT : PENTICTON
LAND DISTRICT : OSOYOOS DIVISION OF YALE

Signature M. A. Baulne
Date MAY 25 1992

LEGEND

Scale : 500 feet to 1 inch
Point of Diversion : ●
Map Number : WR 1550A
Pipe : ——·——
Permit over Crown Land : ▬▬▬

C.L. 104082 for C.L. 41357, in part
File 8001928
P.C.L. 20187

The boundaries of the land to which this licence is appurtenant are shown thus: ▬▬▬

Province of British Columbia

Ministry of Environment and Parks (Environment Division)

PERMIT UNDER THE WATER ACT AUTHORIZING THE OCCUPATION OF CROWN LAND

SUPERCEDED BY C104081, C104082

ABANDONED

The holder of Conditional Water Licences 64196, 61571, 59060, 58922, 52739, ~~41357~~, ~~38167~~, being Sage Mesa Water & Public Service Co. Ltd. at the date of issue of the said licence, whose licence authorizes the diversion and use of water from Okanagan Lake, is hereby authorized to occupy Crown Land by constructing, maintaining and operating thereon the works authorized under the said licence and any licence which may be issued in substitution thereof.

(a) The Crown Land which is authorized to be occupied under this permit is a portion of unsurveyed foreshore and land, Osoyoos Division of Yale District covered by the waters of Okanagan Lake, the location of which is shown approximately on the plan attached to the said water licences.

(b) The approximate dimensions of the Crown Land authorized to be occupied under this permit are 400 feet in length and 15 feet in width having an area of .14 acre.

(c) The permittee may cut and remove from the said Crown Land any timber necessary to permit construction and maintenance of the said works. Prior to the cutting, destruction or flooding of any timber, the permittee shall apply for and obtain a licence to cut timber from the District Manager and the amount of stumpage, royalty and (or) compensation payable to the Crown in respect of trees, including merchantable or young growth, cut, removed, damaged, or destroyed by the permittee, shall be the sum or sums fixed by the Forest Service of the Province of British Columbia.

(d) This permit is appurtenant to the land, mine or undertaking to which the aforesaid water licence is appurtenant.

(e) This permit shall become void if the water licence with respect to which the permit is issued should terminate, be abandoned or cancelled, or amended so as to render this permit unnecessary.

(f) This permit is issued and accepted on the understanding that the permittee shall indemnify and save harmless the Government of the Province of British Columbia for all loss, damage to works, cost or expense suffered by the permittee by reason of the Crown Land or any portion thereof being submerged or damaged by erosion or otherwise affected by flooding.

(g) The holder of this permit shall not be entitled to compensation if the Crown grants permits to other persons to occupy the land affected by this permit.

(h) In the event of a dispute at any time with respect to the area or boundaries of the land affected by this permit, the holder shall, at his own expense, have the said land surveyed by a duly qualified surveyor.

(i) The annual rental for this permit is $4.00, which is subject to review and revision at any time at the discretion of the Crown.

(j) This permit replaces Permit No. 15751 and 12153.

(k) This permit is subject to the provisions of the Navigable Waters Protection Act.

B. E. Marr
Deputy Minister of Environment and Parks

File No. 8000681 0341815
0369962 0285808
0368663 0270855
0368604

Date Issued
FEB 10 1987

Permit No. 15781

Province of British Columbia

Ministry of Environment

PERMIT UNDER THE WATER ACT AUTHORIZING THE OCCUPATION OF CROWN LAND

The holder of Water Licence 104082, whose licence authorizes the diversion and use of water from Okanagan Lake, is hereby authorized to occupy Crown Land by constructing, maintaining and operating thereon the works authorized under the said licence.

(a) The Crown Land which is authorized to be occupied under this permit is a portion of unsurveyed foreshore and land within Osoyoos Division of Yale District, the location of which is shown approximately on the plan attached to the said water licence.

(b) The approximate dimensions of the Crown Land authorized to be occupied under this permit are 400 feet (122.0 meters) in length and 15 feet (4.6 meters) in width, having an area of 0.14 acre (.06 hectares).

(c) The permittee may cut and remove from the said Crown Land any timber necessary to permit construction and maintenance of the said works (and clearing of the said lands which may be flooded). Prior to the cutting, destruction (or flooding) of any timber, the permittee shall apply for and obtain a licence to cut timber from the District Manager and the amount of stumpage, royalty and (or) compensation payable to the Crown in respect of trees, including merchantable or young growth, cut, removed, damaged, or destroyed by the permittee, shall be the sum or sums fixed by the Forest Service of the Province of British Columbia.

(d) This permit is appurtenant to the land, mine or undertaking to the which the aforesaid water licence is appurtenant.

(e) This permit shall become void if the water licence with respect to which the permit is issued should terminate, be abandoned or cancelled, or amended so as to render this permit unnecessary.

(f) This permit is issued and accepted on the understanding that the permittee shall indemnify and save harmless the Government of the Province of British Columbia for all loss, damage to works, cost or expense suffered by the permittee by reason of the Crown Land or any portion thereof being submerged or damaged by erosion or otherwise affected by flooding.

(g) The holder of this permit shall not be entitled to compensation if the Crown grants permits to other persons to occupy the land affected by this permit.

(h) In the event of a dispute at any time with respect to the area or boundaries of the land affected by this permit, the holder shall, at his own expense, have the said land surveyed by a duly qualified surveyor.

(i) The annual rental for this permit is $8.00, which is subject to review and revision at any time at the discretion of the Crown.

(j) This permit replaces Permit No. 9194 in part.

(k) This permit is subject to the provisions of the Navigable Waters Protection Act.

M. G. Bancha

A.D. Zackodnik, P.Eng.
Regional Water Manager
duly authorized designate of
the Ministry of Environment,
Lands and Parks

Date Issued: MAY 25 1992

File No. 0001928

Permit No. 20187

Province of British Columbia

Ministry of Environment

PERMIT UNDER THE WATER ACT AUTHORIZING THE OCCUPATION OF CROWN LAND

The holder of Conditional Water Licence 104081, whose licence authorizes the diversion and use of water from Okanagan Lake, is hereby authorized to occupy Crown Land by constructing, maintaining and operating thereon the works authorized under the said licence.

(a) The Crown Land which is authorized to be occupied under this permit is a portion of unsurveyed foreshore and land within Osoyoos Division of Yale District, the location of which is shown approximately on the plan attached to the said water licence.

(b) The approximate dimensions of the Crown Land authorized to be occupied under this permit are 400 feet (122.0 meters) in length and 15 feet (4.6 meters) in width, having an area of .14 acre (0.6 hectares).

(c) The permittee may cut and remove from the said Crown Land any timber necessary to permit construction and maintenance of the said works. Prior to the cutting, destruction of any timber, the permittee shall apply for and obtain a licence to cut timber from the District Manager and the amount of stumpage, royalty and (or) compensation payable to the Crown in respect of trees, including merchantable or young growth, cut, removed, damaged, or destroyed by the permittee, shall be the sum or sums fixed by the Forest Service of the Province of British Columbia.

(d) This permit is appurtenant to the land, mine or undertaking to the which the aforesaid water licence is appurtenant.

(e) This permit shall become void if the water licence with respect to which the permit is issued should terminate, be abandoned or cancelled, or amended so as to render this permit unnecessary.

(f) This permit is issued and accepted on the understanding that the permittee shall indemnify and save harmless the Government of the Province of British Columbia for all loss, damage to works, cost or expense suffered by the permittee by reason of the Crown Land or any portion thereof being submerged or damaged by erosion or otherwise affected by flooding.

(g) The holder of this permit shall not be entitled to compensation if the Crown grants permits to other persons to occupy the land affected by this permit.

(h) In the event of a dispute at any time with respect to the area or boundaries of the land affected by this permit, the holder shall, at his own expense, have the said land surveyed by a duly qualified surveyor.

(i) The annual rental for this permit is $8.00, which is subject to review and revision at any time at the discretion of the Crown.

(j) This permit replaces Permit No. 9194 in part.

(k) This permit is subject to the provisions of the Navigable Waters Protection Act.

M. A. Bouchard

A.D. Zackodnik, P.Eng.
Regional Water Manager
duly authorized designate of
the Ministry of Environment,
Lands and Parks

Date Issued: MAY 25 1992

File No. 0270855

Permit No. 20184

APPENDIX D

Permit to Operate

Issued by Ministry of Health

Province of British Columbia

Ministry of Health and Ministry Responsible for Seniors

PERMIT TO OPERATE

A Drinking Water System With 15 to 300 Connections

Premises Number : 0511501
Name of Premises : SAGE MESA WATER & UTILITY
Address : SAGE MESA SUBDIVISION
: PENTICTON, B.C.

Purveyor : DEPUTY COMPTROLLER WATER RIGHTS

September 1, 1994
Effective Date

John C. Beaupré
Public Health Inspector

This permit must be displayed in a conspicuous place and is nontransferable.

Place Decal Here

HLTH 148 92/04

APPENDIX E

Water Utility Act
Water Tariff No. 5
Rates and Rules

Sage Mesa Water and Public Service Co. Ltd.
June 01, 1998

WATER UTILITY ACT

WATER TARIFF NO. 5

RATES AND RULES
For
WATER SERVICE
Near

Penticton, B.C.

By

Sage Mesa Water & Public Service Co. Ltd.

c/o Kemp, Harvey Lister
445 Ellis Street. Penticton. B.C. V2A 4M1

Contact Person

This Tariff is available for public inspection at:

445 Ellis Street. Penticton. B.C.

Accepted for Filing by the
Comptroller of Water Rights

Effective: June 1, 1998

Secretary to the Comptroller

02.09.98

Definitions

In this tariff the following definitions shall apply:

(a) "Utility" means *Sage Mesa Water & Public Service Co. Ltd.*

(b) "Rates" shall be the amount to be paid by any customer for the quantity of water supplied to him by or for the service to his premises for a stated period of time.

(c) "Service" shall include:

(1) The supply of water to the customer.

(2) The plant, equipment, apparatus, appliances, property and facilities employed by or in connection with the utility in providing the supply of water to the property line of the premises.

(d) "Domestic Service" means in-house use plus lawn & garden sprinkling to a maximum area of 1/10 of an acre.

(e) "Premises" means land and buildings therein.

(f) "Authorized Premises" means premises which are entitled to, and authorized for, service in accordance with the Certificate of Public Convenience and Necessity of the Utility.

(g) "Eligible Premises" means premises which may reasonably qualify as authorized premises, and includes existing premises peripheral to the Utility's authorized service area and premises within the boundaries of the Utility's authorized service area requiring additional service connections as a result of re-subdivision and/or rezoning of existing authorized premises or any other change in land use, but does not include premises created by any other proposed land subdivisions.

(Note: Where no zoning regulations were in effect at the time of the issuance of the C.P.C.N. it is assumed that the properties authorized for service are for single family use.

(h) "Customer" means any person who is the owner or lessee of an authorized premises whose application for service has been accepted by the utility, or any person who is actually receiving service supplied by the Utility.

(i) "Unit" means a unit of accommodation occupied separately or to be occupied separately by an owner or lessee and, which either separately or jointly with other units, receives service from a connection to the Utility's waterworks and, without restricting the generality of the foregoing, includes the separate units of accommodation in all dwellings.

(j) "Comptroller" means the Comptroller of Water Rights, Water Utility Act, Province of British Columbia.

Rules and Regulations

1. Application for Service

All applications for water service shall be made in writing by the owner or lessee of the premises to which the application refers, or by the owner's duly authorized agent. All applications for service shall state:

(a) the purpose(s) for which the service is to be used (i.e. domestic, commercial, irrigation, etc.);

(b) the size (diameter) of the Utility's pipe through which water will be supplied to the premises;

(c) the legal description of the premises;

(d) the number of units within the service connection;

(e) the location of the unit or units to be served.

Additional applications for service shall be made for all extensions of service to additional units and for additional purposes.

2. Charges for New Service

Charges for new service are intended to recover the Utility's costs in responding to the request. The nature of the request will determine the appropriate charges as follows:

(a) At the time an application is made for service to premises which had not previously been connected for service, the applicable charge shown in schedule "A" and/or "B" of this tariff shall be paid by the applicant.

(b) A turn-on fee of $50.00 shall be applicable when:

(i) a turn-on of a valve at an existing curb-stop is made at a date after the service connection was installed;

(ii) a customer becomes re-connected after service has been shut-off at the request of the customer, for non-payment of rates, or for violation of these rules and regulations.

(c) There is no charge for service shut-off.

(d) At the time an application for service is made by a new customer, an administration charge of $25.00 shall apply. This charge is not only applicable for a new connection, but also when a new customer, either owner or lessee of the property, commences receiving service to an existing authorized premises.

3. Billing and Payment

All bills are issued quarterly and are due and payable within ten (10) days of the date of issue except availability charges which are billed annually and commercial units which are billed monthly. Flat rates are billed in advance of service including the base rate of the upper area units and commercial units. For metered rates, excess consumption is billed in arrears.

If a cheque is returned by the customer's financial institution an administration fee of $25 will be charged.

4. Service Shut-Off due to Non-Payment

When an account becomes one month overdue service may be shut off upon 15 days' written notice. A notice mailed to the last known postal address of the customer shall be deemed good and sufficient. A collection charge of $30 shall be paid each time a Utility representative attends a customer's premises to disconnect service, following the issuance of a shut-off notice but, on attending, the customer pays the representative the full amount due.

Service will not be turned on until all outstanding charges against the service have been paid.

5. Discontinuance of Service

(a) Customers must give at least two working days' notice in writing at the office of the Utility when requesting discontinuance of service and shall be liable for payment for all service until such service has been discontinued.

(b) Any customer who desires to discontinue the use of water for any of the purposes stated in his application for service shall give notice of his intention, in writing, at the office of the Utility, and shall further show that any fittings used for the supply of water for such purposes have been disconnected.

(c) The Utility may discontinue service to any customer who violates the terms and conditions contained in this tariff. In the event of further contravention of the tariff, the Utility may detach the service connection from the customer's premises and, upon re-application for service, the customer shall be liable to pay the Utility's cost of performing the said detachment and re-connection in addition to other applicable rates and charges.

6. Access to Premises

The Utility shall have the right of access to the customer's premises at all reasonable times for the purposes of making connections or disconnections, reading meters, inspecting pipes and appurtenances, or checking on the use or waste of water.

7. Interruption of Service

The Utility intends to maintain at all times an adequate and continuous supply of water at suitable pressures but accepts no liability for interruptions due to circumstances beyond its control. However, for the interruptions in excess of 48 hours, a proportionate rebate will be allowed to customers served on flat rates.

8. Restriction of Use of Water

The Utility may restrict or prohibit the use of water for gardening, sprinkling, air conditioning, the filling of swimming pools, or other purposes when, in its opinion, such action is necessary to conserve the water supply or to maintain water pressure. A customer who contravenes water use restrictions is subject to one warning notice per year. A notice delivered to the customer's premises shall be deemed good and sufficient. For each subsequent contravention during the year, a $50 fine is applicable.

9. Misuse of Water Supply

No customer shall sell or dispose of any water or permit same to be carried away, or use water or allow it to be used in premises, or for purposes other than those stated in the customer's application for service.

10. Multiple Dwellings

In the case of apartment houses, duplexes or houses containing one or more suites, each such accommodation, whether or not self contained, shall be considered as a separate unit and the customer shall be charged the appropriate rate.

11. Water Meters

The Utility may, if in its opinion an undue amount of water is used at any time by any customer being served under a flat rate, install a water meter and thereafter charge the customer in accordance with the meter rates included in this tariff. All such meters shall remain the property of the Utility.

12. Work to be done by the Utility

No person who is not an agent or employee of the Utility shall make any connections with or alterations to or tamper with any of the Utility's waterworks, including any water meter belonging to the Utility, nor turn on or off any value or curb stop of the Utility, without authorization by the Utility in writing.

13. Minimum Size of Services

The minimum size of pipe used to serve any one premises shall be 3/4" (19mm) nominal diameter. The type and diameter of pipe used on the customer's premises should be selected with due consideration of pressure losses from friction.

14. Minimum Earth Cover Over Services

All services on the customer's premises shall be buried below the maximum depth of frost penetration but in any event at a minimum depth of five feet below the surface of the ground.

15. Ownership of Service

All water service pipes and fittings carrying water from the main to the premises property line shall be the property of the Utility.

16. Stop Cock

The customer shall provide a shut-off valve (stop cock) inside each of the customer's buildings in which water is used, for the use of the customer in case of leaky or defective pipes or fixtures, or in case the premises is vacated.

17. Customer's Service Pipes

Service connection materials installed on the customer's premises shall be rated by the manufacturer to sustain a minimum working pressure of 160 psi (1100 kilopascals). No service pipe or fitting shall be covered until they have been inspected and approved by the Utility.

18. Dangerous Cross-Connections

The customer shall not permit the plumbing on his premises to be connected to any source of water supply other than the Utility's, or to any potential source of contamination, without first obtaining the Utility's permission in writing. Any back-flow preventers deemed necessary by the Utility to prevent the entry of contaminants shall be installed at the customer's expense.

19. Condition of Customer's Pipes and Fixtures

All customers at their own risk and expense shall keep their pipes, stop cocks and other fixtures in good working order and shall protect them from frost and other damage. The Utility shall notify the customer of any leaky pipes and fixtures that are evident on the premises. If the necessary repairs are not made within two (2) working days after such notice has been given, or when the condition of the pipes or fixtures is such as to cause serious waste of water or damage to property, then without further notice the Utility may shut off the water supply. The water shall not be turned on again until such repairs have been made to the satisfaction of the Utility, and the charges paid as provided by clause 2 and 5(c) of this tariff. No person whose water supply is shut off pursuant to this section shall have any claim against the Utility for discontinuance of supply.

20. Notice of Service Shut-off

The Utility shall have the right at all times to shut the water supply off temporarily to any premises in order to make repairs, replacements, alterations and extensions to the Utility's waterworks as shall, in the opinion of the Utility, be deemed necessary. Whenever possible the Utility will give reasonable advance notice of shut-off, and, in all cases where the Utility expects service to be interrupted for 24 hours or more, the Utility shall give advance notice to its customers.

Schedule "B" - Contribution in Aid of Future Construction

The charges shown below apply only to eligible premises (see page 1).

Where as a result of eligible premises becoming qualified as authorized premises a greater number of units require or may require service from the utility, thus utilizing waterworks capacity presently or in the future, then, upon application for a service connection, in addition to the connection charge and any main extension costs, the charge shown below shall be paid.

For each unit qualifying as authorized premises	$ 2,000.00

Note: Moneys collected are to be deposited to the utility's Deferred Capacity Trust Fund and may only be released at the discretion of the Comptroller of Water Rights.

Schedule "G" - Availability of Service Charge

Applicability: To owners of lots with Rent Charge Agreements registered on title.

Availability: To all applicable lots not receiving water service.

Rate: $164.00 per annum

Note: 1. Billing is in accordance with page 3, section 3 of tariff.

2. A 10% discount will apply if payment is received within 21 days of date of billing.

APPENDIX F

Financial Statements – November 30th, 1998

prepared by Kemp Harvey Lister Inc.

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.

FINANCIAL STATEMENTS

NOVEMBER 30, 1998

STRENGTH IN NUMBERS

Kemp Harvey Lister Inc.

Certified General Accountants

Penticton, Grand Forks, Kelowna, North Vancouver, Burnaby, Richmond

Kemp Harvey Lister Inc.
Certified General Accountants

TRENGTH IN NUMBERS

Tom Kemp, FCGA
Bob Harvey, BSc, CGA
Colleen Lister, CGA
Edith Schwarz, CGA

REVIEW ENGAGEMENT REPORT

To the shareholders of Sage Mesa Water & Public Service Co. Ltd.

We have reviewed the balance sheet of Sage Mesa Water & Public Service Co. Ltd. as at November 30, 1998 and the statements of income and changes in cash resources for the year then ended. Our review was made in accordance with generally accepted standards for review engagements and accordingly consisted primarily of enquiry, analytical procedures and discussion related to information supplied to us by the company.

A review does not constitute an audit and consequently we do not express an audit opinion on these financial statements.

Based on our review, nothing has come to our attention that causes us to believe that these financial statements are not, in all material respects, in accordance with generally accepted accounting principles.

Kemp Harvey Lister Inc.

Penticton, BC
January 19, 1999

CERTIFIED GENERAL ACCOUNTANTS

STATEMENT A

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
BALANCE SHEET
NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	1998	1997	1996
ASSETS			
CURRENT ASSETS			
Cash	$ 14,065	$ 23,264	$ 18,324
Accounts receivable and prepaids - Note 2	9,856	9,342	3,805
	23,921	32,606	22,629
RESERVE FUNDS	32,339	93,506	75,522
WATER SYSTEM - Note 1	1	1	1
	$ 56,261	$ 126,113	$ 98,152
LIABILITIES			
CURRENT LIABILITIES			
Accounts payable - Note 4	$ 7,646	$ 12,567	$ 5,103
Due to reserve funds	2,946	-	-
	10,592	12,567	5,103
RESERVES			
Maintenance reserve - Schedule I	18,800	18,800	18,800
Upper area replacement reserve - Schedule II	15,801	26,680	19,194
Lower area replacement reserve - Schedule II	(12,754)	32,880	24,690
Deferred capacity reserve - Schedule IV	10,492	15,146	12,838
	32,339	93,506	75,522
	42,931	106,073	80,625
SHAREHOLDER EQUITY			
SHARE CAPITAL - Note 5	2	2	2
RETAINED EARNINGS			
Beginning balances	20,038	17,525	12,239
Net income (loss) - Statement B	(6,710)	2,513	5,286
Ending balances	13,328	20,038	17,525
	13,330	20,040	17,527
	$ 56,261	$ 126,113	$ 98,152

APPROVED ON BEHALF OF THE BOARD

_____

_____

See accompanying notes to financial statements

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
STATEMENT OF INCOME
FOR THE YEAR ENDED NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	1998	1997	1996
INCOME			
Flat rate water	$ 74,418	$ 68,245	$ 64,795
Metered water	8,290	4,768	6,223
Connections	1,747	1,400	1,118
Meter installations	2,654	1,427	495
Non-user fees	7,470	8,725	4,740
	94,579	84,565	77,371
EXPENSES			
Accounting and legal	1,210	1,492	1,351
Bad debts	1,116	-	-
Bank charges and interest	8	10	39
Billing and office	12,860	11,881	10,659
Contract labour	10,632	10,632	10,632
Insurance	1,800	1,000	1,000
Lawsuit costs	-	-	12,809
Licence and dues	1,135	1,232	1,629
Meter relocations	-	-	157
Power	18,858	11,739	14,321
Repairs and maintenance	40,751	28,400	3,961
Replacement reserve provision	15,845	14,715	14,130
Telephone	1,873	1,130	385
Water treatment supplies	2,870	1,691	1,679
Workers' compensation	1,249	610	541
	110,207	84,532	73,293
	(15,628)	33	4,078
Miscellaneous income- Note 6	6,925	3,195	2,761
	(8,703)	3,228	6,839
INCOME TAX (RECOVERED)	(1,993)	715	1,553
NET INCOME (LOSS)	$ (6,710)	$ 2,513	$ 5,286

See accompanying notes to financial statements

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
NOTES TO THE FINANCIAL STATEMENTS
NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

Note 1 Significant Accounting Policies

a) Fund accounting
The company uses the fund method of accounting for reporting reserve fund transactions.

b) Capital assets
Capital assets are written off in the year acquired. The original purchase of capital assets was recorded in the accounts at a nominal value of $1. Provision for replacement of assets has been charged at rates determined by the Utilities' filed tariff as set out in Note 3.

c) Water system
The water system was created to provide water service to residential and commercial properties within the boundaries of Sage Mesa, Husula Highlands and Westbench Estates "authorized service area". The system for Sage Mesa was created in 1965 and 1971 with additional service provided to the golf course in 1974. The system was expanded in 1979 and 1982 to encompass the Husula Highlands and Westbench Estates area. Sage Mesa Water & Public Service Co. Ltd. is a private company being managed by the Comptroller of Water Rights, Water Utility Act of the Province of British Columbia pursuant to section 97, Utilities Commission Act since June 28, 1990.

Note 2 Accounts Receivable and Prepaids

	1998	1997	1996
Accounts receivable	$ 6,063	$ 7,542	$ 2,805
Income tax receivable	1,993	-	-
Prepaid expenses	1,800	1,800	1,000
	$ 9,856	$ 9,342	$ 3,805

Note 3 Reserves

Maintenance Reserve Trust Fund -	$ 18,800

This fund is a restricted asset subject to control of the Comptroller of Water Rights, Water Utility Act of the Province of British Columbia. Interest earnings may be withdrawn from the fund to help defray operating costs of the Utility.

Replacement Reserve Trust Funds - Upper	$ 15,801
Replacement Reserve Trust Funds - Lower	$ (12,754)

Represents a replacement reserve established by way of separate funds for both the upper and lower area water users. The funds are allocated from an assessment of $5.00 and $8.50 per month per customer for upper and lower area users respectively. The intention is to provide reserve funds to keep the utility's property in a "state of efficiency". The changes to this reserve are set out in detail on schedules II and III. The funds are comprised of bank accounts which are restricted assets subject to control of the Comptroller of Water Rights, Water Utility Act of the Province of British Columbia. Interest earnings must be reinvested in the fund.

..continued..

Note 3 Reserves - continued

The negative balance in the replacement reserve fund for the lower portion is the result of capital expenditures made in the current year exceeding the amount set aside for the expenditures.

Deferred Capacity Trust Fund	$ 10,492

This fund represents contributions from developers for aid to future construction of supply works for additional authorized service area lots. Contributions of $12,000 were made during 1991 for a six lot extension. These funds are restricted assets subject to control of the Comptroller of Water Rights, Water Utility Act of the Province of British Columbia. Interest earnings must be reinvested in the fund.

Note 4 Accounts Payable

	1998	1997	1996
Accounts payable	$ 7,646	$ 11,852	$ 3,550
Income tax payable	-	715	1,553
	$ 7,646	$ 12,567	$ 5,103

Note 5 Share Capital

The authorized share capital of the company consists of 10,000 preferred shares of $10 par value, and 10,000 common shares with no par value. The issued capital of the company is 2 common shares.

Note 6 Other income

	1998	1997	1996
Goods and Services Tax rebates	$ 6,276	$ 2,519	$ 1,621
Interest	649	676	1,140
	$ 6,925	$ 3,195	$ 2,761

Note 7 Uncertainty due to the Year 2000 issue

The Year 2000 Issue arises because many computerized systems use two digits rather than four to identify a year. Date-sensitive systems may recognize the year 2000 as 1900 or some other date, resulting in errors when information using year 2000 dates is processed. In addition, similar problems may arise in some systems which use certain data in 1999 to represent something other than a date. The effects of the Year 2000 Issue may be experienced before, on, or after January 1, 2000, and, if not addressed, the impact on operations and financial reporting may range from minor errors to significant systems failures which could affect an entity's ability to conduct normal business operations. It is not possible to be certain that all aspects of the Year 2000 Issue affecting the entity, including those related to the efforts of customers, suppliers, or other third parties, will be fully resolved.

continued

SCHEDULE I

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
SCHEDULE OF MAINTENANCE RESERVE
FOR THE YEAR ENDED NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	1998	1997	1996
BALANCE, beginning of year	$ 18,800	$ 18,800	$ 18,800
ADDITIONS			
Interest earned	435	408	725
DELETIONS			
Interest earnings contributed to general fund	(435)	(408)	(725)
BALANCE, end of year	$ 18,800	$ 18,800	$ 18,800
REPRESENTED BY:			
Cash in bank	$ 6,200	$ 18,800	$ 18,800
Due from Lower Replacement Reserve	12,600	-	-
	$ 18,800	$ 18,800	$ 18,800

SCHEDULE II

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
SCHEDULE OF UPPER AREA REPLACEMENT RESERVE
FOR THE YEAR ENDED NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	1998	1997	1996
BALANCE, beginning of year	$ 26,680	$ 19,194	$ 12,603
ADDITIONS			
Replacement reserve assessment - Note 4	8,195	7,065	6,480
Interest earned	665	421	111
TOTAL ADDITIONS	8,860	7,486	6,591
DELETIONS			
Replace main line	14,669	-	-
Fabricate inlet pipe	4,048	-	-
Replace reservoir top	1,022	-	-
TOTAL DELETIONS	19,739	-	-
BALANCE, end of year	$ 15,801	$ 26,680	$ 19,194
REPRESENTED BY:			
Cash in bank	$ 12,676	$ 26,680	$ 19,194
Due from General fund	3,125	-	-
	$ 15,801	$ 26,680	$ 19,194

SCHEDULE III

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
SCHEDULE OF LOWER AREA REPLACEMENT RESERVE
FOR THE YEAR ENDED NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	1998	1997	1996
BALANCE, beginning of year	$ 32,880	$ 24,690	$ 16,888
ADDITIONS			
Replacement reserve assessment - Note 4	7,650	7,650	7,650
Interest earned	642	540	152
TOTAL ADDITIONS	8,292	8,190	7,802
DELETIONS			
Hookup to Verano Place	31,429	-	-
Replace main line	14,669	-	-
Replace service connections	4,890	-	-
Replace curb stops	1,121	-	-
Replace gate valve	1,817	-	-
TOTAL DELETIONS	53,926	-	-
BALANCE, end of year	$ (12,754)	$ 32,880	$ 24,690
REPRESENTED BY:			
Cash in bank	$ 25	$ 32,880	$ 24,690
Due to Maintenance Reserve	(12,600)	-	-
Due to General Fund	(179)	-	-
	$ (12,754)	$ 32,880	$ 24,690

SCHEDULE IV

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
SCHEDULE OF DEFERRED CAPACITY RESERVE
FOR THE YEAR ENDED NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	1998	1997	1996
BALANCE, beginning of year	$ 15,146	$ 12,838	$ 12,545
ADDITIONS			
Interest earned	415	308	293
Contribution from Mr. Grasswick	-	2,000	-
TOTAL ADDITIONS	415	2,308	293
DELETIONS			
Replace main line	5,069	-	-
TOTAL DELETIONS	5,069	-	-
BALANCE, end of year	$ 10,492	$ 15,146	$ 12,838
REPRESENTED BY:			
Cash in bank	$ 10,492	$ 15,146	$ 12,838

SAGE MESA WATER & PUBLIC SERVICE CO. LTD.
SCHEDULE OF INCOME BY AREA
FOR THE YEAR ENDED NOVEMBER 30, 1998
Unaudited - See Review Engagement Report

	Lower area	Upper area	1998 Total	1997 Total
INCOME				
Flat rate water	$ 26,686	$ 47,732	$ 74,418	$ 68,245
Metered water	2,378	5,912	8,290	4,768
Connections	157	1,590	1,747	1,400
Meter installations	-	2,654	2,654	1,427
Non-user fees	-	7,470	7,470	8,725
	29,221	65,358	94,579	84,565
EXPENSES				
Accounting and legal	388	822	1,210	1,492
Bad debts	1,116	-	1,116	-
Bank charges and interest	2	6	8	10
Billing and office	4,516	8,344	12,860	11,881
Contract labour	3,610	7,022	10,632	10,632
Insurance	622	1,178	1,800	1,000
Licence and dues	373	762	1,135	1,232
Power	3,228	15,630	18,858	11,739
Repairs and maintenance	16,043	24,708	40,751	28,400
Replacement reserve provision	7,650	8,195	15,845	14,715
Telephone	630	1,243	1,873	1,130
Water treatment supplies	971	1,899	2,870	1,691
Workers' compensation	407	842	1,249	610
	39,556	70,651	110,207	84,532
	(10,335)	(5,293)	(15,628)	33
OTHER INCOME - Note 7	1,860	5,065	6,925	3,195
	(8,475)	(228)	(8,703)	3,228
INCOME TAX (BENEFIT)	(639)	(1,354)	(1,993)	715
NET INCOME	$ (7,836)	$ 1,126	$ (6,710)	$ 2,513

APPENDIX G

- *Berge and Company Letter dated December 30th, 1996*
- *Burke Frame Letter dated June 01, 1998*
- *Deputy Controller of Water Rights Letter dated June 18th, 1998*

BERGE & COMPANY

BARRISTERS & SOLICITORS

HOWARD R. BERGE
J. DOUGLAS FLANNIGAN
R. JAMES HERPERGER
BRADLEY C. CRONQUIST
JEFFREY F. MURRAY
SONYA D. WHITE
JOHN M. HANNAH
RODNEY C. PACHOLZUK
JEFFREY N. THOM (Also of Alta. Bar)*
WESLEY C. SHIELDS
CLAY B. WILLIAMS
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#101 - 346 LAWRENCE AVENUE
KELOWNA, BRITISH COLUMBIA
V1Y 6L4

TELEPHONE: (250) 762-4222
TELEFAX: (250) 762-8616

*Denotes A Law Corporation

REPLY TO: Howard R. Berge

OUR FILE NO.: 48789

December 30, 1996

VIA FAX - (250) 953-5124

BC Lands and Water Management
Water Resources Branch
3rd Floor, 765 Broughton Street
Victoria, B.C.
V8V 1X4

COPY

Attention: **J.E. Farrell,**
Comptroller of Water Rights

Dear Sir:

Re: Sage Mesa Water & Public Service Co. Ltd.

