Apple Hill
Communal Water Project
Class Environmental Assessment
Environmental Study Report

M.S. Thompson & Associates Ltd.

Project No. 94519

November 24, 1999

SUMMARY

This document is the Environmental Study Report for the Apple Hill Communal Water Supply Project, summarising activities from Phases 1, 2, and 3 of the Class Environmental Assessment process.

The environmental process described was preceded by the Ministry of the Environment (MOE) investigation into Apple Hill well contamination in 1989. Following the MOE study, the Township of Kenyon conducted further studies of private water systems and groundwater. In 1995, the Private Water Systems Project Preliminary Hydrogeological Evaluation concluded that individual well correction was not a viable solution for each of the contaminated wells in the hamlet. A communal water supply was identified as the preferred solution and the study was redirected to comply with the requirements of a Class Environmental Assessment for Municipal Water and Wastewater Projects.

The preferred solution is a communal water supply, supplying the community with potable water from groundwater sources located inside the former village area. The preferred design is a medium flow system that meets peak flow demands, but does not provide flow to meet fire fighting requirements. The communal system includes five wells, H_2S removal, a 120 m^3 wet well, low lift and high lift pumping, and disinfection. A distribution system will be installed along existing road allowances and easements in the community.

The preferred design is estimated to cost $1,500,000. With Provincial funding assistance of 70%, the net capital cost per typical lot is $4,500. With Provincial funding assistance of 90%, the net capital cost per typical lot is $1,500. Annual operating costs are estimated at $200 per lot.

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BIBLIOGRAPHY

Water Pollution Survey, Community of Apple Hill (Ontario Ministry of the Environment, 1991)

Class Environmental Assessment for Municipal Water and Wastewater Projects (Municipal Engineers Association, 1993)

Provincial Water Quality Objectives (MOE, 1994)

Township of Kenyon, Apple Hill - Private Sewage Study (M.S. Thompson & Associates Limited, 1997)

1.0 INTRODUCTION

This document is the Environmental Study Report (ESR) of the Class Environmental Assessment for the Apple Hill Communal Water Project. The proponent for the project is the Township of North Glengarry (formerly the Township of Kenyon).

The Apple Hill Water Supply Project was initiated by the Township of Kenyon following a 1991 Ontario Ministry of the Environment (MOE) study indicating unsafe drinking water in the community. The township responded to the MOE study through the formation of a Public Liaison Committee, and the initiation of studies that addressed both water and sewage problems. M.S. Thompson & Associates Ltd. was retained by the municipality to complete the various studies and to develop a preferred alternative design for the hamlet. On January 1, 1998, Kenyon Township became part of the amalgamated municipality of North Glengarry.

In conjunction with the water supply problem, a sewage study was also undertaken. Although the water problem and the sewage problem are related, funding for each project was independent and a separate report was issued for the sewage project.

1.1 Statement of Purpose

The purposes of this report are:

- to document the evaluation of alternative solutions and selection of a preferred design;
- to document activities from Phase 1, Phase 2 and Phase 3 of the Class Environmental Assessment (EA)
- to prepare an Environmental Study Report for review by the public and review agencies; and
- to conduct public consultation activities consistent with the Class EA process.

1.2 Project Team

A project team approach was used for this project. The major parties for the project are identified in Figure 1.

1.3 Organisation of Report

This ESR is organised to reflect the activities and decision points completed during the first three phases of the project. Most of the Appendices associated with the public consultation activities are published as a second volume, Volume II.

Section 1.0 of this report contains an introduction, an overview of the project and a description of the Class Environmental Assessment process. Section 2.0 documents the activities from Phase 1 including a discussion of the background issues surrounding the project and a definition of the problem. Further technical information is contained in the reports:

- Apple Hill Private Water Systems Project
  Preliminary Hydrogeological Investigation (MSTA 1995);

- Apple Hill Water Study - Phase II Private Well Hydrogeological Study and Preliminary Communal Well Evaluation (MSTA 1997); and

- Apple Hill Communal System Hydrogeological Investigation (Phase III Hydrogeological Report) (MSTA 1999).

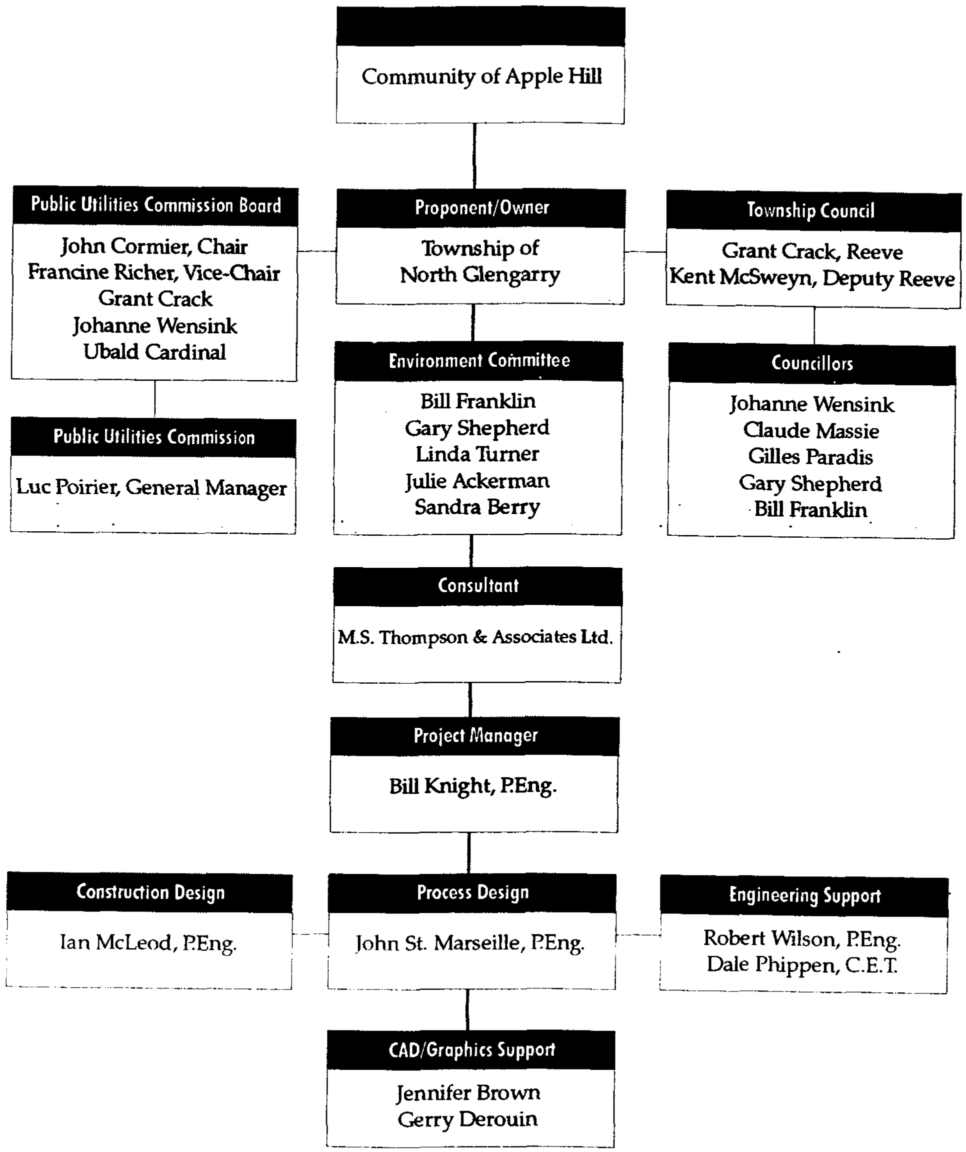
These reports are included in the Appendices.

Section 3.0 contains a description of the alternative solutions evaluated for the project and a summary of the evaluation. The preferred solution is described in Section 4.0.

Section 5.0 describes the activities from Phase 3. It contains a detailed inventory of the social, natural and economic environment, as they pertain to the project. Section 5.0 also contains an evaluation of individual designs considered for the project, the process used to select the preferred design, and the public consultation programme followed.

The preferred design is detailed in Section 6.0. Included in the details are a description of the plant construction and operation, a confirmation of environmental impacts, and a cost breakdown.

Figure 1
Apple Hill Communal Water Project
Organisational Chart

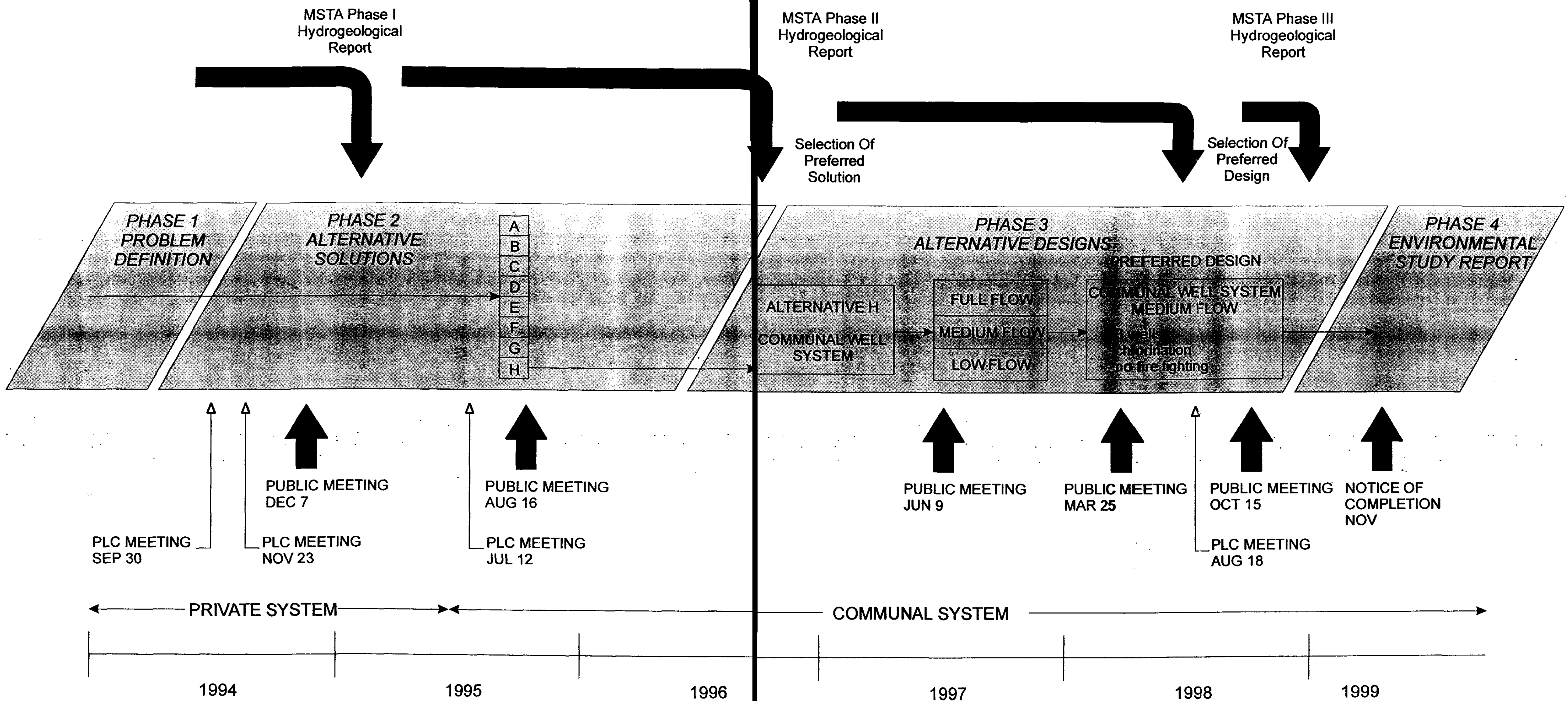


A diagram of the design progression of the Apple Hill Communal Water Supply Project is provided in Figure 2. The phases of the Class EA process are shown as grey bands. The demarcation points for the phases are as follows:

- Phase 1 "Problem Definition";
- Phase 2 Identification of the "Preferred Solution"; and
- Phase 3 Identification of the "Preferred Design."

Screening processes and technical stages are indicated by the bold arrows pointing down. Public consultation activities are shown by bold arrows pointing up. The centre of the diagram shows the broad range of identified alternative solutions being reduced to a single preferred solution by the end of Phase 2. Alternative designs of the preferred solution are reduced to a recommended design, at the end of Phase 3.

While this report is intended to be a complete record of activities up to the end of Phase 4, there may be some details of the design process that have been omitted for the purposes of readability. For clarification of any material presented in this report, or for additional information, readers are encouraged to contact the authors at the Thompson Rosemount Group.



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APPLE HILL COMMUNAL WATER PROJECT
ENVIRONMENTAL STUDY REPORT

CLASS ENVIRONMENTAL ASSESSMENT
DESIGN PROGRESSION

scale	NTS
date	NOV 1999
drawn	JBH
job no.	94519
drawing no.	FIGURE 2

1.4 Environmental Assessments

1.4.1 Environmental Assessment Process

In Ontario, municipal water and wastewater projects are subject to the provisions of the Class Environmental Assessment (document) for Municipal Water and Wastewater Projects, June 1993. The Class Environmental Assessment (Class EA) is an approved planning document which describes the process which proponents must follow in order to meet the requirements of the Environmental Assessment Act of Ontario. By following the Class EA, the municipality (proponent) does not have to apply for an individual environmental assessment under the act. The Class EA approach allows for the evaluation of the environmental effects of carrying out a project and alternative methods of carrying out a project, includes mandatory requirements for public input, and expedites the environmental assessment of smaller recurring projects.

The Class EA planning process was developed to ensure that the potential social, economic and natural environmental effects are considered in planning water, stormwater and sewage projects. Class EAs are a method of dealing with projects that display the following important common characteristics:

- recurring,
- usually small in nature,
- usually limited in scale,
- predictable range of environmental effects, and
- responsive to mitigating measures.

Projects that do not display these characteristics would not be able to use the planning process of this Class EA, and must undergo an individual environmental assessment. The Class EA planning process represents an alternative for Ontario municipalities to carrying out individual environmental assessments for most municipal sewage, stormwater management, and water projects.

1.4.2 Schedules in Environmental Assessments

Since sewage, stormwater management and water projects undertaken by municipalities under the Class EA planning process vary in their environmental impact, such projects are classified in terms of schedules.

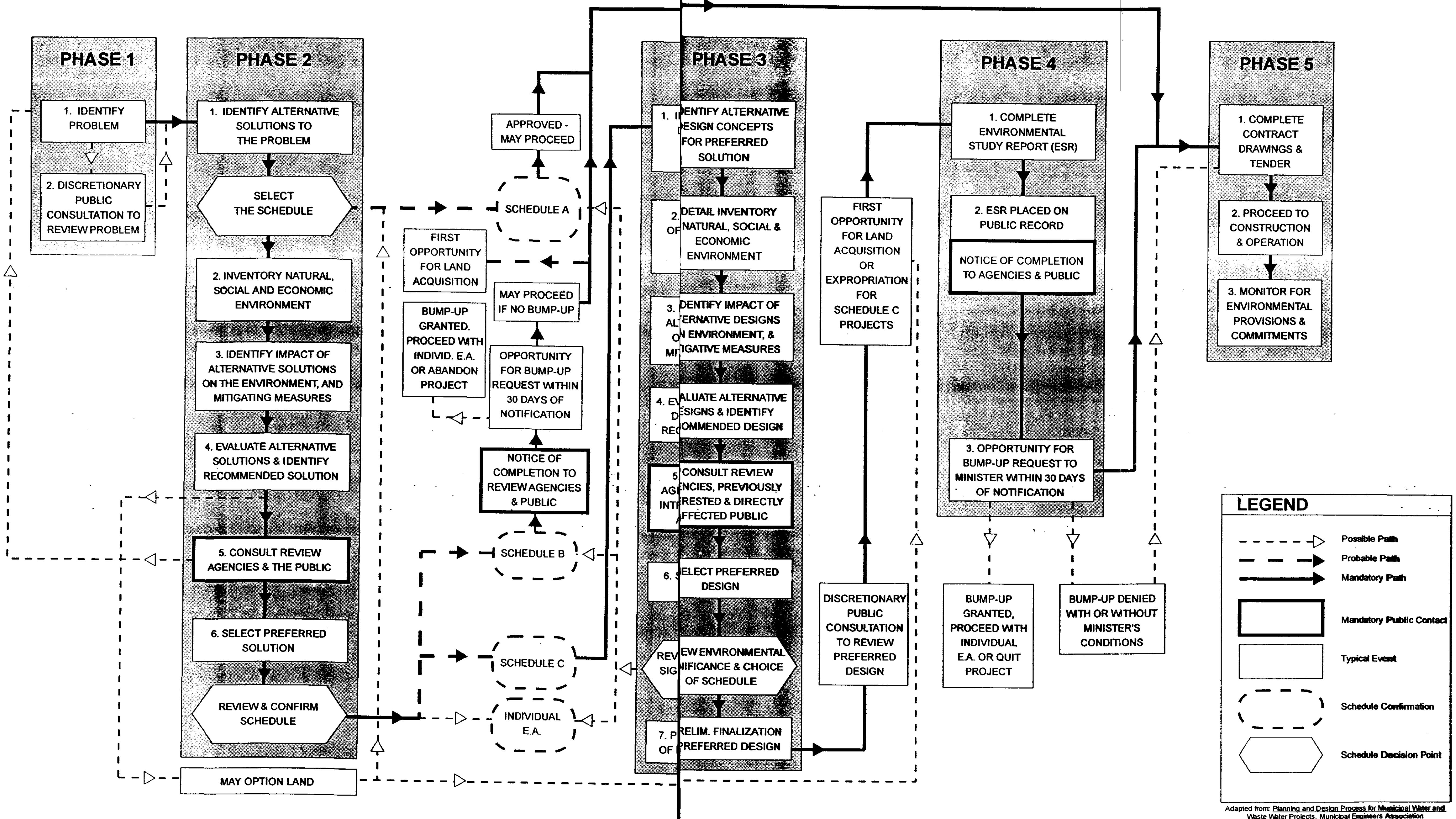
Schedule A projects are limited in scale, have minimal adverse effects and include the majority of municipal sewage, stormwater management and water operations and maintenance activities. These projects are approved and may proceed to implementation without any further requirements under the provisions of the Class EA planning process.

Schedule B projects have the potential for some adverse environmental effects. The proponent is required to undertake a screening process involving mandatory contact with directly affected public and with relevant government agencies. The screening process is to ensure that affected parties are aware of the project and that their concerns are addressed. If there are no outstanding concerns then the proponent may proceed to implementation. If, however, the screening process raises a concern that cannot be resolved, then the "bump-up" procedure may be invoked; alternatively, the proponent may elect voluntarily to plan the project as a Schedule C undertaking. Typically, Schedule B projects involve extensions to existing municipal infrastructure such as sewage collection systems and water distribution systems.

Schedule C projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Class EA process. Schedule C projects require that an Environmental Study Report be prepared and submitted for review by the public. If concerns are raised that cannot be resolved, the "bump-up" procedure may be invoked, which may result in the requirement to complete a full environmental assessment. Refer to Section 1.4.5 for further discussion of the "bump-up" procedure. Typically, these projects involve the construction of municipal infrastructure such as wastewater treatment facilities, new sewage collection and water distribution systems, and water treatment facilities.

Figure 3 presents a flow chart that illustrates the Planning and Design Process for Municipal Water and Wastewater Projects. The precise path to be followed in the process is dependent on the nature of the project and more particularly the schedule in which the project falls. As the proponent proceeds through the planning process beginning with Phase 1 (Problem Definition) and advances towards the end of Phase 2 (Evaluation of Alternative Solutions), the preferred alternative solution is determined. Having determined the preferred solution, the appropriate project schedule and process to be followed for the completion of the project is also determined.

For example, constructing a new sewage treatment facility is a Schedule C activity. Expanding an existing sewage treatment plant including outfall works up to its approved rated capacity is a Schedule B activity. Establishing, extending or enlarging a sewage collection system and all works necessary to connect the system to an existing sewage outlet where such facilities are not shown on an approved development plan nor are in an existing road allowance is also a Schedule B activity. For these projects, the planning process is set out in the Class EA document.



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APPLE HILL COMMUNAL WATER PROJECT
ENVIRONMENTAL STUDY REPORT

PLANNING AND DESIGN PROCESS FOR MUNICIPAL WATER AND WASTEWATER PROJECTS

scale	NTS
date	JAN 1999
drawn	EJC /DWP
job no.	94519
drawing no.	FIGURE 3

1.4.3 Phases of the Class EA Process

Phase 1 defines the nature and extent of the problem. Often a discretionary public meeting is held to inform interested parties of the EA planning process and to discuss the problem.

Phase 2 involves the identification of the preferred alternative solution. Also included are:

- an inventory of the natural, social, and economic environment;
- the identification of the impacts of alternative solutions on the environment;
- the identification of mitigating measures;
- an evaluation of alternative solutions;
- consultation with review agencies and the public regarding the identified problem and alternative solutions;
- the identification of the recommended alternative solution; and
- confirmation of the path or schedule to follow for the balance of the Class EA process.

Public consultation is mandatory at this phase and includes review agencies and the affected public.

Phase 3 involves the identification of alternative designs for the selected alternative solution. Also included are:

- a detailed inventory of the natural, social, and economic environment relating to the selected alternative solution;
- the identification of the impacts of alternative designs on the environment;
- the identification of mitigating measures;
- an evaluation of alternative designs;
- consultation with review agencies and the public regarding the alternative designs;
- the identification of the recommended alternative design; and
- confirmation of the path or schedule to follow for the balance of the Class EA process.

Public consultation is again mandatory at this phase and includes review agencies and the affected public.

Phase 4 represents the culmination of the planning and design process as set out in the Class EA. Phase 4 involves the completion of the documentation including the Environmental Study Report (ESR) if required and the Notice of Completion. The ESR documents all the activities undertaken through Phases 1, 2 and 3 including the Public Consultation. The ESR is filed with the Clerk of the municipality and placed on the public record for at least 30 days to allow for public review. The public and mandatory agencies are notified through the Notice of Completion, which also discloses the "bump-up" provisions.

Phase 5 is the implementation phase of the Class EA process, and includes final design, construction plans and specifications, tender documents, and construction and operation. It also includes monitoring for environmental provisions and commitments as defined in the ESR.

This report documents the project with respect to the Class EA process and is presented along with the Notice of Completion for the 30-day review by the public and review agencies consistent with the requirements of the Class EA process.

1.4.4 Liaison Committee

The Class EA process recommends the creation of a Public Liaison Committee (PLC) to act as "front line" reviewers and monitor the progress of the process. Typically, the PLC is composed of elected officials, senior staff, and residents.

Even as a Private Systems Study in 1994, the Council of the Township of Kenyon directed its Environment Committee to fulfil the PLC mandate of the Environmental Assessment process. Subsequently, with municipal restructuring, the Township of North Glengarry entrusted the responsibility for managing water and wastewater infrastructure to its Public Utilities Commission (PUC), along with the PLC mandate for this project.

1.4.5 Bump-Up Rights

As previously stated, projects subject to a Class EA are recurring, usually small in nature, usually limited in scale, have a predictable range of environmental effects, and are responsive to mitigating measures. Hence the Class EA process is streamlined and typically less onerous to complete compared to an Individual EA.

An Individual EA involves a more complex procedure incorporating similar stages and public/agency consultation. Individual EAs are more expensive and time consuming and typically involve projects that are more unique, larger and wider ranging, have uncommon or unpredictable environmental effects, and may not be responsive to mitigative measures.

Examination of Figure 3 reveals that there is an opportunity for any interested parties to request that the project be bumped up from a Class Environmental Assessment to an Individual Environmental Assessment. The "bump-up" opportunity exists at the Notice of Completion stage and must be filed with the Minister of Environment within thirty (30) days of the notice date. The Notice of Completion occurs at the end of Phase 2 for Schedule B projects and at the end of Phase 4 for Schedule C projects. It signifies that the Class EA process has been completed for the project and that the resulting document has been placed on the public record.

For projects subject to the provisions of the Class Environmental Assessment Process, a person or agency with a significant concern must communicate the concern to the proponent any time between Phases 2 and 4. If the concern cannot be resolved between the party and the proponent, then that person or agency can request the proponent to "bump-up" the process to an Individual EA. If this request is denied then the concerned party may write to the Minister of the Environment and Energy with the same request. This must be done within thirty calendar days during the public review period after the Notice of Completion has been issued.

The Environmental Assessment Branch of the Ministry of the Environment then has forty-five days to prepare a report to the Minister, who then has twenty-one days to make a decision. The Minister may deny the request, deny the request with conditions, refer to the Environmental Assessment Advisory Committee, or comply with the request. Since the bump-up procedure is arduous, an individual or agency with a significant and legitimate concern is wise to engage in an early and meaningful dialogue with the proponent.

The bump-up process was specifically addressed during the public meeting presentation and referenced in the handouts.

2.0 PHASE 1 – PROBLEM DEFINITION

Phase 1 activities of the Class EA are associated with defining the problem.

Before arriving at a formal definition of the problem, or Problem Statement, an examination of the issues is undertaken. This examination is necessary to frame the project in the proper context, and to ensure that all issues are addressed. The examination is also necessary to limit the scope of the project.

2.1 History of Issues

2.1.1 1989 MOE Survey

The Apple Hill Communal Water System has a long history that can be traced to 1989 when the MOE initiated a survey of wells in the community and identified widespread contamination. The well survey was completed in 1990 and the results were published in 1991. A copy of the MOE study is contained in the Preliminary Hydrogeological Evaluation in Appendix A.

The MOE study's main conclusion was that the majority (55%) of the wells in the community were classified as "unsafe"[1]. Water is considered "unsafe" for drinking when the total coliform count is greater than 10 per 100 mL of the sample, or when fecal coliforms are present. A "doubtful" or "poor" indication is assigned when fecal coliforms are absent and total coliforms are between 2 and 10 per 100 mL of the sample. [2]

With the release of the MOE study, the Township of Kenyon was encouraged by the MOE to retain a consulting engineering firm and to apply for direct grants to finance the studies and investigations that would investigate remedial alternatives.

2.2 Initial Public Consultation

2.2.1 Public Liaison Committee Formation

A Public Liaison Committee was struck by the Township of Kenyon with an inaugural meeting on September 27, 1994. Members of the committee were:

Mr. Don Besner	Chair, (former Deputy Reeve), Kenyon Township
Mr. Bernie Raymond	Village of Apple Hill
Mr. Marc Robert	MOE
Mr. Sylvain Diotte	Eastern Ontario Health Unit (EOHU) Sewage Systems Approval
Ms. Clothilde Howieson	Eastern Ontario Health Unit (EOHU) Water Approvals
Mr. Wilfred Vallance	Former Reeve, Kenyon Township

[1] Ontario Ministry of the Environment, Water Pollution Survey, Community of Apple Hill, 1991
[2] Ibid.

Mr. Peter Solda	Ontario Clean Water Agency (OCWA), Toronto
Mr. Patrick Newland	Ontario Clean Water Agency (OCWA), Glen Walter
Mr. John St. Marseille	M.S. Thompson & Associates Ltd. (MSTA)

Mr. Don Besner replaced Mr. Wilfred Vallance as chair on the committee. Mr. Patrick Newland of OCWA's Glen Walter operating division joined the committee after the first meeting. The first full meeting of the PLC was on September 30, 1994. A second meeting of the PLC was held on November 8, 1994. Minutes from the first two PLC meetings are provided in Appendix D.

2.2.2 1994 Public Meeting

A Public Meeting was held on December 7, 1994, at the Apple Hill Community Centre. The Open House was advertised in The Glengarry News before the event. A copy of the sign in sheets, comment sheets and hand-out material is provided in Appendix E.

At the Public Meeting options regarding private and communal well construction were presented, including preliminary cost estimates. The most significant issue raised by the community in attendance was cost. Although some Apple Hill residents expressed objection to any costs above the current (no cost) situation, most residents supported a continued investigation into the groundwater contamination problem.

At this time, the Apple Hill project was considered a private study.

2.3 Initial Studies

Following the release of the MOE study in 1991, the Township undertook several additional studies to characterise the problems with the water supply, and to identify possible solutions:

- a Private Well Correction Study;
- a Private Sewage System Correction Study; and
- a Communal Water Supply Study (this document).

2.3.1 Private Well Correction Study (Preliminary Hydrogeological Investigation)

The first study undertaken by the Township was a preliminary hydrogeological investigation of the area to identify aquifers and contaminants. This study was undertaken in November of 1994, with MAP funding as a private water study (OCWA project 07-3170). The water study is documented in the Preliminary Hydrogeological Investigation report in Appendix A, and discussed in Section 2. This study confirmed the presence of widespread groundwater contamination, but was limited in its scope as a Phase I study. Additional investigation was required to delineate the full nature and extent of contamination, the condition of local aquifers, or the feasibility of corrective actions.

The Preliminary Hydrogeological Investigation was completed in draft form for the December 7, 1994 Public Meeting, but was not finalised until the following January.

2.3.2 Private Sewage Systems

A private sewage study was later funded as OCWA Project Number 50-0111-01. This study is documented in the report Township of Kenyon Apple Hill Private Sewage Study, (MSTA 1997). The sewage study was conducted concurrent with the water study, and does not contain any additional hydrogeological information.

2.4 Apple Hill Project Service Area

2.4.1 Geographic Location

The hamlet of Apple Hill is located at the south west corner of the recently amalgamated Township of North Glengarry, Glengarry County, approximately 20 km west of Alexandria. Zoning for the hamlet includes residential, commercial, industrial and institutional. The centre of the community is the intersection of County Road 20 and County Road 17. A map of the area is provided as Figure 4.

2.4.2 Population

Prior to amalgamation, Apple Hill was a hamlet in the Township of Kenyon. Population records were not kept, except by census. The population recorded in the 1976 census was 271. The population recorded in the 1986 census was 257, a slight decline. The 1991 MOE study identified 98 residences in the community. In 1997, the number of residences had declined to 90, with 8 vacant lots. Based on 2.5 person per residence the current estimated population is 225. There are 10 commercial and institutional lots in the study area, and no industrial lots. Using an equivalent population base of 30 (3 persons per lot) the current total equivalent population for the study area is 255.

Although Apple Hill has experienced a gradual population decline over the past 20 years, it is reasonable to apply a small growth factor when planning an improved water supply. A 20-year design population of 290 would be equivalent to an annual growth rate of 0.65 %.

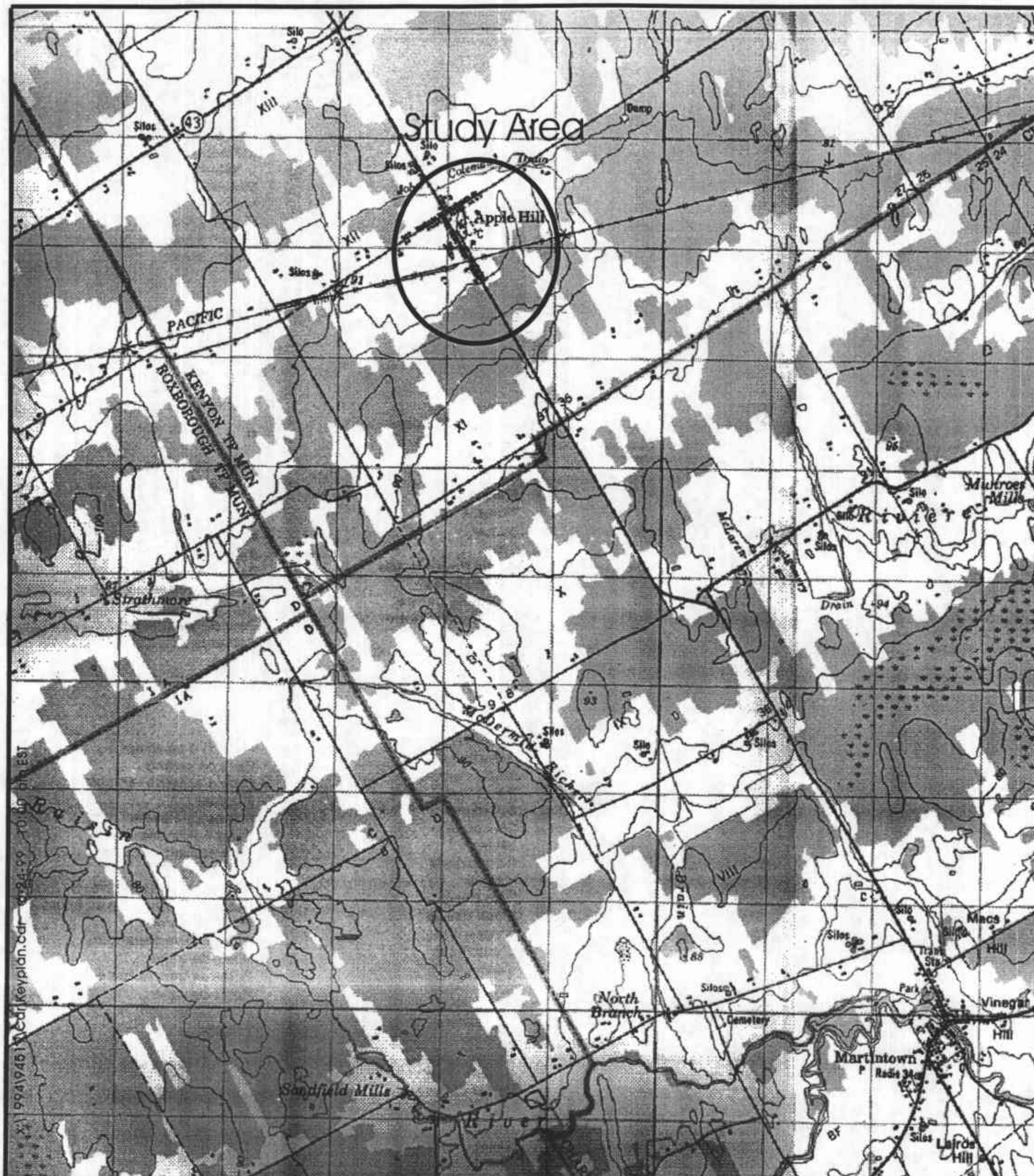
2.4.3 Study Area and Service Area

The study area for the Class EA includes all areas inside the hamlet of Apple Hill, as shown in Figure 5. Within this study area, the proposed service area includes all residential and commercial properties on Kenyon, Kennedy, Joseph and Main streets.

The service area includes all existing developed properties and limited development within the anticipated 20-year planning period. The allowance for limited growth includes 0.65% per annum for population and 0.65% per annum for industrial, commercial and institutional (ICI) related growth.

2.4.4 Land Use

The land use in the hamlet of Apple Hill is predominately residential, with limited institutional, commercial and light industrial components. Approximately 30% of the land within the hamlet is developed, including 90% of the road and street frontages. The undeveloped properties are mostly agricultural, with little road frontage. County Road 20



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The THOMPSON ROSEMOUNT Group	MAP OF APPLE HILL AREA	drawing no. FIGURE 4

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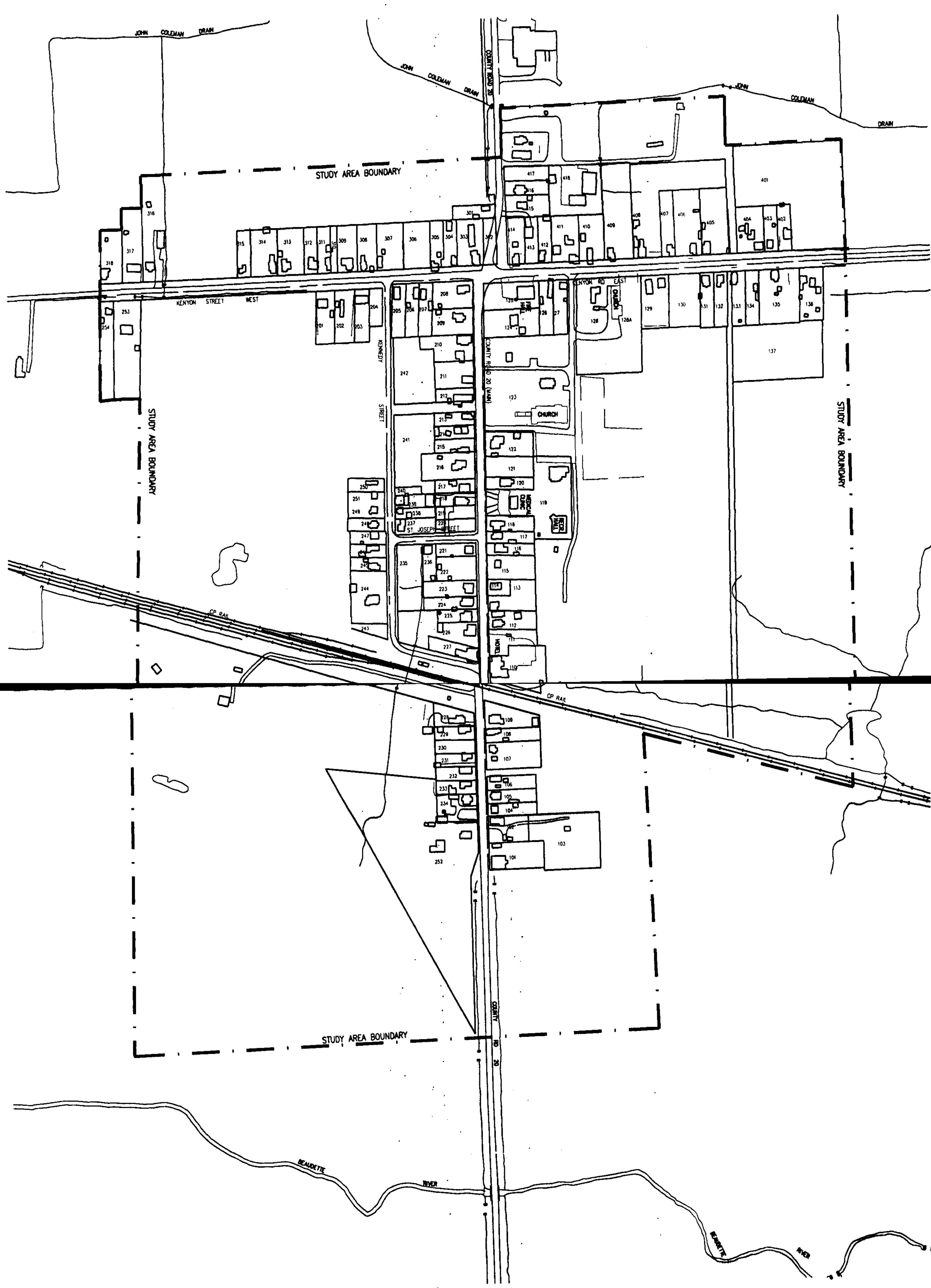

M.S. THOMPSON & ASSOCIATES LTD. consulting engineers CORNWALL KINGSTON	APPLE HILL COMMUNAL WATER PROJECT
The THOMPSON ROSEMOUNT Group	STUDY AREA

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NORTH

(Main Street) runs north-south and bisects the urban area. The northern section of the hamlet is bisected from north to south by County Road 14 (Kenyon Street) and the southern portion of the hamlet is bisected by the Canadian Pacific Railway tracks.

The predominant land use outside the hamlet is agricultural (pasture, cash crop or hay). Land immediately outside the developed areas is zoned agricultural. This land is classified as 70% Class 3 and 30% Class 1, due to stoniness, according to the Canada Land Inventory. Part of the study area is located within the 50-year flood plain of the Beaudette River.

2.4.5 Existing Water Supply and Sewage Disposal Systems

The hamlet is not serviced by a municipal water or sewage disposal system. The current water supply is groundwater, with individual wells. There is no piped system for fire-fighting water. Sewage disposal is by private individual septic systems.

2.5 Summary of Issues

The hamlet of Apple Hill, in the Township of North Glengarry (formerly the Township of Kenyon) has a history of water problems documented from 1989. Groundwater for many individual wells fails to meet MOE guidelines for health and aesthetic parameters. Groundwater quality varies by property, with 55% of properties having unsafe water based on coliform counts reported in the MOE study. Other ODWO parameters not met are nitrate, and iron, chlorides, total dissolved solids and hardness. Groundwater flow varies by property with some properties reporting dry conditions. Although the community has historically included institutional and commercial development these land uses are declining.

2.6 Statement of Problem

Groundwater in Apple Hill is contaminated and many wells fail to meet ODWO for bacteria. Additional contaminants include nitrate, iron, chlorides, total dissolved solids, and hardness.

3.0 PHASE 2 –EVALUATION OF ALTERNATIVE SOLUTIONS

3.1 Alternative Solutions

3.1.1 Inventory of Alternative Solutions

Most water projects have a limited number of alternative solutions, of which only a smaller group meet the technical requirements, at a reasonable cost. The alternative solutions that were available to Apple Hill were identified as:

- Alternative A Do Nothing
- Alternative B Restrict Water Use
- Alternative C Remediate Aquifer
- Alternative D Individual Well Correction
- Alternative E Individual Treatment Systems
- Alternative F Import Containerised Water
- Alternative G Communal Surface Water Supply
- Alternative H Communal Groundwater Supply

The project was initiated as a private well project, however after the completion of the Preliminary Hydrogeological Investigation it became evident that other alternatives required consideration. The following screening criteria were used to assess the merits of the various alternatives:

- a comprehensive solution to the water supply is required;
- the solution must meet MOE design guidelines;
- the water must meet the Ontario Provincial Water Quality Objectives;
- the solution must be proven in under similar operating conditions;
- the solution must be affordable;
- the natural, social, and economical environment must not be significantly impaired by the solution; and
- the solution must meet all applicable Provincial and Federal regulatory requirements.

These criteria were established from discussion with regulatory agencies, input from the municipality, and experience on similar projects. Alternative solutions were evaluated against the screening criteria to determine acceptability for further evaluation.

3.2 Inventory of the Natural, Social and Economic Environment

3.2.1 The Natural Environment

As described in Section 2.4, Apple Hill is mostly developed urban land, surrounded by agricultural land. There are no large surface water sources in the study area. There are no undeveloped lands inside or adjacent to the study area.

Potential impacts for solutions include:

- releases to the urban or agricultural community during construction or operation;
- disruption of agricultural activity or loss of agricultural land during construction;
- disruption of natural ecosystem or loss of species during construction or operation; and
- impairment of groundwater

Although the water supply is currently impaired, alternative solutions must still be evaluated for potential impact.

3.2.2 The Social Environment

Apple Hill is a small community in Glengarry County . The next nearest large community is the community of Martintown, with a population of less than 200 located approximately 5 km south of Apple Hill. Apple Hill is centre for some commercial, religious, and recreational activity, with additional social services and institutions located in the nearby communities of Martintown and Maxville.

The community has remained small, with a population of less than 300. The community has not experienced any growth over the past 25 years. The poor water quality and absence of municipal water and sewage services in the community may have limited social development. Although the community is located on the main Canadian Pacific Railway line, there has been little industrial development in the immediate area. There are no permanent passenger transportation links from Apple Hill to other communities.

3.2.3 Economic Environment

The lack of population growth is tied to the economic environment. Apple Hill has a single small industry (currently closing) and only a few of commercial enterprises. Property values tend to be moderate and a significant number of the residents are on fixed income.[3]

Many lots are less than 1000 m^2 in area. With limited economic activity, many residents have chosen to reside in Apple Hill for the lower, affordable housing costs. Residents generally have limited capacity to directly pay for expensive upgrades to municipal systems, and would require financial assistance.

Improvement of water supply is expected to marginally increase property values in Apple Hill and attract new residential construction, industry and commerce.

3.3 Preliminary Evaluation of Alternative Solutions

3.3.1 Alternative A-The "Do Nothing" Solution

The first alternative considered is the "do nothing" solution. As the name implies, this solution consists of maintaining current conditions. Maintaining current conditions would fail to alleviate any of the problems with water quality, and would increase the risk of health

[3] anecdotal information from Public Meeting, December 7, 1994

issues from water contaminants, particularly microbiological contaminants, for those users without treatment systems.

The failure to correct water quality problems may lead to further declines in population and property values, possibly to the extent that no future community programmes, including certain water and sewage programmes would be economically viable. The loss of property value and population would deter future investment in the community, and strain the existing tax base. The "do nothing" alternative may also lead to further deterioration of the groundwater, since defective sewage systems are the source of most of the microbiological contaminants.

An advantage of the "do nothing" alternative is the possible elimination of direct costs associated with improvements to the water supply. Although exact costs are difficult to compare, any possible savings from the "do nothing alternative are offset by the following:

- health risks
- cost of bottled water
- cost of individual treatment systems;
- cost of loss of quality of life; and
- loss of property value.

The "do nothing" alternative is rejected as not meeting MOE design guidelines, or the Ontario Drinking Water Objectives, under the screening requirements.

3.3.2 Alternative B - Water Use Restrictions

Water use restrictions can include:

- use of groundwater for non-potable uses only;
- limitations on non-essential water uses such as lawn watering and car washes;
- restrictions on industrial and commercial activity;
- implementation of water use reduction devices;
- implementation of on site storage devices;

Water use restrictions alone can seldom overcome problems with water supply. Reduction of water use will not address water quality problems, unless implemented in conjunction with another solution. Contaminants in the water will remain, and the associated social and indirect economic problems will continue.

An estimation of water use for Apple Hill indicates that water use is stable and probably less than 300 litres per capita per day (L/c.d). This residential water consumption is comparable to other small communities. Typical design consumption rates are 400-500 L/c.d, so there is little potential to reduce the total residential water usage by any significant amount. Furthermore, water restrictions do not address the quality issues, and therefore Alternative B fails to meet the screening criteria.

3.3.3 Alternative C - Remediate Existing Aquifer

Remediation of the existing aquifer would include reduction of existing contaminants, and isolation from new contaminants.

The advantage of aquifer remediation is that the contamination source is reduced or eliminated providing a long term, and sometimes permanent, solution. Depending on the nature of the contaminant, remediation could reduce operating costs. The disadvantages of remediation include:

- the cost of identifying and characterising contaminants can be high;
- the cost of remediation can be high;
- the cost of preventing future contamination can be high; and
- without additional sources, yields are limited to current quantities.

Remediation costs on a unit volume basis can vary by two or three orders of magnitude, depending on the nature of the contaminant.

Following the Phase I hydrogeological study, a Phase II study was initiated by the Township in 1995. This study is documented as the Apple Hill Water Study - Phase II Private Well Hydrogeological Study and Preliminary Communal Well Evaluation (Appendix B). At the initiation of the Phase II Study, the project was still considered to be a private systems study, and not subject to the provisions of the Environmental Assessment Act.

The Phase II report confirmed, through the development and analysis of test wells and an analysis of well records, that two aquifers existed within the service area. The northern aquifer, which supplied portions of the north community was a confined bedrock formation with low yield. This aquifer could not supply the water requirements for the entire community.

A shallow gravel aquifer was located in the southern service area. This aquifer, which could supply all of Apple Hills flow requirements, was extensively contaminated. The sources of contamination of the shallow aquifer were numerous and widespread including:

- faulty sewage disposal systems;
- elevated natural mineral concentrations (sodium, calcium);
- surface water contamination (biological); and
- run-off contamination from road salting.

Remediation of this aquifer would require elimination of all sources of contamination. This was considered impractical and expensive. The cost for total elimination of contaminant sources, and remediation of the shallow aquifer was considered to be in excess of $10,000,000. The cost of aquifer remediation eliminated Alternative C as a viable solution.

3.3.4 Alternative D - Individual Well Correction Programme

An individual well correction programme would involve a detailed examination of individual wells, and the reconstruction of faulty ones. In certain cases, wells may have to be shared between users, where satisfactory independent supplies cannot be located. Where significant numbers of shared systems are required, a larger communal system, as described in Alternative H becomes preferable.

A well correction programme in many cases must be completed in conjunction with a private sewer correction programme and individual treatment systems. While sewer correction programmes generally improves the groundwater condition, the improvements may not be adequate. The sewer corrections may eliminate future sources of contamination, but will not necessarily address existing groundwater contamination. Individual treatment systems, as described in Alternative E, can further increase the cost of well correction programmes. Where individual well programmes are possible, their viability further depends on the costs of additional sewer and treatment requirements.

The Phase II Private Well Hydrogeological Study however, determined that Alternative D was not feasible (Appendix B).

3.3.5 Alternative E - Individual Treatment Systems

Individual treatment systems can be installed in conjunction with, or independent of other solutions. The supply of individual treatment systems requires the assessment, design, installation and operation of treatment systems for each user in the service area.

The advantage of this alternative is that systems can be designed to meet individual and varying treatment requirements, which in the case of Apple Hill are considerable. The ability to customise allows for high treatment levels, in some cases surpassing the treatment provided by larger municipal systems. Reverse osmosis treatment technology improves the reduction of microbiological contaminants, including aquatic parasites, as well as reducing dissolved solids such as hardness and sodium.

Users not requiring any treatment are eliminated from the overall cost.