Further to your letter of December 16, 1996, we have reviewed the contents of same with our client and it appears the only outstanding matter is the background relating to Mr. Chapman's request that he, his wife and their companies be relieved from further capital costs of supply of water to their personal and their companies' developments. The following is the information received from our client pertinent to the matter. It is believed some of this information was not readily available to the engineer who prepared the report dated November 1991.

1. The undeveloped portion of Block B DL2497 ODYD, along with water and development rights for a further 61 lots, was purchased by Mr. Chapman from the original owner in 1968 and subsequently transferred to ARA Holdings Ltd. ("ARA"). This consisted of 123 lots in accordance with the original subdivision design by Alan R. Colby, P. Eng., in 1962, less the Phase I development of 62 lots on Plan 13181, registered in 1963. The original developer, Mr. Adam Baumann, has confirmed to you by letter dated May 21, 1991, that the original water system was designed by Mr. Colby to service both phases of this development.

2. Twelve Phase II lots were developed by ARA and were registered in February 1970 on Plan 20001, leaving the balance of 49 lots undeveloped.

3. A proposal for a further 21 Phase II lots submitted in 1973 was blocked by the Runka geotechnical report. Release of the property from the Agricultural Land Reserve was approved in 1974.

4. In 1970 Mr. Chapman and Mr. Colby leased a parcel of land from the Crown adjacent to the lower level reservoir with the intention of developing a public golf course to utilize some of the excess water capacity. Mr. Colby sold his rights to Mr. Chapman who proceeded to develop a 9-hole Par 3 golf course in 1973. A pressure irrigation system and pump were installed in the existing control station at the reservoir at Mr. Chapman's cost. At this time, a water licence was applied for and the licence was issued by the Water Rights branch for 75 acre feet. (The engineer's recommendation was to restrict irrigation to night-watering only in order to maintain full capacity residential use. This was implemented and continues to the present day. The land itself was subsequently purchased from the Crown.)

5. The engineer, Mr. Colby, recommended that if geotechnical constraints prohibited or reduced the number of lots allowed on the remainder of Block B (see paragraph 2 above) water could be drawn from this reservoir to service an equivalent number of lots around the golf course. It was in this connection that Mr. Colby subsequently recommended our client contribute the cost of increasing the pipe size from 6" to 8" diameter on the lower section of the proposed new Husula Highlands Development pipeline (through the then existing Pine Hills Golf Course property).

6. In late 1989, when geotechnical constraints clearly prevented further subdivision in Block B outside Mr. Runka's "Green Zone", ARA submitted a proposal for an 8 lot subdivision within the "Green Zone" to the Ministry of Highways. In May 1990, application was also made to the Comptroller for approval to extend the water pipeline to this development. Approval was received from the Comptroller, conditional upon ARA paying for the extension costs and receiving Highway's tentative approval. In answer to the question on this point, in your November 27, 1996 letter, the extension would be ARA's responsibility, as stated in the utility's letter to Mr. Wigmore dated June 8, 1990. No additional capital costs would be required as the capacity was available and approved for the Phase II lots in 1963. This was reconfirmed by Mr. Baumann in 1991 (see paragraph 1 above).

7. Irrigation consumption at Pine Hills Golf Course never utilized more than a fraction of its authorized license demand of 75 acre feet. In spite of wide monthly variations, annual consumption averages less than 3,500,000 Imperial gals, approximately 1/6th of the 20,350,000 Imperial gals licence allowance. (See also comment in 1991 Engineer's draft report Page 2.3/2.4). Accordingly, when ARA commenced the new golf course on Sage Mesa, application was made for a "change of works", to transfer part of the water

allotment from Pine Hills to Sage Mesa Golf Course. This was approved by Water Rights by letter dated May 25, 1992. For your information, the Sage Mesa Course is presently under redevelopment to a 9-hole course.

8. Water provisions for the existing Sage Mesa residential development have never been fully utilized because:

(a) There are 57 undeveloped lots for which water rights have been approved. These consist of 8 lots in Phase I (Plan 13181) and 49 lots not yet subdivided (in Phase II, Block B). At least 5 of the lots on Plan 13181 can never be developed for housing due to geotechnical constraints imposed by the Regional District.

(b) Residents' awareness of delicate soil conditions in lower area and consequences of over-irrigation are major factors in water consumption being below expectations; and

(c) The average daily water consumption per lot in 1990 was 349 Imperial gals, according to the Engineer's draft report dated November 1991 (Page 2.2). However, it is not clear how the Engineer arrived at this figure from the consumption figures shown in his report. It is believed that the Utility's records for 1989, which show an average daily water consumption per lot of 294 Imperial gals, provide the most reliable usage figure for the existing Sage Mesa residential development. This should be compared with the original design figure of 500 Imperial gals per lot per day, indicating an established usage approximating only 60% of the designed capacity.

The above has resulted in excess water capacity in the lower area which has already been approved for use within that area. This excess capacity should therefore be reserved for use in the lower area and approvals for use should be granted without any further capital costs.

When you have had an opportunity to review the foregoing, we would appreciate your comments at your earliest convenience.

Yours truly,

BERGE & COMPANY
Per:

HOWARD R. BERGE

HRB/plb
cc. Richard Chapman

BURKE FRAME
LITIGATION LAWYERS*

744 Shuswap Ave.
Box 499, Chase BC
V0E 1M0

Telephone: (250) 679-4464
Facsimile: (250) 679-4478
*Denotes Law Corporation
OUR FILE #: 01-01-01

MINISTRY OF ENVIRONMENT
JUN 05 1998
ENVIRONMENT & RESOURCE MANAGEMENT DEPARTMENT

June 1, 1998

Ministry of Environment, Lands & Parks
765 Broughton Street
Victoria, BC
V8V 1X5

Attention: Ingrid Taggart

Dear Madam:

Re: Application for Water Service by ARA Holdings Ltd. for Lot B, DL 2497

We are solicitors for ARA Holdings Ltd. The letter addressed to Richard Chapman concerning the provision of water to the subdivision of ARA Holdings has been referred to me.

You have imposed as a condition a precedent to processing our client's application for water service, the obtaining of preliminary layout approval from the Ministry of Transportation and Highways. Please note that the Ministry of Transportation and Highways is not the approving authority for subdivisions. Our client does not propose to apply for preliminary approval from the Ministry of Transportation and Highways. We urge you to consult legal advice before imposing as condition of considering our client's application, a requirement that is unlawful and does not need to be met by our client.

You referred to the need for an amendment to the utilities' certificate of public convenience and necessity. In our view, no such amendment is required because the property for which the application for services was made is already within the utilities water service area. In these circumstances, perhaps you can explain why you consider an amendment to the existing certificate to be necessary.

We again remind you of the urgency with respect to obtaining water service for this development. The Regional District is presently in the process of adopting a new rural land use bylaw which would have serious consequences to our proposed development. For this reason we are attempting to be in a position to apply for final approval under the *Land Title Act* within the next several weeks.

We look forward from hearing from you.

Yours truly,

BURKE FRAME
Per:

Reinhard Burke
/dm

cc: client

F:\DATA\MAIN\June1.WPD sec2

RECEIVED
UTILITY REGULATION SECTION
JUN - 5 1998
REF.
ACK.
ANS.

BRITISH COLUMBIA

June 18, 1998

File: 0321081

Burke Frame
Box 499
Chase, B.C.
V0E 1M0

via fax no. (250) 679-4478

Attention: Reinhard Burke

Re: Sage Mesa Water & Public Service Co. Ltd.
- ARA Holdings Ltd. - application for service

I refer to your letter dated June 1, 1998 regarding the extension of water service to a 7-lot subdivision of Lot B proposed by ARA Holdings Ltd. Your letter raises a number of issues that require clarification.

You state that the Ministry of Transportation and Highways is not the approving authority for subdivisions, and that your client does not propose to apply for preliminary approval from that ministry. Your client did initially apply to the Ministry of Transportation and Highways for subdivision approval, however, the application was not given approval. Please explain to which authority you are applying for final approval and what that authority's requirements are for subdivision approval or strata development approval, as the case may be.

As provided by Section 45 of the *Utilities Commission Act*, the Comptroller of Water Rights must be satisfied that public convenience, necessity and interest require the granting of an amendment to a Certificate of Public Convenience and Necessity or an approval of an extension of service. Normally an application by a utility includes a copy of the preliminary layout approval (PLA) from the Ministry of Transportation and Highways. This is a component of the submission because it shows that the proposed land development has received conceptual approval, which may be relevant to the issue of public convenience, necessity and interest relative to the extension of water service to the development. The PLA also shows the conditions that are required to be met in order for the subdivision to be registered. These conditions may have an effect on the design of the water system or extension and the conditions of providing service.

In the case of your client's proposed development, it will be necessary for your client to provide information that would normally be obtained from the preliminary layout approval. I will write to him directly for the specific information required.

Ministry of Environment, Lands and Parks | Water Management Branch | Mailing Address: PO Box 9340 STN PROV GOVT VICTORIA BC V8W 9M1 Telephone (250) 387-6341 | Location: 2975 Jutland Rd Victoria BC V8T 5J9

You state that an amendment to the utility's Certificate of Public Convenience and Necessity is not required because the property being developed is already within the utility's service area. Our records do not show this. Please provide the documentation that supports your contention.

Yours truly,

Ingrid Taggart

Ingrid E. Taggart,
Deputy Comptroller of Water Rights

cc: Lee Dodds, Ministry of
Transportation & Highways, Kamloops
✓ cc: Regional District of Okanagan Similkameen

Regional District of Okanagan-Similkameen

WEST BENCH/SAGE MESA AREA GEOLOGICAL HAZARDS REVIEW

PB 5847 0101

KLOHN LEONOFF

KLOHN LEONOFF

Our File: PB 5847 0101
WP 621

August 10, 1992

Regional District of Okanagan-Similkameen
101 Martin Street
Penticton, British Columbia
V2A 5J9

Andrew Swetlishoff

West Bench/Sage Mesa Geological Hazards Review

Dear Sir:

Enclosed are 20 copies of the final report "West Bench/Sage Mesa Geological Hazards Review". We request that all draft reports be destroyed or returned to Klohn Leonoff Ltd.

We have enjoyed being of service to the Regional District of Okanagan-Similkameen on this interesting project. If you have any questions regarding this report or related matters, we would be pleased to be of assistance.

Yours very truly,

KLOHN LEONOFF LTD.

H.R. (Rod) Smith, P.Eng.
Project Manager

HRS/dls

Klohn Leonoff Ltd., 10200 Shellbridge Way, Richmond, B.C., Canada V6X 2W7 • Telephone: (604) 273-0311 • Telex: 04-355520 • Fax: (604) 279-4300
Member, Consulting Engineers of British Columbia Member, Association of Consulting Engineers of Canada

Regional District of Okanagan-Similkameen

WEST BENCH/SAGE MESA AREA GEOLOGICAL HAZARDS REVIEW

PB 5847 0101

AUGUST 1992

KLOHN LEONOFF

August 10, 1992

SUMMARY

This report, prepared for the Regional District of Okanagan-Similkameen, is a review of the geological hazards of the West Bench/Sage Mesa area. The terms of reference were supplied by the Regional District in their call for proposal (October 1991).

West Bench/Sage Mesa is located to the northwest of Penticton. The area is generally composed of dry lacustrine silt bluffs which are bounded on the east by steep scarps down to Okanagan Lake and on the west by kettled outwash sands and gravels. The high steep bluffs is a location which provides a spectacular view of Penticton and Okanagan Valley and so is desirable for residential development. West Bench currently consists of 385 houses with a population of about 1,100 people and Sage Mesa currently consists of 73 houses with a population of about 225 people.

The silt bluffs of the study area were deposited into glacial Lake Penticton during retreat of the last phase of glaciation. When the lake level lowered to the current elevation, extensive silt erosion probably occurred, from surface slumping to large landslides and subsurface and surface erosion. The gravels west of the silt also had to drain as the lake level lowered which may have resulted in additional landslides and gully development.

Following deglaciation and lake level lowering, the geologic activity in the study area probably decreased significantly. However, there is evidence for an ongoing hazard of landslides, mass wasting, sinkholes (subsurface erosion) and gully erosion in the study area. These geological processes can be hazardous, and can cause loss of life and major property damage.

Twelve major landslides have been reported in the region. The majority of these slides occurred after irrigation began and before the use of sprinklers. The cause of these slides is therefore believed to be high groundwater pressures. Remnants of only one slide were identified in the West Bench Sage Mesa study area and that slide is very old. Under natural conditions, landslides are apparently rare in this area.

Development pressures led to a geotechnical study of the area in the mid-70s. A report entitled "Geological Hazards and Urban Development of the Silt Deposits in the Penticton Area" (Nyland and Miller, 1977) recommended restrictions in development by creating zones of development. A resurfacing of development pressures since the late 1980s led to this study for evaluation of possible further development.

This study indicates that the use of septic fields for house wastewater disposal significantly increases the groundwater levels in the silt bluffs and therefore significantly increases the probability of a landslide. Less significant is the increased groundwater from septic fields installed in the sands and gravels to the west of the silts. To reduce the risk associated with landslide hazard, we recommend that all further development be restricted within a set back distance from the bluff toe of 2.2 times the height of the silt bluff plus 10 m. In addition, we recommend that development be restricted a distance from the slope toe 1.8 times the height of the silt bluff plus 10 m for slide runout. We also recommend that no further development proceed in the remainder of the study area or in the catchment for the study area without suitable measures to control the increase of groundwater levels.

As a result of groundwater flow causing subsurface erosion, sinkholes have developed over a large portion of the study area. Sinkholes occur above large subsurface erosion pipes which carry water off site. Recent sinkhole development has apparently doubled compared to the average sinkhole development since glacial times. The air photo analyses carried out for this study indicates that all sinkholes occur within 40 m of another sinkhole or a bluff edge. To reduce the risk associated with subsurface erosion, a setback of 40 m from any past or existing sinkhole or gully edge is recommended. Development-induced trigger mechanisms such as broken pipes, leaking swimming pools and ornamental ponds, and uncontrolled concentration of precipitation run-off can increase the likelihood of sinkhole development.

Erosion in the gullies occur whenever there is an adequate supply of water for free flow. On application of even moderate quantities of water, subsurface erosion in the valley floor begins with piping and sinkhole development. Common sources of water include high precipitation or snowmelt, discharge of road runoff into a gully and discharge of groundwater from bedrock and gravel into the gullies. Continued gully erosion could lead to wider and deeper gullies further eroding the land suitable for development in the study area. Gully erosion is best controlled by collecting runoff from the site and transmitting the water to Okanagan Lake level and by reducing groundwater entering the gullies from the bedrock and sand and gravel units to the west.

Drawing D-1007 presents development zones based upon the above criteria for landslides, subsurface erosion and gully erosion. Also included is a matrix which suggests an administrative decision for types of development applications in each zone.

For some of the zones, development is recommended only with implementation of mitigative measures. The Regional District requires that such mitigative measures be practical, be enforceable at the time of construction and not require ongoing policing. Recommended measures meeting these criteria include:

- restriction of development in the study area and study area catchment to limit the quantity of water entering the silts and gullies;
- installation of septic sewers, storm sewers, road curbs and gutters and roof and driveway runoff collection to carry water to Okanagan Lake level;
- improvement of water system distribution and maintenance requirements;
- collection of groundwater from the sands and gravels downstream of Madeline Lake and use as irrigation or transport to Okanagan Lake level;
- restriction on construction of swimming pools and ornamental pools; and

- restriction on construction of swimming pools and ornamental pools; and

- distribution of information to the residents of West Bench and Sage Mesa regarding the potential hazards and associated risks along with methods for mitigating the potential trigger mechanisms.

TABLE OF CONTENTS

PAGE

SUMMARY i

1. INTRODUCTION 1

1.1 General 1

1.2 Scope of Work 1

1.3 Site Description 2

2. DATA ACQUISITION 4

2.1 Data and Report Review 4

2.1.1 General Review 4
2.1.2 Key Reports 5
2.1.3 Rationale of the Nyland and Miller Report 5

2.2 Air Photo Interpretation 7

2.2.1 General Air Photo Interpretation 7
2.2.2 Air Photo Observations 7

2.3 Field Investigations 8

2.3.1 Geology Mapping 8
2.3.2 Geophysics 9

2.4 Interviews 10

2.4.1 Discussions with Residents 10
2.4.2 Discussions with Agencies 11

3. GEOLOGY 12

3.1 Regional Geology 12

3.2 Land Form Development 14

3.2.1 Glacial Occupation 14
3.2.2 Glacial Retreat 14
3.2.3 Late Glacial 16
3.2.4 Postglacial 17
3.2.5 Current Environment 20

3.3 Engineering Parameters 25

3.3.1 General 25
3.3.2 Hydrogeology 26
3.3.3 Material Properties 27

TABLE OF CONTENTS

PAGE

4. HYDROLOGY 30
   4.1 General Water Balance 30
   4.2 Climate 31
   4.3 Madeline Lake Catchment 32
   4.4 Developed Area Water Balance 33
   4.5 Watershed Water Balance 34
5. SEISMICITY 36
6. HAZARD ASSESSMENT 38
   6.1 General 38
   6.2 Mass Wasting 39
      6.2.1 Description 39
      6.2.2 Triggering Mechanisms 41
      6.2.3 Prevailing Conditions 42
   6.3 Subsurface Erosion 44
      6.3.1 Description 44
      6.3.2 Triggering Mechanisms 45
      6.3.3 Prevailing Conditions 45
   6.4 Gully Erosion 48
      6.4.1 Description 48
      6.4.2 Triggering Mechanisms 48
      6.4.3 Prevailing Conditions 49
7. RISK ASSESSMENT 51
   7.1 General 51
   7.2 Mass Wasting 52
      7.2.1 Geometric - Slide Debris Angle 52
      7.2.2 Geometric - Historic Slides 54
      7.2.3 Probability - Slope Morphology 54
      7.2.4 Probability - Development Impact 55
      7.2.5 Mass Wasting - Summary 57
   7.3 Subsurface Erosion 57

TABLE OF CONTENTS

PAGE

8. GUIDE TO ADMINISTRATIVE DECISIONS 60
8.1 General 60
8.2 Risk Acceptability 60
8.3 Hazard Rating 61
8.4 Mitigative Measures 62
8.4.1 Hazard Avoidance 62
8.4.2 Hazard Reduction 63
8.4.3 Waivers 65
9. DECISION MATRIX 67
9.1 Hazard Zones 67
9.1.1 Matrix Development 68
9.1.2 Decision Matrix 70
10. CONCLUSIONS AND RECOMMENDATIONS 71
10.1 Conclusions 71
10.2 Recommendations 72
REFERENCES 74
GLOSSARY 78

PHOTOGRAPHS

PHOTO 1 - PHOTO OF FAILURE PLANE OF ANCIENT SLIDE 9
PHOTO 2 - PHOTO OF RAVELLING SLOPE IN WEST BENCH 20
PHOTO 3 - PHOTO OF FAILURE OF COLLUVIUM TALUS SLOPE IN SAGE MESA 21

TABLE OF CONTENTS

PAGE

FIGURES

FIGURE 1 - REVIEW OF EXISTING SLIDES (AFTER NYLAND AND MILLER, 1977) 24
FIGURE 2 - TYPICAL LANDSLIDE SECTION 40
FIGURE 3 - GEOMETRIC SLIDE ANGLE ASSESSMENT 53
FIGURE 4 - LANDSLIDE PROBABILITY ANALYSIS 58
FIGURE 5 - SETBACK AND RUN-OUT SECTION 68

TABLES

TABLE 1 - WEST BENCH - MEAN MONTHLY WATER BALANCE 34
TABLE 2 - SUMMARY OF INFILTRATION INTO SILT COMPARED TO AVERAGE LOT SIZE 35
TABLE 3 - SEISMIC HAZARD CALCULATION SUMMARIES 36
TABLE 4 - HAZARD ASSESSMENT 62
TABLE 5 - DECISION MATRIX 70

APPENDICES

APPENDIX I - TERMS OF REFERENCE
APPENDIX II - SINKHOLE DISTRIBUTION AND LANDSLIDE PROBABILITY ANALYSIS
APPENDIX III - GEOPHYSICS
APPENDIX IV - WATER BALANCE

TABLE OF CONTENTS

DRAWINGS

DRAWING A-1001 - LOCATION PLAN
DRAWING B-1002 - SITE PLAN
DRAWING B-1003 - GEOLOGY PLAN
DRAWING BX-1004 - GEOLOGY SECTIONS
DRAWING D-1005 - LANDSLIDE HAZARD PLAN
DRAWING D-1006 - SINKHOLE HAZARD PLAN
DRAWING D-1007 - STUDY AREA ZONE PLAN

1. INTRODUCTION

1.1 General

The Regional District of Okanagan-Similkameen requested the services of Klohn Leonoff Ltd. to carry out a review of the geological hazards of the West Bench/Sage Mesa area based on current practice in hazard mapping. The Terms of Reference are included as Appendix I.

The purpose of the study was to determine criteria for development, taking into account identified geological conditions and associated risks.

This report describes the work carried out in the study, presents an interpretation of geological conditions, identifies geological hazards and evaluates the probability of the hazards. The report also includes a guide to administrative decisions, introduces bench marks for acceptable risk levels and suggests a matrix format for application of the study results to bylaw preparation.

1.2 Scope of Work

The scope of work carried out in this study is briefly described below:

- A review was made of all previous studies and the rationale behind the hazard zones of the Nyland and Miller Report (1977) was examined. The site was visited to review existing hazard boundaries as defined by Nyland and Miller (1977).
- Effects of development to date were reviewed using air photo interpretation, field investigation and interviews with residents and agencies operating within the area. The study area was evaluated both analytically and probabilistically for identified hazards.
- Benchmarks for administration were outlined to determine levels of acceptable risk.

- Practical and enforceable mitigative measures to reduce identified hazards were designated and a matrix and hazard boundaries recommended for ongoing administrative controls.

1.3 Site Description

This study was carried out on the West Bench and Sage Mesa developments of the Regional District of Okanagan-Similkameen. The study area is located on the west side of the Okanagan Valley west and northwest of Penticton, British Columbia. As of 1991, West Bench consists of 358 houses with a population of 1,100 and one school with 221 ha (545 acres), of which 130 ha (315 acres) is irrigated land. Sage Mesa consisted of 73 houses with a population of approximately 225 and covers an area of approximately 19 ha (47 acres).

Between West Bench and Sage Mesa is an undeveloped tract of land covering 19 ha (47 acres). An application to rezone the tract for golf course use is currently underway. Above Sage Mesa to the west is Pine Hills Golf Course consisting of 28 ha (70 acres).

A development is underway east of West Bench on Penticton Indian Reservation No. 1 land. This development will consist of 75 houses. To the west of West Bench is the Hsula Highlands development consisting of 87 houses.

The study area is located at latitude 49° 30.5′ north longitude and 119° 37.5′ west longitude and covers the area shown on Drawing A-1001 and Drawing B-1002. The area generally comprises a dry silt bench which is bounded on the east by steep scarps down to Okanagan Lake and Okanagan River and on the west by kettled outwash sands and gravels, Blue Mountain and Nkwala Mountain.

West Bench was developed in the late 1950s under the Veterans Land Act as affordable property for veterans of the Canadian Armed Forces. Sage Mesa was developed in the late 1960s by a developer.

The West Bench Irrigation District supplies domestic and irrigation water to the residents by pumping water from Okanagan Lake. Irrigation water is supplied at a maximum of 6 gallons/minute/irrigated acre. The West Bench Irrigation District is owned privately and managed by the residents of West Bench.

The Sage Mesa Irrigation District supplies domestic and irrigation water to the residents of Sage Mesa, the Pine Hills Golf Course and Hsula Highlands by pumping water from Okanagan Lake. The Sage Mesa Irrigation District is a private utility presently under control of the British Columbia Ministry of Environment, Lands and Parks, through the Water Rights Branch.

Sewage is disposed of through individual septic fields provided by the residents on their individual properties. Storm drainage is controlled through ditches and some curbed roads where the run-off is diverted through culverts into gullies. Other storm drainage, including water collected on driveways and roofs, is disposed of by individual residents by various means.

2. DATA ACQUISITION

2.1 Data and Report Review

2.1.1 General Review

The initial stages of the study included an extensive data and report review. The object of the review was to put together as complete an information database as possible in the time available. The majority of the work for this task was completed prior to starting the other tasks of the project, although data and report collection continued throughout the entire length of the project.

Air photo flight lines for the area were reviewed and four sets of air photos were ordered from Maps B.C. of the British Columbia Ministry of Environment, Lands and Parks, Survey and Resource Mapping Branch, in Victoria. The air photos sets reviewed were from 1951 (which predates most of the development in the area), 1966, 1985 and 1990 (which was the latest set available for the area).

All groundwater well logs available for the West Bench/Sage Mesa area were ordered from the Water Investigation Branch of the Department of Environment, Water Resources Division, in Victoria. A total of 22 well logs were received and reviewed.

Seismic hazard calculations were ordered from Energy, Mines and Resources Canada, through the Geological Survey of Canada, at the Pacific Geoscience Centre in Sidney, British Columbia, for the West Bench/Sage Mesa area.

Rainfall data was ordered from the Atmospheric Environment Service of Environment Canada. Other rainfall and climatic data was obtained from the Rainfall Frequency Atlas of Canada (1985) and the Canadian Climate Normals (1980).

The most current maps of the site were ordered from Maps British Columbia of the British Columbia Ministry of Environment, Lands and Parks, Survey and Resource

Mapping Branch, in Victoria. The maps purchased were the 1:20,000 scale Terrain Resource Information Management (TRIM) series.

A literature review was carried out to obtain pertinent articles on geology, geotechnical properties, hazards, and mitigative measures relating to geologic conditions at the site and to other similar geologic terrains to the Okanagan Valley. Reports on hazard assessment and classification were also reviewed. A list of references is compiled for this report.

Previous studies were carried out on the West Bench/Sage Mesa area. These reports are particularly relevant for this geological hazards review. These reports are listed in Section 2.1.2.

2.1.2 Key Reports

Wright, A.S.C. and C.C. Kelly, "Soil Erosion in the Penticton Series. West Bench Irrigation District, Penticton, British Columbia", Soil Survey Branch, Department of Agriculture, Kelowna, British Columbia, June 1959.

Runka, G.G., "Soil Stability Ratings - South Okanagan", September 1971.

Nyland, D. and G.E. Miller, "Geological Hazards and Urban Development of Silt Deposits in the Penticton Area", British Columbia Ministry of Highways and Public Works, Geotechnical and Materials Branch, 1977.

Evans, S.G. and R.G. Buchanan, "Geotechnical Problems Associated with Silt Deposits in the Thompson Valley, British Columbia", British Columbia Ministry of Highways and Public Works, Geotechnical and Materials Branch, 1977.

Wilson, G., "Terrain Analysis for part of Lot 137, Plan 68395 C.L.S.R. Being Part of Penticton I.R. No. 1", Prepared for Redwing Resorts Ltd., Gordon Wilson and Associates Inc., 1991.

2.1.3 Rationale of the Nyland and Miller Report

The present basis for decisions regarding subdivision of new or existing lots in the West Bench/Sage Mesa area is the report "Geological Hazards and Urban Development of Silt Deposits in the Penticton Area" (Nyland and Miller, 1977). The report was prepared for

the Ministry of Transportation and Highways, Geotechnical and Materials Branch, after an extensive field and laboratory investigation of the study area.

The Nyland and Miller (1977) report concluded that urban development in the West Bench/Sage Mesa area is subject to two types of hazards:

(i) piping, caving and collapse of the silt; and

(ii) landslides along the steep silt slopes.

These phenomena were considered natural and would occur sporadically without development. The study determined that the main triggering mechanism for failures is water, and that urban development would increase water inputs well beyond the natural supply of the area. Consequently, development would increase the occurrence of failures.

The report by Nyland and Miller (1977) recommended that hazardous areas be delineated and the addition of water reduced. A zone map was prepared covering the study area. The map contained three zones:

- **Red Zone:** The red zone covered areas where the hazard was so great that no further building should be allowed.

- **Orange Zone:** The orange zone covered areas where no further development was allowed unless water controls were implemented in all developed areas of West Bench (including the green zone).

  Water controls were to include storm and sanitary sewer systems, curb and gutter street design, sprinkling controls, dole valves on outside water services, collection of roof and driveway run-off and conveyance to storm sewer systems, plus maximum safeguards against damage from breakage of water and sewer lines.