The main limitation of individual treatment systems is the requirement to locate a suitable groundwater supply. Although treatment technologies exist for the residential scale treatment of almost any contaminant, the treatment technology will not improve quantity or flow. In certain cases, individual treatment can be combined with use restriction (Alternative B) to meet water requirements, however in the case of Apple Hill further water use reduction is not feasible.

The additional disadvantage of individual treatment systems is cost. Both capital and operating costs are generally higher on a per user basis. Most systems are add-ons to existing wells, and the capital costs include the configuration of individual units, sometimes in series, and the appropriate connection and power supply. Operating costs include chemicals, cleaners, and replacement components. As new users are added, new individual treatment systems are required. Typically, additional water is required for back washing, rinsing or operation of the treatments system, which further taxes limited supplies. Depending on the individual system configuration, and degree of treatment required to meet the Ontario Drinking Water Objectives, capital costs are estimated to be $10,000-$15,000 per user. Annual operating costs, including chemical, exchange resins, membranes, cartridges, testing, monitoring and power, can exceed $1,000 per year. Individual treatment systems offer none of the economies of scale of a communal system, and each new user is required to install a new treatment system.

The contaminants found in Apple Hill wells would require treatment for bacteria, nitrate and iron. Some additional treatment may be desired for hardness. The Phase II report confirmed that bacteria contamination was widespread. To correct biological contamination, individual treatment systems would be required for disinfection and iron removal. Generally, the Ministry of the Environment and the Ministry of Health, through the Eastern Ontario Health Unit, have not approved large scale (more than 10) individual systems where bacteria contamination is present, due to the cost of providing individual monitoring. Furthermore, the treatment costs for individual systems that remove bacteria and dissolved ions are high in capital and other operating costs. The capital and operating costs of individual treatment systems for these parameters, if approved by the MOE, are estimated to be $15,000 and $1,000 respectively, as stated above. These costs, and the uncertainty of funding eligibility in light of other alternatives, eliminate Alternative E.

3.3.6 Alternative F - Import Containerised Water

Containerised water can be supplied to meet all of the water requirements of Apple Hill, or only the drinking water requirements (incorporating Alternative B). The full supply of water would include an external source, public or private, a distribution system and the provision of large individual storage containers, typically cisterns.

The partial supply of water, typically only water that meets the Ontario Drinking Water Objectives for potable water requirements, would include an external source and a distribution system.

The advantages of imported water include the ability to obtain higher quality water than local supplies, and the ability to provide distribution to small users or remote locations.

The disadvantages of imported water are:

- individual storage and containerisation systems are required;
- quantities are restricted;
- inconvenience;
- flow is not continuous;
- supply costs are high; and
- distribution costs are high.

Except for communities with no immediate long-term supply of surface or groundwater, the cost of containerised water is usually prohibitive when compared with other alternatives.

Typical communal systems provide treated water at a unit operating cost of less than $0.30 per m³ (1000 litres). Capital costs for typical communal systems over a 20 year lifespan are less than $1.00-2.00 per m³ (1000 litres). The cost of supplying containerised water in bulk quantities is estimated to be more than $ 30.00 per m³ (1000 litres).

3.3.7 Alternative G - Communal Surface Water Supply

There are no surface water sources located within the community. The two nearest surface water sources are the Beaudette River, and Loch Garry.

The Beaudette River flows from west to east, immediately south of the community, as shown in Figure 5. The Beaudette River is dry during part of the summer so there is insufficient flow to meet the requirements of the community. Supplementing flow during the dry period is not feasible.

Loch Garry is the headwater for the Garry River system, which provides water to the downstream community of Alexandria. Although there may be sufficient capacity in the small lake to meet Apple Hill's requirements, the source is located approximately 6 km east of the community. The incremental cost of establishing a pipeline and providing a pumping station and physical/chemical treatment is estimated at $3,000,000 beyond the cost of developing a groundwater source within 500 m of the study area.

The nearest communal water system that could possibly be expanded to serve Apple Hill is located in St. Andrews West, as part of the Cornwall system. This system is located approximately 14 km away, more than double the distance to Loch Garry. There is not sufficient capacity in the St. Andrews system to service Apple Hill. The next nearest large surface water source is the St. Lawrence River, approximately 20 km south of Apple Hill. The estimated cost for a pipeline, pumping station, and treatment plant near the St. Lawrence River is more than $10,000,000.

Because there are no existing outside surface water or treated water supplies that can meet the requirements for Apple Hill at a reasonable cost, Alternative G is not viable.

3.3.8 Alternative H - Communal Groundwater Supply

For many Ontario communities, the development of a communal groundwater system is a viable alternative for water supply problems. New wells can be developed within the immediate service area, within the study area, or close to the study area. There are numerous examples of communal groundwater systems in Eastern Ontario including Glen Robertson, Lunenburg, Lancaster, Moose Creek and Green Valley.

The advantages of a communal well system include improvements to water quality and quantity, isolation from contaminants, improved quality control through regulated operating practices, and lower overall operating costs.

The disadvantages of communal groundwater systems include the costs of locating and developing a suitable well system, variability in water quality, limitations in supply quantities, and increases in certain operating costs.

Where large surface water supplies are not economically obtainable, groundwater sources may supply comparable water quality and quantity, for a comparable, and in some cases lower cost.

The estimated cost for a communal groundwater and distribution system is $10,000,000 to $15,000,000, or approximately $15,000 per typical lot. The estimated annual operating cost is $20,000, or approximately $200 per typical lot.

3.4 Identification of Preferred Solution

A summary of the preliminary alternative evaluation is provided in Table 3.4.

Table 3.4 Alternative Solutions Summary

Alternative	Estimated gross capital cost, $/user	Estimated net operating cost, $/User/year	Reasonable overall combined cost?	Meets MOE/ODWO parameters?
Alternative A Do Nothing	0	0	Yes	No
Alternative B Restrict Use	0	0	Yes	No
Alternative C Remediate Aquifer	n.a.	n.a.	No	No
Alternative D Well Corrections	n.a.	n.a.	No	No
Alternative E Individual Treatment	15,000	1,000	No	Possible
Alternative F Import Water	1,000	>5,000	No	Possible
Alternative G Surface Water Supply	30,000	200	No	Possible
Alternative H Groundwater Supply	15,000	200	Possible	Possible

As reviewed in the previous sections, only Alternative G - Communal Groundwater Supply, meets both the technical and economic criteria. The preferred solution therefore is Alternative G, a communal groundwater system. This solution should meet all of the technical requirements established by the MOE, and the economic requirements required by the community.

As a communal system, the preferred solution is subject to the provisions of the Environmental Assessment Act. The undertaking is defined as a Schedule C activity in the Class Environmental Assessment for Municipal Water and Wastewater Projects. The preferred solution encompasses a number of design alternatives, which must also be evaluated in Phase 3 of the EA process.

4.0 THE PREFERRED SOLUTION

4.1 Description of Preferred Solution

The preferred solution is a communal water supply system, with local groundwater as the supply and a piped distribution system. Exact location and number of wells, as well as routing of watermains, treatment and flow parameters are considered Phase 3 issues.

The preferred solution will have the following components:

- groundwater wells;
- low lift pumping:
- water storage;
- disinfection;
- H_2S sparging;
- high lift pumping:
- metering; and
- water distribution.

A schematic of the process is provided in Figure 6. Final technical specification of the individual unit operations, including arrangement, sizing and location will be completed in Phase 3.

4.2 Preliminary Environmental Impacts

The preferred solution is not expected to have any significant environmental impacts. On the contrary, the preferred solution, in conjunction with a sewage correction project, is expected to improve the natural, social, and economic environment of Apple Hill.

4.2.1 The Natural Environment

The net environmental impact of the preferred solution is anticipated to be positive, with gradual improvement to the contaminated aquifers. Some minor impact on surrounding local aquifers is expected. A discussion of geology and hydrogeology, and measures to mitigate impact on local aquifers is provided in the Phase III Hydrogeological Report. During construction of the new system measures will be required to ensure the continued use of the existing wells.

Measures will also be required to ensure that construction activity does not release any contaminants to the environment. Standard barriers, traffic control, dust control and materials management will prevent any releases. The municipality, the Engineer and the project manager should insure that the environmental construction impacts are minimised and mitigated through the final design and construction administration phases. An inventory of natural environment features along the final alignment should be completed during the final design stage. Methods that will be employed during construction to minimize the impacts and post-construction to mitigate the impacts should be defined in the construction specifications.

Typical mitigating measures are described in the Ontario Class Environmental Assessment (document) for Municipal Water and Wastewater Projects as approved by the Ministry of Environment June 1993. Further information is provided in the Ontario Environmental Construction Guidelines for Municipal Road, Sewage and Water Projects (1987).

The preferred solution will require the acquisition of a small parcel of land for permanent housing of wells and treatment systems. The majority of the system components will be located underground, with negligible permanent impact on the surface environment.

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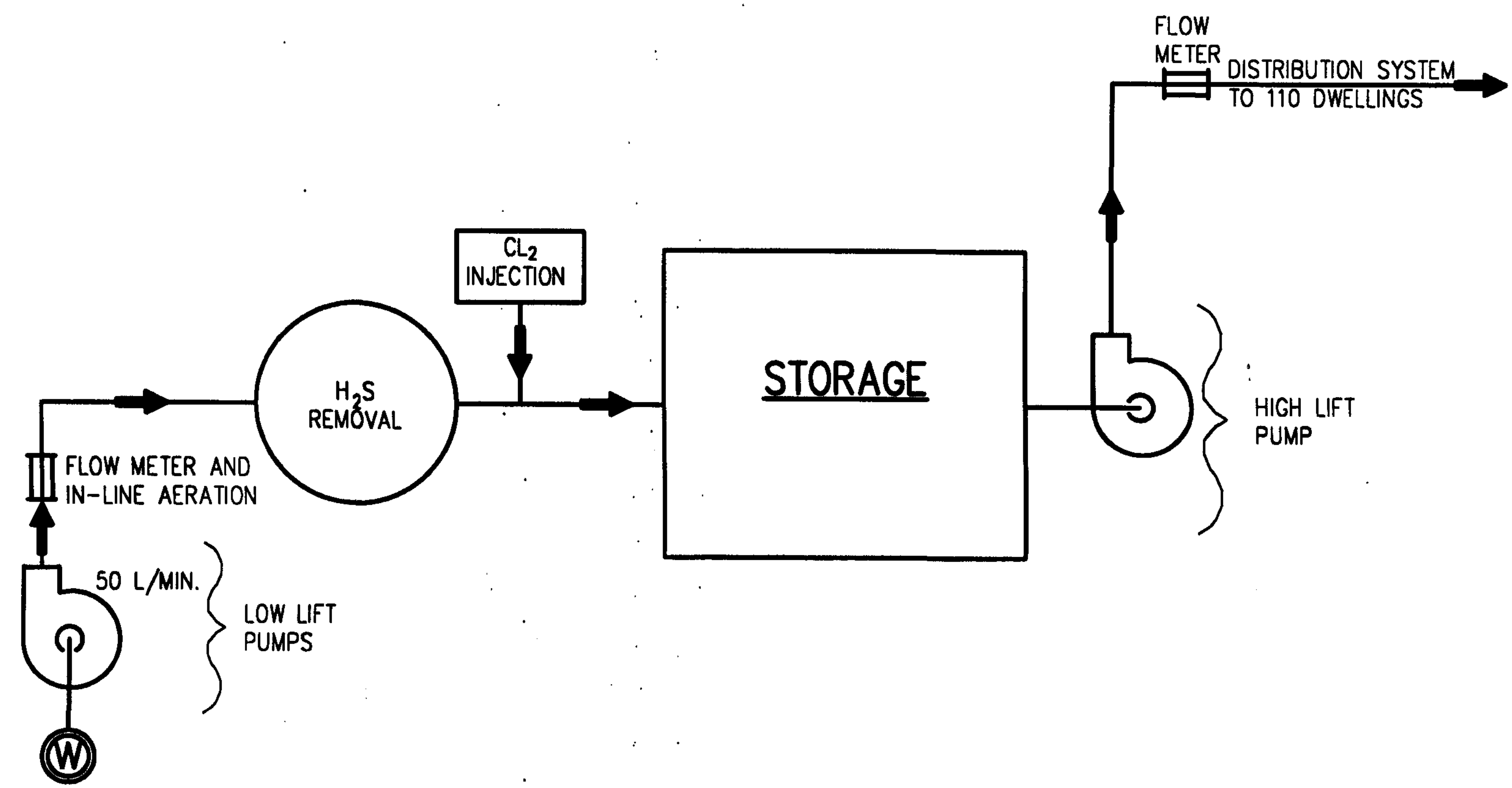

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The THOMPSON ROSEMOUNT Group

APPLE HILL COMMUNAL WATER PROJECT

PREFERRED SOLUTION
PROCESS FLOW DIAGRAM

scale	N.T.S.
date	NOV., 1999
drawn	G.A.D.
job no.	94519
drawing no.	FIG.6

4.2.2 The Social Environment

Construction of the preferred solution will temporarily increase employment in the community, however no significant changes are expected as a direct result of the new operation.

4.2.3 The Economic Environment – Preliminary Costs

The capital cost of the preferred solution is estimated at $1,500,000. The operating cost is estimated as $200 per lot per year. A breakdown of costs is provided in Tables 6.2, 6.3, and 6.4. It is anticipated that provincial funding will provide approximately 70 to 90 % of the construction costs with the Township providing the balance. At 70% funding, the Township would be required to contribute approximately $450,000. This amount equates to $4,500 per typical lot. Debentured over 10 years, at 8% interest, the annual payment is $871 per typical lot including capital and operating costs. At 90% funding, the amount is $1,500, or $424 per year including capital and operating costs. Actual property costs will depend on funding contributions, final construction costs, and the assessment formula.

There are no other economic impacts associated with the preferred solution. In Phase 3, the preferred design will be determined, and the costs refined accordingly.

While the community has little capacity to absorb any significant cost increases, the net economic effect of the preferred solution is expected to be positive. Indirect positive impacts include a short-term economic expansion from construction. The provision of fresh potable water will allow growth in the community and economic expansion.

4.3 Confirmation of Schedule C Status

Based on the selection process followed during Phase 2, it is confirmed that the project is a Schedule C project. The preferred solution will require construction of a new facility, a Permit to Take Water (PTTW), and a Certificate of Approval (C of A). A full evaluation under Schedule C of the Class EA is required.

4.4 Phase 2 Public Consultation

With the identification of a communal system as the preferred solution, public consultation became mandatory. The Township of Kenyon continued to utilise public consultation through the Public Liason Committee, and Public Meetings.

4.4.1 PLC Meeting #4

The fourth PLC meeting was held on July 12, 1995. At this meeting, MSTA confirmed that individual well correction was not viable and that a communal well system would probably be the preferred solution, pending the outcome of the Phase II hydrogeological study. Cost estimates and suggested material for public communication were discussed. A second Public Meeting was scheduled for August 16, 1995.

4.4.2 Public Meeting August 16, 1995

Public consultation in the format of a Public Meeting held on August 16 1995 at the Apple Hill Community Centre. The Public Meeting was advertised in the Glengarry News prior to the event. Copies of the advertisement are provided in Appendix F.

At the event, the results of the Phase 1 Hydrogeological Investigation were presented, along with estimated costs for alternatives. A copy of the presentation material is contained in Appendix F. Media coverage of the Public Meeting was provided in the Glengarry News.

4.4.3 Additional Presentation

Following the August 1995 Public Meeting, MSTA completed additional hydrogeological investigations. This work was documented as a private study in the Phase II Private Well Hydrogeological Study and Preliminary Communal Well Evaluation. The Phase II investigation confirmed that a communal well system would be viable.

This alternative was further detailed to the Kenyon Township Council on May 14, 1997, along with the results of the Phase II study. This meeting was an open Council meeting, with PLC members in attendance. A copy of the presentation material is included in Appendix H.

4.4.4 Public Meeting June 9, 1997

An additional public consultation in the format of a Public Meeting held on June 9, 1997 at the Apple Hill Community Centre. This Public Meeting was also advertised in the Glengarry News. At the Public Meeting, the results of the Phase II Hydrogeological Investigation were presented, along with revised estimated costs for options. A copy of the presentation material is contained in Appendix I.

The material from the PLC meeting was presented, in slide format, with handouts. A copy of the advertised meeting notice and the attendance is also provided in Appendix I.

4.4.5 Notification

Mandatory contacts, established in the Class EA document, were notified of the completion of Phase 2. Mandatory Contacts had been previously notified of the project status through the Hydrogeological Report. Correspondence is included in Appendix G.

5.0 PHASE 3 –EVALUATION OF ALTERNATIVE DESIGNS

5.1 Alternative Designs

The preferred solution included a number of options for well configurations, treatment systems, and flow ranges. Major subgroups, or alternative designs, can be characterised primarily by their flow rates as follows:

- Full Flow (includes fire protection);
- Medium Flow; and
- Low Flow;

A more detailed description of each of these alternative designs is provided in Section 5.5.

5.2 Design Criteria

The preferred solution must meet further design criteria. These criteria incorporate the ODWO, MOE guidelines, and community standards. Design criteria are summarised in Table 5.2.

Table 5.2 Design Criteria

Parameter	Design	Basis
Water quality	ODWO	MOE guidelines
20-year Design Population	290 equivalent population	0.65% growth
Design Consumption	275 L/capita day	MOE design for small communities
Average Day Flow	80,000 L/day	20-year design
Peak Day Flow	220,000 L/day	Modified MOE peak day factor of 2.75
Peak Hour Flow	5.7 L/s	MOE peak hour factor of 6.2
Lawn Watering	11 L/s, 1 hour	MOE design factor
Fire Flow	38 L/s, 2 hours	MOE design factor
System pressure	250-600 kPa	MOE design factor

5.3 Detailed Inventory of the Natural, Social and Economic Environment

A suggested list of environmental factors to be considered for a new water treatment system is provided in the "Class Environmental Assessment for Municipal Water and Wastewater Projects" document. The list has been reproduced as Table 5.3, Environmental Issues. All issues identified under the Class EA process, from Table 5.3, were evaluated for potential impact.

Due to the nature of Apple Hill Communal Water Project, few of the issues that were identified as having a potential for environmental impact required any significant further evaluation. Those issues that were considered to have an impact, as shown on the Table, are addressed in subsequent parts of this ESR. Potential impacts were evaluated within the groupings of natural, social, and economic environment.

5.3.1 Natural Environment

As described in Section 2, the community of Apple Hill is mostly developed urban land, surrounded by agricultural land. The land use mix in the community is mostly residential with some industrial, commercial, institutional, and recreational uses. No land use changes are proposed for the water project for the life of the undertaking, other that the small parcel required for the water pumping and treatment facility. The undertaking is not expected to impact any adjacent land or environment to any significant extent or change any land use.

The most vulnerable components of the natural environment that might be affected by the undertaking are the local aquifers. Potential impacts to the aquifers are initially addressed in the Phase II hydrogeological report. As part of the design evaluation, additional hydrogeological testing was conducted. This testing is documented in a Phase III Hydrogeological Report (Appendix C).

The Phase III report identifies an aquifer recharge area up to 10km from the wellhead area, in addition to the local recharge. Accordingly, a groundwater protection strategy is recommended.

The purpose of the groundwater protection strategy is to limit the risk to groundwater resources from historic or existing land uses, and secondly, minimize the risk from future land uses. The components that should be considered include :

1. Community consultation and awareness,
2. Water resources definition,
3. Contaminant inventory,
4. Monitoring and management of water quality,
5. Data management,
6. Policy development, and
7. Contingency planning.

Since many of these components have regional groundwater as well as surface water implications, guidance from the Eastern Ontario Water Resource Management Study would be prudent. Certainly, public education and awareness of groundwater quality protection are critical. The formation of a Water Resources Protection Committee, consisting of members of the public and municipal staff should be considered.

Additionally, proper well abandonment and rehabilitation or replacement of on-site sewage systems is necessary.

Table 5.3 Environmental Issues

TYPICAL EFFECTS ON THE ENVIRONMENT CAUSED BY CONSTRUCTION ACTIVITIES, EXPANDED FACILITIES AND FACILITY OPERATION AND MAINTENACE. (From section 4.2 "Class Environmental Assessment for Municipal Water and Wastewater Projects" Municipal Engineers Association June, 1993)	COMPONENTS				EVALUATED	POTENTIAL IMPACT	COMMENTS
	GROUNDWATER WELL	IN-GROUND RESERVOIR	PURIFICATION FACILITY	MAINS & PUMPING STATION			
AESTHETICS							
removal of vegetation or landscape features		◆	◆	◆	◆		
change of compatibility with landscape		◆	◆	◆	◆		
residents, non-residents, recreationalists and tourists exposed to new view		◆	◆	◆	◆	-1	minor impact
AGRICULTURE							
removal of productive farmland	◆	◆	◆	◆	◆	-1	minor impact
disruption of field access from public roads				◆	◆		
disruption of tile and surface drains	◆	◆	◆	◆	◆		
change in water quality			◆	◆	◆		
change in water quantity	◆			◆	◆		
change in crop yield				◆	◆		
reduced viability due to land loss		◆	◆	◆	◆		
effects of chemical, bacteria, noise, dust on crops, livestock and people		◆	◆	◆	◆		
CLIMATIC EFFECTS							no impact
change in air quality					◆		
vegetation removal or snow accumulation, windscreening and shade on adjacent buildings and activities		◆	◆	◆	◆		
ECONOMIC AND SOCIAL EFFECTS							
change to tax base		◆	◆	◆	◆	1	possible growth
change in employment opportunities		◆	◆	◆	◆	1	minor growth
change in 'quality of life'	◆	◆	◆	◆	◆	3	improved public health
change in tax rate or cost of service	◆	◆	◆	◆	◆	-2	increased taxes
FISH, AQUATIC WILDLIFE AND VEGETATION							
change or removal of existing habitat including food and shelter				◆	◆		
change in water quality			◆	◆	◆		
change in water temperature	◆				◆		
effects of timing of construction activities on spawning and breeding periods			◆	◆	◆		
lowering water table	◆			◆	◆	-1	possible impact
production of new habitat			◆		◆		
collection of fish and organisms on intake screens					◆		
GROUNDWATER							
change in quality	◆	◆	◆	◆	◆	3	will meet ODWO
change in quantity	◆				◆	2	improved flow
interference with flows or levels	◆	◆	◆	◆	◆	1	regional recharge
HERITAGE RESOURCES							no impact
disruption and/or destruction of sites and structures having significant archaeological, historical, architectural, or economic values	◆	◆	◆	◆	◆		
PUBLIC HEALTH							
effects on water quality	◆				◆	3	meets ODWO
effects of air pollutants					◆		
effects on existing subsurface sewage disposal systems	◆		◆		◆		requires separate study
effects on 'quality of life' e.g. decreased sewage back-up	◆	◆	◆	◆	◆	2	improved safety

" " no impact, "1" negligible impact, "2" some impact, "3" significant impact

Table 5.3 Environmental Issues (cont.)

TYPICAL EFFECTS ON THE ENVIRONMENT CAUSED BY CONSTRUCTION ACTIVITIES, EXPANDED FACILITIES AND FACILITY OPERATION AND MAINTENACE.

(From section 4.2 "Class Environmental Assessment for Municipal Water and Wastewater Projects" Municipal Engineers Association June, 1993)

	COMPONENTS						
	GROUNDWATER WELL	IN-GROUND RESERVOIR	PURIFICATION FACILITY	MAINS & PUMPING STATION	EVALUATED	POTENTIAL IMPACT	COMMENTS
NOISE AND VIBRATION							no impact
changes in existing noise and vibration levels	◆		◆	◆	◆		
RECREATION							no impact
effects of accessibility changes		◆	◆	◆	◆		
disruption during construction	◆	◆	◆	◆	◆		
effects on layout or operations		◆	◆	◆	◆		
effects on quality of user experience due to environmental changes	◆	◆	◆	◆	◆		
RESIDENTIAL, COMMERCIAL INDUSTRIAL, INSTITUTIONAL							
temporary disruption during construction	◆	◆	◆	◆	◆	-1	minor impact
safety and movement patterns of pedestrian traffic			◆	◆	◆	-1	minor impact
improved sewage collection and water treatment	◆	◆	◆	◆	◆	2	consistent water
change in use or layout due to property loss	◆	◆	◆	◆	◆		
reduction in water quantity and and quality due to drawdown in private wells	◆	◆	◆	◆	◆		
effects on insurance rates via fire protection		◆		◆	◆		no change
change in property value	◆	◆	◆	◆	◆	2	increased value
financial and social effects of relocation or removal of homes, businesses and institutions		◆	◆	◆	◆		
SOIL AND GEOLOGY							no impact
erosion or compaction during construction		◆	◆	◆	◆		
deposition of sediment on adjacent properties		◆	◆	◆	◆		
contamination of soils			◆		◆		
mixing of topsoil with subsoil		◆	◆	◆	◆		
scarring of unique landforms		◆	◆	◆	◆		
SURFACE DRAINAGE							no impact
diversion and/or channelization of watercourses				◆	◆		
effects of floodplain				◆	◆		
contamination of surface watercourse		◆	◆	◆	◆		
"ponding" effects on adjacent properties due to natural drainage disruption		◆		◆	◆		
increased surface runoff		◆		◆	◆		
decreased surface water quality	◆				◆		
decreased surface drainage		◆			◆		
sedimentation and turbidity of adjacent water bodies due to construction activities		◆	◆	◆	◆		
TERRESTRIAL VEGETATION AND WILDLIFE							no impact
effect on wildlife habitat	◆	◆	◆	◆	◆		
effect of contaminants on vegetation and wildlife					◆		
conditions resulting in reduction and/or deterioration of wildlife habitat	◆	◆	◆	◆	◆		
changes in vegetative composition as a result of environmental changes	◆	◆	◆	◆	◆		
removal or disturbance of significant trees and/or ground flora	◆	◆	◆	◆	◆		
new or increased exposure of trees leading to increased loss of habitat for wildlife		◆	◆	◆	◆		
mortality/stress of vegetaion due to sediment deposition, construction equipment movement or changes in soil moisture		◆	◆	◆	◆		
UTILITIES							
effects on other utilities, e.g., relocations		◆	◆	◆	◆	-1	some electrical relocation req'd

" " no impact, "1" negligible impact, "2" some impact, "3" significant impact

Impacts are considered during two distinct aspects of the project: construction, and operation. Potential impacts of the alternative designs include:

- releases including noise during construction or operation;
- alterations to soil quality and drainage during construction or operation;
- disruption of natural ecosystem or loss of species during construction or operation; and
- impact on aquifers from operation of the communal system.

These potential impacts are considered in the evaluation of the alternative designs.

5.3.2 The Social Environment

As previously described, Apple Hill is a small community in Glengarry County. Potential impacts for the alternative designs include:

- alteration of land use including loss of agricultural land during construction or operation;
- disruption of socio-economic stability during construction or operation;
- alteration of landscape including alteration of view;
- change in quality of public health during construction or operation;
- changes to quality of life including traffic disruptions and relocations during construction or operation; and
- change to recreational facilities during construction or operation;

Social impacts for any of the alternative designs were considered negligible.

5.3.3 Economic Environment

Potential economic environmental impacts of the alternative designs include:

- loss of municipal property assessment for lands used in undertaking;
- change in private property value for land adjacent to project lands
- change in property value for community lands;
- change in industrial commercial tax base (growth or business closings);
- change of residential tax base (growth or migration);
- loss of agricultural productivity;
- business interruption loss during construction or operation;
- capital cost impact on the assessed property owners; and
- operating cost impact on the assessed property owners.

Economic impacts were considered the most significant environmental issue for the project.

5.4 Analysis of Environmental Inventory

The environmental factors inventoried in Section 5.2 were further evaluated to determine the impact of the alternative designs. Because the alternative designs were all variations of groundwater systems, the impacts of most of the designs were considered similar, varying in magnitude only. For example, traffic disruption in the community due to construction of the water treatment plant was considered similar for all alternative designs, with only slight differences due to duration of construction.

The exception to the similarities is the impact on the economic environment, where percentage differences in construction costs amount to significant burdens on both an overall basis, and on an individual ratepayer basis.

In evaluating the alternative designs, priority was given to economic environmental impacts. The priority was based on the relative impact of the alternative designs, which were considered reasonably similar with the exception of costs, since all were groundwater source solutions. Economic factors were considered the most significant, based on input from the public, Council, and the Public Liason Committee.

5.4.1 Natural Environment

From the inventory listing of Section 5.2, few issues were considered to have significant impact on the natural environment, except on the groundwater system. Design alternatives are considered similar, except for flow.

Because the study area is currently developed, and the alternative designs are all to be located within the study area, no damage to the above surface natural ecosystem is foreseen. No changes to the soil or agricultural land are anticipated from the project, and no releases to air, land or water are foreseen.

Hydrogeological impacts, and their mitigation are addressed in the Phase III Hydrogeological Report. The most significant impairment to the natural environment is through the continued groundwater contamination from faulty septic systems. This is addressed separately in the Private Sewage Corrections studies.

5.4.2 Social Environment

No changes in the land use, building use, or recreational facilities are identified for the project. Water quality in the community is expected to improve as a result of the project, reducing potential health risks. Some minor increases in traffic are expected as a result of the facility construction, however these are considered insignificant, and possibly welcomed by the local retail industry. Similarly, a minor increase in the economy during construction is considered beneficial.

No significant changes in the labour force are foreseen as a result of the project. The treatment facility designs can all be housed in a small building (less than 5 m in height), and no significant change in the landscape is anticipated.

5.4.3 Economic Environment

Economic impacts are considered the most significant environmental impacts. Although a minor return of growth to the community and the increase in economic activity from construction is considered beneficial, the overall cost of the project is considered a significant burden to taxpayers. The community has little capacity to absorb significant costs.

Alternative designs are evaluated for both capital and operating costs. Cost estimates are based on vendor estimates, scaled comparisons to existing plants, and unit cost databases. An additional factor considered is reliability. Designs with histories of equipment malfunction, difficult maintenance, or high replacement costs are evaluated with higher operating costs.

5.5 Technical Evaluation of Alternative Designs

5.5.1 Full Flow System

A full flow system provides flow for all daily water requirements as well as peak day flow, peak hour flow, lawn watering and fire flow as shown in Table 4.2. Water supply for all flow requirements, except fire fighting, is provided by five groundwater wells, as indicated in the Phase III Hydrogeological Report. Fire fighting flow can be provided from either additional wells or storage, however storage is substantially less expensive. Cost estimates for the full flow design therefore are based on the use of storage to meet fire fighting requirements.

Storage requirements for fire fighting are 240 m^3. This volume can be stored above or below grade, however below grade storage is generally more cost effective for this volume. Cost estimates for storage are based on below grade storage. Hydrants would be placed at approximately 100 m intervals along the distribution system for a total of 25 hydrants.

The distribution system for full flow is sized as nominal 150 mm diameter pipe and components, to meet requirements for fire flow and pressure. Fire flows were verified using Cybernet modelling software.

The full flow system has an average retention time in the storage system of approximately 2.8 days, and 0.6 days in the distribution system. Chlorine residuals can be maintained during this periods with moderate boosting, however the distribution system contains several dead ends, as shown in Figure 8. To maintain disinfection in the system, periodic flushing of the system will be required. Flushing and additional chlorine requirements increase the operating cost of the full flow system.

5.5.2 Medium Flow System

The medium flow system provides all flow requirements as the full flow, except fire fighting. Accordingly, the storage requirements are reduced to 120 m^3.

Modelling of the medium flow using Cybernet software indicates that flow and pressure requirements can be maintained with 100 mm piping and components. This reduced diameter justifies a reduction from conventional MOE design, which in turn reduces the overall cost for the distribution system. Modelling outputs are provided in Appendix P.

A further reduction in capital costs is achieved with the elimination of hydrants. Operating costs compared to the full flow system are lower because of the reduction in chemical usage and the elimination of flushing.

5.5.3 Low Flow System

The low flow system provides flow for daily requirements only.

Modelling of the medium flow using Cybernet software indicates that flow and pressure requirements can be maintained with 75 mm piping and components. This reduced diameter justifies a further reduction from conventional MOE design, which in turn reduces the overall cost for the distribution system.

To provide adequate supply for peak demands however, individual household storage systems are required. These storage systems would be installed at each lot for an approximate cost of $1,600 per lot. The storage tanks would be constructed of FRP or HDPE for an average capacity of approximately 500 litres. This capacity would provide peak flow for individual users, but would still not provide sufficient flow for lawn watering, or other high flow/ high volume water use.

A further reduction in capital costs is achieved with the elimination of hydrants. Operating costs compared to the full flow system are lower because of the reduction in chemical usage and the elimination of flushing.

The main disadvantage of the low flow system is the maintenance and inspection costs. Because the design uses individual storage containers, the cost of inspection and maintenance, through water testing is increased proportionally. The estimated operations, maintenance and inspection cost for the low flow system is 150,000, or $150 per household.

5.6 Summary of Phase 3 Evaluation Process

The Phase 3 evaluation process yielded the medium flow system as the preferred design. This selection was previously identified in the June 9, 1997 Public Meeting. The preferred design was presented to the PLC on August 18, 1998 and to North Glengarry Township Council on September 23, 1998. A comparison of the cost factors used in the evaluation is presented in Table 5.6.

Table 5.6 Alternative Design Cost Evaluation

Alternative		Do Nothing	Communal Water Supply Options		
			Low Flow	Full Flow	Medium Flow (no fire protection)
Capital	Water Supply	n/a	$ 750,000	$ 2,900,000	$1,500,000- $1,900,000
	Typical Household Cost	n/a	$ 6,000	$ 23,200	$ 12,000- $ 15,200
	"Lot-line/In-Home" Provisions	n/a	$ 1,600	$ 400	$ 400
	Subtotal	n/a	$ 7,600	$ 23,600	$ 12,400- $ 15,600
	After Provincial Grant of 70%	n/a	$ 2,280	$ 7,080	$ 3,720 – $ 4,680
	Equivalent Annual Cost (10 years @ 7%)	n/a	$ 304	$ 942	$ 495 – $ 623
Operating		$250	$ 150	$ 175	$ 150

As shown in Table 5.6, the medium flow design has a lower capital cost, and lower operating cost compared to the alternative low flow and full flow systems.

At the meeting, Council confirmed MSTA's recommendation for a medium flow design, and endorsed the selection as the preferred design. The endorsement for this design was achieved after a complete review of the construction and operating costs of the other designs. Council also evaluated options for long term financing, including the possibility of 10 and 20-year debentures.

5.7 Phase 3 Public Consultation

5.7.1 Initial Presentation

Alternative designs for the preferred solution were initially presented to the Kenyon Township Council on May 14, 1997. This meeting was an open council meeting, with council, PUC, and PLC members in attendance.

At the meeting, Council and the PUC confirmed MSTA's recommendation to use the communal well system, and adopted the medium flow design as the preferred design. The Council/PUC support for this design was provided after a complete review of the construction and operating costs of the other designs. Council and the PUC also evaluated options for long term financing, including the possibility of 10 and 20-year debentures.

In 1997, the Township of Kenyon was amalgamated with the Township of Lochiel, the Village of Maxville and the Town of Alexandria to form the Township of North Glengarry. An Public Meeting was scheduled, by North Glengarry Council for March 25, 1998. The

Public Meeting was held to update residents on the status of the project. The meeting was not advertised, except through an article in the Glengarry News. A copy of the article and the sign-in list from the Public Meeting, and media coverage is provided in Appendix J.

A subsequent PLC meeting was held on August 18, 1998. At this meeting, the selection of the preferred design was re-confirmed, and a Public Meeting scheduled for October 15, 1998. A copy of the material from the August 18, 1998 meeting is provided in Appendix K.

5.7.2 Public Meeting

Public consultation in the form of a Public Meeting was held on Thursday October 15, 1998 at the Apple Hill Community Centre. This meeting constituted the second mandatory public consultation required under the Class EA process. A copy of the meeting advertisement is provided in Appendix L. The material from the August 18, 1998 meeting was presented, in poster format, with handouts. Copies of the attendance sheet, handouts, and comment sheet are also provided in Appendix L.

The Preferred Alternative, a Medium Flow Communal Water Supply System, was reaffirmed by the residents in attendance. Concern was expressed regarding the affordability, which further confirmed the importance of Provincial funding assistance.

5.7.3 Council Resolution to Proceed with Project

Following the distribution of the Phase 2 report, and the Phase 3 public consultation process, Township Council passed a resolution on April 9, 1999 to adopt the preferred design and direct the completion of the ESR. A copy of the resolution is provided in the Appendix O.

5.7.4 Additional Public Consultation

A copy of this ESR is to be filed with the MOE, for placement on the Environmental Registry. In addition, the Notification of Completion of the ESR, which is provided in Appendix M will be distributed to the parties identified on the contact list (Appendix N), with mandatory contacts receiving full copies of the report . The Notice of Completion will also be advertised in the local newspaper. Multiple copies of the ESR are to be provided to the Township of North Glengarry for public viewing or distribution, as requested.

6.0 THE PREFERRED DESIGN

6.1 Description of Preferred Design

6.1.1 General Description

The preferred design is a communal water supply system with a groundwater source and a piped distribution system. The rated capacity is 80 m^3/day (0.9 L/s). The preferred design can deliver up to 276 m^3/day (3.2 L/s) under peak flow conditions. The design will also provide wet well storage to provide peak hour flow of up to 6.4 L/s. Lawn watering for up to one hour can be provided at flows of up to 11 L/s.

Groundwater would be supplied from a single aquifer, by five individuals wells located outside the developed service area, but inside the hamlet boundaries. A description of the recommended supply well design is provided in the Phase 3 Hydrogeological Report.

Water from the three wells will be pumped under controlled rates to a common header for treatment including H_2S sparging, and chlorination. Chlorinated water will be stored in a wet well. Treated water will be pumped from the wet well to a forcemain for distribution to the community. A schematic of the preferred design is provided in Figure 7. The process components are conventional technologies, in widespread use at communal water treatment systems in Ontario.

The wells and treatment system would be located within the study area (the hamlet of Apple Hill) as shown in Figure 8. The five wells are located on agricultural land, with supply piping to the community buried underground. A single building on the site will accommodate pumps, H_2S sparging, chemical disinfection, water storage (wet well) access, process control and metering. The preliminary design calls for a single building to be constructed of concrete block with a steel roof. A profile of a typical building, showing construction materials is provided in Figure 9. Exterior finishes will be specified in natural colours to blend into the existing agricultural surroundings. The overall profile of the building is low (less than 3.5 meters) and will not obstruct sightlines in the area.

The preferred design can be considered in two components: a treatment system, and a distribution system. The preliminary design for each of these components is described in the following sections. Detailed design will be provided in Phase 5 of the design process.

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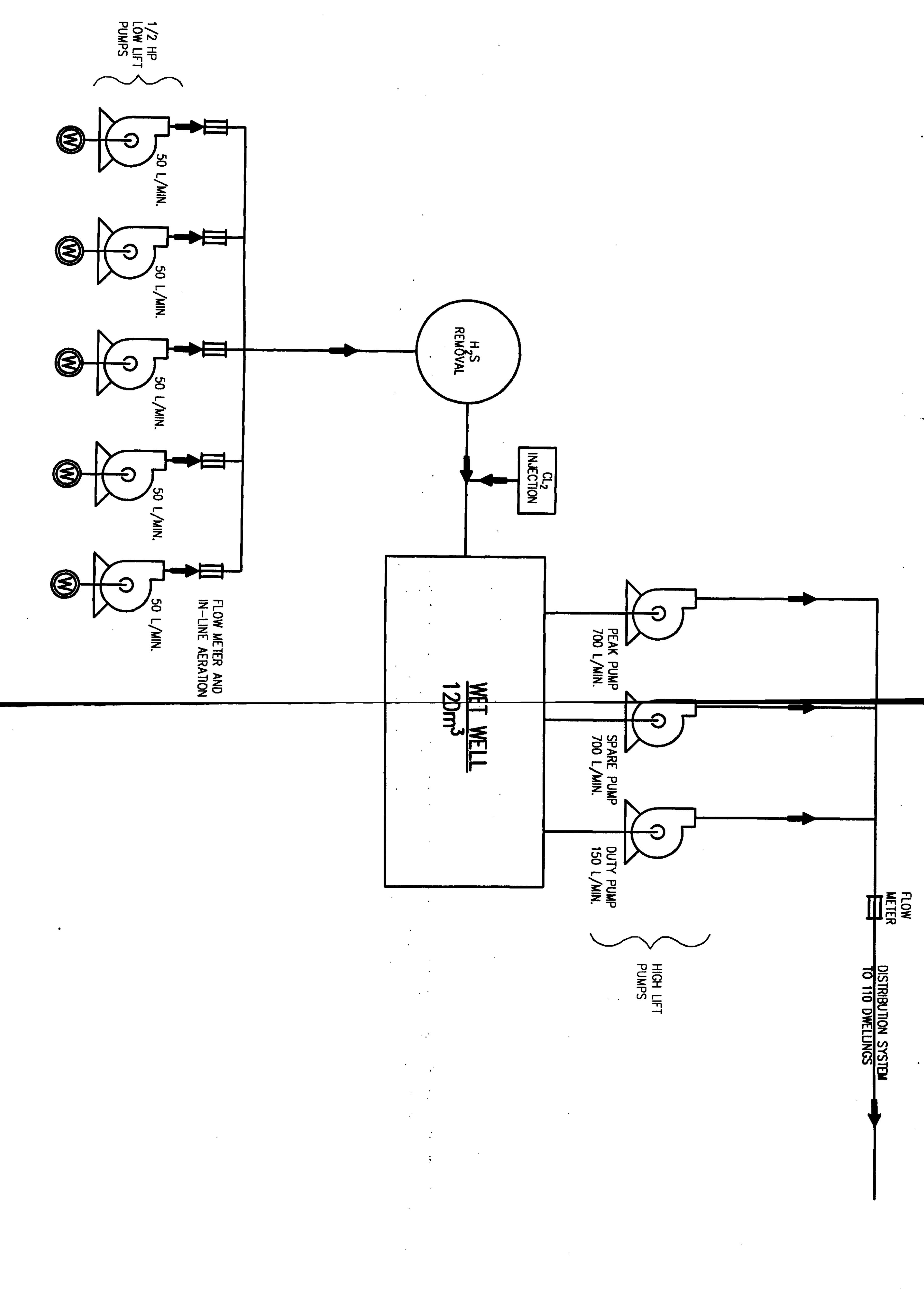
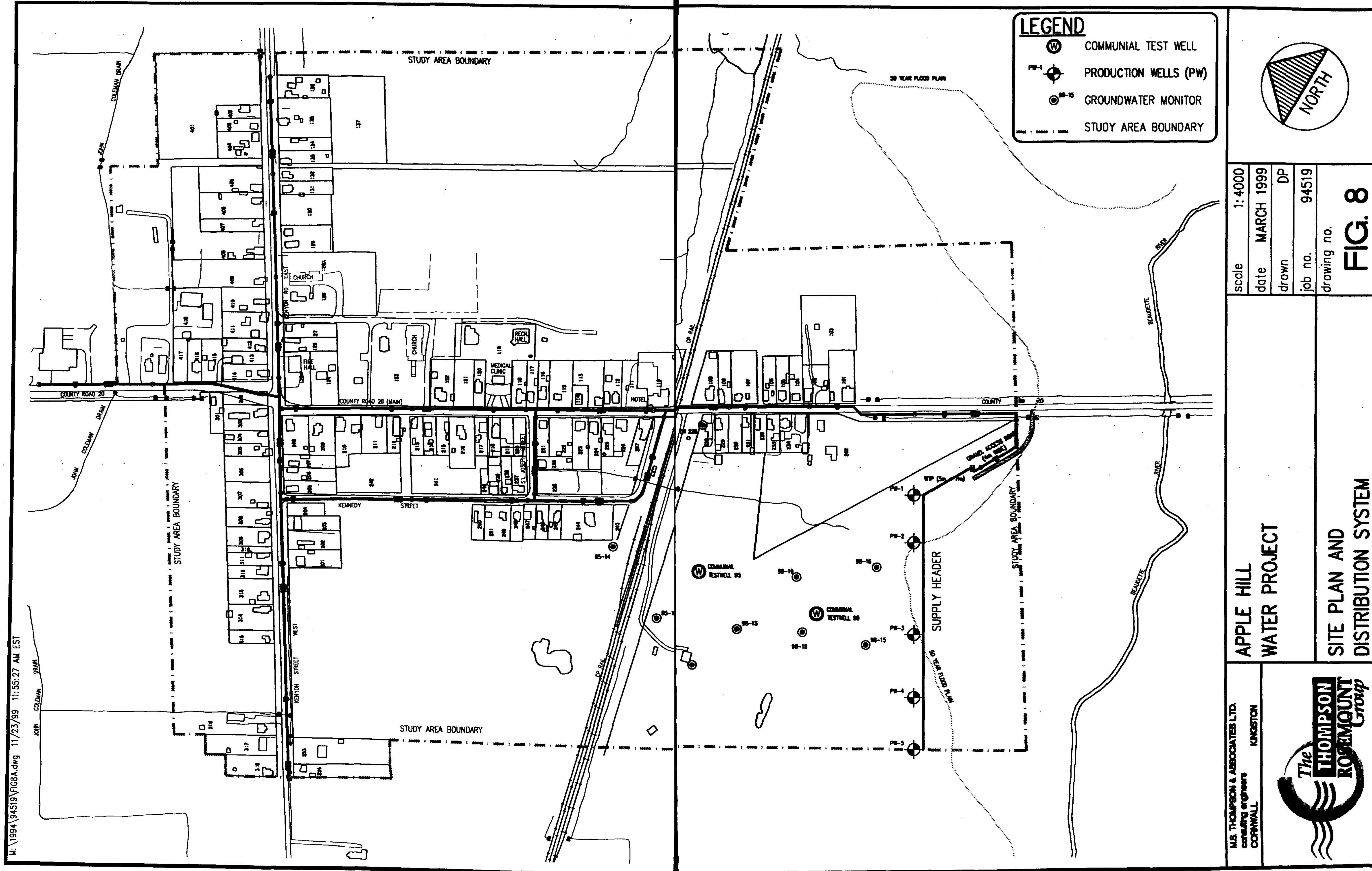
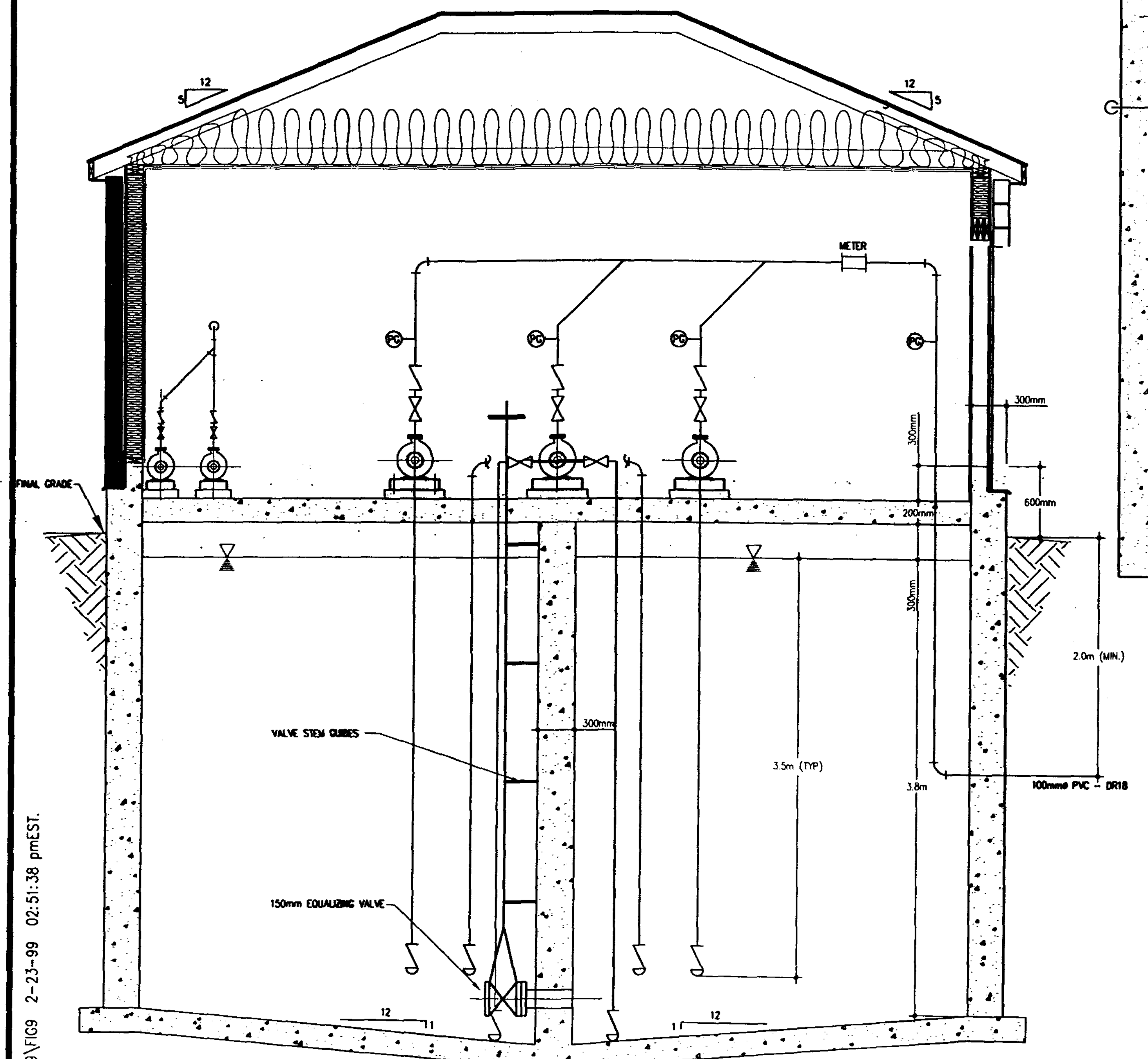
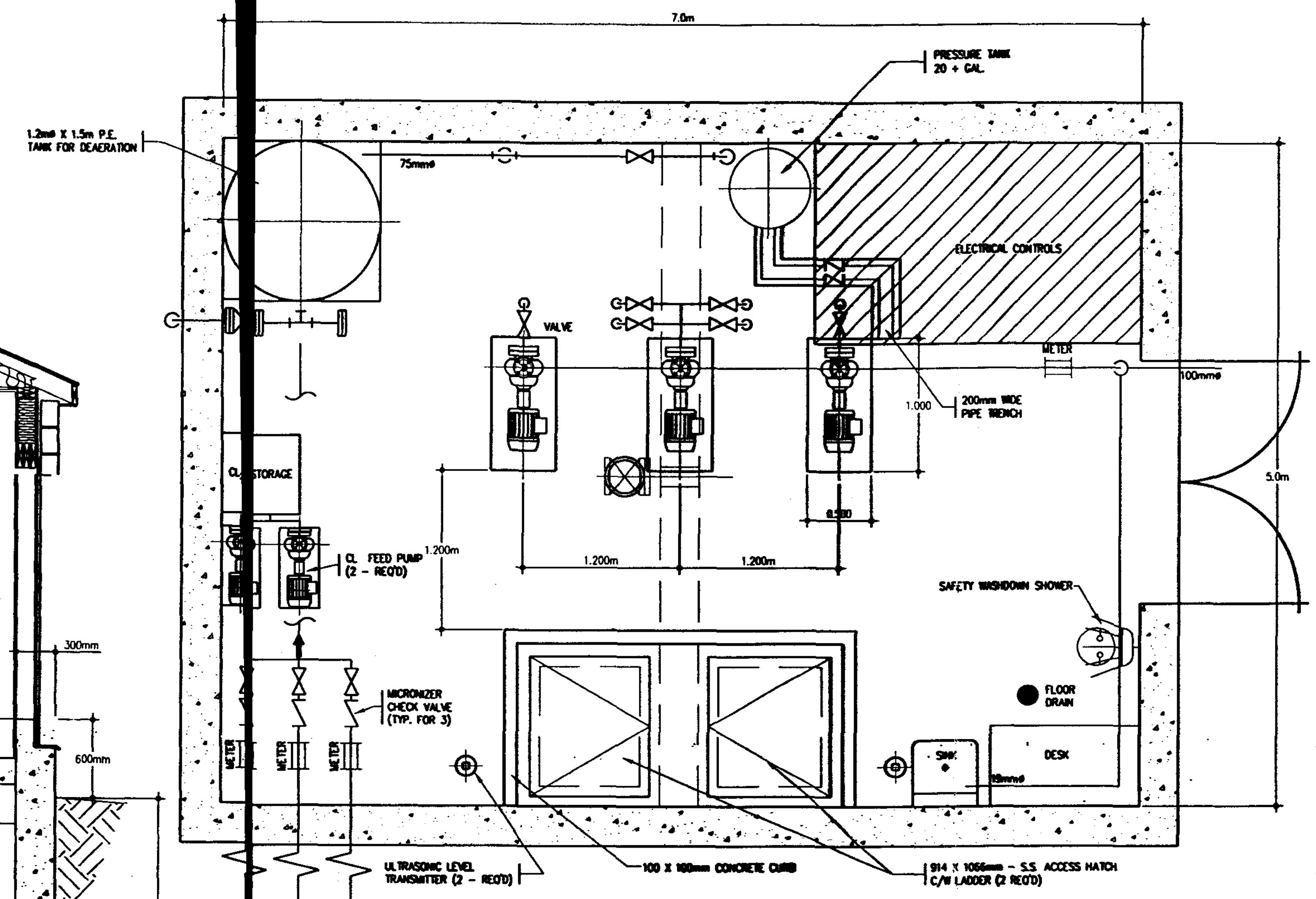