- **Green Zones:** The green zone covered areas where the hazard was judged sufficiently low to allow subdivision to the 1/2 acre minimum lot size with no additional controls on water input to the soils (unless development is to take place in the orange zone).

2.2 Air Photo Interpretation

2.2.1 General Air Photo Interpretation

An air photo interpretation was carried out on four stereo sets of air photos. Air photos reviewed include the 1:31,680 scale 1951 series, the 1:31,680 scale 1965 series, the 1:15,000 scale 1985 colour series and the 1:12,500 scale 1990 series. A total of forty photos of the study area from four sets spanning time from predevelopment to the present were reviewed.

Photos were compared to determine if any development of gullies, sinkholes, or slides had occurred over the period of record. All sinkholes visible were mapped and plotted and a review made of the occurrence of a sinkhole in relation to another sinkhole or bluff edge (see Appendix II). Photos were also used to assist in the field mapping and interpretation of the geology.

2.2.2 Air Photo Observations

Air photo interpretation revealed the following observations:

- the distribution of sinkholes evident on the air photos reveal that all sinkholes occur within less than 40 m of another sinkhole or bluff edge (see Appendix II);
- sinkholes generally occur in a dendritic pattern and individually near bluff edges;
- gullies appear to be associated with coalescing of sinkholes;
- no major landslides, development of sinkholes or gully advancement is obvious over the period of record;
- ravelling of the natural slopes can be observed;

- north facing slopes have a higher incidence of ravelling than do south facing slopes;
- an ancient landslide exists at the mouth of the gully in which Sage Mesa Drive connects Sage Mesa with the Highway 97; and
- the various geologic units can be delineated on the air photo.

2.3 Field Investigations

2.3.1 Geology Mapping

A field mapping program was carried out between March 6, 1992, and March 20, 1992. A total of 235 outcrops were mapped in and around the study area. Outcrops were both man-made and natural, and consisted of varved lacustrine silt, colluvial silt, sands and gravels, and bedrock. Outcrops were also observed for structure to determine depositional environment; piping, sinkholes and collapse features; slope angles and slope failures; and any jointing or lineations that were present.

A map was prepared including outcrop information as well as geologic information confirmed in other reports (Drawing B-1003). Sections were drawn (Drawing BX-1004) to assist in interpreting the geology. Air photos were used in conjunction with the other geology information to prepare a geology map.

An ancient landslide at the mouth of the gully in which Sage Mesa Drive connects Sage Mesa with the Highway 97 was mapped. A shear surface was observed (see Photo 1) and the landslide included on the geology map.

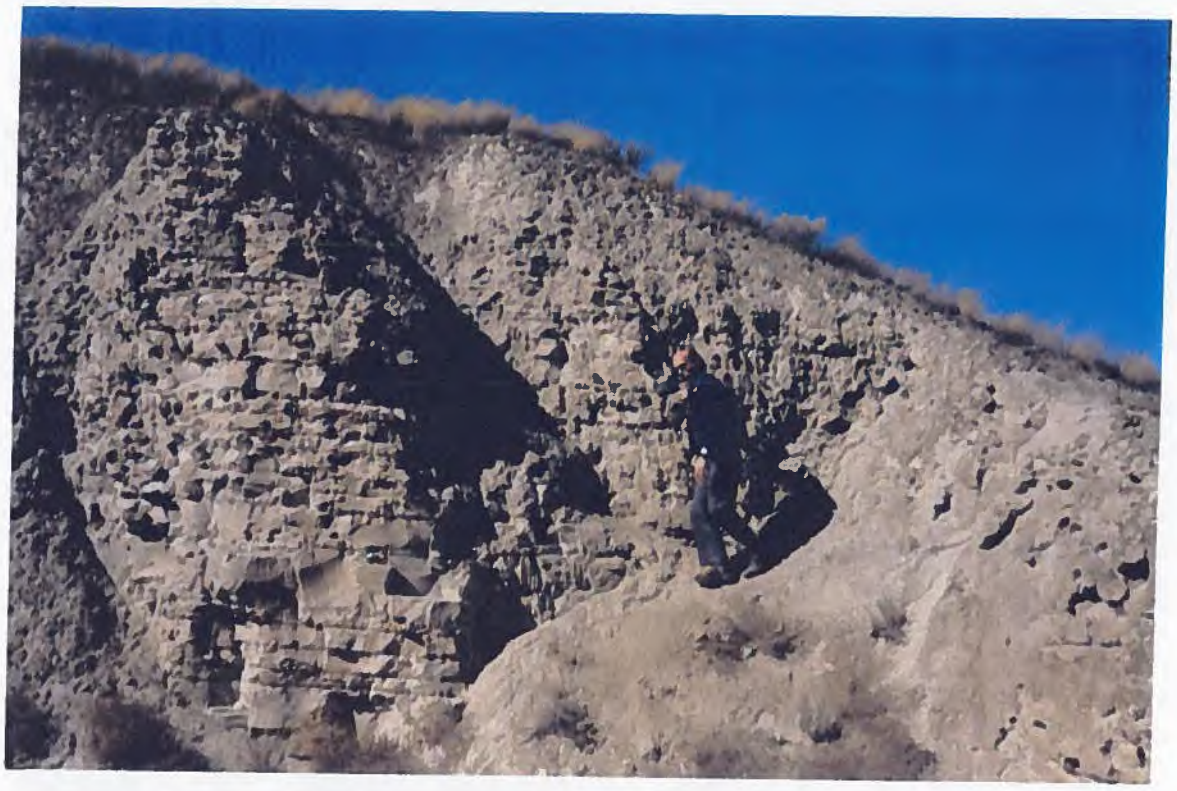


Photo 1 - Photo of Failure Plane of Ancient Slide

2.3.2 Geophysics

On March 13 and 14, 1992, a small program of dipole-dipole apparent resistivity was carried out at the Pine Hills Golf course, in West Bench.

The objective was to assess the effectiveness of the resistivity method in mapping possible ground water flow and voids which would indicate subsurface erosion within the silt formation.

The resistivity survey consisted of three lines totalling 800 m in length. This survey consists of passing a current through the ground between two probes and measuring the potential across two other probes. The ease with which the ground passes or does not pass the current is the resistivity of the material. If the different material types over

which the survey is performed have a large difference in resistivity then the results of the survey can be interpreted.

The results from the survey performed show two areas of very high resistivity which could be interpreted as bedrock, dry granular material or possibly open voids (see Appendix III).

More work would need to be performed to verify the source of the anomaly if this information is to be correlated to geology. These results appear promising for the use of resistivity surveys as a tool in distinguishing voids in the silt.

2.4 Interviews

2.4.1 Discussions with Residents

A general information meeting was held at the offices of the Regional District of Okanagan-Similkameen for interested residents on the evening of Tuesday, March 10, 1992. Approximately 30 residents attended. Residents were informed of the geological hazards review under way and asked for comments and input. The following concerns were raised:

- Residents were concerned that the Redwing Resort currently under construction on the Penticton Indian Reservation Land between West Bench and the bluff edge might prevent subdivision of land in the West Bench area, as the new houses may be more exposed to potential slope failures.

- Concerns were raised that small individual properties would be missed in the scope of the overall study. Many residents requested that the guidelines be written so that they could be applied to individual cases rather than as broad, general lines on a map.

Residents were also requested to provide the study with any reports for geotechnical investigations carried out on their individual properties. A number of reports were supplied for review (see the list of references for reports provided).

A number of discussions were held with individual residents at their request. These discussions covered the same issues raised during the information meeting and details of topics brought up at the meeting.

2.4.2 Discussions with Agencies

Agencies operating in the West Bench/Sage Mesa area were interviewed for information pertaining to the study. Those interviewed include:

- the Regional District of Okanagan-Similkameen;
- Ministry of Transportation and Highways, Thompson-Okanagan Regional office;
- Ministry of Transportation and Highways, Geotechnical and Materials Engineering office;
- West Bench Irrigation District;
- Sage Mesa Irrigation District, through Water Rights Branch in Victoria; and
- British Columbia Gas local office.

3. GEOLOGY

3.1 Regional Geology

The Okanagan Valley is a major physiographic feature that trends generally north/south through the Interior Plateau of south central British Columbia and the Columbia Plateau of north central Washington State, where it joins the Columbia River System.

From Vernon to the U.S. - Canada Boundary, the Okanagan Valley consists of a main trench and parallel valleys cut deeply into the surface of the plateau. South of Vernon, no major valley joins the Okanagan in Canada, and the watershed divides are abnormally close to the main valley for such a major valley system. Minor tributary streams flow from the plateau surface in narrow valleys with steep gradients to join the Okanagan Valley.

Several sequences of glaciation are thought to have occurred during the Pleistocene Epoch. The Okanagan Valley acted as an important channel for the movement of ice. During glacial advance, the Okanagan Valley was deeply incised, with the valley bottom ranging from 4 km to 22 km in width. The Fraser ice sheet was the last glacial stage to advance through this region with deglaciation occurring between 11,000 years and 9,000 years ago (Fulton, 1975). During the period of final deglaciation, most of the unconsolidated sediments that are found in and around the Okanagan Valley were deposited. Extreme climatic changes, according to Nasmith (1962), account for the Fraser ice sheet apparently wasting away through down-wasting rather than by retreat. As the rapid down-wasting occurred, the unconsolidated sediments were laid down.

An expanded interpretation of the origin of the surficial deposits and resultant topography have been reported by Nasmith (1962). A summary of the sediment origin and deposition environment as described by Nasmith follows:

Glacial Occupation

During the stage of glacial occupation the main ice lobe occupied the Okanagan Valley. Morainal ridges consisting of sorted and unsorted material were deposited at the edge of the ice lobe. Kame terraces consisting of stratified drift were deposited by meltwater streams flowing along the edge of the ice.

Glacial Retreat

During the stage of glacial retreat the ice lobe occupied the central part of the valley and large streams and lakes were formed by the melting ice of the main lobe. Outwash terraces consisting of stratified drift, including fine sand to coarse gravel, were deposited by meltwater streams. These are similar to kame terraces, although in kame terraces the gradient is controlled by the adjacent ice. Where outwash was deposited over glacial ice, kettled outwash resulted when the buried ice melted and subsequent depressions, known as kettles, formed.

During the retreat of the Okanagan ice lobe, the valley was blocked by ice near the present day location of Okanagan Falls. This blockage caused the formation of glacial Lake Penticton. Glacial lake sediments consisting of thick deposits of silt, clay and sand accumulated in the calm water. Much of the Okanagan Valley from Okanagan Falls north to Vernon is flanked by bluffs consisting of glacial lake sediments.

Late Glacial

During the late stages of ice retreat, raised alluvial fans and deltas were deposited by local streams grading into a lake water level higher than present.

Postglacial

Recent sediments include floodplain sediments of sand, silt and swamp deposits. One example of this is the Okanagan River floodplain between Okanagan and Skaha Lakes. Alluvial fans, deltas and stream channels created by present-day streams are graded to present day base level. Erosion of the lacustrine silt bluffs results in colluvial silt deposits.

3.2 Land Form Development

3.2.1 Glacial Occupation

The local geology interpretation is based on the extensive work of Nasmith (1962), the work of Nyland and Miller (1977) and the field program for this study. The interpretation follows Nasmith with minor enhancements where more details are available.

During the early stages of the glacial recession, the highland areas that surrounded the Okanagan Valley were ice-free while the ice still occupied the main valley. The ice at the south end of the valley down-wasted earlier than the ice in the North. As melting occurred, the Marron Valley, a parallel valley located 14 km to the west, acted as a channel for the meltwater to move away. The water flowed south then west to the Similkameen Valley. Over time the ice tongue blocking the Shingle Creek Valley melted down to allow the flow of water to return to the Okanagan Valley down Shingle Creek. At about the same time as the Shingle Creek Valley opened up meltwater began to follow the course of Trout Creek and was diverted into the Trout Creek - Penticton Diversion, the valley between Blue Mountain and Nkwala Mountain.

Kame terraces are visible on the eastern flank of Blue Mountain above West Bench at El. 520 m. These kame terraces were deposited when the ice lobe filled the main valley to an elevation of 550 m and meltwater was flowing through the Trout Creek - Penticton Diversion. The water deposited sediments along the ice-rock contact to form the kame terraces.

3.2.2 Glacial Retreat

During the initial stages of Lake Penticton the ice down-wasted further, so that meltwater flowing south through the Trout Creek - Penticton Diversion and east down Shingle Creek deposited sands and gravels into the ice-marginal valley. The resulting outwash terraces and kettled outwash were formed throughout the area on the west side of West Bench. These silty sand and gravel deposits are exposed between elevation 450 m and 500 m and in outcrops below 450 m and are easily recognized by

the kettle topography. The eastern edge of the kettled outwash deposit dips steeply to the east.

When the ice lobe had down-wasted to below 450 m, the meltwater started to flow down the main valley and stopped flowing through the Trout Creek - Penticton Diversion and Shingle Creek. Shingle Creek continued to act as a drainage creek for the watershed. The level of Lake Penticton was controlled to the south by a dam formed from outwash deposits and buried ice.

The lacustrine silts, clays and sands were deposited within the waters of Lake Penticton close to the ice margin and on top of the ice lobe. Silt is evident as a surficial mantle up to El. 450 m, but most evident in the thick silt benches left along the valley edge at El. 400 m.

The lacustrine silt is most easily identified by the varving. Varving is horizontal layering caused by changes in the depositional rates of the sediments. The silt is varved most probably as a result of seasonal fluctuations, climatic changes, or variations in flow as the lake level declined. Varves range in thickness from 2 cm to 3 cm up to approximately 1 m, with the thickest varves found on the lower slopes. The clay varves indicate that there were periods of calm water that allowed the clay to settle out.

Where silt was deposited over the ice lobe, the ice became insulated by the silt. When the ice support of the silt was removed, slumping and differential settlement of the silt occurred. Evidence of this are broad synclinal sags and normal faults first noted in the Okanagan Valley by Flint (1935).

At the north end of Sage Mesa, the silt bluffs are interbedded with some fine to coarse sand deposits. There may have been a meltwater channel formed by the ice lobe and the east side of Nkwala Mountain which juts east into the Okanagan Valley. The interbedded silt and sand may be a small delta formed as the meltwater, flowing through the channel, entered the deeper, wider channel south of Nkwala Mountain.

3.2.3 Late Glacial

The late glacial period was geologically a very active time. As the level of Lake Penticton dropped, the lacustrine silt deposits were drained rapidly. If lake level decline exceeded the ability of the silt to drain the excess pore pressures would have resulted in dramatic slope failures all along the edge of the lacustrine silt deposit.

The relatively rapid lowering of Lake Penticton, and a climate at the end of the glacial period with rainfall much greater than today, probably caused the major gullies along West Bench to form. The excess pore water, the high rainfall run-off, and drainage from the gravels to the west may have combined to erode through the silts as the lake level fell.

Any deltas formed by the debris eroding from the gullies or by slope failures have been washed away by the flow of the Okanagan River or by wave action on Okanagan Lake. This erosion activity is evident even today: where landslides occur into Okanagan Lake, the toe is completely eroded away in only a few years. Estimating the date of gully formation, the incidence of landslides along the silt bluffs or the rate of cliff erosion is therefore not possible.

The ancient slide that created the slide remnants observed in Sage Mesa most probably predates the forming of the gully that flows through the slide. The slide at the mouth of the gully probably caused the gully to form there.

The outwash and lacustrine silt insulated the ice lobe in the early stages of melting. As the climate continued to warm, the buried ice gradually melted slowly removing the ice support of the overlying materials. The overlying materials then settled into the resulting void.

The outwash collapsing into the voids created kettles. Where there was a thin veneer of silt over the outwash, a kettle now occurs in the silt. Where the silt partially covered the ice below, differential settlement and slumping occurred in the silt.

3.2.4 Postglacial

While Lake Penticton existed, Shingle Creek flowed to the higher lake level depositing an alluvial fan on to the area south of West Bench. When the level of Lake Penticton dropped, the base level of Shingle Creek also dropped. A gully on the raised alluvial fan indicates a temporary drainage course followed by the creek. In its present course, Shingle Creek follows a narrow channel that it has eroded through the alluvial fan.

According to Nasmith (1962), Penticton, Ellis and Shingle Creeks have built alluvial fans graded to the present lake level. These fans are sufficiently extensive to coalesce and divide the formerly continuous lake into two lakes. The City of Penticton is built upon the coalescing fans.

The present Okanagan River follows a sinuous course between the fronts of the fans from Okanagan Lake to Skaha Lake. The base of the silt bluffs in the southern portion of the study area is in the floodplain of the Okanagan River. The air photos clearly illustrate that the course of the Okanagan River has meandered back and forth, at times eroding into the base of the silt bluffs and at other times leaving swamps next to the silt bluffs.

Slides probably have been an ongoing process since the recession of Lake Penticton to its present level. As outlined in Section 3.2.3, the lake and river can remove the toe of a slide in only a few years, so any evidence of old slides is difficult, if not impossible, to find. Therefore, the forming of gullies may have occurred in the late glacial period, or may have occurred postglacially. This is also true for the ancient slide at Sage Mesa. The slide may have occurred postglacially, and thus the gully behind it could also have formed postglacially.

If the gullies are not late glacial features, they could have formed in the postglacial period. There was an increase in rainfall at the end of the glacial period due to the change in climate and the gullies may have been formed by increased run-off during this

period. Water flowing down to lake level, both as surface water and through the gravels, would have caused rapid erosion of the silts.

At least three of the gullies in the silt bluffs have bedrock exposed in the base at the upstream ends. The exposed bedrock in the gullies indicates that the headward advance of the gully is stopped. Sand and gravel outwash deposits exposed in some of the gullies has also slowed or stopped the headward progression of the gully.

Some of the gullies may have been formed by the coalescing of sinkholes in the silt. The dendritic pattern of sinkholes visible on the air photos is very likely the present expression of pipes caused by erosion from internal drainage. The pipes have collapsed and formed lines of sinkholes. As erosion of the pipes continued, gullies formed. Once the gully started to form, the water flowing along the drainage path would continue to advance the gully headward.

The visible sinkholes are less developed than the sinkholes that have formed gullies. Water entering the silts through joints or cracks would flow internally causing erosion where the gradients were high. Once the erosion starts, the eroded pipe acts as a conduit to collect and carry more water. Once they start to erode, subsurface, subhorizontal pipes intersect and draw more water from other surface areas through joints and cracks. The piping is therefore expected to be an ongoing process, concentrating flow into existing pipes. The ground eventually collapses into the pipe, creating sinkholes.

The lacustrine silt contains extensive near-vertical jointing. The causes of the jointing may be both the internal properties of the silt and external forces. Jointing may be caused by shrinkage from desiccation, stress relief, differential settlement and wet-dry cycles. The stress relief joints and wet-dry cycle joints should primarily affect the bluff faces of the silt.

The colluvial silt is postglacial. Colluvial silt forms when the lacustrine silt erodes. The colluvial silt is found in gullies, depressions, and on the slopes below the bluffs. This colluvial silt could be a direct erosion deposit, or it could be blown by wind into gullies and kettles. As an erosion product of the lacustrine silt, the colluvial silt is similar in composition to the lacustrine silt.

The erosion of silt from the bluff edges, through toppling, small planer slides, and small circular slides, is known as ravelling. Ravelling is a process that would probably have been continuous since the draw-down of Lake Penticton. Where the Okanagan River and waves from Okanagan Lake have eroded away the colluvial silt that has ravelled down, the ravelling will continue actively. Once the ravelled material has reached the top of the slope, new ravelling will not occur until this colluvial material moves away, exposing the bluff once again. The colluvial material is highest on slopes that have not had active river or lake erosion at the toe for the longest the period of time. Photo 2 shows the silt bluffs of West Bench. The colluvial slopes reach the top of the bluff at the point on the slope furthest from Okanagan Lake and very little colluvium at the point nearest Okanagan Lake.



Photo 2 - Photo of Ravelling Slope in West Bench

Other than erosion from the river and lake, the colluvial slopes would also move to flatter angles through erosion of the colluvial material. The colluvial slopes can fail as a result of shallow planer and circular failures of the colluvial material itself.

3.2.5 Current Environment

The current active erosion processes include:

- ravelling;
- long-term slope adjustments;
- piping and sinkhole formation;
- gully formation; and
- landslides.

The current active processes visible are the slope ravelling and adjustments. Photo 2 shows current ravelling and Photo 3 shows a recent circular failure in the colluvial material. The process of ravelling will continue until the slopes have been covered with colluvium to the crest.



Photo 3 - Photo of Failure of Colluvium Talus Slope in Sage Mesa

Man-made cuts in the silt slopes are evident at the entrance to West Bench Drive at Highway 97. As shown on Photo 2, the silt slopes were cut back to allow the road to be placed at the base. With construction of Highway 97, a berm was created between the cliff toe and Okanagan Lake which prevents the lake from removing material at the toe of the slope. Similarly, the Okanagan River is presently controlled by a weir, and flows in a lined channel built away from the bluff edge. These man-made alterations at West Bench and Sage Mesa prevent further river and lake erosion of the colluvial slopes.

Field reconnaissance shows that the colluvial silt in the gully bottoms are very prone to piping. Sinkholes and horizontal pipes were evident in the base of many of the gullies in the colluvial silt. Piping is also active in the lacustrine silt. Signs of recent activity were observed at a few sinkholes in lacustrine silt.

On February 3, 1992, a water main break at a house on Hyslop Drive in Sage Mesa caused a sinkhole 12 ft deep to appear next to the house where the break occurred. The sinkhole ran under the carport and across the front lawn to the nearby cliff (Penticton Herald, February 4, 1992).

Other sinkholes have resulted from domestic water leaks throughout the West Bench and Sage Mesa area. Additionally, a number of small sinkholes have occurred where roof and road drainage has been diverted directly on to the silt. Other known examples of erosion caused by cultural development are:

- In December 1958, during construction of a house on Lot 132, Hyslop Drive, a large cave-in occurred about 60 m from the site of the house. The shaft was 4 m in diameter and about 6 m deep. At the bottom of the shaft two fairly large tunnels were exposed, both about 1.4 m high and 0.75 m wide (Wright and Kelly, 1959).

- A house in Sage Mesa was reported damaged, apparently as a result of a cave-in initiated by septic discharge from a lot above. The house reverted to a mortgage company which spent $15,000 repairing the damage (Nyland and Miller, 1977).

- In March 1974 a water main burst on Sage Mesa Drive resulting in the development of two large sinkholes eight to ten feet in diameter. These required approximately 15 cubic metres of granular fill to refill (Nyland and Miller, 1977).

- On October 29, 1976, a cave-in occurred on Lot 14 in the Sage Mesa area. The resulting hole was approximately 3 m in diameter and 2 m deep. A pipe apparently had formed up- and down-gradient from the caved-in structure (Nyland and Miller, 1977).

- The owner of Lot 102, Jonathan Drive, West Bench, reported that his lot was susceptible to subsidence with the addition of water. He stated that when he left a tap running for less than 24 hrs, a depression approximately 1.2 m in diameter and 0.3 m deep resulted. The owner reported a similar occurrence on a neighbouring lot (Nyland and Miller, 1977).

- In the last week of June, 1982, excessive rainfall initiated a serious soil erosion problem at 54 Solana Crescent in Sage Mesa. A ravine adjacent to the property developed a large sinkhole 5 m to 10 m downslope of where a culvert empties into the ravine. The sinkhole appeared in an area of existing sinkholes which had been backfilled by the property owner (MOTH memorandum, December 7, 1982).

- In August 1986 a large sinkhole (1.8 m x 1.5 m x 5 m deep) occurred at the top of Sage Mesa Drive, 3 m off the pavement on the east side of the road. A horizontal pipe was observed extending in the up- and down-hill directions from the base of the pipe. The triggering mechanism for the sinkhole was attributed to a leaking water line recently installed to service fire hydrants (MOTH memorandum, No. 2M5-30-26, August 22, 1986).

Major landslides of the silt bluffs of the Okanagan Valley have occurred recently. Nyland and Miller (1977) studied ten major slides that have occurred over the last 60 years in the Okanagan Valley in silt material similar to that of the study area. The slides were studied to determine existing slide profiles, to estimate the position of the toe of the slide prior to failure, and to determine postfailure angles. One additional slide has been documented that occurred since the Nyland and Miller (1977) report in silt material similar to the study area. The Summerland slide of 1984. An additional slide also occurred at the Summerland Research Station in December 1987. Figure 1 is a summary of these slides.

Of the slides studied by Nyland and Miller, seven of ten were located adjacent to irrigated land. The study showed that many of the landslides occurred after irrigation began and before the use of sprinklers for irrigation.

	SLIDE	H	COT. I_1	COT. I_2	COT. I_3	DATE OF OCCURRENCE
S-2	Chute Creek	120	1.2	2.3	2.5	1947, west 150' into lake
S-4		159	1.0	1.8	2.2	1951
S-5	Johnson Creek	191	1.7	2.2	2.2	1951 (July)
S-6	Randolph Creek	230	0.6	1.4	1.4	1936
S-7	North Marina	182	1.0	1.4	1.5	1930 approx.
S-8	Mid. Marina	178	1.0	1.6	1.9	
S-9	South Marina	152	0.8	1.6	1.7	
S-10	Skaha Lake	252	1.3	1.7	1.7	
S-11	Research Stn.	124	0.8	1.4	1.4	1969 (Aug) with a minor slide same year also Dec. 1971 and 1974 and 1987
S-12	O.K. Lake	140	1.0	1.4	1.7	1975 (March)
-	Lakeshore Drive Summerland	-	-	-	-	1983 Dec (60,000 m^3)
NOTE: COT. $I_3 = L_3/H$						

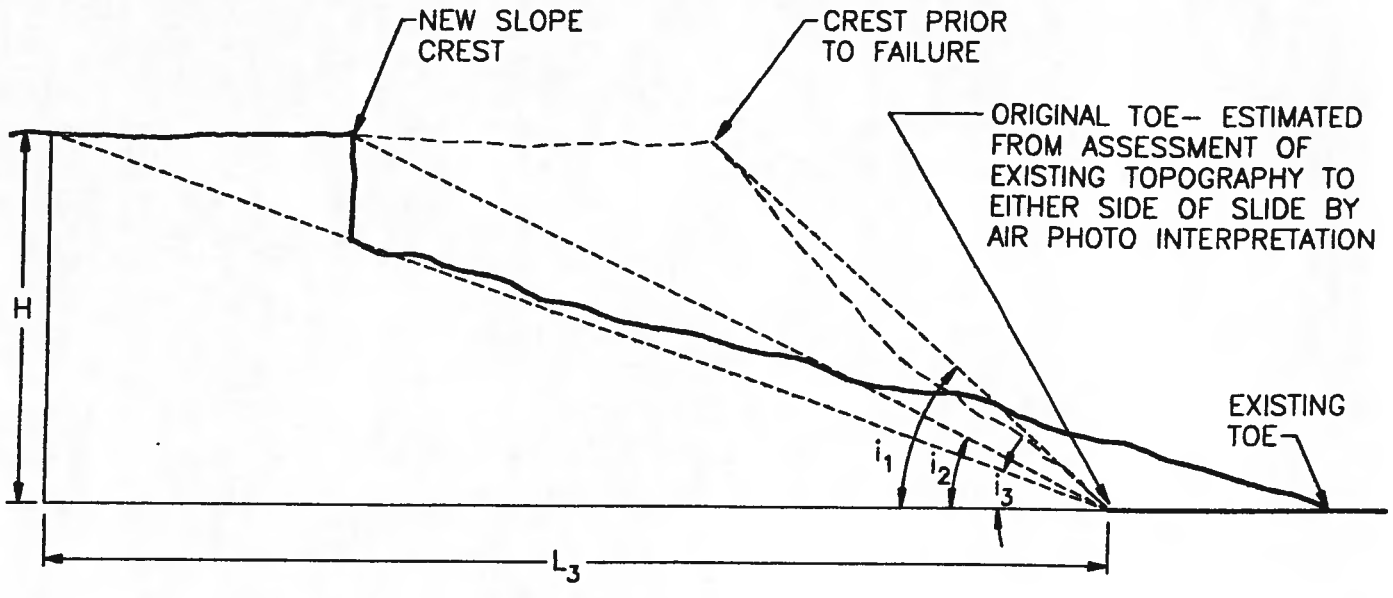


Figure 1 - Review of Existing Slides (after Nyland and Miller, 1977)

3.3 Engineering Parameters

3.3.1 General

There are five geological units within the West Bench/Sage Mesa area. The units, from youngest to oldest, are:

- colluvial silt;
- glacio-lacustrine silt;
- glacio-fluvial kettled outwash;
- glacial till; and
- bedrock.

The bedrock exists as a lower bound for the sedimentary geology. From the exposures on the upper slopes the bedrock surface dips steeply to unknown depths in the Okanagan Valley. The bedrock is generally exposed at elevations above 500 m to 550 m.

Drill logs from Nyland and Miller (1977) show a till above the bedrock in some of the drill locations (Holes 2 and 5). This till unit was also observed in one of the gullies. This till is comprised of gravelly till material. This material is likely a recessional till left behind from one of the previous glacial stages that advanced through the region.

The kettled outwash deposits, as described in Section 3.2.3, are comprised of silty sand and gravel. These units are located on the west side of the study area, exposed as a large terrace from El. 450 m to 500 m and in outcrops in the gullies below El. 450 m.

Lacustrine silt consists of silt and small amounts of clay and sand. Random boulders and gravel pockets are attributed to material dropped from melting ice rafts. The silt is visible as a blanket over the kettled outwash between El. 400 m and 450 m, and as the dominant silt bluffs at El. 400 m. The lacustrine silt is distinguished primarily by its varved structure.

The youngest unit is the colluvial silt. This silt is the erosion product of the lacustrine silt, and is recognized by its lack of structure and lack of varves. The material is found in gullies, in depressions, and on the slopes below the bluffs. The colluvial silt is also recognized by its almost uniform slope angle of approximately 40° where it rests against the bluff.

3.3.2 Hydrogeology

The top few metres of the bedrock is heavily fractured, probably from stress relief and weathering. This upper layer of bedrock is expected to have a relatively high hydraulic conductivity because of the fractures. The fractured bedrock would be less pervious than the gravel but more pervious than the silt.

The glacial till would have a relatively low hydraulic conductivity, although it is most likely discontinuous and would not affect the flow of groundwater significantly.

The outwash deposits have a relatively high hydraulic conductivity relative to the other units. The coarse nature of this unit (sand and gravel) allows water to pass through with relative ease. Infiltration into the outwash deposits could ultimately come into contact with the silt where the outwash pinches out.

The hydraulic conductivity of the lacustrine silt is relatively low because the material is fine grained, although the joints and varves in the silt would most likely make this unit anisotropic, with the preferential flow directions down along the joints and outward along the varves. The relatively low hydraulic conductivity of the lacustrine silt will cause it to act as an aquitard above the outwash and fractured bedrock.

3.3.3 Material Properties

The following is a summary of laboratory analysis and field observations from both the reports on the West Bench/Sage Mesa area and the field investigation for this report. Grain-size analysis (Nyland and Miller, 1977) of the lacustrine silt indicates a clay content of 8% to 17%; a silt content of 80% to 87%; and a sand content of 0% to 2%. The varved nature of the deposit indicates that sorting of the material occurred and that much finer and coarser layers can be expected.

Index tests summarized in the Nyland and Miller Report (1977) show that the liquid limits of samples collected were grouped around the "A" line and ranged from 21% to 39%. Plastic limits ranged from 13% to 31%. Plastic indices varied from 1.1% to 14%. Natural moisture contents ranged from 0.9% to 7.9%.

Density testing by standard Proctor method from Nyland and Miller (1977) yielded maximum dry densities ranging from 1557 kg/m^3 to 1734 kg/m^3 (97 lb/ft^3 to 108 lb/ft^3) with optimum moisture contents ranging from 17% to 24%.

Microscopic analysis (Quigley, 1976) showed both lacustrine and colluvial silts have an open, porus structure.

Mineralogical data (Quigley, 1976) indicated the presence of abundant quartz, moderate feldspar and minor clay minerals. X-ray diffraction traces on the clay fraction indicate a dominance of montmorillonite clay.

All samples tested by Quigley (1976) appeared to be above the critical void ratio. Small amounts of soluble precipitates or evaporates were also found.

Both the lacustrine and colluvial samples tested by Quigley (1976) showed varying degrees of sudden decrease in void ratio when flooded under load in the consolidometer.

Direct shear tests were performed by Sobkowicz and Coulter (1992) using undrained direct shear test procedures on samples with natural moisture content. For silt samples with moisture contents significantly below the plastic limit, peak strength parameters are 30 kPa for cohesion and 35° for angle of friction. For silt samples with moisture content at or near the plastic limit, peak shear strength parameters are 30 kPa for cohesion and 30° for angle of friction. Tests were also performed for materials of higher plasticity. The following strength parameters were reported:

Clayey Silt, Peak Strength	Cohesion - 35 kPa Angle of Friction - 22°
Silty Clay, Peak Strength	Cohesion - 35 kPa Angle of Friction - 17°
Silty Clay, Residual Strength	Cohesion - 10 kPa Angle of Friction - 10°

As the direct shear tests were carried out in an undrained state, these strength parameters would be appropriate for dynamic slope stability analysis provided the slope is not saturated, but would not necessarily be the appropriate strength parameters for long-term stability analysis.

Reports by Wright and Kelly (1965), Nyland and Miller (1977), and Evans and Buchanan (1977) noted that the silt has a high strength in the air dry state but that in the wet state the strength is low. Work has been done by Nyland and Miller (1977) and Quigley (1976) to try to quantify both the lacustrine and colluvial silts. It appears that wetting of the silt leads to collapse of the soil structure and corresponding loss of strength of the material.

The lacustrine silt deposit exhibits intensive vertical joint patterns at the bluff edge. Factors that may have caused this jointing include shrinkage, stress relief, differential settlement, and seasonal wet-dry cycles. Jointing due to differential settlement and shrinkage most likely continue through the entire deposit while jointing caused by stress

release and wet-dry cycles most likely affect only the material near the surface or bluff faces.

4. HYDROLOGY

4.1 General Water Balance

A conceptual water balance was created to account for all sources and sinks of water in the study area. The general sources of water entering the site include precipitation, domestic water and off-site water flowing on to the site. See Appendix IV for water balance.

Precipitation sources for water include rainfall and snow melt. Precipitation can occur directly on the site in the catchment basin or it can be concentrated on roads and roofs and then added to the system. Of the rainfall and snow melt, some of the water becomes run-off, some infiltrates into the ground and the remainder leaves by evapotranspiration.

Domestic water includes water added through septic fields and irrigation water applied to the site. Septic field water enters the system through infiltration and leaves by evapotranspiration. Irrigation water can become run-off, infiltration or evapo-transpiration.

Sinks for water on the site include evapotranspiration of water from the system and groundwater and surface water flowing off the site. If the volume of water entering the system is greater than or less than the volume leaving the system, then the remainder of the water is accounted for as increased or decreased storage.

Water infiltrating in the silts will move slowly because of the low hydraulic conductivity of this material. During the winter, flow in the unsaturated zone will most likely be downward, while in the summer, flow may turn upward because of the high evapotranspiration rate. If the net flow for the year is positive, there will be a raising of the water table.

Water concentrated on roofs and roadways, or by other means, entering the silts can flow along joints causing internal erosion and increasing the flow rate. If this water does not have a place to exit the silt, then it will collect at the water table, raising the water table.

Water flowing on to the site as groundwater or infiltrating on the site into the outwash will move through the outwash sands and gravels or the fractured bedrock. The water flowing along these high hydraulic conductivity units must either flow out as surface water in the gullies or as groundwater discharging to the lake. If not, the excess water will build behind the silts and any trapped water will raise the water table in the silts.

4.2 Climate

Climatic conditions for the West Bench/Sage Mesa area are consistent with a mid-latitude, semi-desert type, with warm summers and cool winters. Climatic records from the Penticton Airport for the period of 1945 to 1985 (Hogg and Carr, 1985) show that the area has a mean monthly temperature of 8.9°C and a mean annual precipitation of 282.9 mm, of which 76.0 mm is snowfall, and that the average annual precipitation occurs over 100 days. The mean lake evaporation, calculated from pan evaporation data at Penticton Airport, is 845 mm, the majority of which occurs in the months of April through September (see Table 1). Based on the 10-year period from 1981 to 1991, mean annual precipitation is 355 mm. Lake level fluctuations are minimal.

The maximum monthly rainfall on record is 86.1 mm in August 1976, while the maximum three-month rainfall is 193.5 mm, occurring April through June 1948. The 1:1000 probability per annum monthly rainfall was calculated to be 130 mm, using a log normal distribution, while the 1:500 probability per annum three-month rainfall is calculated to be 230 mm.

4.3 Madeline Lake Catchment

The Madeline Lake catchment is located west of the West Bench/Sage Mesa area on the slopes of Blue Mountain and Mount Nkwala. The catchment area is approximately 13.5 km^2 and ranges in elevation from 500 m to 1360 m. The valley bottom areas of the catchment are vegetated with scrub grass and bushes while the higher portions of the catchment are treed. Several small lakes are located on the upper slopes of Blue Mountain. There is no discernible surface outlet from Madeline Lake, although the water in Madeline Lake is not stagnant, indicating significant groundwater inflow and outflow.

There are two Water Survey of Canada stream flow gauges west of this area:

- Shingle Creek above Kaleden Diversion (08NM037), drainage area of 44.8 km^2; and
- Shatford Creek near Penticton (08NM037), drainage area of 100 km^2.

Data for Shingle Creek consists of 20 years of manual daily readings during the summer months. The Shatford Creek data consists of 25 years of continuous records throughout the year. The Shingle Creek catchment ranges from El. 900 m to El. 2100 m and the Shatford Creek catchment ranges from El. 700 m to El. 2100 m, the majority of which is above El. 1000 m. Thus it is expected that these catchments would experience more precipitation and more snowfall than the Madeline Lake catchment and, therefore, somewhat higher run-off.

Mean monthly recorded discharge data from Shingle Creek and Shatford Creek were used to estimate the water yield from the Madeline Lake catchment. The recorded discharge data were prorated by drainage area and also reduced by 50% (to account for the reduced precipitation at the lower elevation Madeline Lake catchment). The resulting Madeline Lake catchment yield is 0.01 m^3/s (100 gpm) or less for the months

of January through March and July through December. The yield for May and June is approximately 0.1 m^3/s (1000 gpm) and consists of rainfall and melting of the snow pack.

4.4 Developed Area Water Balance

All of the domestic and irrigation water for the area is supplied by the West Bench or Sage Mesa irrigation districts by pumping water from Okanagan Lake. The area is not serviced by sanitary sewers and therefore sanitary waste is disposed of in septic fields. Ditches and culverts collect surface run-off, but do not take it out of the area.

The Red Wing development will be different from the other developments in the West Bench/Sage Mesa watershed, as we understand that septic sewer will be connected directly to the City of Penticton sewer system, and all roads, driveways and roofs will have storm water collected and delivered to lake level in storm sewers. Red Wing will provide their own water supply.

Current water consumption per household in the study area is approximately 200 gallons/day based on winter water use and 431 occupied dwellings. To accommodate future demographic changes a discharge of 375 gallons/house/day which is the B.C. Health Act design standard for a four bedroom house, has been adopted in this study.

Table 1 is a water balance for West Bench based on mean monthly conditions. The pumped water supplied to the area is based on the mean of nine years of pumping records. These records demonstrate that water use significantly increases for the months of June to September. The mean precipitation is based on records from Penticton Airport and include rain and snow for the 10-year period from 1981 to 1991. The evaporation information is based on pan evaporation data from the Penticton Airport.

Table 1 can be used as a basis for calculating net input into the silt annually. The calculations assume that good irrigation practices are being followed and that during dry

months, when evaporation is high, water is available for evaporation. Results show between 100 mm and 200 mm net evaporation. The actual evapotranspiration that takes place is lower as a rate for pan evaporation rather than for evapotranspiration has been used.

Table 1 - West Bench - Mean Monthly Water Balance

WEST BENCH - MEAN MONTHLY WATER BALANCE						
10-YEAR AVERAGE	PUMPED WATER		PRECIPITATION	TOTAL INPUT	EVAPORATION	WATER INPUT MINUS EVAPORATION
Month	m^3	mm	mm	mm	mm	mm
January	9706	4	40	44	4	40
February	9293	4	25	29	0	29
March	11451	5	21	26	0	26
April	46804	21	26	47	102	(55)
May	64727	29	36	65	128	(63)
June	100957	46	35	81	159	(78)
July	151235	68	26	94	174	(80)
August	104216	47	34	81	136	(55)
September	95192	43	23	66	91	(25)
October	51825	23	19	42	54	(12)
November	10932	5	30	35	0	35
December	10024	5	39	44	0	44
Total	666362	300	354	654	848	(194)

4.5 Watershed Water Balance

A water balance was performed for the entire watershed to estimate the water movement through the area. Table 1 shows the water balance based on average precipitation data from 1981 to 1991 and average water consumption based on 1983 to 1992.

A rainfall equivalent of approximately 43 mm of water is currently expected to flow through the silt in an average year (200 gallons/day/household). Compared to the water balance calculated for predevelopment conditions (Appendix IV) where the rainfall equivalent flow through silt is 20 mm of water, this is an increase of 114%. With the design domestic water usage of 375 gallons/day/household, the calculated flow through the silt increases to 59 mm, an increase of 193% over predevelopment.

An analysis of various housing densities in West Bench compared to overall background water balances was carried out. Results are in Appendix IV. A summary of the calculations is presented in Table 2.

Table 2 - Summary of Infiltration into Silt Compared to Average Lot Size (based on 375 gallons/day/household)

HOUSES IN WEST BENCH	AVERAGE LOT SIZE ACRES/HOUSE	FLOW INTO SILT (RAINFALL EQUIVALENT)
0	N/A	20 mm/yr
358	1.14	59 mm/yr
388	1.05	62 mm/yr
410	1.00	64mm/yr
545	0.75	78 mm/yr
825	0.50	104 mm/yr

5. SEISMICITY

Seismic hazard calculations were carried out by Energy, Mines and Resources Canada, through the Geological Survey of Canada, at the Pacific Geoscience Centre in Sidney, British Columbia. Table 3 summarizes the seismic hazard calculation for the West Bench/Sage Mesa area.

Table 3 - Seismic Hazard Calculation Summaries

Probability of exceedance per annum	1:100	1:200	1:475	1:1000
Probability of exceedance in 50 years	40%	22%	10%	5%
Peak Ground Acceleration (G)	0.029	0.040	0.060	0.083
Peak Ground Velocity (m/sec)	0.038	0.052	0.075	0.099

The corresponding zoning based on the National Building Code of Canada (NBCC, 1990) applied to this data:

Acceleration Zone:	1
Zonal Acceleration:	0.05 G
Velocity Zone:	1
Zonal Velocity:	0.05 m/sec

To put these numbers in perspective, there are seven zones established by the NBCC. These zones are numbered 0 to 6, with 0 the lowest and 6 the highest. Zone 1 indicates that there is a probability of ground motion due to a seismic event but the peak ground acceleration and velocity used for building design (the event with a probability of 10% in 50 years) are relatively low.

From a deterministic point of view, the maximum credible earthquake (MCE) for the study area is expected to be in the order of magnitude 6.5. This earthquake could produce a peak ground acceleration in the order of 0.35 G and peak ground velocity in the order of 0.35 m/sec. As an upper-bound earthquake, no probability can be assigned, though it could occur tomorrow or several tens of thousands of years from now.

6. HAZARD ASSESSMENT

6.1 General

Geological hazards can include a variety of natural events, listed as follows:

- flood water;
- stream erosion;
- debris flows;
- mass wasting;
- piping and subsurface erosion;
- subsidence;
- faulting;
- volcanism;
- snow avalanche;
- rock falls; and
- major landslides.

In order for any natural event to occur, there must be both prevailing conditions and a triggering event. The study area was assessed to verify if prevailing conditions existed for each of the possible events listed above. Geology, geomorphology and climate rule out a number of the potential events and leave:

- mass wasting; including
  - landslides;
  - ravelling of slopes;
  - long term adjustments;
- piping and subsurface erosion; including
  - new subsurface erosion;
  - sinkholes formed by existing pipes; and
- gully erosion.

6.2 Mass Wasting

6.2.1 Description

Historical records for the Okanagan Valley from south of Penticton to north of Summerland indicate 10 landslides have occurred over the past 60 years (Nyland and Miller, 1977). As described in Section 3.2.5, all of these slides occurred in silt from the same depositional environment as the silt bluffs of West Bench/Sage Mesa area.

Field investigations described in Section 2.3.1 show geologic evidence of a landslide having occurred at the mouth of the gully where Sage Mesa Drive connects with Highway 97. This ancient landslide is also visible on all air photos of the area.

Landslides are defined as large-scale failures of the silt bluffs. Landslides occur very rapidly, resulting when the silt bluff material breaks away and moves out to a lower angle of repose at the base of the bluff. Typical slides are 50 m to 400 m in width and result in a final slope angle from the new toe of about 18° to 20° (see Figure 2).

Factors causing a steep slope would be high internal strength, erosion at the toe of the slope, or a weak underlying material. Factors causing slope failure include gravity, water pressure, changes in strength due to saturation, and seismic acceleration acting on the silt. Both reduction in forces resisting failure and increases in driving forces causing failure can cause the slope to move.

Landslides can result in property loss, as well as loss of life. A slide in Summerland in 1970 destroyed three houses located below the slide and killed one person.

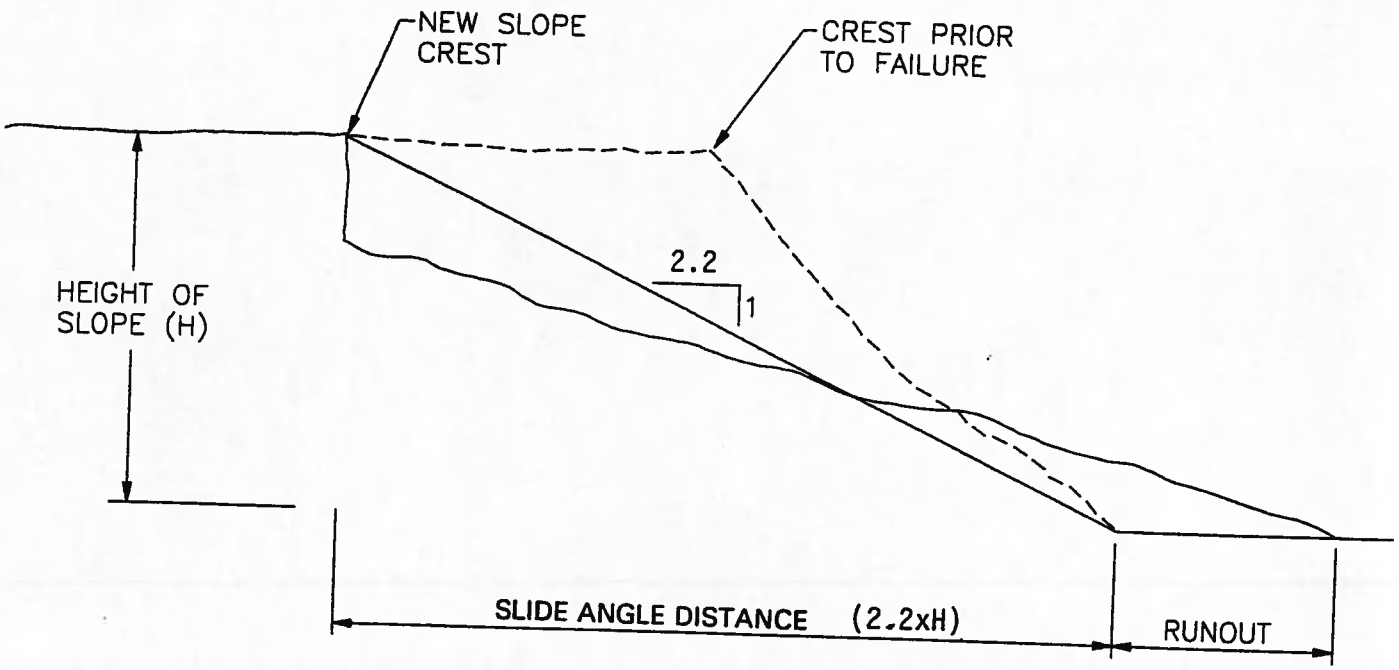


Figure 2 **Typical Landslide Section**

The angle from the toe of the slope prior to failure to the furthest point at the top of the slope where the landslide occurred is called the slide angle. The slide angle can be expressed as a ratio of the horizontal distance back from the preslide toe in relation to the height of the slope. Houses and property behind the slide angle would not be affected while houses and property within this zone would. A line established to define the hazard zone is known as the setback.

Similarly, run-out is the distance the slide moves out from the preslide toe, stated as a ratio to the slope height (Figure 2).

Ravelling and long-term adjustments are special cases of the landslide. Ravelling is defined as small scale failure of the silt bluffs from toppling failures, shallow circular failures and small block failures.

The process of ravelling is ongoing in the study area. Ravelling is seen to varying degrees at the face of all silt bluffs. The product of ravelling is the colluvial slope seen next to the steep lacustrine silt faces. Photo 2 shows a slope on the east side of West Bench varying from no colluvium to colluvium at the top of the slope.

Long-term slope adjustments, that is, small movements in the colluvial slopes, are visible throughout the study area. Long-term adjustments occur as the colluvial slopes move to shallower, more stable slopes.

6.2.2 Triggering Mechanisms

A review of the 10 recent landslides in the Penticton area of the Okanagan Valley studied by Nyland and Miller (1977) indicated that 7 of the 10 landslides occurred after open ditch irrigation and before sprinkler irrigation. On one of the remaining slides, seepage was seen on the bluff face prior to failure. A high groundwater level is considered the trigger for each of these slides.

A simplified analysis using simple circular and block-failure methods indicates that a rise in groundwater levels of about 1 m can result in a 3% to 6% reduction in the factor of safety.

A second triggering mechanism is earthquakes. As Penticton is not located adjacent to a major tectonic boundary, the maximum credible size of earthquake is limited. The earthquake-induced ground motions may, however, cause enough displacement within the silt bluffs to break or crack the slope-forming materials. Once the desiccated silt has been broken, its resistance to movement will be lowered, so that late or postearthquake failure could occur. The size of such a failure block will depend on the current groundwater conditions and the size of the earthquake. Smaller earthquakes would

likely cause small scale block and toppling failures. Larger scale failures are possible with larger earthquakes when prevalent conditions are near failure (i.e., high water table).

6.2.3 Prevailing Conditions

Prevailing conditions which may lead to a landslide include:

- geometry;
- material strength; and
- groundwater.

Previous landslides in the silt bluffs of the region occurred on steep slopes. The slopes along West Bench and Sage Mesa, as described in the geology section, are steep and, therefore, no significant difference is believed to exist between the study site and the known location of slides.

The failures were probably across varves in the upper reaches of the slide and possibly along weaker materials at the base of the slide. As the dip of the bedding is not documented in detail at previous slides, but is known to be subhorizontal in all silt bluffs, we anticipate that the geometry at West Bench and Sage Mesa is similar to the sites where slides have occurred.

Predevelopment conditions allowed the Okanagan Lake and Okanagan River to erode away ravelled material at the toe of the silt bluffs. Highway 97, at the base of the slope, now acts as a protective berm at the toe of the slope. Continued ravelling and long-term adjustments will, with time, improve the prevailing conditions.

The material strengths of the silts and clays in the silt bluffs in the Okanagan Valley are expected to be very similar. All are expected to contain material which will have low strengths in the horizontal direction when wet and have very high dry strengths. The

study site is therefore expected to be similar in this regard to sites where slides have occurred.

Groundwater conditions are believed to have been the trigger mechanism for most of the documented slides in the silt bluffs. The majority of the slides were triggered by open ditch irrigation.

Factors which contribute to prevailing groundwater conditions at the site include long-term climatic conditions which influences the quantity of precipitation entering the silts, both from the top and from the gravels to the west, domestic sewage disposal, and the collection and management of storm water run-off.

Adding water to the general water balance for the watershed will change the prevailing conditions such that a smaller triggering event is needed. As shown in Section 4.5, the calculated current infiltration through the silt is 114% greater than predevelopment conditions. The housing density has the potential to increase the infiltration up to 193% greater than predevelopment by a change in demographics. This increased infiltration raises the water table so that a smaller triggering event, such as higher than average rainfall, is required to induce a landslide. The seepage analysis indicates that water infiltrating into silt from the surface will raise the water table more than water added to the gravel to the west.

Landslides have probably occurred in the Okanagan Valley since glacial melting. The frequency of these events was probably much greater during lowering of Lake Penticton and the wetter conditions prevalent at that time. Recently, however, a number of landslides have occurred as the result of irrigation practices. Those irrigation practices have been changed. The hazards, however, still exist in the study area, awaiting adequate water to trigger the event. Potential sources of water include rainfall directly onto the site, rainfall moving to the site from the catchment upstream, and pumping of water to the site for irrigation and household use. The major change to the water balance of the area is the additional irrigation and household use water.

6.3 Subsurface Erosion

6.3.1 Description

Subsurface erosion in glacial lake deposits of British Columbia occurs in the south Thompson Valley, the Okanagan Valley and the Kootenay River Valley. All of these materials were deposited in glacial lakes during the late stages of glaciation. They are typically varved silt and clay bluffs along the valley walls in a relatively dry climate.

The subsurface erosion may be composed of two mechanisms, piping and sinkholes. The first, piping, is the result of a series of events. High groundwater gradients may cause material to be eroded away, leaving an open void. Removal of this material shortens the flow and concentrates more flow to the void. Consequently, the hydraulic gradient at the exit is even higher, and erosion at the head of the void or pipe is more intense. The pipe advances at an increasing rate toward the source of the water.

Once the pipe has reached a source of water, much higher flow rates are possible, so that the flow of water along the pipe can mobilize silts along the pathway, thereby enlarging the size of the cavity.

In the study area, an additional component is the existence of fractures which can act as pathways for the pipes to develop even without high hydraulic gradients. The fractures can also act as small courses along the pipe pathway, collecting water to the main pipes.

Sinkholes are the result of a collapse of a pipe roof when the strength of the silt material is inadequate to maintain the roof. Sinkholes are therefore a surface expression of relatively large scale pipes.

The pipe exits are not always observable as they may be covered by failure of roof materials or movement of talus slopes.

6.3.2 Triggering Mechanisms

Trigger mechanisms for piping involves supplying water to the erodible silts. Triggers therefore can include two broad categories:

- an increase in the supply of water to an area; and
- a change in catchment conditions leading to concentration of water to a smaller area.

Natural cycling of water supplied to the gravel west of the study area can be expected. The site geology and geometry suggests that increased groundwater supplied from the gravels will result in a small increase in water levels in the gravel, combined with a significant increase in discharge to the gullies. This discharge to the gullies will result in gully-widening with time. Only small incremental increase to groundwater levels is expected in the varved silts which may slightly enhance the piping potential near the bluff toes.

Natural cycles of precipitation onto the site is also expected, with extreme events promoting additional piping activity, as has occurred in the past. Colluvial activity, particularly related to leaking of water lines and swimming pools, will continue to be a significant trigger mechanism. The increase in water infiltration from septic drain fields and irrigation will probably not act as a trigger but may reduce the necessary precipitation intensity required to initiate internal erosion.

Driveways, compacted silt fill, and roof and road drainage are the most notable changes to catchment conditions which may serve to concentrate water which can lead to internal erosion. Additionally, as new erosion progresses, and new natural catchments are added to existing drainage paths, erosion potential increase.

6.3.3 Prevailing Conditions

Prevailing conditions which may lead to subsurface erosion include:

- erodible materials;
- adequate supply of water; and
- hydraulic conditions.

The glacial lake silts at the site have demonstrated that they are erodible. Many pipes and sinkholes have been mapped. As described in this report, laboratory work confirms the erodibility of the silts. A simple practical test is to drop water on the desiccated silt and observe silts eroding from the block. This can also be observed in the field. After a light rainfall, the bluffs look like flowing wax after the silts mobilize.

The timing of pipe formation is not known. Many of the gullies leading back to the gravel may have eroded during drawdown of glacial Lake Penticton. However, "recent" erosion around some sinkholes at the site implies that the process is ongoing. The presence of erodible materials is therefore considered certain at the study site.

A supply of water is necessary both for headward migration of a pipe and for erosion along a developed pipe. Once a pipe is established and begins migrating towards the "source" of water, a larger and larger catchment may be included. Termination of any pipe will probably only occur where one pipe extends and "captures" the water source of a second pipe. The potential sources of water at the study site include:

- groundwater in gravels to the west of the silt bluffs migrating into the gullies and into the silts;
- groundwater moving from the bedrock beneath the site into the silts. This volume is considered to be relatively small and stable;
- precipitation onto and migrating through the silts;
- precipitation onto roofs and roads being concentrated and redirected;
- the septic field discharge from residences;
- irrigation of orchards and yards;

- leakage from water supply pipes; and
- leakage from swimming and ornamental pools.

Any incremental increase in prevailing conditions can be expected to reduce the necessary size of event which triggers initiation of piping.

Most of the existing gullies are believed to have developed from subsurface erosion and collapse rather than as surface erosion.

All of the major gullies terminate at bedrock or at the gravel contact. The major source of water leading to this gully development is believed to be the gravel and the top of bedrock. As erosion has exposed the gravel in the gullies, drainage of the gravel into the gullies is possible. The resulting reduced head in the gravels is expected to reduce the erosion rate of the silt bluffs.

Most of the mapped sinkholes can be attributed to natural climatic conditions which periodically reach a threshold value which has renewed erosion. This natural condition is expected to continue. Additional water is now made available from Okanagan Lake for irrigation or household uses.

Some additional water from roofs or roads which previously fell directly on the ground and either infiltrated or evaporated is now concentrated in time and space. As a result, the quantity available for evapotranspiration may be reduced.

The hydraulic conditions which may have led to piping at this site include the following. The quantity of water infiltrating into the silts might exceed the ability of the silts to discharge at low gradients. The gradients would therefore increase until piping commenced. The ability of the silt to discharge is dependent on the hydraulic conductivities. This type of piping phenomenon would therefore occur where mass

permeabilities are low, which would be where fracture flow did not occur. This piping phenomenon might therefore be prevalent in colluvial silts.

Water infiltrating into fractures would tend to travel at higher velocities, causing erosion and transportation of silts. This type of erosion would follow joint patterns. Both of the above conditions may have existed at the study site since the draining of glacial Lake Penticton.

6.4 Gully Erosion

6.4.1 Description

The gully erosion may result from two processes. The first is internal and surface erosion of the colluvial silt material form the gully bases. Sinkholes and pipes in the gullies show current internal erosion in bases of all gullies. One gully shows some surface erosion as well. Water flows along the gully bases from the bedrock and gravel outcrops.

The second process is mass wasting of the silt slopes. When the erosion of the base removes the colluvial silt talus or support for the talus, the slopes regress. This regression could include small slope failures in the colluvial material, ravelling and even small- to large-scale landslides of the silt bluffs above.

6.4.2 Triggering Mechanisms

The triggering mechanism for gully erosion involves supplying water to the gullies. There are two sources of increase in water supply:

- climatic conditions, such as spring run-off or wet periods; and
- irrigation and septic fields, through increased development.

As discussed in Section 6.3.2, natural cycling of water supplied to the gravels and bedrock west of the study area can be expected. The site geology and geometry suggests that increased groundwater supplied from the gravels will result in small increases in the water levels in the gravel combined with a significant increase in discharge to the gullies. This discharge to the gullies will result in widening of the gullies with time. This cycling in natural climatic conditions through high spring run-off or extreme wet periods acts as the triggering mechanism for the erosion of the gully bases and, consequently, the continued mass wasting of the gully side slopes.

The increased water supply can also result from increased water input from development. At present all houses on the gravels dispose of waste water through septic fields. This discharge from septic fields and increased infiltration from irrigation acts as the triggering mechanism for the erosion of gully bases and the subsequent mass wasting of the gully side slopes.

6.4.3 Prevailing Conditions

Prevailing conditions which may lead to gully erosion include:

- erodible materials;
- hydraulic conditions; and
- adequate supply of water.

As discussed in Section 6.3.3, and by Nyland and Miller (1977), the colluvial silt has demonstrated that it is erodible. Evidence during the field investigation showed active erosion to varying degrees of the colluvial silts in the bases of all gullies. Actual changes in erosion conditions were observed in the gully between Hyslop Drive in West Bench and the proposed golf course between the February 1992 and March 1992 site visits.

All of the major gullies terminate at bedrock or at the gravel contact. The major source of water leading to this gully development is believed to be the gravel or the near-surface bedrock. As erosion has exposed the gravel in the gullies, drainage of the gravel into the gullies is possible.

As the silt bluffs are the same along the gully side slopes as they are along the eastern silt bluffs, they are expected to have the same potential for erosion. The erosion of the gully bases and toe of the colluvial talus slopes would increase the likelihood of mass wasting events occurring.