M.S. THOMPSON & ASSOCIATES LTD. consulting engineers CORNWALL KINGSTON	APPLE HILL COMMUNAL WATER PROJECT	scale	N.T.S.
		date	SEPT. 1998
The THOMPSON ROSEMOUNT Group		drawn	G.A.D.
		job no.	94519
	PREFERRED DESIGN PROCESS FLOW DIAGRAM	drawing no.	FIG. 7


LEGEND
COMMUNIAL TEST WELL
PRODUCTION WELLS (PW)
GROUNDWATER MONITOR
STUDY AREA BOUNDARY
NORTH
STUDY AREA BOUNDARY
50 YEAR FLOOD PLAIN
JOHN COLEMAN DRAIN
CHURCH
RECR. HALL
FIRE HALL
MEDICAL CLINIC
HOTEL
COUNTY ROAD 20
COUNTY ROAD 20 (MAIN)
COUNTY RD 20
KENNEDY STREET
ST. JOSEPH STREET
KENYON STREET WEST
KENYON RD EAST
CP RAIL
BEAUDETTE RIVER
SUPPLY HEADER
PW-1
PW-2
PW-3
PW-4
PW-5
COMMUNAL TESTWELL 95
COMMUNAL TESTWELL 98
95-14
98-13
98-15
98-16
98-18
98-19
scale 1:4000
date MARCH 1999
drawn DP
job no. 94519
drawing no.
FIG. 8
APPLE HILL WATER PROJECT
SITE PLAN AND DISTRIBUTION SYSTEM
M.S. THOMPSON & ASSOCIATES LTD.
consulting engineers
CORNWALL KINGSTON
The THOMPSON ROSEMOUNT Group
M:\1994\94519\FIG8A.dwg 11/23/99 11:55:27 AM EST



ELEVATION



PLAN

NORTH

scale	1:50
date	FEB. 1999
drawn	G.A.D.
job no.	94519
drawing no.	FIG. 9

APPLE HILL COMMUNAL
WATER PROJECT

TREATMENT SYSTEM

M.S. THOMPSON & ASSOCIATES LTD.
consulting engineers
CORNWALL KINGSTON

The THOMPSON ROSEMOUNT Group

M:\1994\94519\FIG9 2-23-99 02:51:38 pmEST.

6.2 Treatment System

6.2.1 Groundwater Supply

The three wells will be pumped to a common treatment system, located north east of Well 1. Access to the well sites will require the negotiation of an agreement between the Township and the current property owner(s). A preliminary site evaluation, and the installation of test wells indicates that soils will support the limited traffic and site activities required for construction. Water storage will be provided by a wet well, with a capacity of 120 $m^{3,}$ located at the treatment facility. A detailed description of the groundwater supply system and well design is provided in the Phase III Hydrogeological report.

6.2.2 Sparging

Sparging, to convert H_2S, will occur in a sparging tank, before chlorination. Additional sparging will occur in the wet well.

6.2.3 Disinfection

Disinfection of microbiological contaminants is to be achieved through chlorination. Disinfection will be maintained by continuous monitoring of chlorine residuals, with chemical additional automatically controlled. The chlorination method specified is the addition of sodium hypochlorite solution (bleach) as a 12% strength solution. Although slightly more expensive that chlorine gas, sodium hypochlorite provides equivalent disinfection and is significantly less hazardous.

Hypochlorite will be added to the water supply upstream of the wet well, as shown in Figure 7. The addition point provides disinfection of the wet well water, while allowing a residual to be maintained in the system.

6.2.4 Utilities

Power will be provided nearby overhead lines located along County Road 20. Approximately 15 kW is required to operate the system under normal load conditions. Heating in the treatment buildings will be provided by small electrical heaters. Alarm and process information will be transmitted from the treatment facility by a land based telephone line. Drinking water, a sink, and a safety shower will be provided at the treatment facility. No sanitary facilities will be provided.

6.2.5 Control

The system is designed for continuous operation with provisions for outages of any single component for inspection or maintenance. Normally, the pumping systems will be operated in automatic mode, requiring no operator. The three submersible pumps will operate on microprocessor controlled demand. Normal flow will be provided by a single feed pump to the header, with a peak pump available to meet intermittent peak demand. Flow rates provided by high lift pumps will be regulated by demand responsive microprocessor control. Pump control will include manual override. Process control will include:

- wet well level control;
- flowrate control;
- chlorination;
- temperature control in treatment building;
- automatic lighting;

Detailed design of the supervisory control and data acquisition system (SCADA) will be provided in Phase 5.

6.2.6 Contingency

The water supply system is designed for a nominal 80 m^3/day flow. The design will allow for a peak flow increase of up to 6.4 L/s for one hour, or up to 220 m^3/day. In the event of a low lift pump loss, or loss of one of the wells, the remaining two wells can supply all of the non-peak daily requirements, until the loss is corrected. In the event of the loss of a high lift pump, the spare will be utilised. The chlorine pumps have built in redundancy. Process equipment and components will be designed in accordance with the appropriate electrical safety standards. Detailed design and specification will be completed in Phase 5.

6.2.7 Operations and Maintenance

Regular inspection and maintenance activities would be required for:

- power and pump activation checks;
- wet well level checks;
- sparging efficiency
- chemical addition maintenance and dosage checks; and
- routine water analyses.

6.2.8 Costs

Capital cost estimates for the treatment components of the preferred design are detailed in Table 6.2.

6.3 Distribution System

6.3.1 System Flow and Pressure

Normally, MOE recommends minimum diameter of 150 mm for water distribution systems. For the Apple Hill design, fire protection is not being provided and hence the pipe size is reduced to 100 mm. A network analysis using Haested Methods™ software was conducted to confirm the piping sizes and configuration.

The distribution system consists of 2,800 m of 100 mm diameter PVC piping. Flow will be provided by the high lift pumps at a nominal head of 50m. Pressure in the system will be 600 kPa, reduced to 269 kPa during lawn watering events.

6.3.2 Distribution Routing

Preliminary routing for the outing for the distribution is along existing roadway allowances, except the initial feedermain header line to County Road 20. Distribution piping, as shown on Figure 8, will provide potable water to all developed lots, with servicing for each lot to be provided from the street frontage. The buried distribution system, as proven in most Ontario communities:

- does not require the conversion of any additional land, particularly agricultural land;
- meets current zoning;
- minimises private easement requirements;
- allows connection to existing well water lines;
- minimises construction cost;
- supports future growth; and
- minimised "dead ends";

6.3.3 Land Acquisition and Access

Access to the distribution systems will be along existing municipal road allowances. The study area and service area are entirely within the Township, although County Roads 14 and 20 are maintained by the United Counties of Stormont Dundas and Glengarry, and will require a separate approval and easement.

No additional traffic is anticipated during the operation phase of the project beyond the existing traffic load. During portions of the construction phase, heavy truck traffic will be elevated for brief periods, particularly when concrete is being poured. Contract specifications will include provisions for truck routing, idle operation, road sweeping, and dust control to prevent the emission of any excess levels of dust or noise.

6.3.4 Capital Costs

Capital cost estimates for the distribution portion of the system are presented in Table 6.3.

6.4 Construction and Operation

Construction of the communal water system will occur while the existing individual wells are still in operation to provide uninterrupted supply. The overall construction period is estimated at 9 months, allowing for seasonal conditions to accommodate excavation. As discussed in the environmental evaluation sections, construction is expected to have little to no environmental impact.

6.4.1 Operating Costs

The estimated annual operating cost of the system is $20,000. This cost is equivalent to $200 per typical lot. Estimated annual operating costs are presented in Table 6.4.

Table 6.2 Treatment System Capital Cost Estimate

Water Treatment Plant Cost Estimate for Apple Hill						
Item	**Description**	**Unit**	**Quantity**	**Cost/unit**	**Labour**	**Installed Cost**
Civil/Structural						
Mobilization/Demobilization		LS	1	$8,250.00	$0.00	$8,250.00
Sitework		LS	1	$8,050.00		$8,050.00
Concrete	as per drawing	LS	1	$26,603.00		$26,603.00
Building	wood frame insulated with brick and asphalt roof	LS	1	$47,157.00		$47,157.00
Access Hatch	MSU 304SS 914x1066	ea	2	$1,850.00	$1,000.00	$5,700.00
Access Ladders	OPSD 406.01 c/w anchors (5 m)	ea	2	$525.00	$500.00	$2,050.00
Fencing	10m chainlink fence c/w 3.0 m gate	LM	60	$25.00	$0.00	$1,500.00
Access Road	4m wide 300 gran B 150 gran A, culvert	LM	125	$88.00	$0.00	$11,000.00
Process						
Wells	drilled wells c/w concrete casings	ea	5	$5,000.00	$0.00	$25,000.00
Piping	25.4mm PE pipe ($4.1/m materials)	lm	500	$20.00	$25.00	$22,500.00
	75mm PVC Sched. 80	lm	31	$10.00	$10.00	$620.00
	100mm PVC Sched. 80	lm	14	$15.00	$10.00	$350.00
	150mm PVC DR18	lm	1	$25.00	$250.00	$275.00
Globe Valve	75mm PVC Chemline Globe Valve	ea	7	$500.00	$30.00	$3,710.00
	100mm PVC Chemline Globe Valve	ea	6	$650.00	$30.00	$4,080.00
Gate Valve	150mm PVC Chemline Gate Valve	ea	1	$5,000.00	$300.00	$5,300.00
Foot Valves	75mm PVC Chemline Foot Valve	ea	9	$550.00	$30.00	$5,220.00
Check Valve	100mm PVC Chemline Check Valve	ea	6	$1,500.00	$30.00	$9,180.00
Flow Meters	series 3000 1/2" and Signal Converter	ea	5	$2,000.00	$300.00	$11,500.00
	series 4000 4" and Signal converter	ea	1	$2,500.00	$300.00	$2,800.00
Pressure Gauges	Trerice Model 450-LFD 115mm face 1/4" connection	ea	4	$150.00	$60.00	$840.00
Pressure Control System	Pressure tank and switch to control large pumps	LS	1	$600.00	$300.00	$900.00
Air release valves		ea	6	$150.00	$30.00	$1,080.00
Autodialer		ea	1	$2,000.00	$1,000.00	$3,000.00
Micronizers	Wellmate 3929-5	ea	5	$125.00	$60.00	$925.00
Aeration Tank	PE $2000 for materials	ea	1	$2,000.00	$1,000.00	$3,000.00
Chlorine Injector	LMI Chlorinators	ea	2	$550.00	$100.00	$1,300.00
Chlorine Analyzer	Hach CL-17 (88147 2a file 2 of 2)	ea	1	$4,000.00	$0.00	$4,000.00
Turbidimeter	Hach 1720C (88147 2a file 2 of 2)	ea	1	$3,000.00	$0.00	$3,000.00
Colorimeter	DR70 (88147 2a file 2 of 2)	ea	1	$1,500.00	$0.00	$1,500.00
Chart Recorder	Dual Pen 10" (88147 2a file 2 of 2)	ea	1	$1,500.00	$60.00	$1,560.00
Low Lift Pumps	0.5 hp submersibles incl. Controls	ea	5	$750.00	$60.00	$4,050.00
High Lift Pumps	10 hp centrifugal (700 L/min)	ea	2	$3,188.00	$600.00	$7,576.00
High Lift Duty Pump	7.5 hp centrifugal (150 L/min)	ea	1	$2,188.00	$600.00	$2,788.00
Mechanical						
Misc. Plumbing	Sink and 19mm service	ea	1	$1,500.00	$0.00	$1,500.00
	two piece washroom	ea	1	$1,500.00	$0.00	$1,500.00
	floor drain	ea	1	$50.00	$100.00	$150.00
	septic system - 40 m of perforated pipe	ea	1	$5,000.00	$0.00	$5,000.00
	4 sampling lines from wells and distribution	ea	6	$200.00	$0.00	$1,200.00
Safety Shower	Guardian Equipment G1902P-HPC	ea	1	$935.00	$100.00	$1,035.00
Fire Extinguisher	dry chemical extinguisher Type ABC	ea	1	$50.00	$25.00	$75.00
Electrical						
Pump Instrumentation	Two Ultrasonic level meters and PLC	LS	1	$6,000.00	$0.00	$6,000.00
Pump Controls	magnetic starters and controls		8	$1,350.00	$0.00	$10,800.00
Lighting	fluorescent lighting/exterior security lighting	LS	1	$1,500.00	$0.00	$1,500.00
Service to Property	three phase service from county rd 20 (approx. 125 m	LS	1	$8,500.00	$0.00	$8,500.00
Heaters	unit heaters	ea	2	$300.00	$0.00	$600.00
Misc. Electrical	start-up/inspection misc. connections	LS	1	$1,000.00	$0.00	$1,000.00
HVAC	Louvres, Dampers, Fan as per Redwood			$1,220.00	$0.00	$0.00
SUBTOTAL						$275,224.00
MATERIAL ALLOWANCE		LS				$27,522.40
CONTINGENCY		LS				$116,421.10
Net GST (3.0002%)						$12,575.86
TOTAL						$431,743.36

Table 6.3 Distribution System Capital Cost Estimate

ITEM	DESCRIPTION	UNIT	L.M.	S.M	CM	ESTIMATED QUANTITY	ESTIMATED QUANTITY (ROUNDED)	UNIT PRICE	AMOUNT
UNDERGROUND									
1	100mm PVC WATERMAIN	L.M.				2389	2450	$100	$245,000
2	19mm COPPER WATER SERVICE	L.M.				665	700	$70	$49,000
3	25mm COPPER WATER SERVICE	L.M.				50	60	$75	$4,500
4	100mm WATERVALVES AND VALVE BOXES	EACH				27	27	$500	$13,500
5	19mm COPPER WATER SERVICE - JACK AND BORE)	L.M.				224	230	$80	$18,400
6	100mm PVC WATERMAIN - (JACK AND BORE)	L.M.				78	80	$125	$10,000
7	ROCK (BOULDER) EXCAVATION	C.M.	200	300	300	300	300	$50	$15,000
REINSTATEMENT									
8	GRANULAR B (300mm)	T			3121	7178	7500	$10	$75,000
9	GRANULAR A (150mm)	T			1630	3749	4000	$11	$44,000
10	HL-6	T		10460		1281	1300	$45	$58,500
11	HL-3	T		10148		1243	1300	$45	$58,500
12	ASPHALT DRIVEWAY	S.M.		432		432	500	$25	$12,500
13	TOPSOIL AND SOD	S.M.	1071			1071	1200	$6	$7,200
14	TOPSOIL AND HYDROSEED	S.M.	200			200	300	$4	$1,200
15	CONCRETE SIDEWALK	S.M.	145	174		174	200	$46	$9,200
16	CURB AND GUTTER	L.M.				120	140	$45	$6,300
17	SHOULDERING	L.M.				1030	1200	$40	$48,000
18	WATER SERVICE(PRIVATE PROPERTY)	L.M.	1070			1070	1200	$70	$84,000
19	SOD REINSTATEMENT (PRIVATE PROPERTY)	S.M.	1070	5350		5350	3500	$6	$21,000
20	WELL ABANDONMENT	EACH					100	$300	$30,000
21	WATER METERS	EACH					110	$200	$22,000
								SUBTOTAL	$832,800
22	CONTINGENCY 25%	L.S.						$208,200.00	$208,200.00
								TOTAL	$1,041,000
								NET GST	$31,232.08
								TOTAL	$1,072,232

Table 6.4 Estimated Annual Operating Costs

Component	Annual Cost	Comment
Power	$ 6,000	Pumps, lighting, heat
Chemicals	$ 1,000	Sodium hypochlorite
Maintenance/Operations	$ 8,000	4 hours/ week @ $40/hr incl.
Repairs	$ 3,000	1 % of capital
Other	$ 2,000	Capital replacement contribution
TOTAL	$20,000	

6.4.2 Schedule

Final design, construction, and system operation will be dependant on funding assistance. As previously discussed, the estimated time required for final design and construction is nine months, although the total period could be compressed or expanded to accommodate seasonal conditions, and other factors.

6.4.3 Environmental Control

Conventional environmental control measures including traffic control, truck washing, dust suppression, run-off control, and noise reduction will be utilised, as required during the construction phase.

6.5 Class EA Schedule

The proposed project is a Schedule C project as defined by the Class Environmental Assessment (document) for Municipal Water and Wastewater Projects, June 1993. The project involves the construction of a communal groundwater system. This document and the planning and public consultation processes have been completed consistent with the requirements of the Class EA.

This document will be placed on the public record for the prescribed 30 days following a Notice of Completion.

6.6 Bump-Up Provisions

The public is encouraged to ask questions and provide input to the recommendations before the expiry of the 30-day review period by contacting:

The Township of North Glengarry
90 Main Street
Alexandria, Ontario
K0C 1AO
Attention: Mr. Leo Poirier, Clerk

or;

M.S. Thompson & Associates Ltd.
1345 Rosemount Avenue
Cornwall, Ontario
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Failing a satisfactory resolution of the concern, the public may file in writing a request for "bump-up" by contacting:

The Minister of the Environment
135 St. Clair Avenue West
Toronto, ON
M4V 1P5

Apple Hill
Communal Water Project
Class Environmental Assessment
Appendices- Volume 1

M.S. Thompson & Associates Ltd.

Project No. 94519

November 24, 1999

APPENDIX A

Township of Kenyon Apple Hill Private Water Systems Project-Preliminary Hydrogeological Investigation (MSTA 1995)

Township Of Kenyon

Apple Hill
Private Water Systems Project

Preliminary Hydrogeological Evaluation

M.S. Thompson & Associates Ltd.
Consulting Engineers

November 1994
Revised January 1995

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1.0 Introduction

M.S. Thompson & Associates Ltd. Consulting Engineers (MSTA) was retained by the Township of Kenyon to complete a Private Water Systems Renewal/Replacement Program (PWSRR) for the Community of Apple Hill. The community has a history of water quality problems, both in private wells and in the storm water drains. As a result of these concerns, the Ministry of Environment & Energy (MOEE) undertook a pollution study. Private wells and stormwater locations were sampled in 1989 and 1990, the results of which showed that bacteriological and chemical contamination was widespread throughout the community and further study was needed to quanitfy the problem in order to provide remedial action alternatives. The municipality was successful in receiving funding to complete a Private Water Systems Correction Study.

1.1 Private System Correction Program

The purpose of the program is "to provide financial assistance to eligible municipalities and property owners for the upgrading or repair of existing, privately-owned water supply systems." The objective of the program is to ensure safe and adequate water supply in small communities where soil and groundwater conditions are suitable and the community's growth potential is low such that communal servicing is not warranted.

Until recently, the program was administered by the Ministry of Environment and Energy (MOEE) under the Private System Funding Program, but it has now been re-directed to the Ontario Clean Water Agency (OCWA) and funded under the Municipal Assistance Program (MAP). Funding under MAP varies according to population and other factors, up to a maximum of 85 %. Since the Apple Hill project was initiated prior to the startup of MAP, the funding level for the engineering study has been set at 85 %. If private well correction is demonstrated to be feasible the funding level will have to be established. Again, a maximum 85 % funding level would apply.

From a funding and study objective's prespective, the PWSRR Program is formulated into two distinct divisions - water and sewage. Although the PWSRR is distinct in this funding context, from an environmental impact perspective, water and sewage are interdependent. It is difficult to consider providing potable water in private wells in isolation of sewage concerns.

The Apple Hill PWSRR project was undertaken as a Water Systems Study only and as such, septic systems have not been evalauted as part this preliminary evalaution other than to comment on the lot sizes and the results of the MOEE Pollution Survey. The overall project approach, as described in the project terms of reference (Appendix A), is divided into 5 phases :

- Preliminary hydrogeological evaluation;
- Detailed hydrogeological study program;
- Lot-by-lot survey and sampling program;
- Finalizing solutions; and
- Pre-construction.

This report describes the work undertaken as part of the preliminary hydrogeological investigation.

The 6 tasks completed as part of the first phase of the project include: project initiation meeting; existing information review; private service site restrictions; development of typical system layouts; preliminary hydrogeological assessment and system feasibility; and assessment of the need for a full hydrogeological study.