7. RISK ASSESSMENT

7.1 General

In the practice of assessing risk there are numerous uncertainties associated with assigning "a number". There are the geotechnical uncertainties in assigning a probability due to the short historical time-frame used to predict the long-term process. There are also the uncertainties caused by incomplete information regarding the site. Geotechnical engineering requires the prediction of the varying geologic conditions at a site from surface and limited subsurface investigations. These would include the spatial variation of material properties such as permeability, porosity, fracture location and density, and the temporal variation of rainfall and evapotranspiration. In addition, the parameter distributions must also include the inherent uncertainty in establishing parameter values in a geologic environment. The calculation of probability is sensitive to many of these parameters so that the result calculated in the low probability range is usually highly dependent on the input uncertainty. For this reason, geologic hazards are often assessed deterministically (assignment of single value conservative numbers) or by assigning probability based on evidence of past performance. In this study, we have established the risk based on a combination of these methodologies to establish the best available answer.

Probability is expressed as a number from 0 to 1 with "0" meaning no occurrence and "1" meaning 100% chance of occurrence in one year. Typically, probability of occurrence used as a threshold for acceptability is in the order of 0.005 to 0.0001. As such small numbers are difficult to relate to, most people will refer to the inverse of probability known as the "return period".

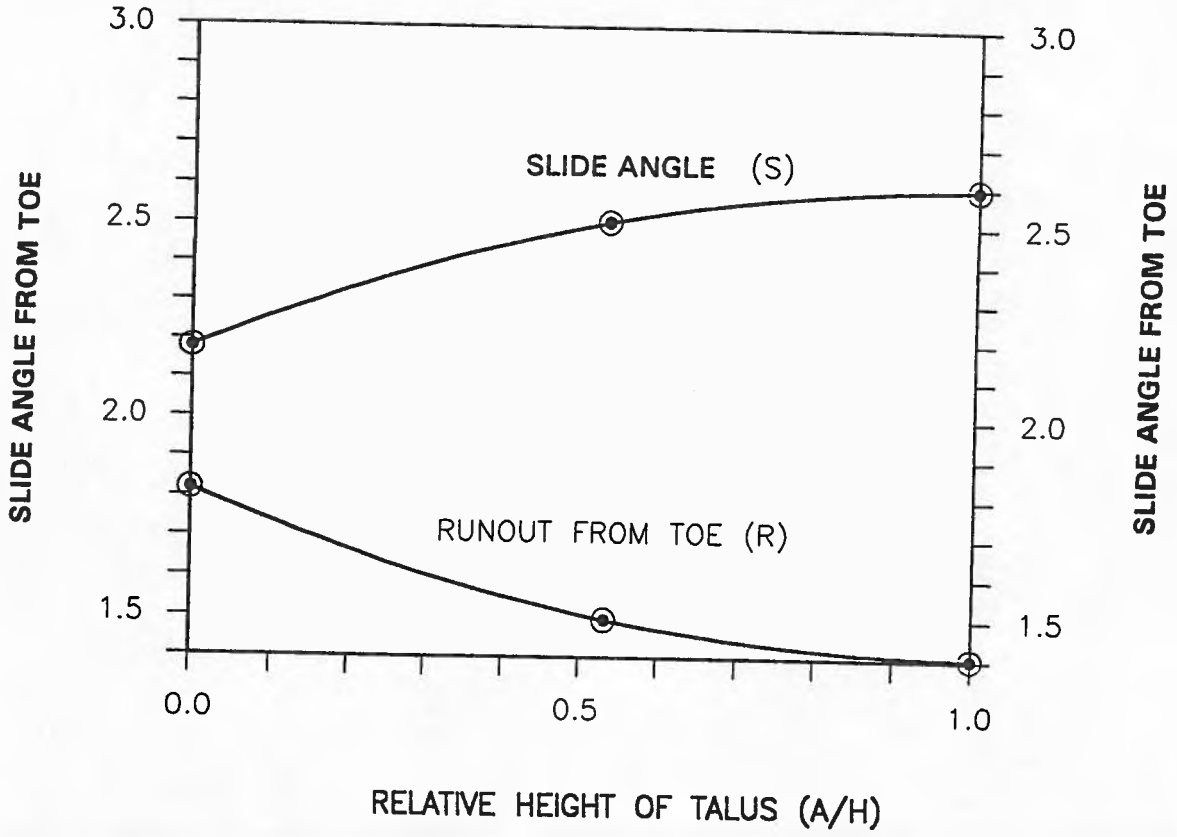
A probability of 0.005 is the same as 1/200, commonly stated as a 1-in-200 chance per annum. This does not mean that an event will only occur once every 200 years. In fact, the event could occur twice in a single year, or not for 1,000 years. What once-in-200-years indicates is that there is a 1/200 (0.005) chance of an event occurring in any single year.

Once a probability of occurrence is established, the mode of failure is then evaluated in reference to the consequences of the occurrence. Two criteria impact the consequences of a hazard. First, the predictability of an event controls the warning that could be given prior to the event occurring. An event that happened without warning would have more severe consequences than an event that would allow days or even hours of warning. Second, the type of damage ranging from minor property damage through major property damage to loss of life is considered. When the two criteria are put together, a risk category can be assigned.

7.2 Mass Wasting

7.2.1 Geometric - Slide Debris Angle

A geometric analyses was carried out to relate slide angle and run-out, and to examine the maximum setback criteria. The basic assumption in the analyses is that the volume of material missing from the top of the preslide profile equals the volume of material added to the bottom of the preslide profile. Based on a stable slide debris slope and a preslide profile, the slide angle can be calculated. Field measurements of the stable slide debris slope angle range between 3:1 and 4:1. Figure 4, calculated using the more conservative stable angle of 4:1 indicates a slide angle of 2.2:1 (horizontal: vertical) from the existing slope toe for a slope with no talus and a slide angle of 2.6:1 for a slope with all talus.



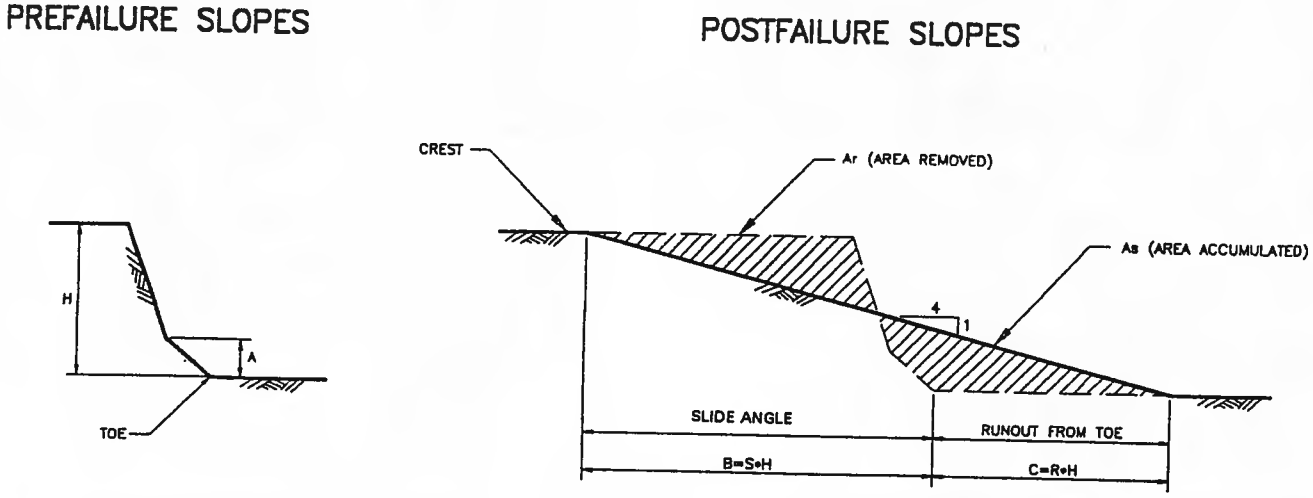


Figure 3 - Geometric Slide Angle Assessment

7.2.2 Geometric - Historic Slides

By reviewing case histories of the landslides studied by Nyland and Miller (1977) and using the post failure angle I_2 calculated, a maximum slide angle was estimated, (see Figure 1). The angle I_2 was used rather than I_3 used by Nyland and Miller, as I_2 reflects the slide angle which would have resulted in immediate property damage.

The Chute Creek slide as described by Nyland and Miller failed into the lake, causing much more mobility of the silt than other comparable slides. For this reason, this study does not include that slide.

In addition Wilson (1991) suggests that the Chute Creek Slide does not apply as the slide was caused by seepage from Koosi Creek, possible irrigation water from the silt bench above and was over an old channel of Koosi Creek.

Wilson also discounted two additional slides (S-4 and S-5 on Figure 1) on the east side of Okanagan Lake because of heavy irrigation, creeks and large amounts of groundwater in these locations. He concluded that groundwater on the west side is much less and that the resulting maximum slide angle is about 1.7:1. He therefore concludes that a safe setback at West Bench - Sage Mesa is 1.75:1 if water controls are used and 2.0:1 if effluent disposal is done on each lot.

Based on the remaining nine slides from Nyland and Miller (1977) and the additional slide in Summerland, the maximum overall slide angle for all relevant historic slides in the region is 2.2:1 (horizontal: vertical). All investigators concur that high groundwater levels are the primary cause of landslides.

7.2.3 Probability - Slope Morphology

Reviewing the existing slopes qualitatively can give insights into the probability of landslides. Steep bluffs occur in the silt when the toe of the slope has been eroded away. Along the bluffs, between West Bench and Sage Mesa, where the lake shore was adjacent to the slope prior to highway construction, there are steep slopes with little or

no talus. Further south along West Bench where swampy deposits lay along the toe, the talus approaches the top of the slope at a slope angle of 1.2:1. Generally, the talus is higher on the slope, further away from the lake. This talus erosion to a slope angle of 1.2:1 most probably occurred over the order of 500 years to 1,000 years.

There is evidence of one ancient failure in the study area. Under natural predevelopment conditions landslides can occur in the study area. Based on the observation that one landslide is evident in the study area, landslides may have a return period of 2,000 years to 20,000 years in the study area under predevelopment conditions.

After development, landslides occurred rapidly, in the region mostly associated with increased water infiltration due to open ditch irrigation for orchards. At present we believe there is more water infiltrating through the silt bluffs than there was prior to development. This conclusion is based on our calculation of increased infiltration from the residential septic fields.

7.2.4 Probability - Development Impact

The impact of development on the probability of landslides, as discussed in Section 7.1 is difficult to assess. However, an indication of the relative impact on the probability has been estimated as described below. The nine slides from Nyland and Miller (1977), occurred under the prevailing conditions of open ditch irrigation, so that absolute probability of failure is not directly applicable to conditions in the study area. However, these slides have been used to establish the relationship between slides with different slide angles which may be controlled at least in part by the distribution of material properties.

Using a simple wedge failure mechanism, a number of translational limit equilibrium slope stability analyses have been performed to calculate the groundwater gradient emanating at the slope toe necessary to initiate failure. Ground strength parameters and permeabilities were selected which in our judgment are representative of the glacial lake

sediments, and which result in failure with a five year wet period with a probability of exceedance of 1:14000 per annum. A five year wet period was selected as evidence from many geologic environments indicate that long periods of higher than average precipitation are one of the most common natural conditions leading to landslides (see Patton, 1984).

Various infiltration rates were used to calculate water table gradients. Infiltration conditions considered included predevelopment, present estimated infiltration conditions, maximum infiltration expected from present housing density and from present housing density plus 30 extra houses (388 houses), and maximum infiltration for 1-acre/house average lot size and 0.75-acre/house average lot size. The gradient probabilities were compared with gradient required for failure, so that a probability of failure could be estimated for each housing density condition.

A probability curve for a five year wet period induced slide under present conditions was created by combining the probability that infiltration rates which will cause failure would be exceeded with the distribution calculated from historic events, which includes variations in geometry and triggering mechanisms. Results are shown on Figure 4 and Appendix II.

Although the results of the probability study are not precise, they demonstrate the sensitivity of probabilities to development. A sixty-fold increase in likelihood of failure was calculated between predevelopment and present. If infiltration rates increased to the maximum expected from the present housing density, there would be a further five-fold increase in the probability of failure. An additional 30 houses added to the present housing density will increase the probability of failure by an additional 50%, which works out to approximately a 1.7% increase in probability of failure per additional household.

Similarly, slope failure may be initiated by earthquake ground motions. Small ground motions may result in significant strength loss of the desiccated silt. The peak ground

acceleration would then be the appropriate input parameter to a pseudo-static limit equilibrium analyses. Based on this analysis a less than extreme climatic event may be combined with earthquake ground motion to initiate failure. This increase in probability is considered insignificant compared to the calculated probability illustrated on Figure 4.

7.2.5 Mass Wasting - Summary

The risk for mass wasting has been assessed by evaluating the historical and morphological evidence in the study area and in the region as well as by calculating the influence of development on stability. Following is a summary of the findings:

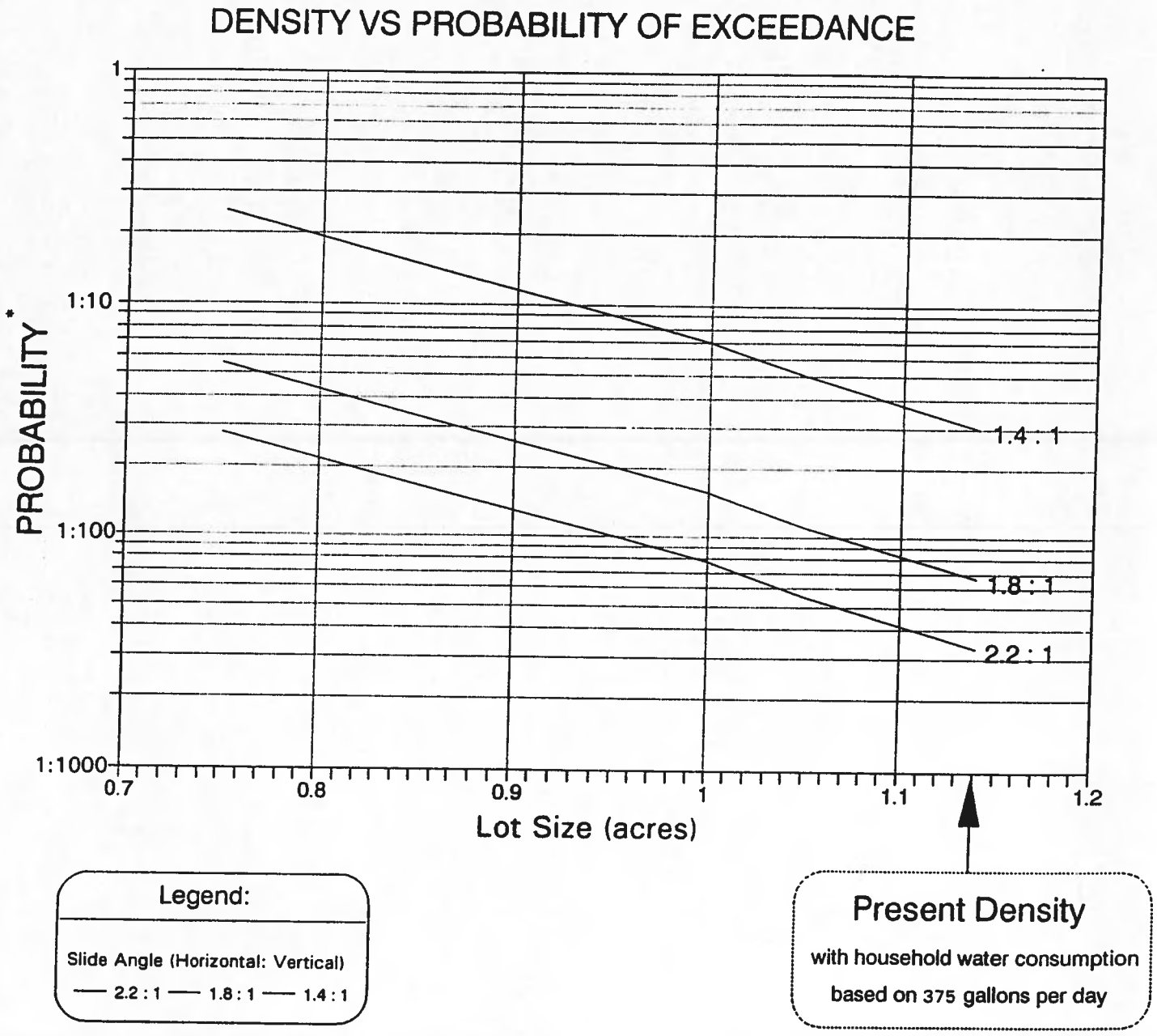
Methodology	Slide Angle
Geometric - Slide Debris Angle equal to 4:1	2.2:1 to 2.6:1
Geometric - Historic Slides	2.2:1
Probability - Slope Morphology	Not Applicable
Probability - Development Impact (1:500 Probability) (Current Density, Design Sewer Loads)	2.4:1

7.3 Subsurface Erosion

Natural Conditions

The probability of sinkhole occurrence has been calculated from mapped sinkholes in West Bench and Sage Mesa. All sinkholes distinguishable on the air photos were drawn on the geology plan, Drawing B-1003. The minimum distance between any sinkhole and the nearest sinkhole or bluff edge was found and plotted (see Appendix II). the mapped sinkholes were assumed to develop at a constant rate over periods of 2,000, 5,000 and 10,000 years.

This sheet presents information derived from the results of calculations using estimated values for many of the input parameters, each of which can vary over a wide range. Consequently, the information on the sheet is for illustration purposes only, and is not reliable for all conditions. The information on this sheet must not be used for design and must not be interpreted in any absolute manner.



* Probability of Exceeding a Slide Angle

Figure 4 - Landslide Probability Analysis

The data also indicate that under natural conditions, development of a new sinkhole has a probability of about 1/10 per annum. A probability of 1:200 per annum has a minimum distance of 32.5 m from any other sinkhole or gully edge. The distances range up to 40 m.

Developed Areas

In developed areas we have not predicted the probability of a sinkhole occurring, but where run-off is concentrated, hoses left running or pipes are broken, sinkholes and piping can and will form.

There have been eight large sinkholes reported in the last 34 years. This works out to a probability of 1-in-4.25 per annum chance of sinkholes caused by development. Minor sinkholes caused by development and some major sinkholes have not been recorded, with these included in the calculations, the probability would become more than 1-in-4 per annum of failure. This represents a doubling of sinkhole development from the calculated predevelopment probability.

8. GUIDE TO ADMINISTRATIVE DECISIONS

8.1 General

This section has been prepared for the Regional District for consideration when preparing by-laws. The engineer can identify and quantify risks. Society must decide what is acceptable. Today, in the Province of British Columbia, there is guidance from the provincial government and courts for what is considered acceptable risk.

8.2 Risk Acceptability

In setting a guideline for acceptability of risk there are few general standards. The Regional District of Fraser-Cheam is one of the pioneers in applying hazard acceptability thresholds for local government approval. The following is a summary of standards based on precedent, from Cave (1991).

The first guideline is derived from the Provincially sponsored flood-proofing program, which provides financial support for protective measures and regulatory control over many forms of development. The design event for this program has a probability of 1:200. Floods greater than this are regarded as too costly to protect against, too unlikely, or both; lesser floods are seen as too frequent and, therefore, too costly if not protected against.

The second guideline is inferred from Provincial policy on subdivision approval in hazardous areas where advice is given to geotechnical engineers "...to think in terms of a 10% probability in 50 years..." (probability of 1:475 per annum). This varies with the hazard.

The third guideline derives from the British Columbia Supreme Court decision of the Honourable Mr. Justice Berger (1973) which found a site exposed to a very low probability of landslide occurrence (probability of 1:10 000 per annum) to be unsuitable for development. The 1:10 000 probability is assigned to an event that, although possible at any time, has not occurred within the last 10,000 years (since the retreat of

the last glaciers). In this sense, the 1:10 000 standard has absolute significance in that such hazards have not occurred under present climatic conditions. In this case, the hazard potential was massive and destructive and could occur with little or no warning. The case involved a development that would have formed the nucleus for a new community. The risk during the lifetime of the new community was deemed to be unacceptably high.

8.3 Hazard Rating

Risk type is broken down into three categories for this project:

- Low Hazard - Events that allowed a reasonable warning or that were ongoing and where the consequences of the event were minor in nature.
- Medium Hazard - Events that give no warning but would not generally result in loss of life, or in events that are predictable but could result in major property damage.
- High Hazard - Events where loss of life is possible and where little or no warning of the event would be possible.

To eliminate subjectivity, the types of hazard present can be assigned a number for the predictability (warning) and for the consequences. The proper risk type can be assigned from the resulting total. This is shown on Table 4.

Predictability		Consequences	
0	Predictable	0	No Damage
1	Partially Predictable	1	Minor Property Damage
2	Not Predictable	2	Major Property Damage
		3	Loss of Life

Although all hazards do have the potential for loss of life, only those hazards where loss of life is significant are considered. The resulting sum is used to assign the hazard category.

0-1 LOW HAZARD
2-3 MEDIUM HAZARD
4-5 HIGH HAZARD

Table 4 - Hazard Assessment

	PREDICTABILITY	CONSEQUENCES	TOTAL	HAZARD RATING
Major Landslide	2	3	5	HIGH
Run-out from Landslide	2	3	5	HIGH
Ravelling	1	2	3	MEDIUM
Long Term Adjustments	0	1	1	LOW
Sinkholes	1	2	3	MEDIUM
Gully Erosion	1	2	3	MEDIUM

8.4 Mitigative Measures

8.4.1 Hazard Avoidance

The obvious approach to reducing risk due to a hazard is to simply avoid the risk. This can be achieved by building in areas where the risk is reduced. The decision matrix in the next section defines zones of hazard, for example, by setback from slopes and sinkholes. In this way a simple decision can be reached according to the acceptably of a hazard. Development can be avoided in areas where the risk is unacceptably high. According to Cave (1991) "...it is worth noting that the Municipal Act encourages the Development Permit regulations to implement such risk avoidance policies even to the point of allowing the permit to over-ride the use and density variations in the zoning bylaw."

8.4.2 Hazard Reduction

General

When development has already occurred hazard avoidance would not be a possibility. If the risk of hazard can be reduced to acceptable limits, a method of hazard reduction may be chosen as an alternative to not developing. Hazard reduction is not a preference to hazard avoidance and should only be used when the method of reduction is long term and "relatively" maintenance free.

Mass Wasting

To reduce the risk of landslides, the prevailing conditions must be improved. Slope stability can be improved by changing slope geometry, by slope reinforcement, by ground improvement or by reducing the groundwater levels. At this site, the only practical method is to reduce groundwater levels by reducing the quantity of water entering the silts.

In the following discussion is a list of water sources and practical and enforceable measures to reduce impact from these sources. The sources are not equal in importance.

To reduce infiltration, a septic sewer system carrying waste water to Okanagan Lake level can be implemented in any new development. Curb and gutter street design with storm sewers and collection of roof and driveway run-off with conveyance to the storm sewer system which would deliver the water to the Okanagan Lake level would also reduce the net input to the water balance.

Water could be removed from the Madeline Lake Valley. At present, this water flows from the valley directly into the gravel. If this water was removed and piped to Okanagan Lake level, the net water balance would be improved. Alternatively, irrigation water could be supplied from groundwater developed around the Madeline Lake Valley.

Watering entering the system from water supply pipes can be reduced by improving the water line maintenance and/or by installing all future water lines in utility culverts reducing the likelihood of infiltration to the silt and improving the ability to identify and repair leaks.

Subsurface Erosion

To reduce the risk of subsurface erosion and sinkhole development, the total quantity of water entering the silts must be reduced and in particular any concentration of water must be collected and removed to Okanagan Lake level by suitable means (i.e., storm sewers, lined ditches, culverts, etc.).

Storm water can be collected using curbs and gutters and carried in lined ditches or culverts down to the base of the silt bluffs at lake level. Because roads presently concentrate water on to the silt bluffs, active piping occurs where the water contacts the silt. This piping induced by concentration of water on roads will only continue and worsen with time if it is not controlled.

Roof storm drainage can be collected and dispersed to avoid concentration. Water collected from driveways and roofs can be removed in storm sewers off the silt to lake level.

Swimming pools and ornamental ponds which are susceptible to leakage are not desirable in the development area. Pool or pond leakage could create serious subsurface erosion problems very quickly.

Dry land landscaping is beneficial, particularly for residents living near the edge of bluffs, a zone of higher hazard. Irrigation water added for lawns and gardening can be detrimental to geologic stability.

A process of educating all residents of the potential hazards and their associated risks, along with methods of mitigating these problems as described above, could go a long

way to reduce the occurrence of subsurface erosion caused by development. Only with the residents' understanding of the hazards and commitment to work together can subsurface erosion be reduced.

Gully Erosion

To reduce erosion of the gully bases and the consequential mass wasting of the gully side slopes, the water entering the gullies must be reduced.

To reduce the water entering the gullies, new development could include septic sewers to remove domestic sewage to lake level.

To effectively reduce the water entering the gullies, existing houses could be provided with septic sewage to lake level. Providing storm sewers and curb and gutter collection of road drainage would also reduce the water entering the gravels, and then on to the gullies.

Finally, use of groundwater from the Madeline Lake Valley for use as irrigation or domestic water or removal of the water down to Okanagan Lake level in lined ditches or culverts, would reduce the water available to the gullies.

8.4.3 Waivers

As Cave (1991) states,

> One of the most common arguments relating to development applications in hazardous areas is whether approval can be granted in return for some form of waiver of the right to sue the regulatory authority in the event that damage or death occurs. This is usually coupled with some form of indemnity to protect the regulatory authority against suits launched by others. Such waivers are known as 'save-harmless' covenants and, if linked to the land use restrictions, can be registered as legal incumbrances against the title of the property pursuant to Section 215 of the Land Title Act.

It should be noted that these covenants are in the nature of private agreements between the landowner and the government. Thus third parties, such as visitors to the property, will be exposed involuntarily to the hazards while not being party to the agreement. Their statutory rights to protection cannot really be transferred by these agreements.

Nevertheless, these covenants do serve a valuable function as an instrument on title, in informing prospective purchasers of known hazards. They may also have value, in some cases, as an attempt to recognize and assign the residual liability after all reasonable remedial and protective measures have been undertaken. They do not, however, provide an alternative to implementation of the requirements of the Municipal Act and the Land Title Act by elected officials, planners, building inspectors and approving officers. The duties of each are rather clearly spelled out in the statutes, and no private agreements or covenants can over-ride these obligations.

9. DECISION MATRIX

9.1 Hazard Zones

In order to put the hazard probabilities into a form that can be effectively used by the Regional District, a study area zone plan has been created which is referenced with a decision matrix. This plan is prepared in consultation with the Regional District.

The first hazard zone includes the area of potential landslide and run-out. The setback required for adequate safety, based on the back analysis of the past failures, is an angle of 2.2:1. This is confirmed by the theoretical analysis and the probability analysis. As the back analysis predicts the edge of failure, occupied residential structures should be setback an additional 10 m to act as a safety factor which would keep the structure serviceable in the event of a landslide. From the theoretical analysis, the run-out should be 1.8:1 from the toe plus 10 m. Figure 5 illustrates the setback and run-out definition and Drawing D-1005 is a plan showing the setback and run-out.

The second hazard zone is delineated by the sinkhole hazard. A setback distance of 40 m from the edge of any present or previous sinkhole or gully edge, the maximum measured distance, has been selected. The sinkhole hazard line is shown on Drawing D-1006, the Sinkhole Hazard Plan.

The third zone is the area that will affect the landslide prevailing conditions. In this zone, increased water input through domestic water disposal in septic fields will increase the probability of landslides occurring. This zone includes all silt bluffs in the study area shown on Drawing B-1003, Geology Plan.

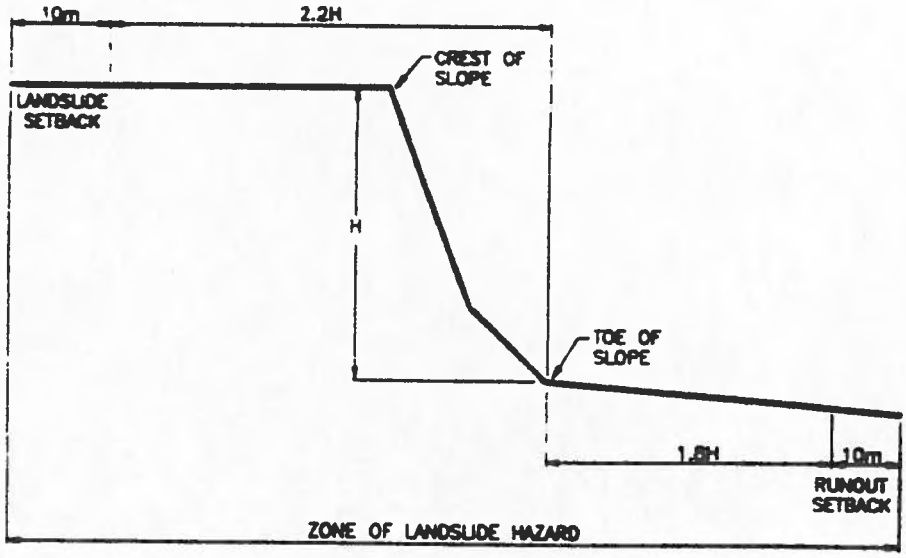


Figure 5 - Setback and Run-out Section

The fourth and fifth zones are defined as all gravel or bedrock outcrops in or above the study area. Increased water input through domestic water disposal in septic fields and through irrigation in this zone will increase gully erosion. This area, including gravel and bedrock both inside and outside of the study area, can be seen on Drawing B-1003, Geology Plan.

The five zones defined above are combined together on Drawing D-1007, the study Area Zone Plan. Where the zones overlap, the zone of higher hazard is used to define the hazard on the Area Zone Plan.

9.1.1 Matrix Development

As a final step in putting this information in a form that is easily usable by the regional district, the type of application and the type of hazard are put together in a matrix

which is designed to produce the appropriate response. To simplify the process, the matrix is based on three types of applications.

- Subdivision of an existing lot into parcels greater than one acre. - Subdivision of an existing lot into smaller parcels allows a greater number of persons to be exposed to an existing risk, and may imply a greater contribution to groundwater infiltration in this study area.

- Subdivision of an existing lot into parcels between 0.5 acre and 1 acre. Subdividing existing lots also means that more water will be directly added to the ground through septic fields and there will be a greater concentration of water from driveways and roofs. As water is the single greatest problem in stability of the silt bluffs, lot size is one of the few ways that the Regional District can directly affect the amount of water directed into the ground.

- Creation of a new community. - The Berger decision (1973) that new communities should not be exposed to high hazard areas is clear. For medium and low hazard, the risk accepted should still be low.

The decision matrix is composed of a series of applications that would be received by the Regional District as described above. The application is compared against the probability of each particular event. The probability of each event is found in its associated drawing. With these two pieces of information, the matrices below are used to find the appropriate response.

The type of response to applications will depend on what zone is being considered and the kind of remedial measures available. Responses are rated on a scale of "a" to "e".

a - Permit approved without conditions.

b - Permit approved only with a covenant registered on the property title clearly defining the hazards present.

c - Permit approved only with installation of septic sewers and storm sewers.

d - Permit approved only with irrigation or domestic water drawn from groundwater.

e - Permit not approved.

9.1.2 Decision Matrix

This decision matrix, Table 5, is to be used with Drawing D-1007 for deciding responses to permit applications in the West Bench/Sage Mesa area.

Table 5 - Decision Matrix

ZONE	NEW COMMUNITY	SUBDIVISION OF EXISTING LOT TO > 0.5 ACRE	SUBDIVISION OF EXISTING LOT TO > 1.0 ACRE
1. Landslide Hazard	e	e	e
2. Sinkhole Hazard	e	e	e
3. Silt Bluff	e	c	c
4. Gravel or Bedrock in Study Area	c	c	d
5. Gravel or Bedrock Outside Study Area	c	c	d

NOTE: To be used with Drawing D-1007.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

Based on the field investigations and reviews of this study of the geological hazards of the West Bench/Sage Mesa area, the following are conclusions of this study:

1. West Bench/Sage Mesa is situated on lacustrine silt bluffs to the east and on kettled outwash sands and gravels and bedrock to the west.

2. The dry climate, high evapotranspiration rates, and natural drainage of the sands and gravels are responsible for the slow erosion rate of the silt bluffs.

3. At least one slide has occurred in the lacustrine silt of the study area in the past.

4. Sinkholes are prevalent throughout the study area in the silt bluffs and the colluvial silt.

5. The principal geological hazards, elements of the erosion process, are gully erosion, subsurface erosion (piping and sinkholes) and mass wasting (landslides).

6. The key trigger for gully erosion is most probably from water derived from the sands and gravels and bedrock located west of the silt deposits.

7. The key trigger for sinkholes on the silt bluffs is increased supplies of concentrated water on the silt.

   Concentration of water can result from extreme precipitation events; collected run-off from sources such as roofs, roads and driveways; leaking swimming pools; and broken water supply lines.

8. Increased water infiltration in the silts will facilitate requirements for a landslide.

   During open ditch irrigation in the Okanagan Valley the occurrence of failures increased dramatically over predevelopment conditions. Under present housing density, the potential for infiltration through septic fields also increases the likelihood of failure.

9. The study area has been subdivided into five zones as shown on Drawing D-1007:

   - Zone 1 - Land within the area of landslide and run-out potential, defined as a setback angle of 2.2:1 from the toe plus 10 m and a run-out distance of 1.8 times the slide height plus 10 m.
   - Zone 2 - Land within the area of potential sinkholes, defined as the area within a distance of 40 m from past or existing sinkholes or gully edge.
   - Zone 3 - Land on the lacustrine silt unit, but not within Zone 1 or Zone 2.
   - Zone 4 and Zone 5 - Land within the catchment on the kettled outwash sands and gravels or the bedrock.

10.2 Recommendations

The following are recommendations of this study:

1. Adopt Drawing D-1007, the Study Area Zone Plan, as the updated geological hazards map.
2. Adopt the geological hazards decision matrix presented as Table 5 and on Drawing D-1007.
3. To facilitate future property development, plan for installation of suitable measures to control infiltration of water to the silt bluffs. These measures would include development restrictions, installation of septic sewers, storm sewers, curbs and gutters, improvement of water distribution systems, interception of groundwater near Madeline Lake and restriction of pools.

4. Inform residents of West Bench and Sage Mesa of the potential hazards and the associated risks that they expose themselves to, along with methods for mitigating the potential trigger mechanisms.

KLOHN LEONOFF LTD.

Erik Rehtanz for

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Project Engineer

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Project Manager

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
H. RODNEY SMITH

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GLOSSARY

Bedrock - The solid, undisturbed rock in place either at the ground surface or beneath surficial deposits of soil.

Caving - Failure of a cavern or pipe roof.

Collapse of Internal Soil Structure - Sudden increase in volume of soil due to failure of the bonding agents maintaining the soil structure.

Collapsible Soil - Low density soil which collapses, when wetted for the first time since deposition, in a process termed hydrocompaction, resulting in ground subsidence and cracking.

Colluvial - Slope wash and gravity carried material deposited on and at the base of slopes.

Consolidation Test - A test in which the specimen is laterally confined in a ring and is compressed between porous plates under load.

Engineering Geology - The application of geologic data, principles, and interpretation to naturally occurring earth materials so taht geological factors affecting planning, design, construction, and maintenance of civil engineering works are properly recognized and utilized.

Geologic Hazard - A naturally occurring or man-made geologic condition or phenomenon that may present a potential danger to life and property.

Glacio-lacustrine - Deposition of materials derived from deglaciation as lake sediments.

Ground Wastewater Disposal System - (commonly called septic or septic disposal system) - disposal to the ground of domestic waste water.

Groundwater - Subsurface water within the zone of saturation that is free to move through a soil mass under the influence of gravity.

Groundwater Table - (Water table) - elevations at which the pressure in the water is zero, with respect to the atmospheric pressure or level below which the soil or rock is saturated.

Hydraulic Gradient - The loss of hydraulic head (water pressure) per unit distance of flow.

Hydro-Compaction - Densification of a soil by saturation with water causing rearrangement of soil grain structure in a more compact form.

Joints - Breaks or discontinuities, general planar, in a soil or rock mass.

Joint Set - A number of joints with the same orientation.

Joint System - A number of joint sets within a formation.

Kettle - A depression in a ground caused by the burial and subsequent melting out of an isolated block of glacial ice.

Lacustrine - Referring to lake deposited sediments.

Loess - A uniform silty wind-deposited material having an open structure and relatively high cohesion due to cementation of clay or calcareous material at individual soil grain contacts.

Mass Wasting - The natural movement of materials downslope from small scale ravelling to large scale landslides.

Meltwater Channels - Water course formed by water derived from melting glacial ice (commonly inactive at present).

Perched Water Table - A water table usually of limited area maintained above the normal water table by the presence of a relatively impervious layer.

Piezometer - An instrument for measuring the elevation of the water table (sometimes a small diameter well).

Piping - Subsurface mechanical erosion in which particles of soil are dislodged from their natural position and entrained in a flow of water to form a conduit.

Runoff - Flow of excess surface water (i.e., flow of water that has not infiltrated or evaporated).

Seepage - (Or seepage flow) - the infiltration and subsurface flow of water derived from natural sources and activities of man.

Silt - (Also inorganic silt or rock flour) - material passing the No. 200 (74 - micron) U.S. standard sieve that is non-plastic or very slightly plastic.

Slope Failure - Downslope ovement of soil and rock under the influence of gravity, commonly termed landsliding (including planar and rotational slides, flows, falls, spreads, and raveling).

Solifluction - The slow downslope flow of masses of soil rock debris which are saturated with water and not confined to definite channels.

Subsidence - The downward settling or sinking of the ground.

Varves - Layers of fine sediments graded from coarse below to fine above deposited annually in a lacustrine (lake) environment.

APPENDIX I

TERMS OF REFERENCE

Regional District of Okanagan-Similkameen

101 Martin Street, Penticton, B.C. V2A 5J9 Fax: 492-0063 Telephone: 492-0237

TERMS OF REFERENCE

PROPOSAL CALL
(OCTOBER, 1991)

FOR A STUDY OF GEOLOGICAL CONDITIONS WITH RESPECT TO DEVELOPMENT IN THE WEST BENCH/SAGE MESA AREA, ELECTORAL AREA 'F'

Background

Development pressures led to a geotechnical study of the area in the mid seventies. A report entitled "Geological Hazards and Urban Development of Silt Deposits in the Penticton Area" recommended restrictions on development by creating green, orange and red zones which effectively impacted further development.

A resurfacing of development pressures since the late eighties requires that previous studies be reviewed in relation to possible further development.

Purpose

To determine criteria for development, taking into account identified geological conditions and associated risks.

Scope of Work

1. Review all previous studies.

2. Examine and update the rationale behind the hazard zones (green, orange, red) referred to in the 1977 report entitled "Geological Hazards and Urban Development of Silt Deposits in the Penticton Area".

3. Re-visit hazard zone boundaries, confirm or modify same and determine which areas can be further subdivided.

4. Determine the effects of development to date, utilizing such methods as air photo interpretation; survey of residents; contact with agencies operating within the area; and limited site investigation.

5. Analyze margin of safety for development within the zones with respect to such issues as: slope stability, piping, drainage, and related phenomena.

6. Establish bench marks for risks to allow administrators to decide on acceptable risk levels.

7. Identify practical and enforceable measures required for geotechnical stability of the entire area.

8. Produce in a matrix format specific criteria versus lot size for each zone, without the requirement for ongoing administrative controls.

Proposal Submission

If you are interested in this assignment, please submit twelve (12) copies of your proposal in writing by 3:00 p.m. local time, November 1, 1991 to:

Mr. Andrew Swetlishoff
A/Director of Development Services
Regional District of Okanagan-Similkameen
101 Martin Street
Penticton, B.C.
V2A 5J9

complete with the following information:

A. The consultant shall confirm all members of his project team and submit a resume for each member.

B. A graphic work plan and a methodology are required. This should include a clear description of the tasks proposed to carry out the various aspects of the work and to fulfil the objectives. The work plan should clearly show the level of effort planned for all project team members on each task. A timetable/schedule for the completion of all tasks is also required. (A preliminary indication of when meetings will be required with Regional District and B.C. Ministry of Transportation and Highways staff and the timing of interim and final reports is attached.)

C. Description of recent experience of the Company in related work.

D. A list of sub-consultants or sub-contractors and their qualifications, if planned to be engaged in this study.

E. Suggested revisions to the terms of reference, if any.

F. Proof of professional liability (errors and omissions) insurance coverage.

G. A schedule of hourly rates for all personnel who might be utilized on the project must be provided. The hourly rates quoted shall be firm for a period of one (1) year from the date of your proposal.

H. The percentage mark-up for disbursements arising from the assignment should be indicated. The estimated value of disbursements shall be listed separately, but included within the consultant's upset limit fee to complete the engineering assignment.

I. A total upset fee to complete the engineering assignment as outlined in the foregoing terms of reference, including all disbursements.

Payment

The method of payment will be based on actual time at the hourly rates provided by the consultant to the upset amount, in accordance with job progress. Progress billings will be made in accordance with the work plan.

Preliminary Time Schedule

- Proposals to close November 8, 1991.
- Contract to commence by December 1, 1991.
- Review meetings to be held on or about the first day of each month at the office of the Regional District of Okanagan-Similkameen.
- Draft report to be completed by February 28, 1992.
- Final report to be completed by March 31, 1992.

NOTE: Please be advised that funding for this assignment is subject to the receipt of grants from the Ministry of Transportation and Highways and the Ministry of Municipal Affairs, Recreation and Culture, which have been applied for by the Regional District of Okanagan-Similkameen.

APPENDIX II

SINKHOLE DISTRIBUTION
AND
LANDSLIDE PROBABILITY ANALYSIS

APPENDIX II

TABLE OF CONTENTS

PAGE

Data Base - Distance to Sinkhole or Gully Edge II-1
Graph - Distance vs. Occurrence II-9
Graph - Distance vs. Probability II-10
Graph - 5-Year Rainfall Average Rainfall vs. Probability of Exceedance II-11
Graph - Recharge Curve II-12
Graph - Recharge Based on 5-Year Rain Average Recharge vs. Probability of Exceedance II-13
Graph - Gradient vs. Recharge II-14
Graph - Gradient Based on 5-Year Rain Average Gradient vs. Probability of Exceedance II-15
Graph - Slide Angle vs. Probability of Exceedance Based on Precedent II-16
Graph - Slide Angle vs. Probability of Exceedance II-17
Graph - Density vs. Probability of Exceedance II-18

Data Base - distance to sinkhole or gully edge

sinkhole/gully #	distance to sinkhole or gully edge (e)	
1	5	e
2	20	
3	25	
4	27	
5	22	
6	22	
7	30	
8	25	
9	25	
10	25	e
11	27	
12	25	
13	25	
14	15	e
15	12	
16	12	
17	20	
18	25	
19	20	
20	25	
21	22	
22	20	e
23	2	e
24	25	
25	17	
26	30	
27	17	
28	15	
29	15	
30	32	
31	25	
32	25	
33	30	
34	25	e
35	20	
36	20	
37	12	
38	22	
39	12	
40	22	
41	20	
42	20	
43	15	
44	15	
45	30	e
46	20	
47	20	
48	20	
49	12	
50	25	e
51	12	

	Distance equal to:	
dist (m)	all	gully
0	1	1
2	2	2
5	4	4
7	5	5
10	13	11
12	33	11
15	35	14
17	37	13
20	73	14
22	51	5
25	35	8
27	21	1
30	14	3
32	6	0
35	4	1
37	1	0
40	1	1
	336	94

This sheet presents information derived from the results of calculations using estimated values for many of the input parameters, each of which can vary over a wide range. Consequently, the information on the sheet is for illustration purposes only, and is not reliable for all conditions. The information on this sheet must not be used for design and must not be interpreted in any absolute manner.

52	15	
53	12	
54	12	
55	10	e
56	27	
57	22	
58	15	
59	15	
60	27	
61	22	
62	15	e
63	22	
64	12	e
65	20	e
66	10	e
67	25	
68	15	
69	15	
70	20	
71	20	
72	20	
73	25	e
74	15	e
75	12	e
76	17	e
77	22	e
78	17	e
79	20	e
80	27	
81	10	e
82	17	
83	17	
84	25	
85	27	
86	15	
87	15	
88	22	
89	17	
90	20	e
91	17	
92	17	
93	17	
94	20	
95	20	
96	20	
97	20	
98	20	
99	20	
100	17	e
101	27	
102	25	

This sheet presents information derived from the results of calculations using estimated values for many of the input parameters, each of which can vary over a wide range. Consequently, the information on the sheet is for illustration purposes only, and is not reliable for all conditions. The information on this sheet must not be used for design and must not be interpreted in any absolute manner.

104	22	e
105	15	e
106	20	e
107	40	e
108	12	e
109	27	
110	20	
111	20	
112	20	
113	22	
114	22	
115	30	
116	22	
117	22	
118	20	
119	20	
120	27	
121	25	
122	17	
123	17	
124	22	
125	22	
126	27	
127	20	
128	20	
129	7	e
130	25	
131	12	
132	12	
133	22	
134	15	e
135	17	e
136	17	
137	22	
138	20	
139	27	
140	20	
141	27	
142	25	
143	25	
144	25	
145	15	
146	15	
147	20	
148	20	
149	22	
150	22	
151	22	
152	17	
153	17	
154	17	
155	22	

This sheet presents information derived from the results of calculations using estimated values for many of the input parameters, each of which can vary over a wide range. Consequently, the information on the sheet is for illustration purposes only, and is not reliable for all conditions. The information on this sheet must not be used for design and must not be interpreted in any absolute manner.

156	20	
157	20	
158	25	
159	27	
160	22	
161	20	
162	20	
163	30	
164	25	
165	20	e
166	20	
167	17	
168	25	
169	17	
170	17	
171	10	e
172	20	
173	17	e
174	22	
175	22	
176	22	
177	15	
178	12	
179	12	
180	15	e
181	15	
182	15	
183	17	e
184	20	e
185	27	
186	7	e
187	10	e
188	22	
189	22	
190	15	e
191	20	
192	27	
193	30	
194	30	
195	30	e
196	27	
197	25	
198	20	
199	25	
200	20	
201	32	
202	10	e
203	17	
204	17	
205	20	
206	22	
207	20	

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208	22	
209	22	
210	17	e
211	27	
212	12	
213	12	
214	27	
215	27	
216	20	
217	15	
218	15	
219	20	
220	12	
221	12	
222	22	
223	27	
224	15	e
225	20	
226	32	
227	30	
228	20	e
229	30	e
230	15	e
231	15	e
232	15	e
233	25	e
234	20	e
235	22	
236	10	
237	10	
238	25	e
239	5	e
240	17	e
241	35	
242	7	e
243	10	e
244	27	e
245	10	e
246	22	e
247	20	e
248	17	
249	17	
250	20	
251	17	e
252	22	
253	17	
254	12	e
255	22	
256	22	
257	30	
258	25	e

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260	32	
261	10	e
262	12	
263	12	
264	12	
265	15	
266	12	
267	12	
268	12	
269	25	
270	15	
271	15	
272	22	
273	22	
274	20	
275	20	
276	17	e
277	20	
278	7	e
279	20	
280	5	e
281	20	
282	20	
283	20	
284	20	
285	22	
286	12	e
287	20	
288	20	
289	17	e
290	25	
291	12	e
292	32	
293	12	e
294	20	
295	10	e
296	20	
297	0	e
298	12	e
299	22	
300	22	
301	20	
302	20	
303	17	e
304	17	
305	17	
306	15	e
307	30	
308	15	e
309	20	e
310	35	e
311	10	e

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312	25	
313	7	e
314	22	
315	15	e
316	22	
317	20	e
318	12	e
319	22	e
320	25	e
321	2	e
322	22	
323	22	
324	25	
325	17	e
326	20	e
327	22	
328	22	
329	35	
330	32	
331	12	e
332	37	
333	35	
334	5	e
335	12	e
336	20	e

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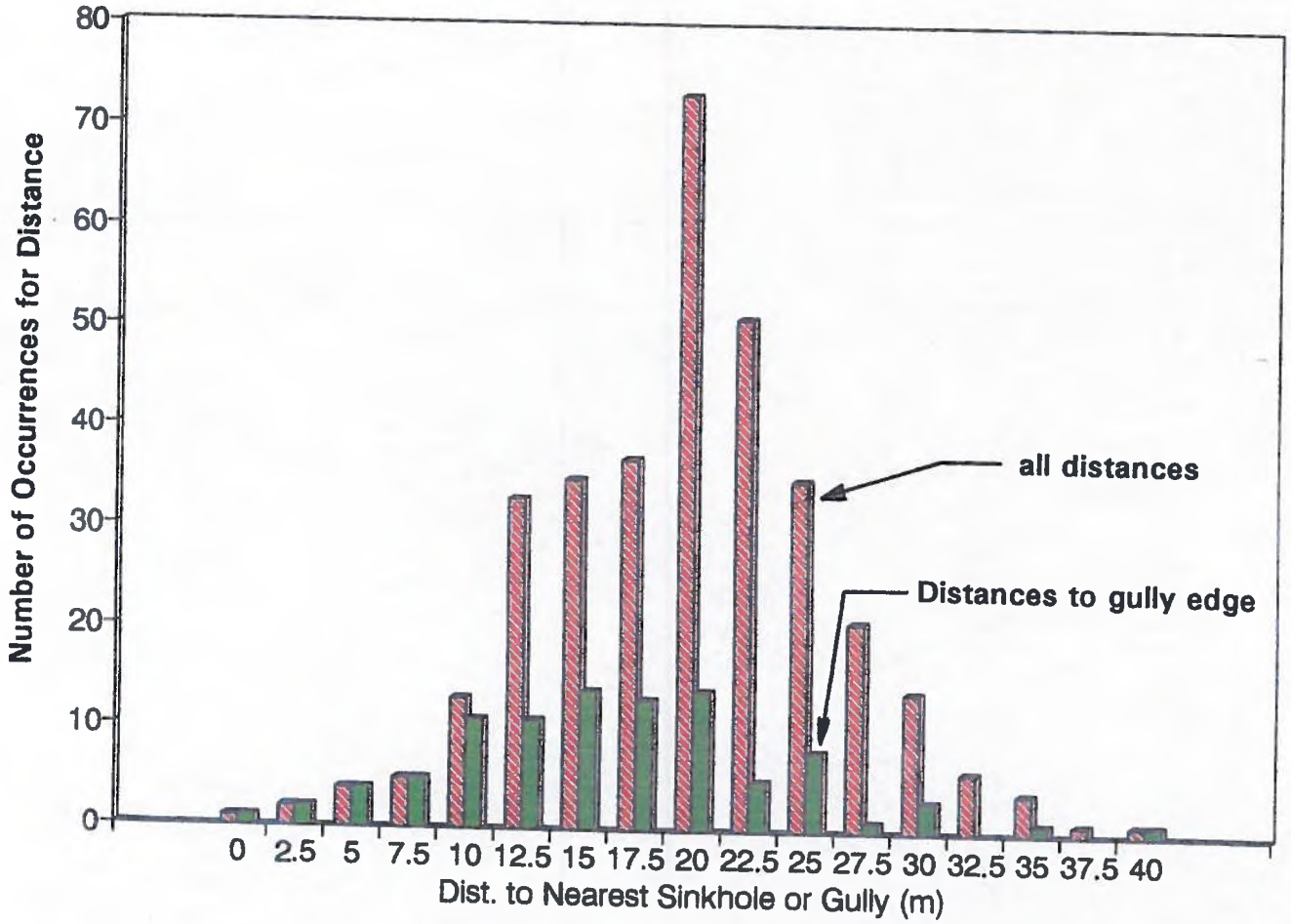
Distance (m)	336/5000	336/2000	336/10000
D	0.0672	0.168	0.0336
0	0.0672	0.168	0.0336
2.5	0.067	0.1675	0.0335
5	0.0666	0.1665	0.0333
7.5	0.0658	0.1645	0.0329
10	0.0648	0.162	0.0324
12.5	0.0622	0.1555	0.0311
15	0.0556	0.139	0.0278
17.5	0.0486	0.1215	0.0243
20	0.0412	0.103	0.0206
22.5	0.0266	0.0665	0.0133
25	0.0164	0.041	0.0082
27.5	0.0094	0.0235	0.0047
30	0.0052	0.013	0.0026
32.5	0.0024	0.006	0.0012
35	0.0012	0.003	0.0006
37.5	0.0004	0.001	0.0002
40	0.0002	0.0005	0.0001

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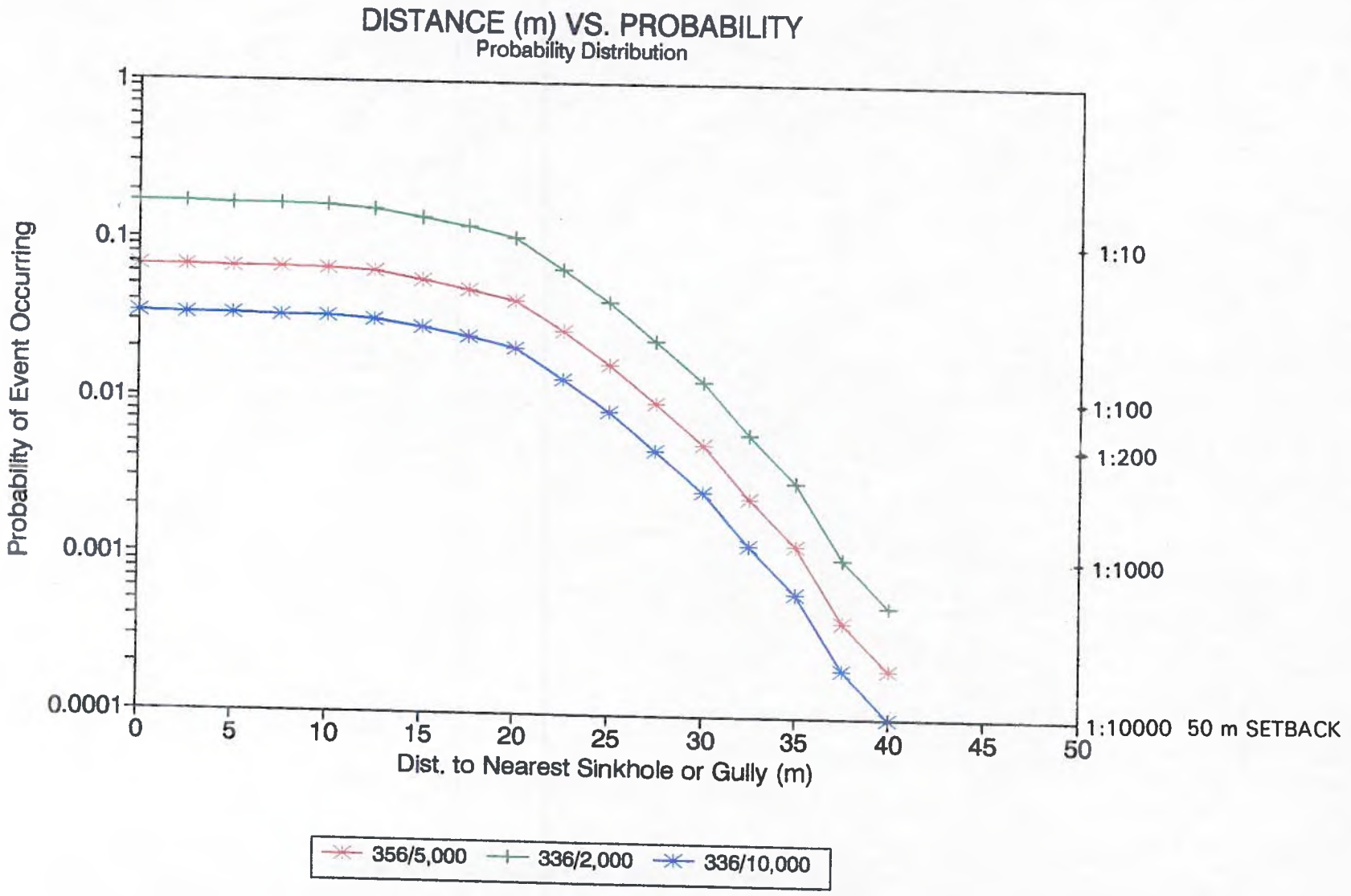
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DISTANCE (m) VS. OCCURRENCE

Frequency Distribution

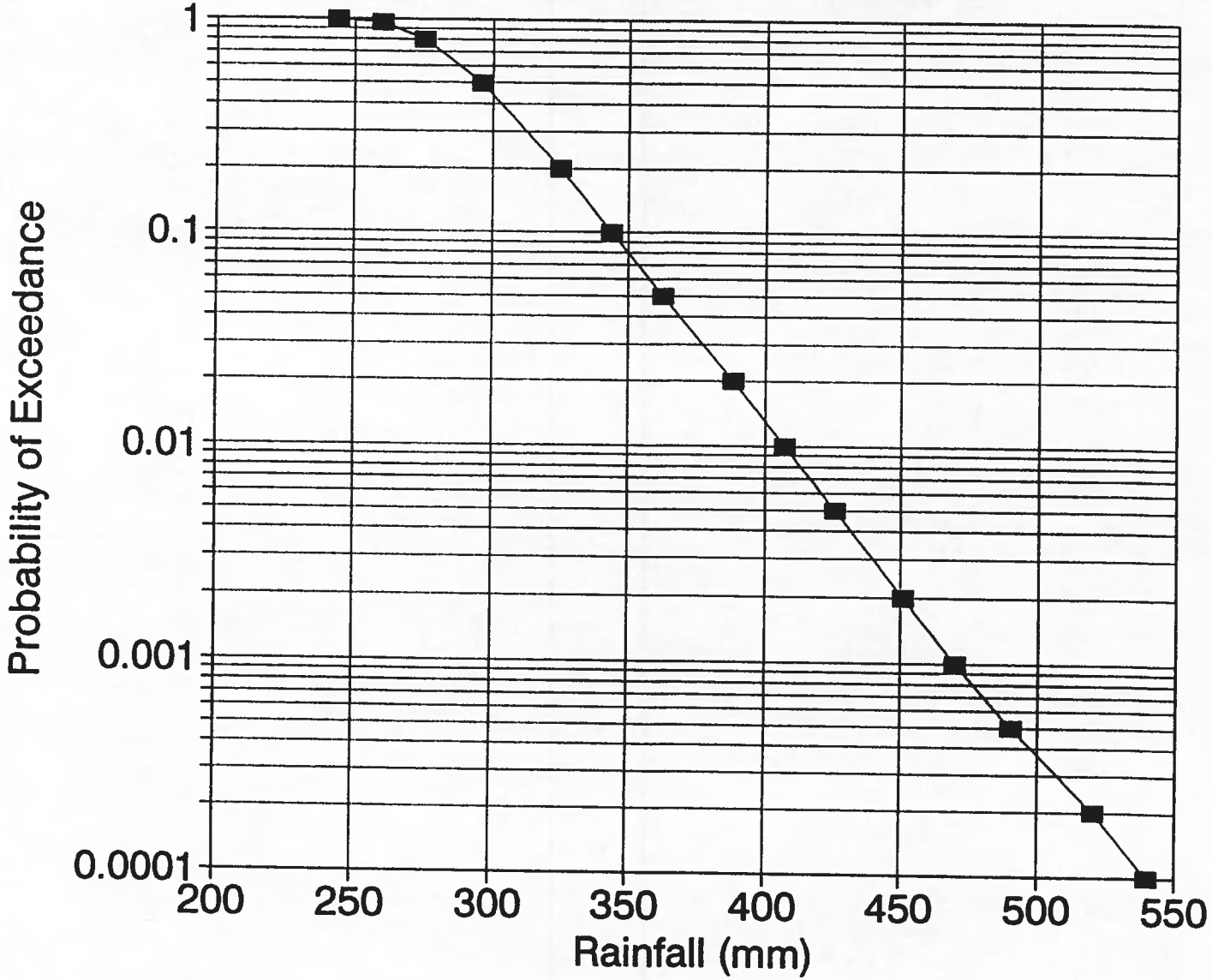


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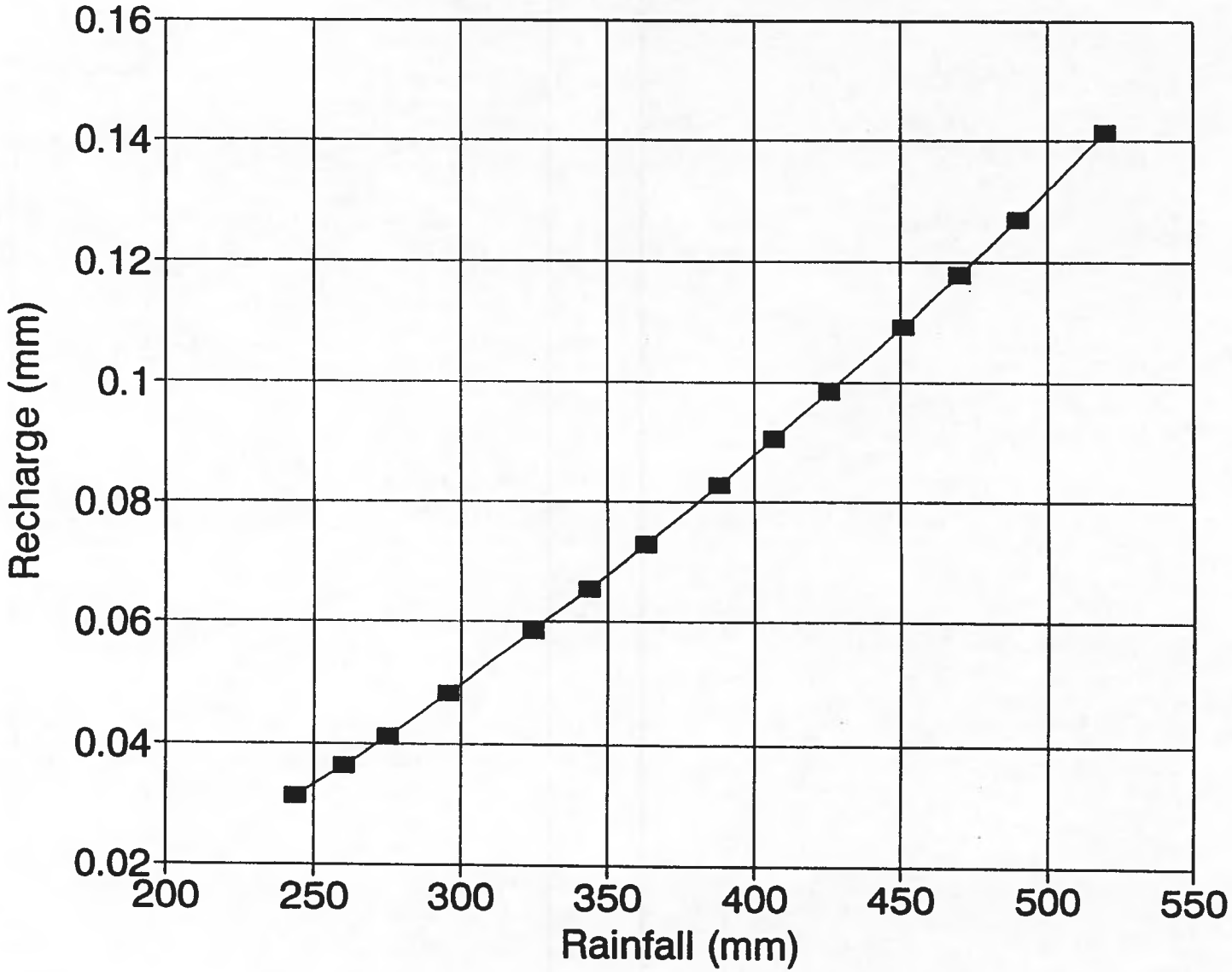
5-YEAR RAINFALL AVERAGE