1.2 Project Initiation Meeting

In order to ensure that the needs of the community are properly addressed and that the policy requirements of funding are satisfied, the terms of reference stipulate that a liaison committee should be formed. Generally, the liaison committee members include representatives of the various regulatory agencies, municipality, and members of the public.

The Apple Hill Liaison Committee includes representatives from the Eastern Ontario Health Unit (EOHU), the MOEE's District Office in Cornwall, a resident from the Village of Apple Hill, and a member of council. The committee members include :

Mr. Bernie Raymond	- Village of Apple Hill
Mr. Marc Robert	- Ministry of Environment & Energy (MOEE), Cornwall
Mr. Sylvian Diotte	- Eastern Ontario Health Unit Sewage System Approvals (EOHU)
Ms. Clo Howieson	- Eastern Ontario Health Unit Water Approvals (EOHU)
Mr. Wilfred Vallance*	- Former Reeve, Kenyon Township
Mr. Don Besner	- Deputy-Reeve, Kenyon Township
Mr. Pierre Solda	- Ontario Clean Water Agency (OCWA), Toronto
Mr. Patrick Newland	- Ontario Clean Water Agency (OCWA), Glen Walter
Mr. John St. Marseille, P.Eng.	- M.S. Thompson & Associates (MSTA)

*Mr. Don Besner, Deputy Reeve of Kenyon Township, was selected to replace Mr. Vallance on the committee following the inaugural meeting. Mr. Partick Newland of OCWA's Operating Division in Glen Walter was asked by the municipality to join the committee following the first meeting.

The inaugural meeting of the liaison committee was held on September 27, 1994. The purpose of the meeting was to introduce the consultant and committee members, discuss the study objectives and problem definition, proposed schedule, availibility of information, and public consultation approaches. The study area was defined as the hamlet boundaries of the village of Apple Hill. It was explained that much of the preliminary hydrogeological information would come from MOEE well records and the Water Pollution Survey report (MOEE 1992).

A question was raised at the meeting with respect to individual homeowner partcipation in the program. It was explained that participation in the program would be voluntary which is one of the inherent problems associated with the private system correction as a means of remediation. Community-wide solutions may not be implemented as a concequence. A discussion about sensitizing the public to the advantages and shortcomings of the program and the need for effective public relations was emphasized. It was rationalized that this could best be achieved through announcements in the media and at the open house.

2.0 Existing Information Review

2.1 Site Description and Mapping

Apple Hill is located about 25 km northeast of Cornwall (Figure 1) in Kenyon Township. During the last 20 years or so, the population has been declining as shown by census data. The 1991 population was 195 compared to 257 in 1986 and 271 in 1976. There are 91 homes within the village some of which have been divided into sections to provide rental units which number about 12. There are 5 commercial and 5 institutional properties within the village including two churches, a hotel and tavern, medical clinic, post office, fire station, general store, convenience store, hairdressing salon, and pool chemical retail oulet.

Detailed topographic information was provided from the Ministry of Natural Resources base mapping (MNR 1993). Contours and physical features are displayed on a 1:2,000 scale topographical mapp developed from 1992 aerial photography. The contour interval is 1 m and all elevations are geodetic (Figure 2).

The latest assessment mapping was superimposed on the topographic plan. From this drawing and using the municipality's assessment roll numbers the property owners were identified. This facilitated the cross-referencing of well records and water quality analysis to a lot location within the village. In this way, water quality, geology, and other hydrogeological data could be spatially analyzed.

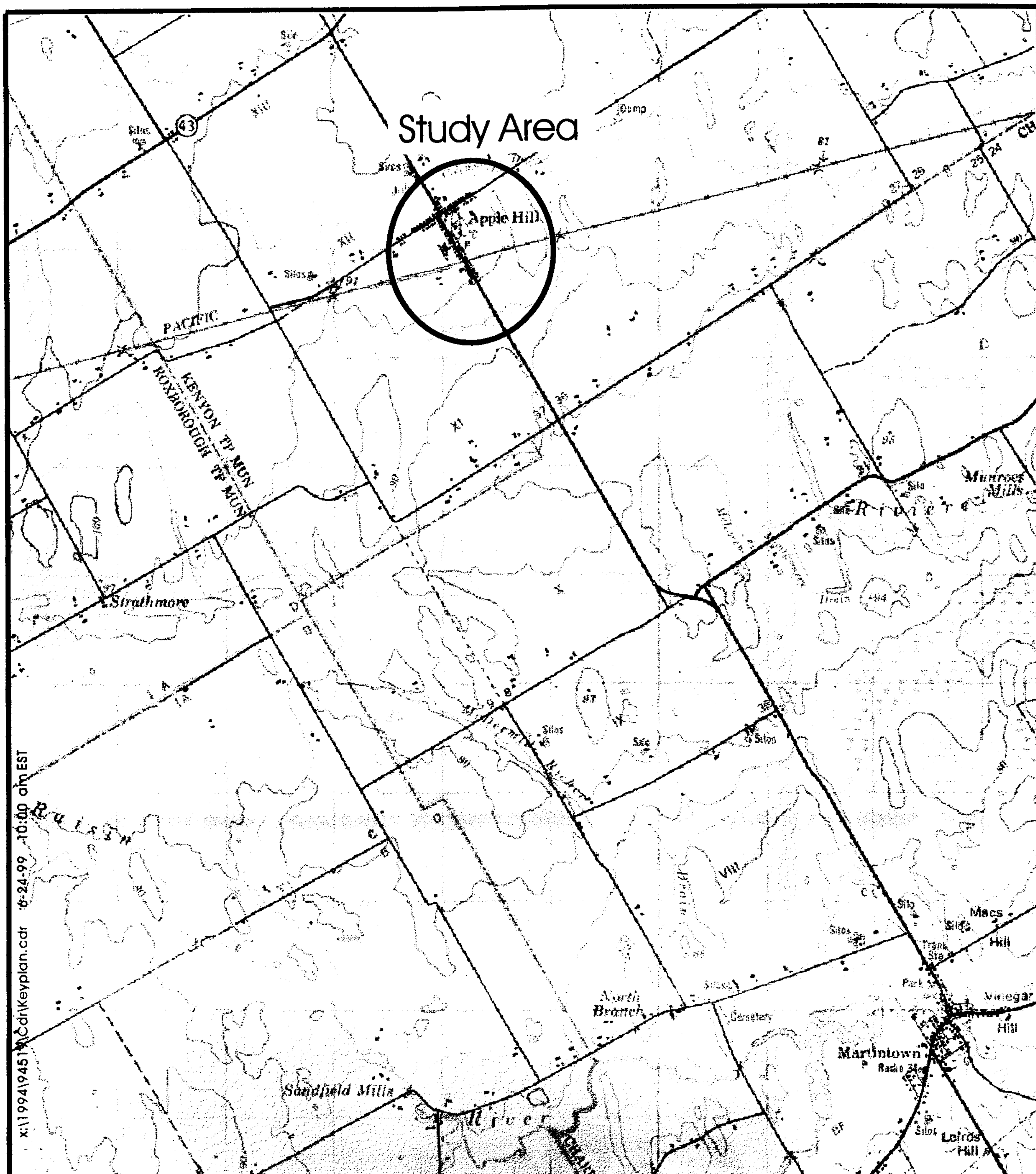
The PWSRR study area includes lots lying within the Hamlet designation as shown on Figure 2. The 1989 and 1990 MOEE survey however did include some wells north and west of the village limits. Those lots outside of the hamlet boundary have not been included in this study.

In order to correlate the lot locations from the various forms of information which exist for the village, MSTA used a 3-digit numbering scheme which described each lot on a 4-quadrant system using the intersection of Main Street (County Road 20) and Kenyon Street as reference. The first digit of the code describes the quadrant (1,2,3, and 4 for SE, SW, NW, NE resepctively). The second and third digits ascend sequentially, in a clockwise rotation for each quadrant beginning from 1 (Figure 2).

2.2 Regional Geology

The surficial geology of the St. Lawrence River area of Eastern Ontario was studied as part of the chacterization work for the St. Lawrence Seaway project (Terasame 1962) and subsequent engineering terrain mapping work (Ringrose et al 1992).

The surficial geology of this area, as with most of Eastern Ontario, is dominated by glacial till. According to Terasmae (1962), this differs significantly from typical surficial deposits because it is physically and lithologically heterogenous with unsorted and unstratified pockets of granular material. The compaction and preconsolidation by succesive glacial advances renders it more impervious to groundwater movement.



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M.S. THOMPSON & ASSOCIATES LTD.
consulting engineers
CORNWALL KINGSTON

The THOMPSON ROSEMOUNT Group

APPLE HILL
PHASE III HYDROGEOLOGICAL STUDY

KEY PLAN

scale	1:50,000
date	March 1999
drawn	JBH
job no.	94519
drawing no.	FIGURE 1

At high and low topographic relief, the till may be continuous. The till consists of stratified and unstratified drift. The stratified drift is proglacial marine silt, sand, and clay in the low lying areas (Ringrose et al). The high-ground consists of ground moraine till which can be very compact and poorly sorted (lodgement till) or partially sorted (abalation till) which may feature some relatively high permeability sand and gravel units.

Terasmae (1962) described the till as two distinct units. The upper or Fort Covington Till, is compact grey (or buff when oxidized) sandy till which includes bouldery washed till on the slopes and hills. The lower unit, Malone Till is very compact, blue silty-gray clay matrix with boulders and cobbles depending on the proximity and character of the underlying bedrock. Most of the pebbles tend to be Palaeozoic sedimentary rocks (Terasmae 1962).

In some locations along the St. Lawrence River, stratified granular deposists have been noted lying in between the two till units. These glacial-fluvial materials were deposited during the waning of the Malone ice-sheet. These stratified deposits were termed middle till complex (Terasmae 1962) and range up to 10 m thick. Owing to their stratified composition they may yield relatively high quantities of water depending upon their thickness. The stratified material may contain embedded cobbles and boulders as described below.

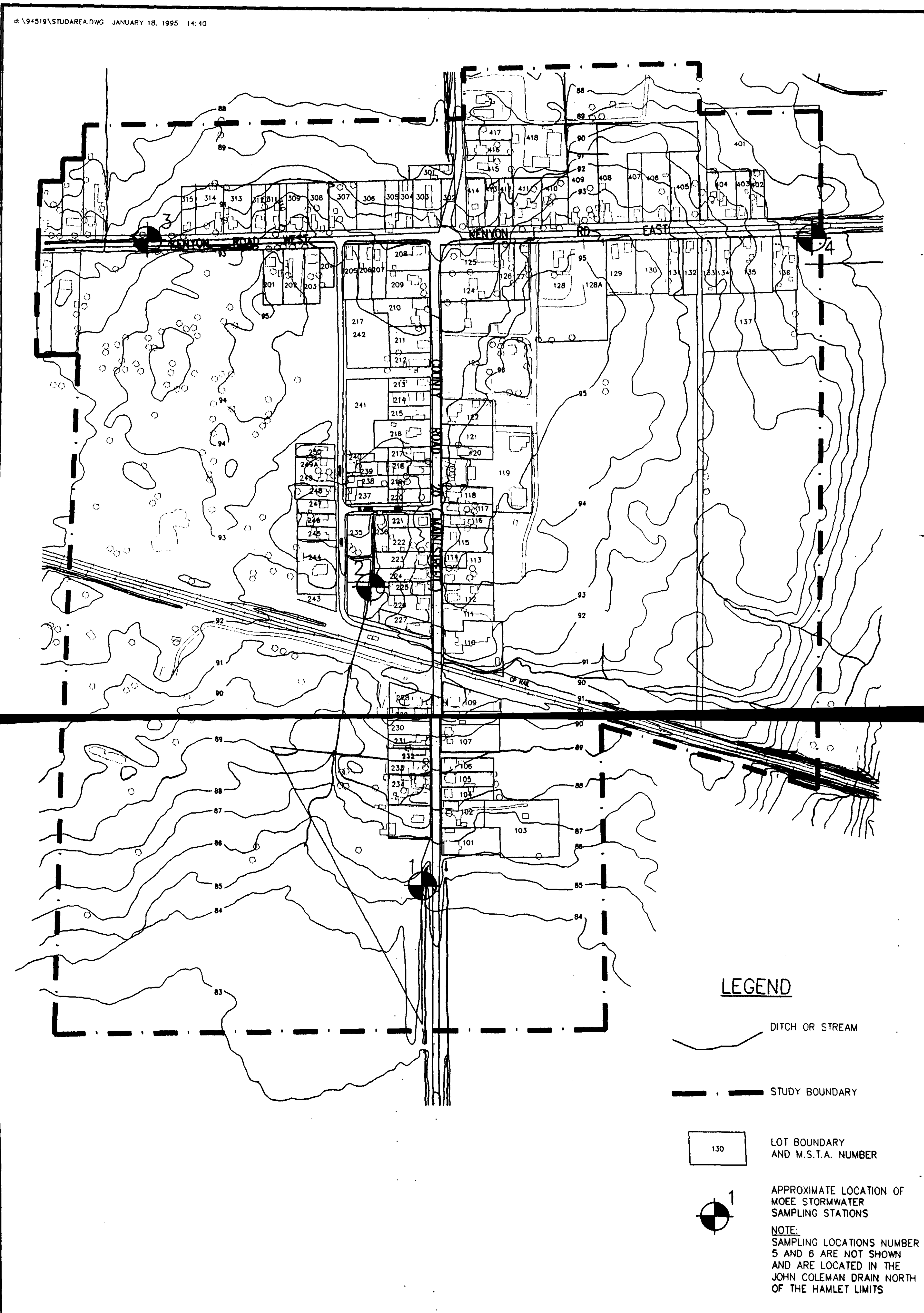
The upper, youngest till is termed Fort Covington. It was deposited by a different glacial advance, is thinner, and has more sand than the Malone till. Fort Covington till was deposited by glaciers flowing from west of north. This till is less compact than the Malone till and has a larger portion of (non-native) igneous rocks which is indicative of transported soil. Outcrops of Fort Covington till, on ridges, tend to be oxidized buff-to-brown colour to a depth of about 6 m.

The Malone till, associated with the initial glacial advance from the northeast, contains a more silty-clay matrix with pebbles, cobbles, and boulders. The fragments are residual sedimentary rocks which were derived from the local bedrock as the glacier advanced and scoured its surface.

2.3 Aerial Photography

Aerial photography was used to correlate some of the landscape features to geological conditions (MNR 1978). The existance of till ridges, drumlins, and troughs provides evidence of re-worked till and perhaps bedrock discontinuities.

The most significant feature of the aerial photographs reveals three parallel ridges within the hamlet boundaries. It is these ridges to which Apple Hill owes its namesake, at least in part (Standard Freeholder 1994). The middle ridge is the most prominent. It is oriented north-south and is likely composed of Malone Till although some re-working by the later Fort Covington advance may have changed the soil fabric and its orientation. The southern limit of this ridge extends near the south boundary of the hamlet at about elevation 91 m. The ridge was partially cut to facilitate the construction of the Canadian Pacific Rail (CPR) line which traverses the south part of the village.



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CORNWALL, OTTAWA, KINGSTON

TITLE
STUDY AREA

PROJECT
APPLE HILL
PRIVATE WATER STUDY

scale	1:4000
date	NOVEMBER 1994
drawn	DWP
job no.	94519

drawing no.

FIGURE 2

The till ridge reaches a maximum elevation of 96 m near the location of the Catholic Church. The less predominant ridges are parallel to, and 300 m east and west of the main ridge. At one time these ridges may have been joined but subsequent glacial advances and re-working in the marine environment has separated them.

Terasmae (1962) did extensive investigations into the geological conditions which occured around till ridges. Because Eastern Ontario was inundated by the Champlain Sea following the receedance of the glaciers, re-working of the till deposits by wave activity occurred. The Champlain Sea was estimated to have existed at a present day elevation of about 92 to 107 m (300 to 350'), so some of the higher till ridges remained above water.

This appears to be the case at Apple Hill. Wave action however, predominately on the westward face of the ridges, reworked some of the till. Lesser re-working would have occurred on the leeward, less exposed shorelines. This re-working resulted in material sorting - the largest materials (boulders) remained close to the ridge while the smaller fractions were carried further offshore and deposited (Figure 3).

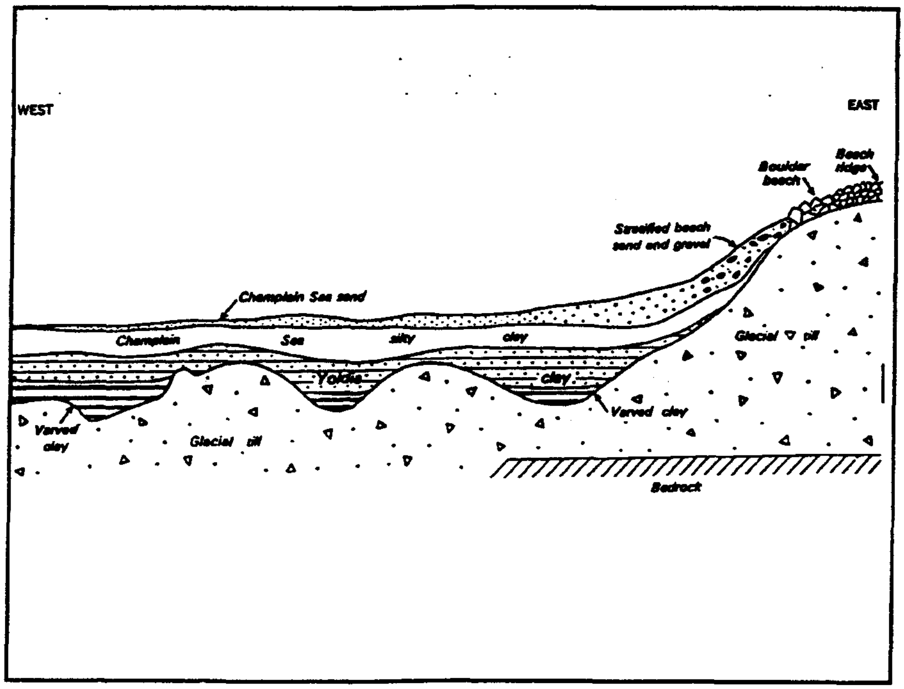

Figure 3 - Typical Cross-Section Through Marine Re-worked Till Ridge (adapted from Terasmae 1962)

This figure is intended to show a generic cross-section through a reworked till ridge and does not necessarily represent the actual lithology at Apple Hill. Detailed hydrogeological investigation is necessary to better characterize the lithology.

The existance of these landforms is important since they provide some insight into the hydrogeological conditions in the area. The two valleys formed between the three ridges became repositories for sorted granular deposits which partially filled the valleys. Sloughing of material on the unstable slopes created by the marine environment resulted in some unstratified deposits (silt and clay) intermingled with the more stratified sand, gravel, and boulder components. The relative elevation between the till ridge and the gravel deposits likely means that the aquifer is locally recharged and its quality may be compromised by sewage effluent. Further study is needed to confirm this.

There is a drumlin about 600 m west of the village which provides further evidence of the extenstive re-working of till ridges by later glacial advances.

2.4 MOEE Well Records

A review of the MOEE well records was completed to further correlate the regional geological and hydrogeological data. Well records are completed by licensed well drillers as well supplies are developed. The vast majority of these records are for wells which are drilled into deeper aquifers as opposed to dug wells which are developed into shallow aquifers. The database includes 28 well records for a period extending from the late 1950s to the late 1980s (Appendix B). Some of the records list the current owners but most were drilled for the previous landowners. For these latter cases, the well records were cross-referenced to a lot location by identifying the previous landowners.

Most MOEE well records provide a ground surface elevation which is estimated (likely accurate to about ± 3 m). Using the base mapping (1:2,000, Figure 2) which was produced from 1992 MNR aerial photography, the surface elevations of all lots were estimated to the nearest 0.5 m. The underlying stratigraphy was correlated from this reference elevation for the lots which had a well record.

2.4.1 Bedrock Geology

The well records were used to compile bedrock depths throughout the village. The bedrock varies in depth from 3 m (10') to 24.7 m (81') from the surface. The bedrock was closest to the surface at the north end of the village and furthest at the south end. The elevation of the till ridge reflects the bedrock's proximity to the surface at the north part of the village. The top of bedrock profile was contoured (Figure 4) by converting the depth to bedrock to geodetic elevation. The results show some variation in the bedrock surface contours but generally, that the bedrock ridges are oriented in the same manner as the till ridges with the general dip direction trending southerly. The existance of the till ridges is thus related to the bedrock ridges. No bedrock depth was provided for well records from the south end of the village so the contours do not extend to this area.

Part of the problem interpreting the top of bedrock contours is related to the well driller's interpretation of where the overburden-bedrock contact exists. The definitive demarcation of the contact can be masked by highly fractured bedrock, and the existance of granular materials. Faults and fractures can also influence the continuity of the contours.

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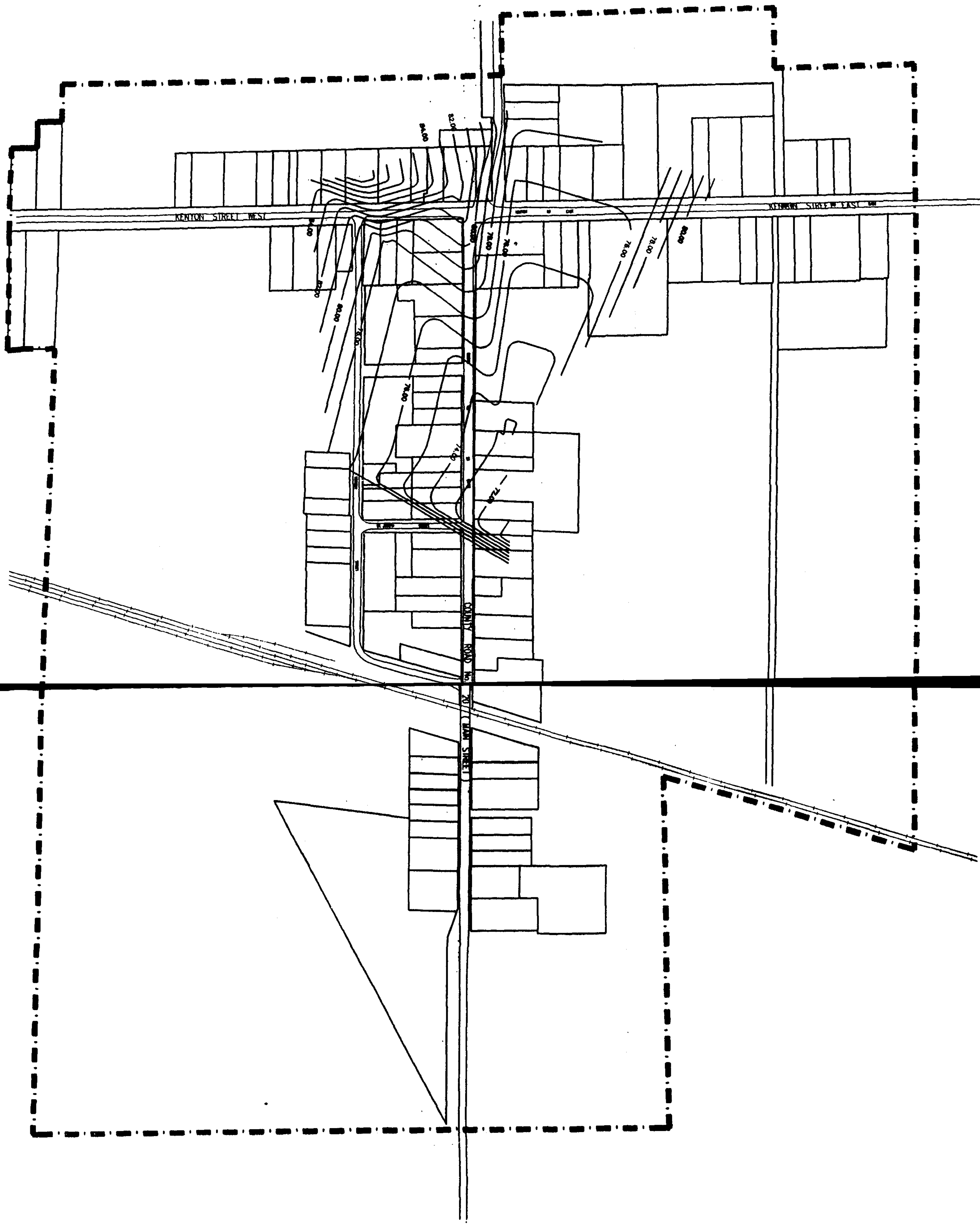


M.S.THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS CORNWALL, OTTAWA, KINGSTON	TITLE TOP OF BEDROCK CONTOURS PROJECT APPLE HILL PRIVATE WATER STUDY	scale 1:4000 date NOVEMBER 1994 drawn DWP job no. 94519 drawing no. FIGURE 4	

The latter conclusion is supported by the existance of shallow troughs oriented east/west which Terasmae (1962) suggests were created by succesive soil moisture depletion episodes. As groundwater seeps into the bedrock through preferential pathways and depletes the soil moisture content, the fine materials in the overburden become dessicated and shrink. These successive depletions cause depressions to form which are distinguishable on the air photos. There does not appear to be air photo evidence of these depressions within the hamlet boundary. However, since they occur regionally, and because of the undulating surface contour of the bedrock, faults and fractures would likely exist in the bedrock under the village. The existance of fractures is important since they may provide bedrock aquifer recharge paths but at the same time they may be preferential pathways for sewage flow. This could be confirmed through completion of the detailed hydrogeological investigation.