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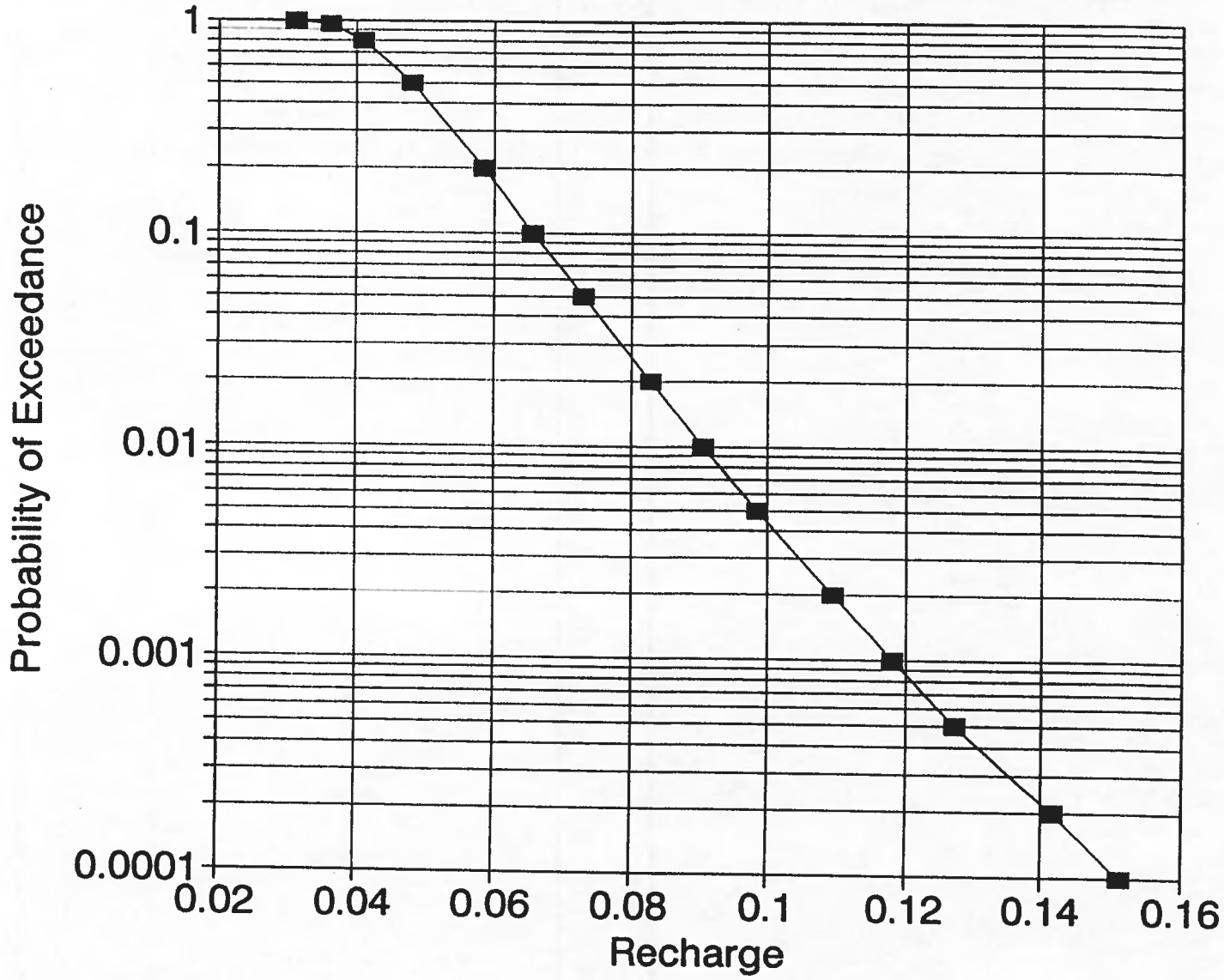
RECHARGE CURVE



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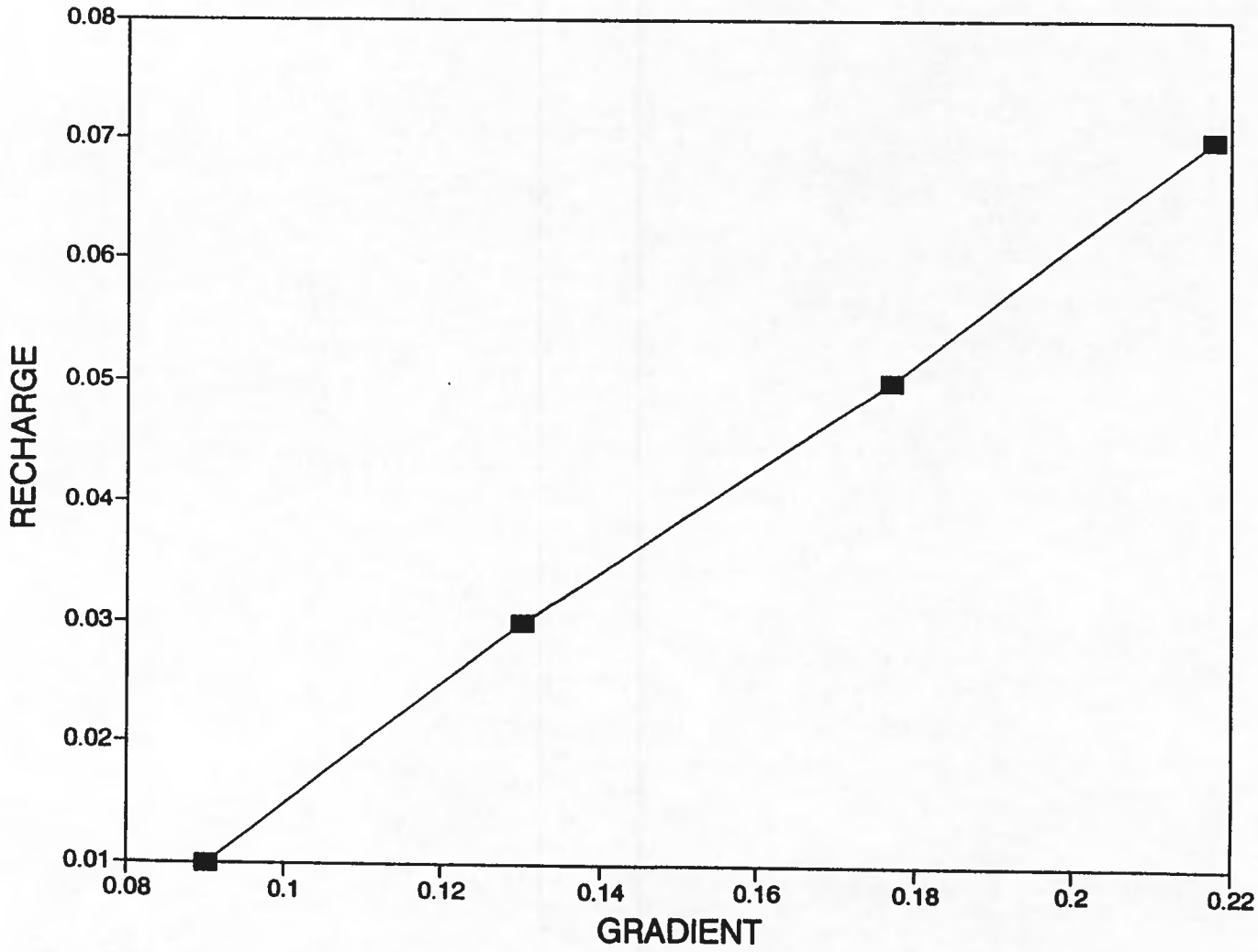
RECHARGE BASED ON 5-YEAR RAIN AVERAGE



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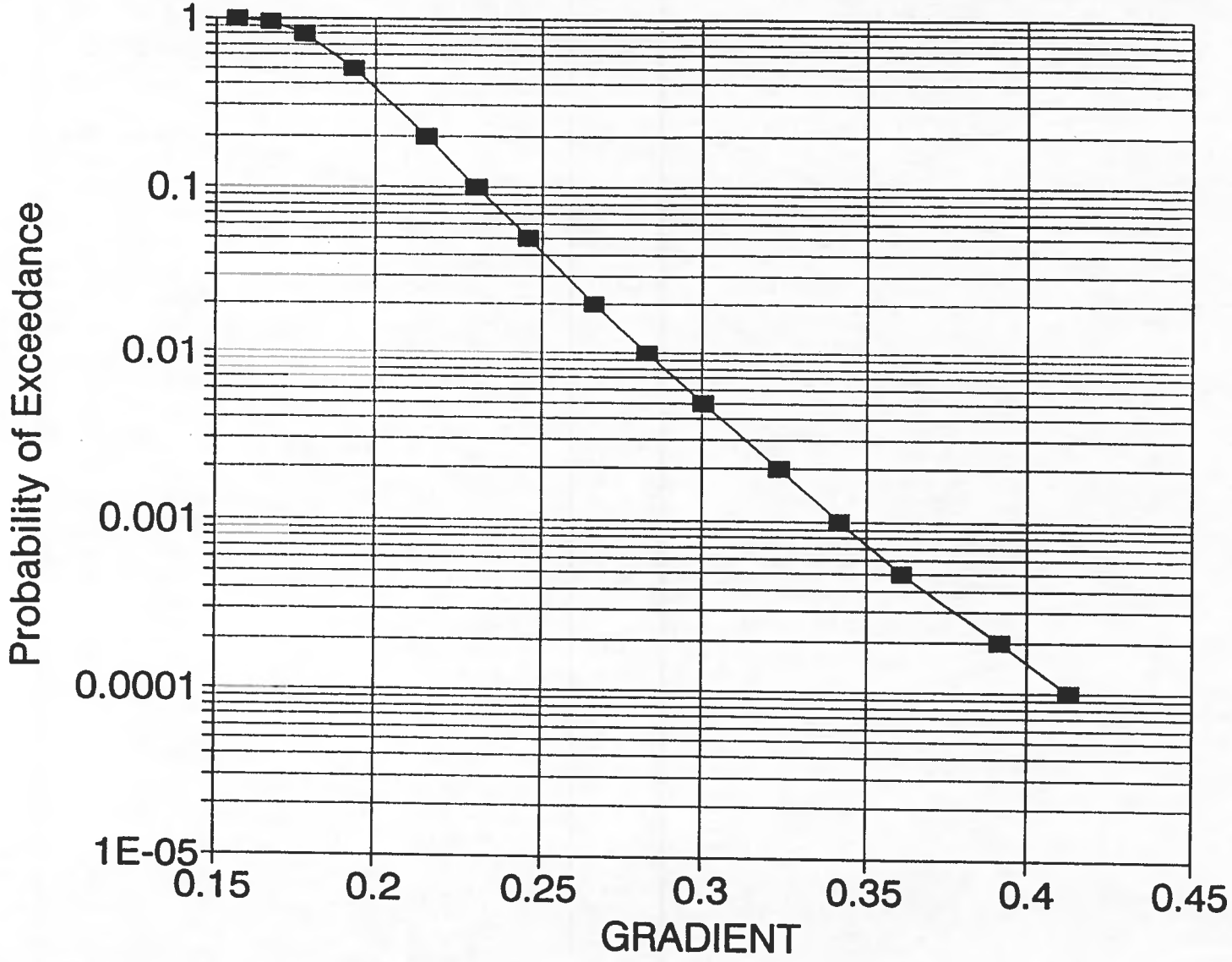
RECHARGE VS. GRADIENT



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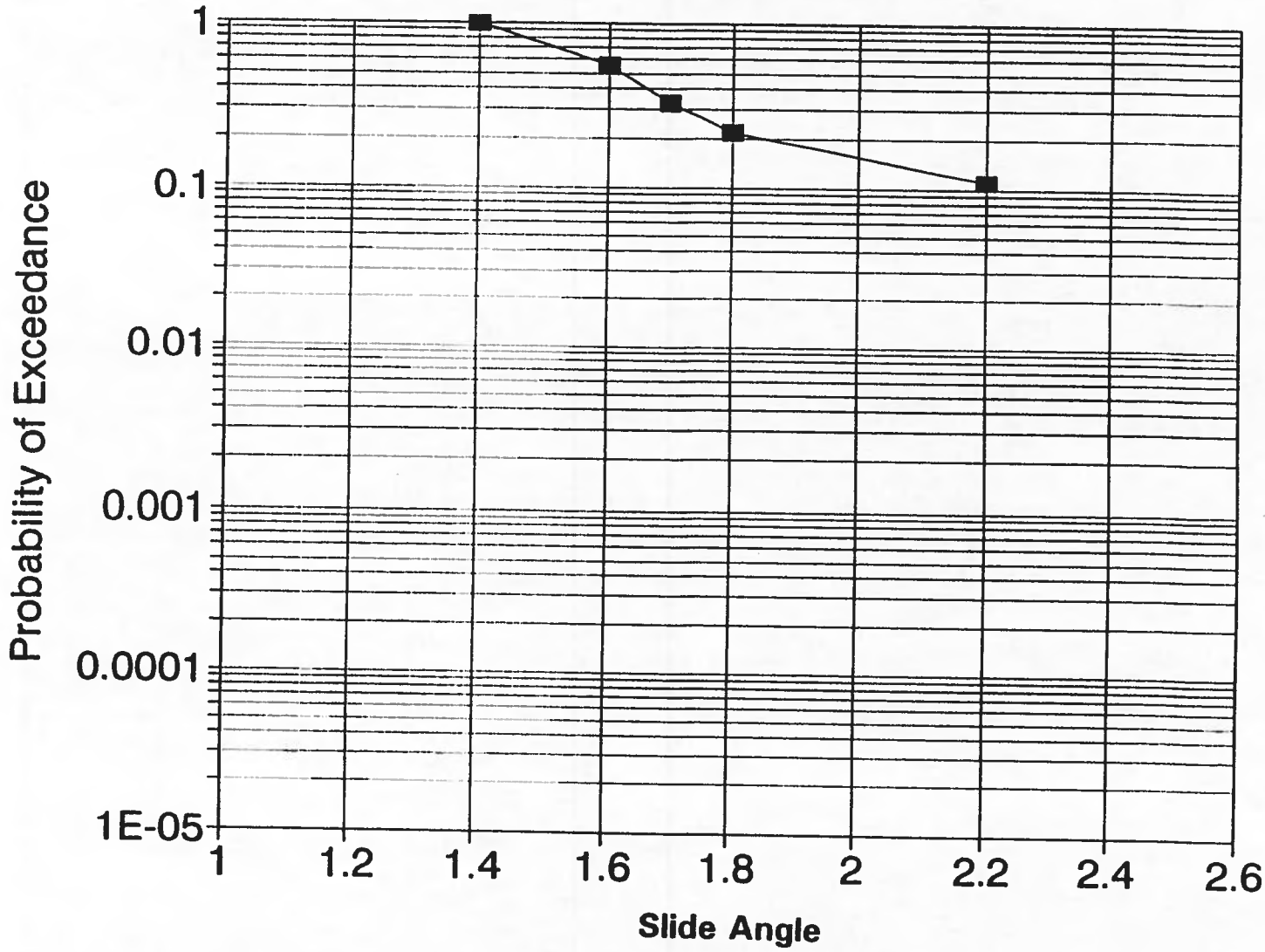
GRADIENT BASED ON 5-YEAR RAIN AVERAGE



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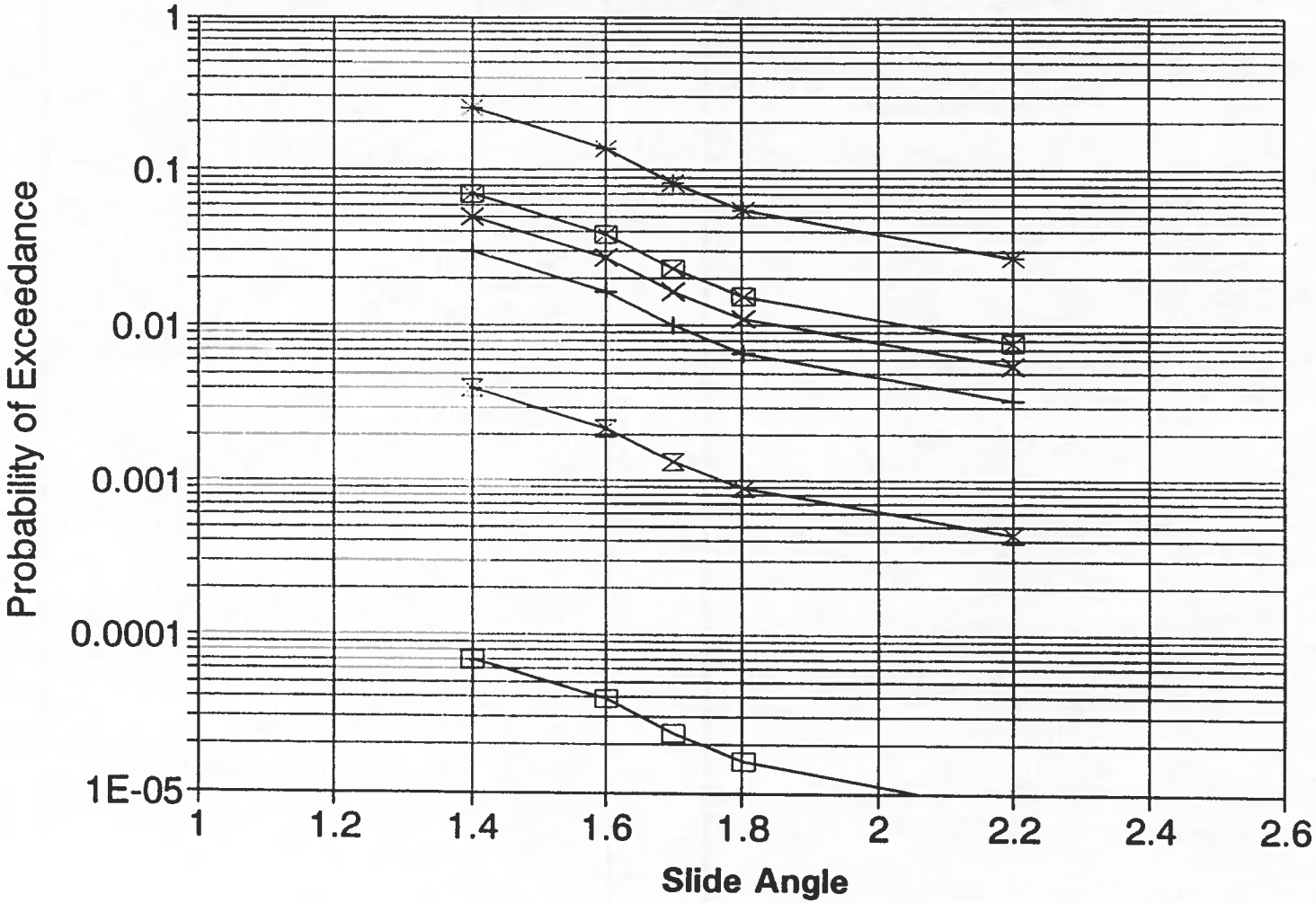
SLIDE ANGLE VS PROBABILITY OF EXCEEDANCE
Based on Precedent



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SLIDE ANGLE VS PROBABILITY OF EXCEEDANCE



KLOHN LEONOFF

APPENDIX III

GEOPHYSICS

Geophysical Dipole-Dipole Resistivity Investigation

Introduction

On march 13 and 14 1992, a small program of dipole-dipole apparent resistivity was carried out at the Pine Hills Golf course, on the West Bench in Penticton, B.C..
The objective was to assess the effectiveness of the resistivity method in an area prone to sinkhole development in mapping out possible ground water flow and voids which would indicate pipes or caved areas within the silt formation.
The resistivity survey consisted of 3 lines totalling 800 metres of dipole-dipole profiling with a 7 separation coverage.

Instrumentation and Survey Procedure

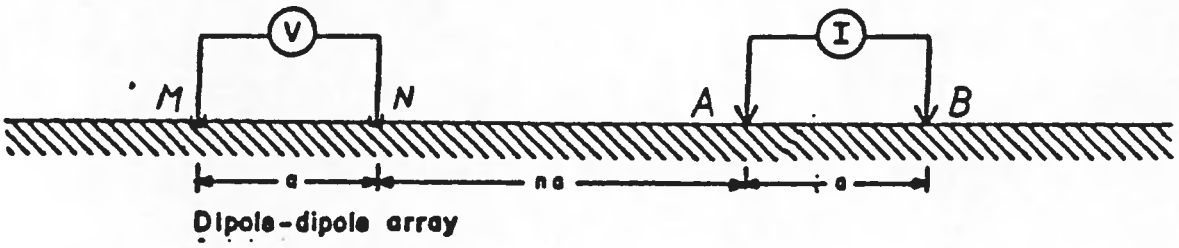
Instrumentation

The resistivity survey was carried out using an ABEM SAS 300B resistivitimeter with stainless steel electrodes and one 100 metre, 26 conductor cable.

Dipole-dipole survey

The "a-na-a" dipole-dipole array is defined as having 4 collinear electrodes with 2 current electrodes on one end and 2 potential electrodes on the other. The current electrodes are separated by a distance "a", which is also the separation between potential electrodes. The distance between the near electrodes (one current and one potential) is "na", where n represen ts the number of separations.
The dipole-dipole configuration allows for definition of both horizontal and vertical locations of discreet resistivity anomalies (sinkholes and zones of piping).
An "a" spacing of 10 metres was employed with "n" values ranging from 1 to 7 .
The dipole-dipole survey was carried out over three North-South trending line with a 20 m spacing between lines and 10 m between stations along the surveyed lines.

Fig, 1 Schematic diagram of dipole-dipole electrodes configuration.



Data processing

The dipole-dipole data was reduced and resistivity values plotted for each line in a 2D "pseudosection" to give a simultaneous display of both horizontal and vertical variations in apparent resistivity. The conventional presentation places each value measured at the intersection of two 45-degree lines through the centre of the dipoles. Each horizontal data line is associated with a specific value of n and, by implication, with a given "effective depth of investigation".
The plotted data were then gridded using a 5 m grid cell; the resulting gridded data were assigned colours in a logarithmic distribution. The 3 resulting false colour pseudosections are presented in Appendix.
The resistivity data was also plotted in plan for each one of the seven "n" separations, gridded using a 5 m grid cell and contoured to create an apparent resistivity colour map for each pseudo "n" level.

Interpretation

Vertical pseudosections and level "n=1" resistivity map indicate most significantly that colluvium and reworked (collapsed silt) can be easily discerned from the lacustrine silt by a much higher recorded resistivity values. Resistivity values calculated using the resistivity interpretation program RESIXP range between 150 to 400 ohm/m for the colluvium and reworked silt and 20 to 40 ohm/m for the lacustrine silt.
A high resistivity anomaly on maps for levels "n=3" to "n=7" could be associated with an open void (developing sinkhole) with an easterly dipping pipe at level "n=7".
A second high resistivity anomaly on maps for levels "n=4" to "n=7" could indicate another large void. This anomaly is in line with a serie of sinkhole, directly East and West of the surveyed area.

Conclusions

Resistivity can be used to detect and map with considerable accuracy, the discontinuity between colluvial silt and in place lacustrine silt on the silt benches in the Penticton area. It also clear from the results that actively developing sinkholes are readily detectable with the dipole-dipole resistivity method and that this geophysical method holds considerable promise as a tool to locate and map otherwise undetectable zones along which sinkhole activity may develop.



Survey Line 3



Survey Line 2



Survey Line 1

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SCALE

KLOHN LEONOFF LTD.

PROJECT: WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE: DIPOLE–DIPOLE RESISTIVITY SURVEY PSEUDO – SECTIONS

CLIENT: REGIONAL DISTRICT OF OKANAGAN–SIMILKAMEEN

DATE OF ISSUE: AUG 10, 1992

APPROVED: ER Aug/92

PROJECT No.: PB5847 01

DWG. No.: APP.III–1

REV.:



n = 2



n = 3



n = 4



n = 5



n = 6



n = 7

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SCALE

KLOHN LEONOFF LTD.

PROJECT: WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE: DIPOLE–DIPOLE RESISTIVITY SURVEY RESISTIVITY MAPS (SEPARATIONS n=2 TO n=7)

CLIENT: REGIONAL DISTRICT OF OKANAGAN–SIMILKAMEEN

DATE OF ISSUE: AUG 10, 1992

APPROVED: ER AUG/92

PROJECT No.: PB5847 01

DWG. No.: APP.III–2

REV.:

APPENDIX IV

WATER BALANCE

General Water Balance		1	2	3	4	5	6	7	8	9	10		TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake		INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X		0
2 Irrigation		X	X	X	X	X	X	X	X	X	X		0
3 Domestic		X	X	X	X	X	X	X	X	X	X		0
4 Catchment		5,360,000	0	0	X	X	X	X	X	X	X		5,360,000
5 Roads and Roofs		0	X	X	X	X	X	X	X	X	X		0
6 Gravel		1,340,000	0	0	1,393,600	0	X	0	X	X	X		2,733,600
7 Silt		670,000	0	0	X	0	0	X	X	X	X		670,000
8 Sub-silt		X	X	X	X	X	35,537	40,200	X	X	X		75,737
9 Evapotranspiration		X	X	X	3,966,400	0	2,022,864	495,800	X	X	X		6,485,064
10 Lake		X	X	X	X	X	675,199	134,000	75,737	X	X		884,936
Flows are in cubic metres per year													
TOTAL FROM UNIT		7,370,000	0	0	5,360,000	0	2,733,600	670,000	75,737	0	0		16,209,337

West Bench

0 houses
545 acres
0 gallons per day (1991 consumption average)

Flow through silt to sub-silt (in rainfall equivalent)
0.0201 m/yr/m²

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General Water Balance Notes

FROM	TO	NOTES
Precipitation	Catchment	Average rain (0.355 m.) over catchment (16,000,000 m²)
Precipitation	Roads and Roofs	None
Precipitation	Gravel	Average rain (0.355 m.) over gravel (4,000,000 m²)
Precipitation	Silt	Average rain (0.355 m.) over silt (2,000,000 m²)
Irrigation	Catchment	None
Irrigation	Gravel	None
Irrigation	Silt	None
Domestic	Catchment	None
Domestic	Gravel	None
Domestic	Silt	None
Catchment	Gravel	26% of catchment water goes to gravel
Catchment	Evapotranspiration	74% of catchment water goes to evapotranspiration
Roads and Roofs	Gravel	None
Roads and Roofs	Silt	None
Roads and Roofs	Evapotranspiration	None
Gravel	Silt	No water flows from the gravel to the silt
Gravel	Sub-silt	1.2% of water in the gravel flows to the sub-silt
Gravel	Evapotranspiration	74% of water in the gravel is evapotranspired
Gravel	Lake	24.70% of the water in the gravel flows out the gullies into the lake
Silt	Gravel	No water flows from the silt to the gravel
Silt	Sub-silt	6% of precipitation moves through the silt to the sub-silt
Silt	Evapotranspiration	74% of precipitation is evapotranspired
Silt	Lake	20% of precipitation runs off into the lake
Sub-silt	Lake	All if the sub-silt water flows out to the lake

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KLOHN LEONOFF

General Water Balance		1	2	3	4	5	6	7	8	9	10		TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake		INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X		0
2 Irrigation		X	X	X	X	X	X	X	X	X	X		0
3 Domestic		X	X	X	X	X	X	X	X	X	X		0
4 Catchment		5,360,000	61,000	17,500	X	X	X	X	X	X	X		5,438,500
5 Roads and Roofs		16,750	X	X	X	X	X	X	X	X	X		16,750
6 Gravel		1,340,000	108,600	24,679	1,414,010	2,345	X	0	X	X	X		2,889,634
7 Silt		670,000	473,400	114,715	X	9,380	0	X	X	X	X		1,267,495
8 Sub-silt		X	X	X	X	X	37,565	86,086	X	X	X		123,651
9 Evapotranspiration		X	X	X	4,024,490	5,025	2,138,329	1,003,615	X	X	X		7,171,459
10 Lake		X	X	X	X	X	713,740	177,795	123,651	X	X		1,015,186
Flows are in cubic metres per year													
TOTAL FROM UNIT		7,386,750	643,000	156,894	5,438,500	16,750	2,889,634	1,267,495	123,651	0	0		17,922,675

West Bench

358 houses

545 acres

208 gallons per day (1991 consumption rate)

Flow through silt to sub-silt (in rainfall equivalent)

0.0430 m/yr/m²

Average lot size in West Bench (25% of area for roads)

1.14 acres per lot

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KLOHN LEONOFF

General Water Balance		1	2	3	4	5	6	7	8	9	10	TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake	INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X	0
2 Irrigation		X	X	X	X	X	X	X	X	X	X	0
3 Domestic		X	X	X	X	X	X	X	X	X	X	0
4 Catchment		5,360,000	61,000	17,500	X	X	X	X	X	X	X	5,438,500
5 Roads and Roofs		16,750	X	X	X	X	X	X	X	X	X	16,750
6 Gravel		1,340,000	108,600	44,493	1,414,010	2,345	X	0	X	X	X	2,909,448
7 Silt		670,000	473,400	193,973	X	9,380	0	X	X	X	X	1,346,753
8 Sub-silt		X	X	X	X	X	37,823	117,789	X	X	X	155,612
9 Evapotranspiration		X	X	X	4,024,490	5,025	2,152,992	1,027,392	X	X	X	7,209,898
10 Lake		X	X	X	X	X	718,634	201,572	155,612	X	X	1,075,817
Flows are in cubic metres per year												
TOTAL FROM UNIT		7,386,750	643,000	255,966	5,438,500	16,750	2,909,448	1,346,753	155,612	0	0	18,152,778

West Bench

358 houses
545 acres
375 gallons per day (1991 consumption average)

Flow through silt to sub-silt (in rainfall equivalent)

0.0589 m/yr/m²

Average lot size in West Bench (25% of area for roads)

1.14 acres per lot

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General Water Balance		1	2	3	4	5	6	7	8	9	10	TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake	INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X	0
2 Irrigation		X	X	X	X	X	X	X	X	X	X	0
3 Domestic		X	X	X	X	X	X	X	X	X	X	0
4 Catchment		5,360,000	61,000	17,500	X	X	X	X	X	X	X	5,438,500
5 Roads and Roofs		16,750	X	X	X	X	X	X	X	X	X	16,750
6 Gravel		1,340,000	108,600	48,222	1,414,010	2,345	X	0	X	X	X	2,913,177
7 Silt		670,000	473,400	208,886	X	9,380	0	X	X	X	X	1,361,666
8 Sub-silt		X	X	X	X	X	37,871	123,755	X	X	X	161,626
9 Evapotranspiration		X	X	X	4,024,490	5,025	2,155,751	1,031,866	X	X	X	7,217,132
10 Lake		X	X	X	X	X	719,555	206,046	161,626	X	X	1,087,226
Flows are in cubic metres per year												
TOTAL FROM UNIT		7,386,750	643,000	274,608	5,438,500	16,750	2,913,177	1,361,666	161,626	0	0	18,196,077

West Bench

388 houses

545 acres

375 gallons per day (1991 consumption average)

Flow through silt to sub-silt (in rainfall equivalent)

0.0619 m/yr/m²

Average lot size in West Bench (25% of area for roads)

1.05 acres per lot

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KLOHN LEONOFF

General Water Balance		1	2	3	4	5	6	7	8	9	10		TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake		INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X		0
2 Irrigation		X	X	X	X	X	X	X	X	X	X		0
3 Domestic		X	X	X	X	X	X	X	X	X	X		0
4 Catchment		5,360,000	61,000	17,500	X	X	X	X	X	X	X		5,438,500
5 Roads and Roofs		16,750	X	X	X	X	X	X	X	X	X		16,750
6 Gravel		1,340,000	108,600	50,956	1,414,010	2,345	X	0	X	X	X		2,915,911
7 Silt		670,000	473,400	219,823	X	9,380	0	X	X	X	X		1,372,603
8 Sub-silt		X	X	X	X	X	37,907	128,129	X	X	X		166,036
9 Evapotranspiration		X	X	X	4,024,490	5,025	2,157,774	1,035,147	X	X	X		7,222,436
10 Lake		X	X	X	X	X	720,230	209,327	166,036	X	X		1,095,593
Flows are in cubic metres per year													
TOTAL FROM UNIT		7,386,750	643,000	288,279	5,438,500	16,750	2,915,911	1,372,603	166,036	0	0		18,227,829

West Bench

410 houses
545 acres
375 gallons per day (1991 consumption average)

Flow through silt to sub-silt (in rainfall equivalent)

0.0641 m/yr/m²

Average lot size in West Bench (25% of area for roads)

1.00 acres per lot

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KLOHN LEONOFF

General Water Balance		1	2	3	4	5	6	7	8	9	10	TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake	INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X	0
2 Irrigation		X	X	X	X	X	X	X	X	X	X	0
3 Domestic		X	X	X	X	X	X	X	X	X	X	0
4 Catchment		5,360,000	61,000	17,500	X	X	X	X	X	X	X	5,438,500
5 Roads and Roofs		16,750	X	X	X	X	X	X	X	X	X	16,750
6 Gravel		1,340,000	108,600	67,734	1,414,010	2,345	X	0	X	X	X	2,932,689
7 Silt		670,000	473,400	286,936	X	9,380	0	X	X	X	X	1,439,716
8 Sub-silt		X	X	X	X	X	38,125	154,974	X	X	X	193,099
9 Evapotranspiration		X	X	X	4,024,490	5,025	2,170,190	1,055,281	X	X	X	7,254,986
10 Lake		X	X	X	X	X	724,374	229,461	193,099	X	X	1,146,934
Flows are in cubic metres per year												
TOTAL FROM UNIT		7,386,750	643,000	372,170	5,438,500	16,750	2,932,689	1,439,716	193,099	0	0	18,422,674

West Bench

545 houses
545 acres
375 gallons per day (1991 consumption average)

Flow through silt to sub-silt (in rainfall equivalent)

0.0775 m/yr/m²

Average lot size in West Bench (25% of area for roads)

0.75 acres per lot

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KLOHN LEONOFF

General Water Balance		1	2	3	4	5	6	7	8	9	10		TOTAL
To	From »	Precip.	Irr.	Domestic	Catchment	Roads ...	Gravel	Silt	Sub-silt	Evap.	Lake		INTO UNIT
1 Precipitation		X	X	X	X	X	X	X	X	X	X		0
2 Irrigation		X	X	X	X	X	X	X	X	X	X		0
3 Domestic		X	X	X	X	X	X	X	X	X	X		0
4 Catchment		5,360,000	61,000	17,500	X	X	X	X	X	X	X		5,438,500
5 Roads and Roofs		16,750	X	X	X	X	X	X	X	X	X		16,750
6 Gravel		1,340,000	108,600	102,533	1,414,010	2,345	X	0	X	X	X		2,967,488
7 Silt		670,000	473,400	426,132	X	9,380	0	X	X	X	X		1,578,912
8 Sub-silt		X	X	X	X	X	38,577	210,653	X	X	X		249,230
9 Evapotranspiration		X	X	X	4,024,490	5,025	2,195,941	1,097,040	X	X	X		7,322,496
10 Lake		X	X	X	X	X	732,970	271,220	249,230	X	X		1,253,419
Flows are in cubic metres per year													
TOTAL FROM UNIT		7,386,750	643,000	546,165	5,438,500	16,750	2,967,488	1,578,912	249,230	0	0		18,826,796

West Bench

825 houses
545 acres
375 gallons per day (1991 consumption average)

Flow through silt to sub-silt (in rainfall equivalent)

0.1053 m/yr/m²

Average lot size in West Bench (25% of area for roads)

0.50 acres per lot

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KLOHN LEONOFF

General Water Balance Notes

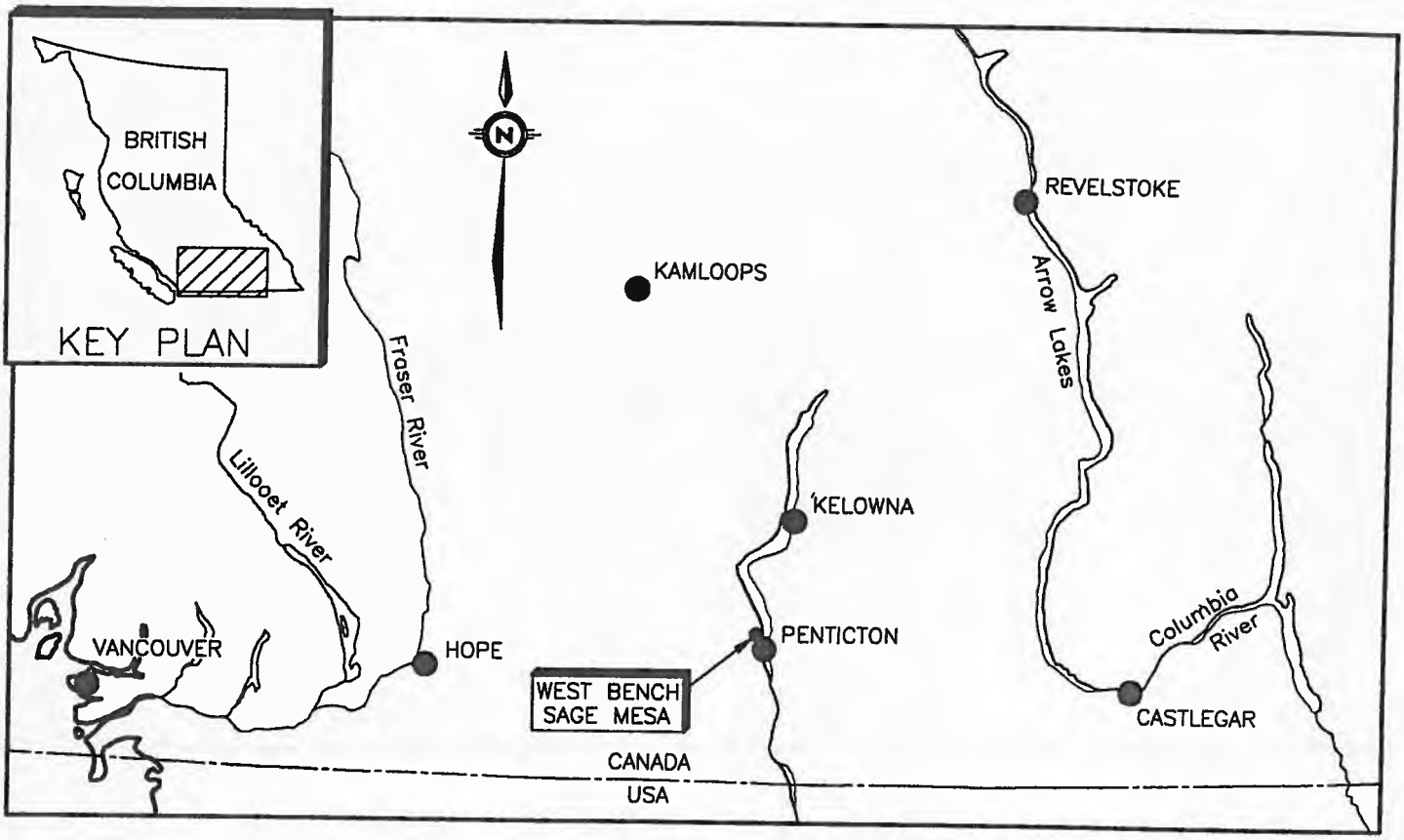
FROM	TO	NOTES
Precipitation	Catchment	Average rain (0.355 m.) over catchment (16,000,000 m²)
Precipitation	Roads and Roofs	Average rain (0.355 m.) over roads and roofs (50,000 m²)
Precipitation	Gravel	Average rain (0.355 m.) over gravel (4,000,000 m²)
Precipitation	Silt	Average rain (0.355 m.) over silt (2,000,000 m²)
Irrigation	Catchment	Irrigation water form Hsula Highlands and Pine Hills Golf Course (17,000 m3 + 44,000 m3)
Irrigation	Gravel	20 % of irrigation water from West Bench (0.2 * 543,000 m3)
Irrigation	Silt	Irrigation water from Sage Mesa and 80% from West Bench (39,000 + 0.8 * 543,000 m3)
Domestic	Catchment	Domestic water from Hsula Highlands (17,500 m3)
Domestic	Gravel	20 % of domestic water from West Bench
Domestic	Silt	Domestic water from Sage Mesa and 80% from West Bench (16,000 m3 + 0.8*West Bench)
Catchment	Gravel	26% of catchment water goes to gravel
Catchment	Evapotranspiration	74% of catchment water goes to evapotranspiration
Roads and Roofs	Gravel	20% of roads and roofs are in gravel areas and 70% of water goes into the ground
Roads and Roofs	Silt	80% of roads and roofs are in gravel areas and 70% of water goes into the ground
Roads and Roofs	Evapotranspiration	30% of water from roads and roofs is evapotranspired
Gravel	Silt	no water flows from the gravel to the silt
Gravel	Sub-silt	1.2% of water in the gravel flows to the sub-silt
Gravel	Evapotranspiration	74% of water in the gravel is evapotranspired
Gravel	Lake	24.70% ofwater in the gravel flows out the gullies into the lake
Silt	Gravel	no water flows from the silt to the gravel
Silt	Sub-silt	6% of precipitation and 60% of domentic water moves through the silt to the sub-silt
Silt	Evapotranspiration	All irrigation, 74% of precipitation and 30% of domestic water is evapotranspired
Silt	Lake	All road and roof drainage, 20% of precipitation and 30% of domestic water runs off into the lake
Sub-silt	Lake	All if the sub-silt water flows out to the lake

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KLOHN LEONOFF

DRAWINGS

DRAWING A-1001	-	LOCATION PLAN
DRAWING B-1002	-	SITE PLAN
DRAWING B-1003	-	GEOLOGY PLAN
DRAWING BX-1004	-	GEOLOGY SECTIONS
DRAWING D-1005	-	LANDSLIDE HAZARD PLAN
DRAWING D-1006	-	SINKHOLE HAZARD PLAN
DRAWING D-1007	-	STUDY AREA ZONE PLAN



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SCALE N.T.S.

KLOHN LEONOFF LTD.

PROJECT: WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE: LOCATION PLAN

CLIENT: REGIONAL DISTRICT OF OKANAGAN–SIMILKAMEEN

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
AUG 10, 1992	PB584701	A–1001	

APPROVED

BLUE MOUNTAIN

1000

900

800

700

600

500

400

MADELINE LAKE

TROUT CREEK
PENTICTON
DRIVE-IN
MADELINE LAKE
VALLEY

MOUNT NKWALA

STUDY AREA BOUNDARY

INLAND NATURAL GAS CO. PIPELINE

CANADIAN PACIFIC RAILROAD RIGHT-OF-WAY-(ABANDONED)

WEST BENCH

SUMMERLAND

SHINGLE CREEK

OKANAGAN RIVER

SAGE MESA

HIGHWAY 97

CITY OF PENTICTON

OKANAGAN LAKE
(EL. 342m)

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
H. RODNEY SMITH

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TO BE READ WITH KLOHN LEONOFF REPORT DATED AUGUST 10, 1992

KLOHN LEONOFF		DATE
DESIGNED	RCG	JULY/92
DRAWN	EP	JULY/92
CHECKED		
RECOMMENDED		
APPROVED		

KLOHN LEONOFF LTD.

CLIENT
REGIONAL DISTRICT OF OKANAGAN-SIMILKAMEEN

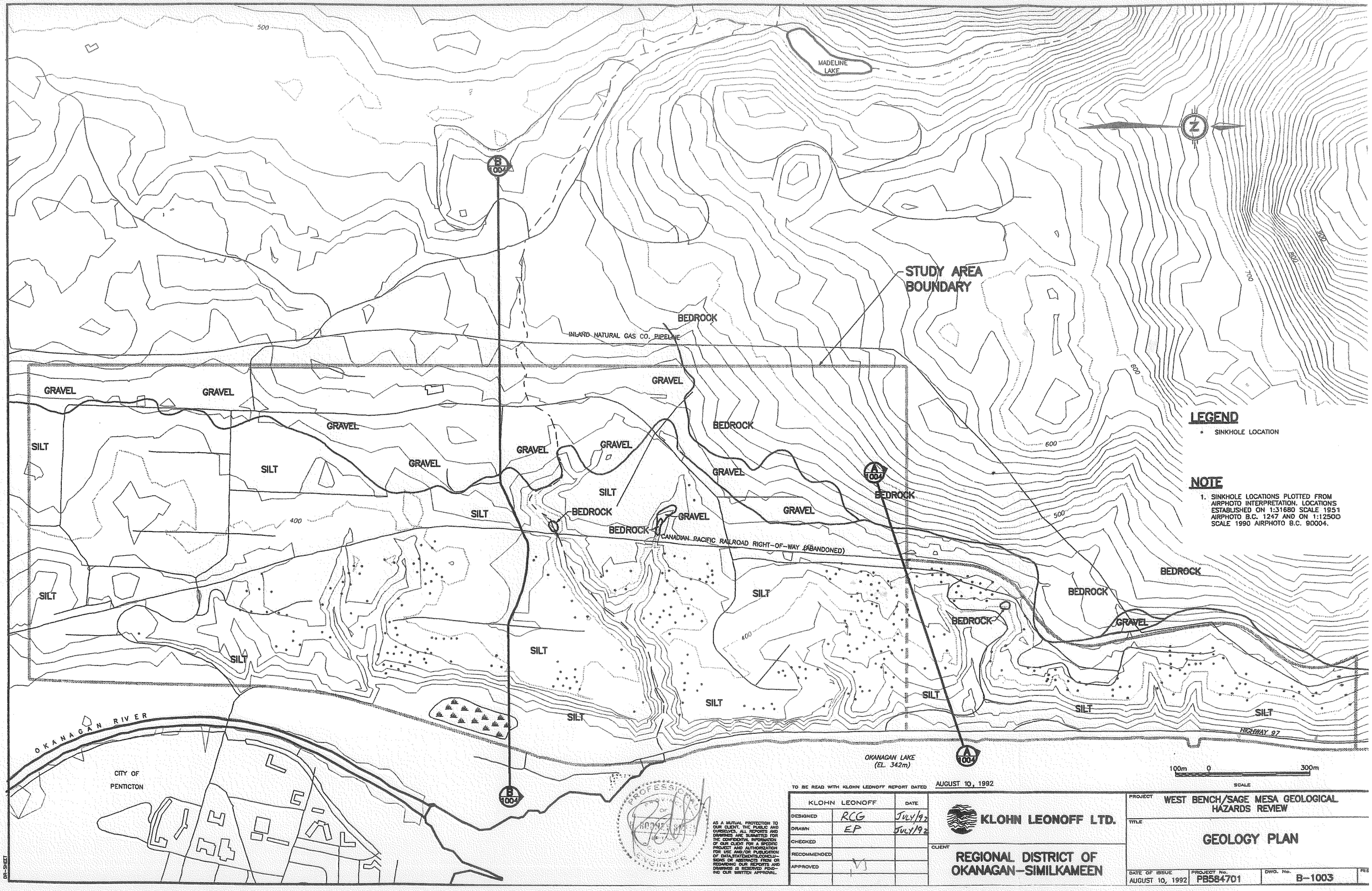
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SCALE

PROJECT
WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE
SITE PLAN

DATE OF ISSUE | PROJECT No. | DWG. No. | REV

DR-SHEET



LEGEND

- SINKHOLE LOCATION

NOTE

1. SINKHOLE LOCATIONS PLOTTED FROM AIRPHOTO INTERPRETATION. LOCATIONS ESTABLISHED ON 1:31680 SCALE 1951 AIRPHOTO B.C. 1247 AND ON 1:12500 SCALE 1990 AIRPHOTO B.C. 90004.

TO BE READ WITH KLOHN LEONOFF REPORT DATED AUGUST 10, 1992

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REGIONAL DISTRICT OF OKANAGAN-SIMILKAMEEN

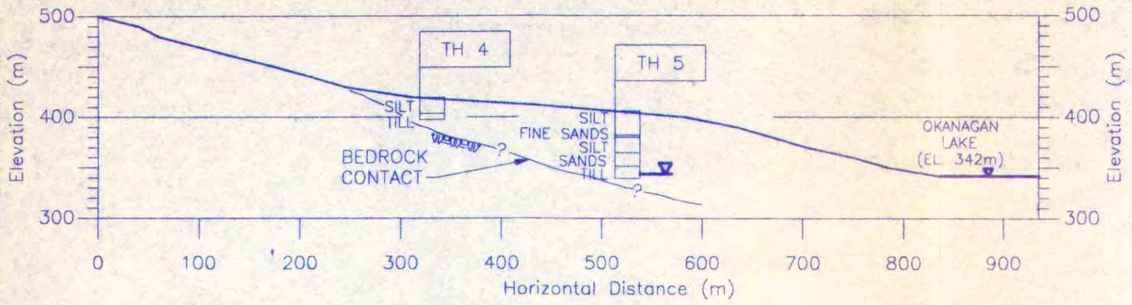
PROJECT: WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE: GEOLOGY PLAN

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
AUGUST 10, 1992	PB584701	B-1003	

DR-SHEET

SECTION ALONG CHAPMAN / BAUER PROPERTY

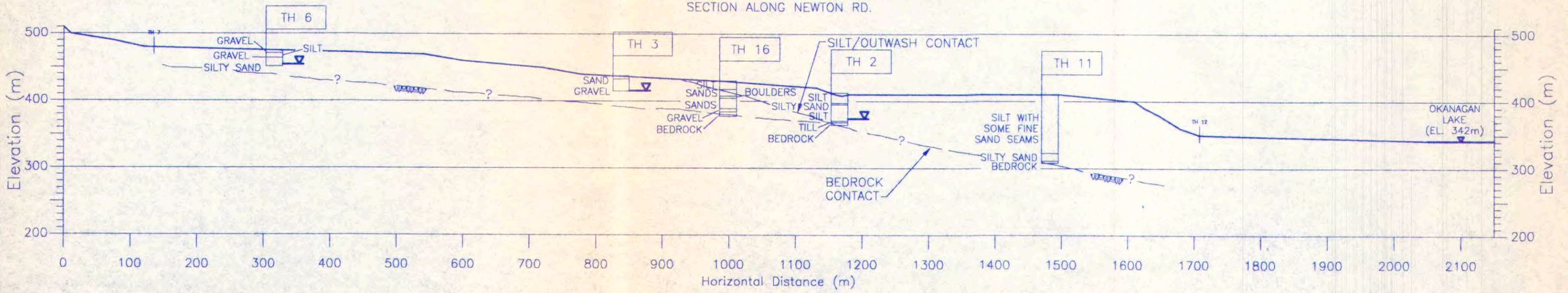


SECTION A 1003

NOTES

1. DRILL HOLE DATA IS FROM ORIGINAL DRILL LOGS PRODUCED DURING THE NYLAND AND MILLER FIELD INVESTIGATION.
2. GEOLOGY IS INTERPRETED FROM SURFICIAL FIELD MAPPING, BORE HOLE DATA AND GEOPHYSICS INTERPRETATION FROM NYLAND AND MILLER (1977).
3. WATER LEVELS ARE MEAN WATER LEVELS FROM 1976–1977 READINGS.

SECTION ALONG NEWTON RD.



SECTION B 1003

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CLIENT: REGIONAL DISTRICT OF OKANAGAN–SIMILKAMEEN

SCALE

PROJECT: WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE: GEOLOGIC SECTIONS

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
AUGUST 10, 1992	PB584701	BX–1004	

MADELINE LAKE

STUDY AREA BOUNDARY

INLAND NATURAL GAS CO. PIPELINE

CANADIAN PACIFIC RAILWAY

WEST BENCH

LANDSLIDE HAZARD ZONE

SAGE MESA

HIGHWAY 97

OKANAGAN LAKE (EL. 342m)

OKANAGAN RIVER

CITY OF PENTICTON

500

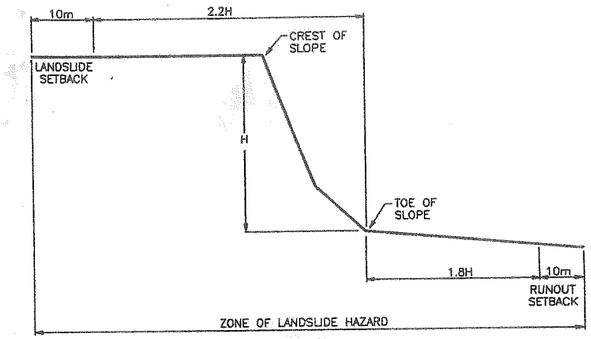
600

700

800

900

400



100m 0 300m SCALE

TO BE READ WITH KLOHN LEONOFF REPORT DATED AUGUST 10, 1992

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA H. RODNEY SMITH

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KLOHN LEONOFF LTD.

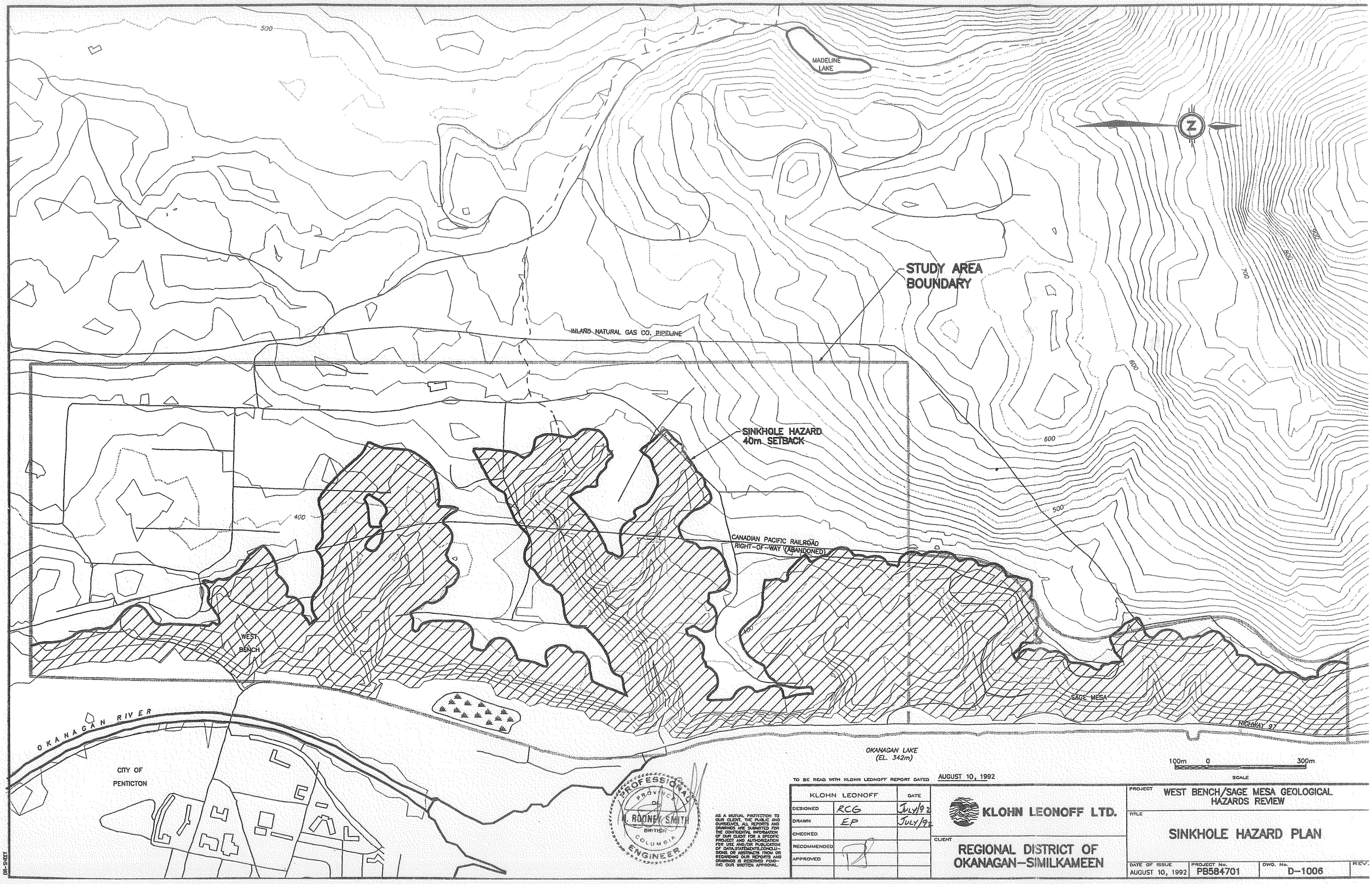
CLIENT
REGIONAL DISTRICT OF OKANAGAN-SIMILKAMEEN

PROJECT WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE
LANDSLIDE HAZARD PLAN

DATE OF ISSUE	PROJECT No.	DWG. No.	REV
AUGUST 10, 1992	PB584701	D-1005	

ON-SHEET



TO BE READ WITH KLOHN LEONOFF REPORT DATED AUGUST 10, 1992

KLOHN LEONOFF		DATE
DESIGNED	RCG	JULY/92
DRAWN	EP	JULY/92
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PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — R. ROONEY SMITH

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CLIENT: REGIONAL DISTRICT OF OKANAGAN-SIMILKAMEEN

PROJECT: WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE: SINKHOLE HAZARD PLAN

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
AUGUST 10, 1992	PB584701	D-1006	

D4-SHEET

MADELINE LAKE

STUDY AREA BOUNDARY

INLAND NATURAL GAS CO. PIPELINE

CANADIAN PACIFIC RAILROAD RIGHT-OF-WAY (ABANDONED)

WEST BENCH

SAGE MESA

HIGHWAY 97

OKANAGAN RIVER

CITY OF PENTICTON

OKANAGAN LAKE (EL. 342m)

500 400 600 700 800 900

LEGEND

5 DENOTES ZONE NO.

ZONE NO.	DESCRIPTION	NEW COMMUNITY	DENSITY OF 0.5 ACRE TO 1.0 ACRE	DENSITY OF >1.0 ACRE
1	LANDSLIDE HAZARD	e	e	e
2	SINKHOLE HAZARD	e	e	e
3	SILT BLUFF	e	c	c
4	GRAVEL OR BEDROCK IN STUDY AREA	c	c	d
5	GRAVEL OR BEDROCK OUTSIDE STUDY AREA	c	c	d

a – PERMIT APPROVED WITHOUT CONDITIONS

b – PERMIT APPROVED ONLY WITH A CONVENANT REGISTERED ON THE PROPERTY TITLE CLEARLY DEFINING THE HAZARDS PRESENT

c – PERMIT APPROVED ONLY WITH INSTALLATION OF SEPTIC SEWERS AND STORM SEWERS

d – PERMIT APPROVED ONLY WITH IRRIGATION OR DOMESTIC WATER DRAWN FROM GROUNDWATER

e – PERMIT NOT APPROVED

100m 0 300m SCALE

TO BE READ WITH KLOHN LEONOFF REPORT DATED AUGUST 10, 1992

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA ROGNE

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REGIONAL DISTRICT OF OKANAGAN–SIMILKAMEEN

PROJECT WEST BENCH/SAGE MESA GEOLOGICAL HAZARDS REVIEW

TITLE

STUDY AREA ZONE PLAN

DATE OF ISSUE	PROJECT No.	DWG. No.	REV.
AUGUST 10, 1992	PB584701	D–1007	

D1–SHEET