Based on the well records, the bedrock is sedimentary grey limestone with some shale interbeds. In 5 of the logs "black rock" formations were noted which is inferred as the shale interbeds. The regional bedrock geology as described by Wilson consists of limestone of the Trenton Group, Ottawa formation. The characteristic of this formation near the surface is pure and thick limestone with some rusty weathering and occasional impure beds and shale partings. This descriptions generally corresponds to the well records descriptions.

2.4.2 Overburden Geology

The composition of overburden material varies greatly across the village but some distinct trends can be seen. Wells drilled along the periphery of the till ridges show a stratigraphy consisting of till, boulders, then bedrock as depth increases. Depending upon where the former shoreline was intersected by the well, the type of stratified deposit which was encountered varies. The till material, being generally heterogeneous and compact does not yield sufficient quanity of water to be exploited for domestic purposes, especially during drier periods of the year.

Granular deposits (gravel, sand) are predominant along Kennedy Street which is in the valley between the two till ridges where wave action would have stratified the till deposits. Drainage of the former sea through the area may have also supplemented the re-working of the sand and gravel deposits. Their high hydraulic conductivity makes them good yielding aquifers but also reduces their degree of isolation from the contaminant sources.

Near surface granular deposits exist sporadically throughout the village. These deposits were formed in the post-glacial marine environment. Given the permeability of the granular materials, they are adequate yielding aquifers to be exploited using shallow dug wells. These aquifers are so-called "perched aquifers" since they form above the underlying, less permeable glacial till. Since the perched aquifer is proximate to the surface and has minimal lateral extent, these dug wells feature minimal yields, poor isolation from contaminant sources, and are susceptible to periodic drying.

2.5 MOEE Pollution Survey

Much of the existing information pertaining to the problem definition was provided in the Water Pollution Survey Report (MOEE 1992). This report, by the MOEE Cornwall District Office highlights the water quality issues associated with the 1989 and 1990 water sampling programs. The intial sampling was undertaken in June and July of 1989. Followup sampling of the "poor" and "unsafe" wells was completed in 1990. The pollution survey extended beyond the Village limits but as indicated, the hamlet boundary forms the limits for this investigation.

The major indicator of water quality was provided by bacteriological testing but some random samples were also collected for chemical analysis of typical health and non-health related parameters.

The bacteriological survey included 87 of the 107 wells within the Village of Apple Hill. The original water quality survey (1989) found that 47 percent of the wells (41 wells) were "unsafe", 9 percent (9 wells) were "poor", and 44 percent (37 wells) were "safe". An "unsafe" water supply, from a bacteriological perspective, exists when Total Coliform bacteria counts exceed 10 or if any faecal coliform counts are observed (MOEE 1992).

There were 38 water samples taken for chemical analyses. This included a nitrogen suite, iron, chloride, and conductivity (Appendix D). Using nitrate-N as a reference, there were 4 wells that exceeded the ODWO limit of 10 mg/L. Of these 4, 3 were shallow dug wells in the north part of the village where the bedrock is proximate to the surface. The drilled well depth was not provided. Also, there were 21 of the 38 samples which had elevated concentrations of nitrate-N. Elevated in this definition refers to results which exceed unimpacted background levels, about 0.5 mg/L.

As part of the MOEE survey, residents were asked about water treatment units and water quality. Some owners employ water softeners, filters, and purifiers (type is unknown). As expected the softeners are employed to treat water from the drilled wells because of the "hard" (calcium and magnesium) nature of the sedimentary rock.

The water quality complaints included those which are typical of groundwater in Eastern Ontario; that is "buildup on fixtures" (inferred as hardness related); "staining" (inferred as being iron or manganese related) ; "sulfur odour" (inferred as dissolved hydrogen sulfide); "rust" (inferred as a combination of iron staining and corrosion related); and "blackness" (inferred as iron, sulfide, or manganese, or sewage related). Water taste and colour problems were also noted which may be related to a number of factors including sewage.

There were 7 homeowners who idenfified that their wells were "undrinkable" or "unsafe". It is presumed that these owners have made alternative arrangements for water supply (eg. bottled water).

It is a subjective decision by the homeowner as to why the water would be undrinkable or unsafe; however, it is likely that the owner knows or strongly suspects that the water supply has been compromised and accordingly will not drink it. Sewage contamination is likely the main source of contamination in these cases although one homeowner reported "oil in well" which should also be further investigated.

Another part of the MOEE study considered stormwater drain quality sampling at 6 stations surrounding the village (Figure 2). Storm drainage in the community is via a network of open ditches. Stations 5 and 6 were taken from the John Coleman Drain north of the village on the west and east sides of Main Street respectively. These sampling stations are outside the study limits and as such are not shown on Figure 2.

The results of the MOEE survey are provided in Appendix D . These results show several hundred to several thousand fecal coliform counts at all 6 sampling stations. It is impossible to infer the location of the problematic sewage systems or direct dicharges, but given the widespread contamination in the storm drains then the existance of direct discharges is confimed as well as many systems working improperly.

The intent of this study is not to consider the sewage problems possibly associated with these drains, but rather that the results indicate well impairment to such an extent that sewage disposal to the drains is affecting well quality. Also, the aesthetic impact of direct discharge cannot be discounted. A problem with discharge to the storm network is not only the localized contamination that this may cause but also the extent that the contaminants may migrate because the storm drains are an effective conveyance route. Remediation of the storm sewers through rehabilitation/replacement of the sewage disposal systems should be considered as an integral part of the long-term provision of safe drinking water in the community.

3.0 Interpretation

3.1 Hydrogeology

Information provided in the well records was interpreted to obtain hydrogeological data.

3.1.1 Water Bearing Zones

Based on the MOEE well records and the pollution survey there are 4 aquifers within the village that are utilized for domestic water supply - 2 overburden and 2 bedrock. The overburden aquifers reside in the near surface and deeper coarse grained materials (sand and gravel) which can be exploited by constructing so-called "dug wells" or drilled wells. The near surface granular deposits exist sporadically throughout the village and are reported as ranging in depth up to 20 m from the surface. Shallow dugs wells are used to exploit this water source.

3.1.1.1 Overburden Aquifers

The MOEE well records show that the deep overburden aquifer (sand and gravel) typically yields about an order of magnitude more water than the bedrock wells except the very shallow dug wells into the perched aquifers which have seasonal water flow problems and very poor water quality.

The overburden aquifers generally have better water quality than the bedrock aquifers since reducing conditions exist at depth which is conducive to formation of odour causing dissolved gases (hydrogen sulfide, methane) and dissolved solids (eg iron, manganese) which cause staining. The drawback with utilizing overburden aquifers as a water supply is that they do not afford the same degree of isolation from potential contaminant sources.

Based on the MOEE door-to-door survey, there are about 30 dug wells within the village. Of these, 19 reported depths varying from 3 to 23 m, the other 11 did not report depths. Although some dug wells were reported to have been constructed to a depth of 23 m, it has not been confirmed if the deepest wells are in fact dug or drilled.

The nature of the dug well construction is such that the rock-lined wells do not seal off potential contaminant entry through the upper part of the well. Typically these contaminants would be attenuated as they travel deeper into the soil through processes such as biological degradation/transformation, dilution, and soil adsoprtion. However, the short-circuiting reduces the opportunity for this attenuation and more concentrated contaminants enter the drinking supply.

There are not enough well records to complete a rigorous statistical interpretation of the data, but of the 19 wells, 4 are between 0 to 5 m deep, 9 are between 6 to 10 m, and 6 exceed a depth of 10 m. This information gives an approximate estimate of the depth to the aquifers. Generally, the degree of isolation of the aquifer from potential contaminant sources is directly related to the depth of the well. This trend is apparent in Apple Hill since all the shallow dug wells (less than 5 m deep) were deemed "unsafe" according to the MOEE survey.

Of the 9 medium depth wells, 6 were "unsafe" and only 3 were rated "safe". Only 2 of the deep dug wells (greater than 10 m) were deemed "safe" and the other 4 were "unsafe". The fact that the deeper dug wells are "unsafe" means either that contaminants are short-circuiting to the well through the upper, more contaminated aquifer(s) or that the deeper aquifers are also contaminated.

A generalized representation of the various well types is shown on Figure 5. This figure is not intended to represent the detailed lithology of Apple Hill but rather to show the paths that are available for contamination from the storm drains, pit privies, and septic beds to enter the wells. The contamination of the shallow dug and drilled wells is directly through the contaminated aquifers. Contaminants move into the deeper wells through the upper aquifer until they intersect the well casings. If the casings are not properly sealed to bedrock, they may "short-circuit" contaminants through the annular space surrounding the casing.

It may be possible to succesfully continue to exploit the deep sand and gravel aquifer for water supply purposes so long as direct sources of contamination are eliminated (stormwater discharges and improper sewage systems) and each well is properly isolated from the surface to the greatest extent possible. More detailed hydrogeological information is required to more fully address this issue.

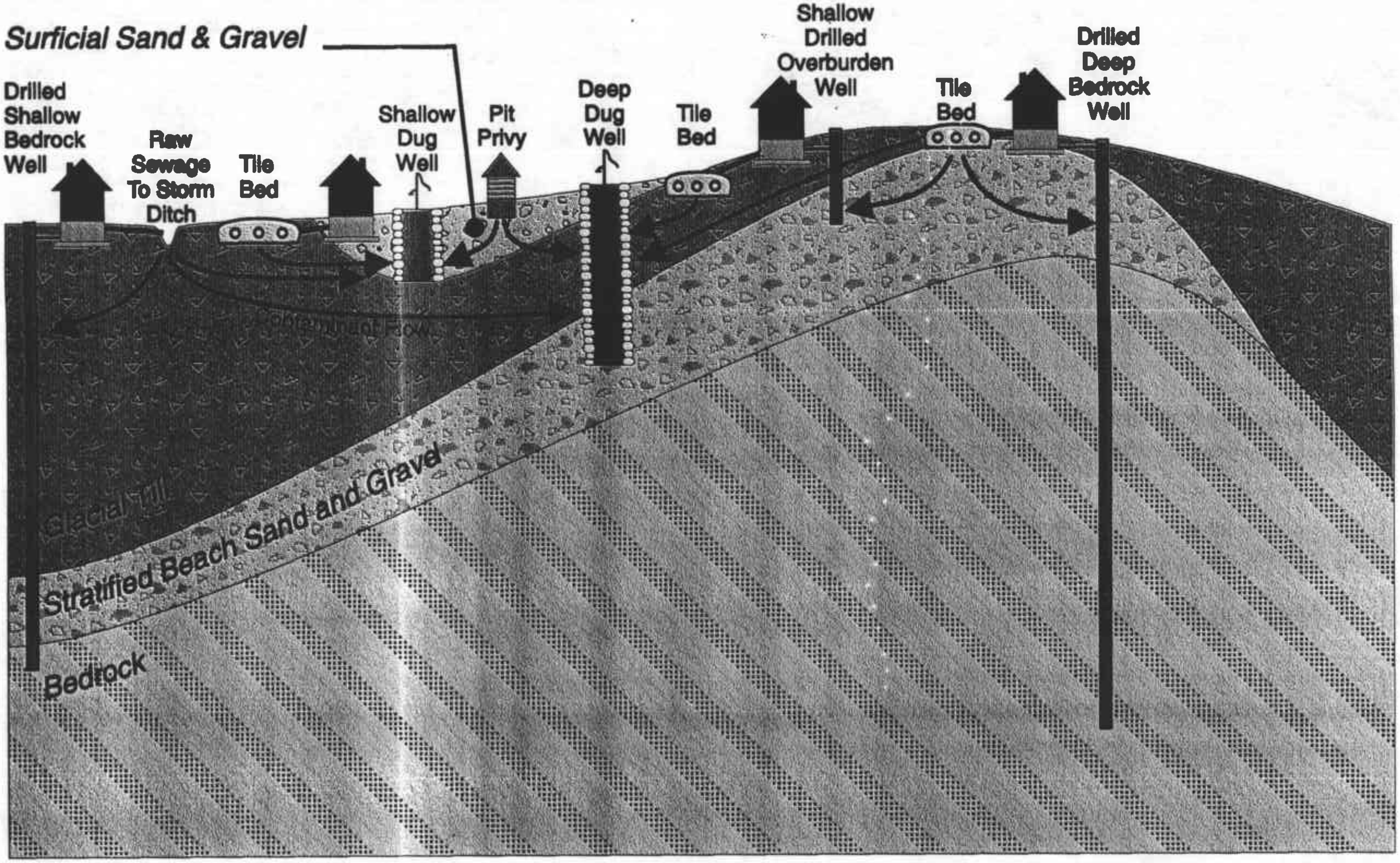
3.1.1.2 Bedrock Aquifer

The bedrock aquifers are located in the top, more fractured part of the bedrock or in the deeper, more competent parts. These aquifers are more isolated from the surficial contaminant sources and as such should be "safe" drinking supplies. The fact that some do not have "safe" water could be a result of shortcircuiting of contaminants (eg. improper well construction, surface water intrusion) or a contaminated
aquifer (Figure 5).

Of the 28 drilled wells in the MOEE database, 7 were developed into a granular aquifers ranging in depth from 9 to 21 m from the surface. Of these wells, 2 were not sampled, 4 were "safe" and 2 were "unsafe". The remaining 21 wells were drilled to either limestone (18) or shale (3) bedrock. The limestone wells ranged in depth from 11 to 43 m and of these 5 were rated "unsafe", 6 were "safe", and 7 were not sampled. Of the 3 shale wells, 2 were safe and 1 was not sampled. These ranged in depth from 14 to 24 m from the surface. It is unknown if the drilled wells are properly isolated from the contaminant sources.

More detailed hydrogeological information is required to more fully address this issue.

FIGURE 5 - TYPICAL AQUIFER AND WELL CROSS-SECTION



3.1.2 Groundwater Chemistry

The MOEE survey and well record data was graphically interpreted and plotted according to the approximate lot location in the village (Figure 6). The data shown on the figure provides the results of the bacteriological and chemical surveys by well type and depth.

Each pie is arranged to show the bacteriological survey results for 1989 and 1990 (in the upper left and right parts of the pie respectively) grouped as "safe", "poor" or "unsafe" (wells which were not sampled are also indicated). The final MOEE resuit of the water quality analyis is shown at the top of the pie for each well. At the bottom right of the pie the chemistry results have been documented using nitrate-N as an indicator since it is a health related parameter and is associated with sanitary wastewater. Values have been plotted for this parameter in three (3) ranges: from less than < 0.02 mg/L (the analytical detection limit for nitrate-N), less than 10 mg/L, and greater than 10 mg/L which is the Ontario Drinking Water Quality Objective for nitrate-N. The well depths and type are shown at the bottom centre and left respectively.

The shading for the pies was chosen such that the darker pies indicate poor quality water. The deep wells (drilled or dug to greater than 17 m) are shown as darker pies. A completely filled pie would thus indicate an "unsafe", deep, drilled well.

The distribution of pies shows random "unsafe" or "poor" water quality conditions throughout the village with some notable exceptions.

Certainly the dug wells, on a percentage basis, are the most contaminated but in areas of concentrated development and where the bedrock is shallow, the drilled wells also show "unsafe" conditions. Since some of the deeper wells are contaminated then improper isolation from the near surface contaminants is inferred. Inadequate sewage disposal systems concentrate the contamination over a small area which does not provide proper attenuation (including dilution and biological treatment) of sewage.

There was oil reported in one of the wells at the north end of the village and the source of this contamination should be investigated.

The notable areas of potential problems that require further study and may be possible areas for locating test wells include :

- north side of Kenyon Street (where bedrock is close to the surface)

The drilled well water quality problems along Kenyon Street are likely related to the minmal amount of contaminant attenuation available in the shallow overburden because of the proximity of the bedrock to the surface. Some wells which are drilled deeper have "safe" water compared to the shallow wells but other drilled wells do not.

The are few dug wells in these areas because of the bedrock's proximity to the surface; the 8 dug wells which were sampled on the north and south side of Kenyon Road had "unsafe" water. The chemistry results are also very poor. The construction of a 20 to 30 m test well in the area of lots 402, 403, and 404 (or 307, 308, 309) could be used to determine the water quality at depth, water treatment requirements, the aquifer yield, and the degree of isolation from potential contaminant sources where the bedrock is close to the surface.

- along Kennedy and Main Street near St. Joseph Street (gravel aquifer);

The 6 dug and 6 drilled wells which were sampled along Kennedy Street had "unsafe" water. Although the gravel aquifer within the village is capable of yielding a good supply of water, it is also the least isolated from the contaminant sources. Relatively high population density, very small lots, and the absence of proper sewage disposal systems makes the situation worse.

An existing domestic well located along Kennedy Street should be tested to determine aquifer yield and quality. Discussions with the well drilling contractor will be initiated to verfiy well construction details. If the owner is agreeable to allow access to the well for measurements then a production well may not have to be constructed in this area.

- west side of Main Street, south of the CPR tracks (gravel aquifer).

As with the situation on Kennedy and Main Street, the issue of gravel aquifer isolation, sewage disposal system adequacy, and well construction problems may be causes for the poor water quality experienced along the west side of Main Street south of the CPR tracks. Furthermore, since the groundwater flow direction (and some of the stormwater flow) through the village is south, contaminants discharged upgradient (ie. north) may advect downgradient (south) through the premeable sand and gravel aquifer toward this part of the village thus worsening the situation.

The existance of the CPR line may be a possible source of contaminants since elevated conductivity readings were observed at the wells south of the tracks (and at other wells within the village). The existance of petroleum hydrocarbons and metals in the groundwater cannot be discounted since they may cause high conductivity readings.

A production well should be drilled into the gravel aquifer in an area close to the CPR line so as to determine the suitablity of this aquifer for domestic purposes. A pumping test would be conducted to determine aquifer yield and quality. The sampling of this well should include standard indicators plus Total Petroleum Hydrocarbons (TPH), and an ICP metals scan.

Many homes have inadequate sewage disposal systems which tend to concentrate the contaminants over a very small area (thus minimizing the attenuation potential) and expedite the movement of raw sewage into the drinking water supply. A detailed hydrogeological evaluation is recommended to better characterize the problems and possible solutions.

3.2 Sewage Disposal Systems

As mentioned, this private systems study is considering the water component only, but as part of the preliminary information review, lot areas were compiled in order to determine sewage system upgrade potential since numerous homes in the village appear to have inadequate sewage disposal systems and the lot sizes are very small.

The MOEE study identifed aging and poorly maintained sewage systems, some of which are antiquaited (eg. pit privies and direct storm discharges). Poorly maintained systems will not operate to their design potential and thus this also contributes to the problem. The type of sewage disposal systems employed in the village were: 96 units (72 %) septic systems; 4 units (3 %) holding tanks; 8 units (6 %) pit privies; and 26 units (19 %) unknown. Of these unknowns, the MOEE report showed that 3 homeowners indicated that their sewage directly discharges to the storm water system although there were likely more direct discharges than reported.

The Eastern Ontario Health Unit (EOHU) regulates the approvals of sewage disposal systems. The EOHU stipluates that a reserve area must be demarcated around the proposed sewage system such that if sewage system failure occurs, a new system can be constructed within the reserve area. However, in a retrofit situation on small lots, allowance for a reserve area is difficult or impossible because of individual lot configurations. In some instances, application for non-conforming use permits must be made since the minimum area required for the septic system only is not availbale.

It appears to be inevitibale that sewage and well corrections are an integral part of a "safe water" solution for the community. Also, the recent decline in population may be in part attributed to the perception that "poor" water quality is the "rule" rather the "exception" in the community.

To study the sewage system retrofit potential a threshold lot area of 1,000 m^2 (no septic system reserve area) or 1,600 m^2 (reserve area provided) was examined. These lot areas were generated based upon a typical sewage design flow of 1,600 L/day for a 3-bedroom house and the area occupied by the house. No allowance for setbacks to property boundaries, wells, buildings, or wells on neighbouring properties (in accordance with MOEE Reg. 358) can be completed without a detailed lot-by-lot assessment.

Of the approximately 152 lots within the village :

- 59 (39 %) were less than 1,000 m^2 and therefore these lots were not capable of accomodating conventional Class IV septic sytems;
- 60 (40 %) were greater than 1,000 m^2; and
- 33 (21 %) exceeded an area of 1,600 m^2.

Although only 21 % of the lots in Apple Hill meet todays requirements for minimum lot size to support a private well and septic system, this program is intended to correct existing problems, and therefore it may still be able to do so on smaller lots. However, before it can be determined if corrections to private wells and septic systems can meet existing legislative requirements (with respect to sizing, separation distances, etc.) and whether these corrections will be an effective solution for both short- and long-term water quality issues, further study is required. A sewage system study should be initiated such that the success of the private well remediation program can be better gauged. The first step is an engineering study to consider characterizing the problem, physical constraints, and hydrogeological data on lot-by-lot basis. From this data, the feasibility and cost of remedial action can better be determined.

4.0 Conclusions and Recommendations

- The village of Apple Hill is situated on a glacial till ridge. The ridge's parent material is heterogenous lodgement and abalation till which consists of silty-sand and clay with boulders and pebbles. Post glacial marine reworking has stratified some of the till ridge leaving an extensive sand and gravel aquifer across the west part of the village. Also, sporadic pockets of surficial sand and gravel have been used for shallow dug wells.

- Based on preliminary information, the groundwater flow is south in the overburden and bedrock aquifers. The deeper aquifers have a sufficient degree of confinement to afford a proper level of protection to the drinking supply. However, improper well construction and inadequate sewage disposal systems cause insufficient attenuation of contaminants thus affecting the water supply.

- Based on the MOEE well records, both dug and drilled wells in the village exploit 2 shallow overburden and 2 bedrock aquifers - about 30 % are dug wells and 70 % are drilled wells. The aquifers range in depth from 3 to 43 m from the surface.

- Of the 87 homes included in the 1989 and 1990 MOEE water quality survey, 48 were deemed "unsafe" for drinking based on bacteriological and chemical analyses.

- Water quality problems in the village include: hardness; iron and manganese staining; dissolved gases; discolouration; taste; rust; or undrinkability. A property owner reported "oil" in the well.

- Some homeowners employ water treatment units which include softeners; filters; and purifyers.

- The MOEE survey also included sewage disposal systems. Based on the interviews, 96 (72 %) of the homes had septic systems, 4 (3 %) have holding tanks, 8 (6 %) have outside privies, and 26 (19 %) were unknown. Some homes directly discharge raw sewage to the storm sewer network.

- The water supply in the village has been compromised as a result of improper well construction, short-circuiting of sewage contaminants into the drinking aquifer(s), and inadequate sewage disposal systems. The proximity of the some of the wells to other sources of contaminants (eg. buried tanks and the CPR line) may also affect water quality.

- To further determine the site stratigraphy, aquifer yield, degree of aquifer isolation, water quality, and suitability of well construction techniques a detailed hydrogeological investigation should be undertaken (ie. Phase II of the project). As part of this work, 2 test wells should be constructed at strategic locations in the village. The locations will be in part based upon discussions with municipal officials and the well drilling subcontractor. The water quality sampling should include TPH and BTEX compounds where warranted by proximity to the CPR line or sources of fuel storage. Also, the source of oil in one well should be further investigated by intiating sampling for TPH and BTEX compounds.

- An integral part of the private well correction program is proper sewage disposal. A sewage study should be undertaken to ensure the success of procuring short- and long-term, plentiful supply of safe water for the community. An application for Municipal Assistance Program (MAP) funding should be undertaken such that this problem can be further examined and remedial options identifed.

John St.Marseille, B.Sc., B.Sc.E. (Hons.), P.Eng.
Environmental/ Municipal Engineer
Project Manager

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APPENDIX B

Township of Kenyon Apple Hill Water Study Phase II Private Well Hydrogeological Study and Preliminary Communal Well Evaluation (MSTA 1997)

Township Of Kenyon
Apple Hill
Water Study (Project No. 07-3170-01)

Phase II Private Well Hydrogeological Study and Preliminary Communal Well Evaluation

M.S. Thompson & Associates Ltd.
Consulting Engineers

April 1997

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1.0 Introduction

The community of Apple Hill has a history of water quality problems, both in private wells and in the storm water drains. As a result of these concerns, the Ministry of Environment & Energy (MOEE) undertook a pollution study. Private wells and stormwater locations were sampled in 1989 and 1990, the results of which showed that bacteriological and chemical contamination was widespread throughout the community and further study was needed to quantify the problem in order to provide remedial alternatives (MOEE 1992). The municipality was successful in receiving funding to complete a Private Water Systems Correction Study. M.S. Thompson & Associates Ltd. Consulting Engineers (MSTA) was retained by the Township of Kenyon to complete a Private Water Systems Renewal/Replacement Program (PWSRR) for the Community of Apple Hill.

From a funding perspective, the PWSRR program is formulated into two distinct divisions - water and sewage. Although the PWSRR is distinct in this funding context, from an environmental impact perspective, water and sewage are interdependent. It is difficult to consider providing potable water in private wells in isolation of sewage concerns.

The Apple Hill Private Water Systems Correction project was undertaken as a Water Systems Study and as such, septic systems have not been considered as part this hydrogeological evaluation. As a result of subsequent recommendations, a separate Private Sewage Systems Correction Study (MSTA 1997) was completed to address this issue. The overall project approach, as described in the project terms of reference (Appendix A), is divided into 5 phases:

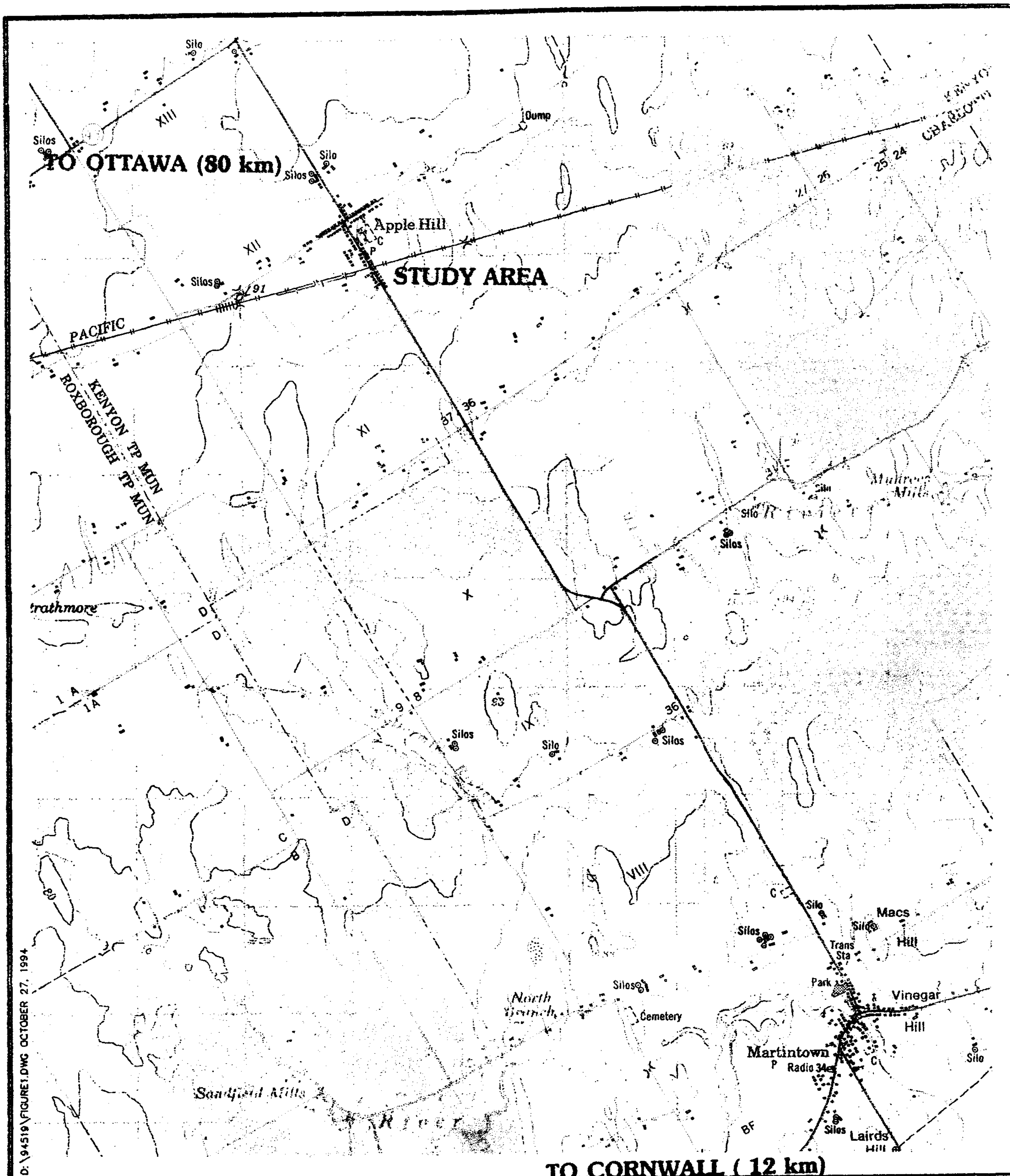
- Preliminary hydrogeological evaluation;
- Interim hydrogeological evaluation;
- Lot-by-lot survey and sampling program;
- Finalizing solutions; and
- Pre-construction.

This report describes the work undertaken as part of phase I and II - the interim hydrogeological investigation. The second part of this report addresses the communal water system option (section 8.0).

1.1 Objectives

The objective of the Phase II study is to determine whether upgrade or replacement of private well systems is technically feasible to provide a long-term source of potable water for the community. To fulfil this objective the following tasks are completed :

- review of existing studies;
- detailed evaluation of geological and hydrogeological conditions within the village;
- assessment of contamination problem;
- completion of test wells;



M.S.THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS
CORNWALL, OTTAWA, KINGSTON

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PROJECT	
APPLE HILL PRIVATE WATER PROJECT	
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- aquifer characterization by completion of pumping tests; and
- evaluation of water provision alternatives and their respective cost estimates.

2.0 Existing Information

2.1 Site Description and Mapping

Apple Hill is located about 25 km northeast of Cornwall (Figure 1) in Kenyon Township. During the last 20 years or so, the population has been declining as shown by census data. The 1991 population was 195 compared to 257 in 1986 and 271 in 1976. There are 91 homes within the village some of which have been divided into sections to provide rental units which number about 12. There are 5 commercial and 5 institutional properties within the village including two churches, a hotel and tavern, medical clinic, post office, fire station, general store, convenience store, hairdressing salon, and pool chemical retail outlet.

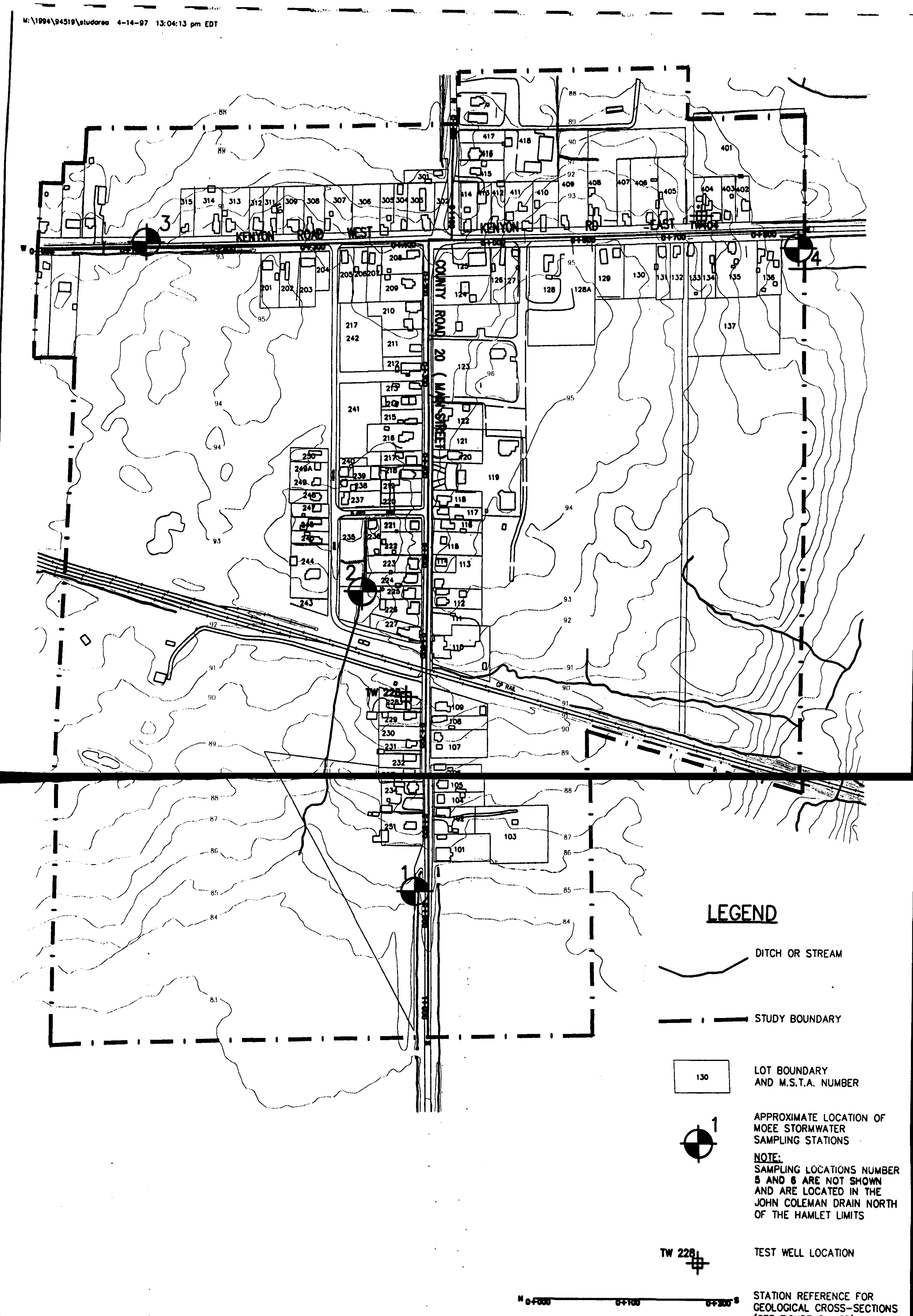
Detailed topographic information was provided from the Ministry of Natural Resources base mapping (MNR 1993). Contours and physical features are displayed on a 1:2000 scale topographical map developed from 1992 aerial photography. The contour interval is 1 m and all elevations are geodetic (Figure 2). The PWSRR study area includes lots lying within the Hamlet designation as shown on Figure 2.

The latest assessment mapping was superimposed on the topographic plan. From this drawing and using the municipality's assessment roll numbers the property owners were identified. This facilitated the cross-referencing of well records and water quality analysis to a lot location within the village. In this way water quality, geology, and other hydrogeological data could be spatially analyzed.

2.2 Regional Geology

The surficial geology of the St. Lawrence River area of Eastern Ontario was studied as part of the characterization work for the St. Lawrence Seaway project (Terasame 1962) and subsequent engineering terrain mapping work (Ringrose et al 1992).

The surficial geology of this area, as with most of Eastern Ontario, is dominated by glacial till. According to Terasmae (1962), this differs significantly from typical surficial deposits because it is physically and lithologically heterogenous with unsorted and unstratified pockets of granular material. The compaction and preconsolidation by successive glacial advances renders it more impervious to groundwater movement. At high and low topographic relief, the till may be continuous. The till consists of stratified and unstratified drift. The stratified drift is proglacial marine silt, sand, and clay in the low lying areas (Ringrose et al). The high-ground consists of ground moraine till which can be very compact and poorly sorted (lodgement till) or partially sorted (ablation till) which may feature some relatively high permeability sand and gravel units. Terasmae (1962) described the till as two distinct units. The upper or Fort Covington Till, is



M.S.THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS CORNWALL, OTTAWA, KINGSTON	TITLE: STUDY AREA AND GEOLOGICAL CROSS-SECTION REFERENCES (FIG.5)	scale: 1:4000
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compact grey (or buff when oxidized) sandy till which includes bouldery washed till on the slopes and hills. The lower unit, Malone Till is very compact, blue silty-gray clay matrix with boulders and cobbles depending on the proximity and character of the underlying bedrock. Most of the pebbles tend to be Palaeozoic sedimentary rocks (Terasmae 1962).

In some locations along the St. Lawrence River, stratified granular deposits have been noted lying in between the two till units. These glacial-fluvial materials were deposited during the waning of the Malone ice-sheet. These stratified deposits were termed middle till complex (Terasmae 1962) and range up to 10 m thick. Owing to their stratified composition they may yield relatively high quantities of water depending upon their thickness. The stratified material may contain embedded cobbles and boulders as described below. The lithology from the test well logs and MOEE well records indicate that the intertill does not exist (or is very thin) in the study area.

The upper, youngest till is termed Fort Covington. It was deposited by a different glacial advance, is thinner, and has more sand than the Malone till. Fort Covington till was deposited by glaciers flowing from NW to SE. This till is less compact than the Malone till and has a larger portion of (non-native) igneous rocks which is indicative of transported soil. Outcrops of Fort Covington till, on ridges, tend to be oxidized buff-to-brown colour to a depth of about 6 m.

The Malone till, associated with the initial glacial advance from the northeast, contains a more silty-clay matrix with pebbles, cobbles, and boulders. The fragments are residual sedimentary rocks which were derived from the local bedrock as the glacier advanced and scoured its surface.

2.3 Aerial Photography

Aerial photography was used to correlate some of the landscape features to geological conditions (MNR 1978). The existence of till ridges, drumlins, and troughs provides evidence of re-worked till and perhaps bedrock discontinuities.

The most significant feature of the aerial photographs reveals three parallel ridges within the hamlet boundaries. It is these ridges to which Apple Hill owes its namesake, at least in part. The middle ridge is the most prominent. It is oriented north-south and is likely composed of Malone Till although some re-working by the later Fort Covington advance may have changed the soil fabric and its orientation. The southern limit of this ridge extends near the south boundary of the hamlet at about elevation 91 m. The ridge was partially cut to facilitate the construction of the Canadian Pacific Rail (CPR) line which traverses the south part of the village. The till ridge reaches a maximum elevation of 96 m near the location of St. Anthony's Parish. The less predominant ridges are parallel to, and 300 m east and west of the main ridge.

Terasmae (1962) did extensive investigations into the geological conditions which occurred around till ridges. Because Eastern Ontario was inundated by the Champlain Sea following the receedence of the glaciers, re-working of the till deposits by wave activity occurred. The

Champlain Sea was estimated to have existed at a present day elevation of about 92 to 107 m (300 to 350'), so some of the higher till ridges remained above water.

This appears to be the case at Apple Hill. Wave action however, predominately on the westward face of the ridges, reworked some of the till. Lesser re-working would have occurred on the leeward, less exposed shorelines. This re-working resulted in material sorting - the largest materials (boulders) remained close to the ridge while the smaller fractions were carried further offshore and deposited (Figure 3).

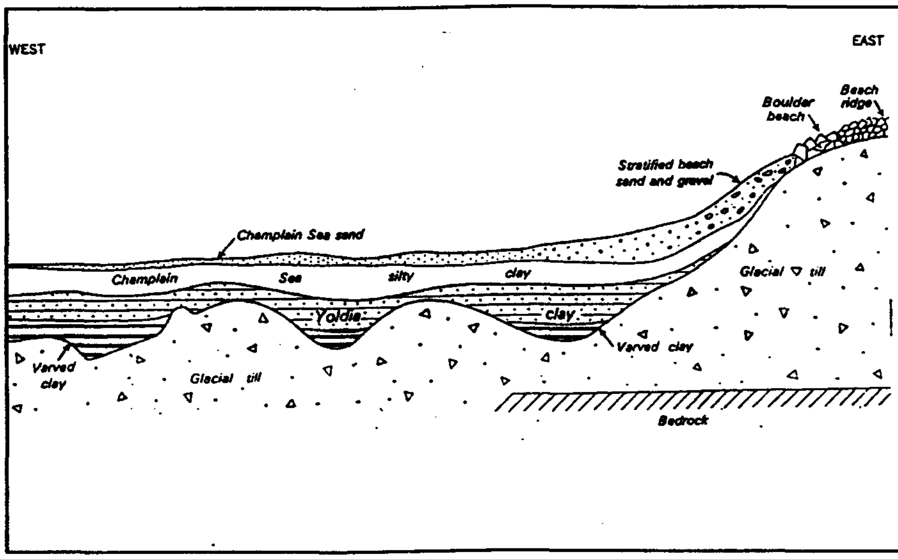

Figure 3 - Typical Cross-Section Through Marine Re-worked Till Ridge (adapted from Terasmae 1962)

This figure does not necessarily represent the actual lithology at Apple Hill but rather it shows a generic cross-section through a re-worked till ridge to demonstrate the variable nature of the deposits associated with these formations. Typical east-west and north-south geological cross sections were developed from the MOEE well records (section 2.4) to graphically detail the Apple Hill lithology.

The existence of these till ridge landforms is important since they provide some insight into the hydrogeological conditions in the area. The two valleys formed between the three ridges became repositories for sorted granular deposits which partially filled the valleys. Sloughing of material on the unstable slopes created by the marine environment resulted in some unstratified deposits (silt and clay) intermingled with the more stratified sand, gravel, and boulder components (diamict). There is a drumlin about 600 m west of the village which provides further evidence of the extensive re-working of till ridges by later glacial advances.

The relative elevation between the till ridge and the gravel deposits likely means that the aquifer is locally recharged and its quality may be compromised by sewage effluent. The hydrogeochemical aspects of the investigation supports the existence of this recharge condition (section 4.4).

2.4 MOEE Well Records

A review of the MOEE well records was completed to further correlate the regional geological and hydrogeological data. Well records are completed by licensed well drillers as wells are drilled. The vast majority of these records are for wells which are drilled into deeper aquifers as opposed to dug wells which are developed into shallow aquifers. The database includes 28 well records for a period extending from the late 1950s to the late 1980s (Appendix B). Some of the records list the current owners but most were drilled for the previous landowners. For these latter cases, the well records were cross-referenced to a lot location by identifying the previous landowners.

Most MOEE well records provide a ground surface elevation which is estimated (likely accurate to about ± 3 m). Using the base mapping (1:2000, Figure 2) which was produced from 1992 MNR aerial photography, the surface elevations of all lots were estimated to the nearest 0.5 m. The underlying stratigraphy was correlated from this reference elevation for the lots which had a well record. It should be noted that the lithological descriptions vary by well driller which can make the log interpretation difficult.

2.4.1 Bedrock Geology

The well records were used to compile bedrock depths throughout the village. The bedrock varies in depth from 3 m (10') to 24.7 m (81') from the surface. The bedrock was closest to the surface at the north end of the village and furthest at the south end. The elevation of the till ridge reflects the bedrock's proximity to the surface at the north part of the village. The top of bedrock profile was contoured (Figure 4) by converting the depth to bedrock to geodetic elevation. The results show some variation in the bedrock surface contours but generally, that the bedrock ridges are oriented in the same manner as the till ridges with the general dip direction trending southerly. The existence of the till ridges appears to be at least partially influenced by the bedrock contour. No bedrock depth was provided for well records from the south end of the village so the contours do not extend to this area.

The fact that bedrock contours can influence the surface topography is supported by the existence of shallow troughs in the area oriented east/west which Terasmae (1962) suggests were created by successive soil moisture depletion episodes. As groundwater seeps into the bedrock through preferential pathways and depletes the soil moisture content, the fine materials in the overburden become desiccated and shrink. These successive depletions cause depressions to form which are distinguishable on the air photos. There does not appear to be air photo evidence of these depressions within the hamlet boundary. However, since they have been noted to occur regionally, and because of the undulating surface contour of the bedrock, faults

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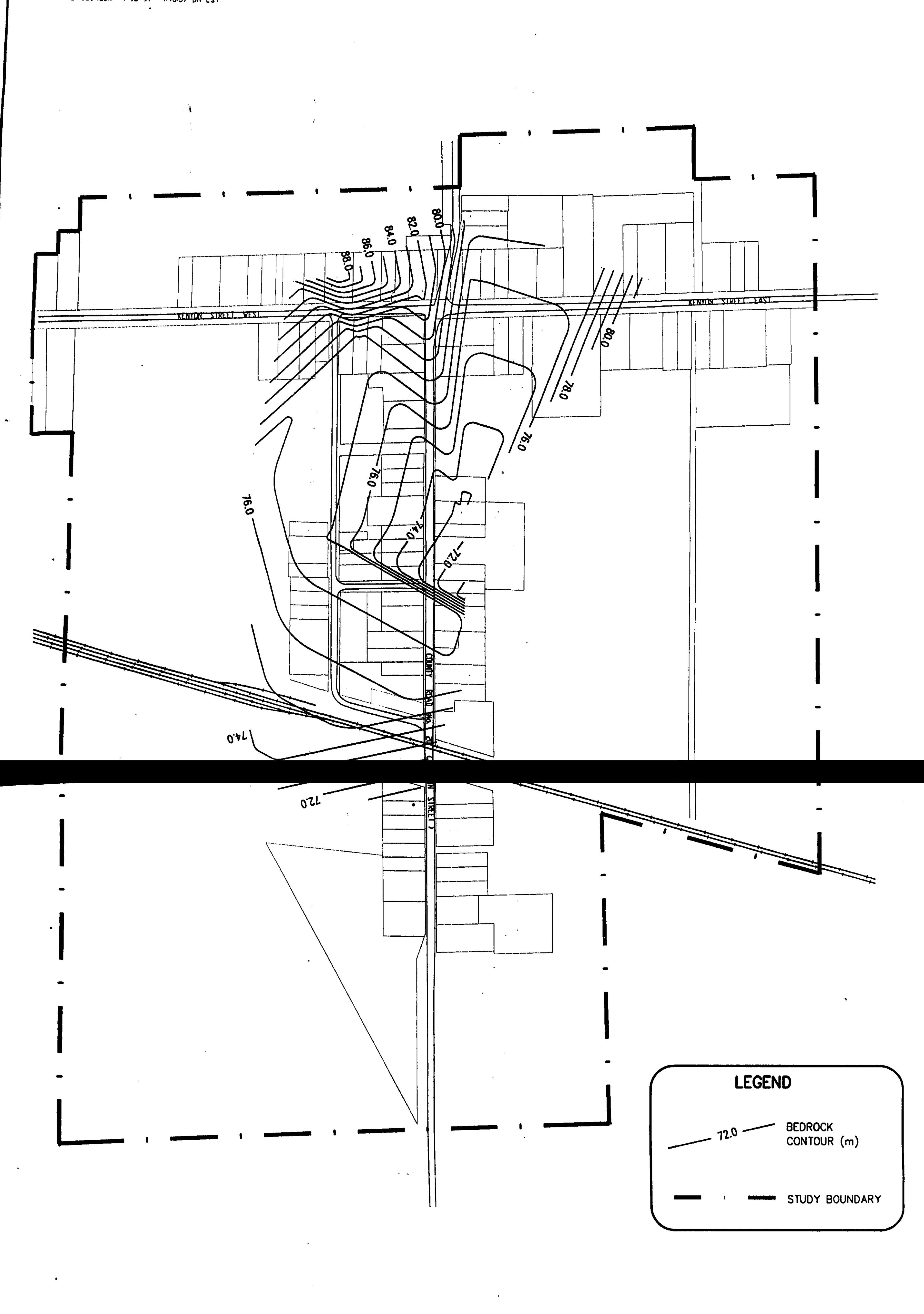

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	PROJECT APPLE HILL PRIVATE WATER STUDY	drawing no. FIGURE 4	

and fractures would likely exist in the bedrock under the village. The existence of fractures is important since they may provide bedrock aquifer recharge paths but at the same time they may be preferential pathways for sewage flow. Based on the well records, the bedrock is sedimentary grey limestone with some shale interbeds. In 5 of the logs "black rock" formations were noted which is inferred as the shale interbeds. The regional bedrock geology as described by Wilson (1929) consists of limestone of the Trenton Group, Ottawa formation. The characteristic of this formation near the surface is pure and thick limestone with some rusty weathering and occasional impure beds and shale partings. These descriptions generally correspond to the well record descriptions.

2.4.2 Overburden Geology

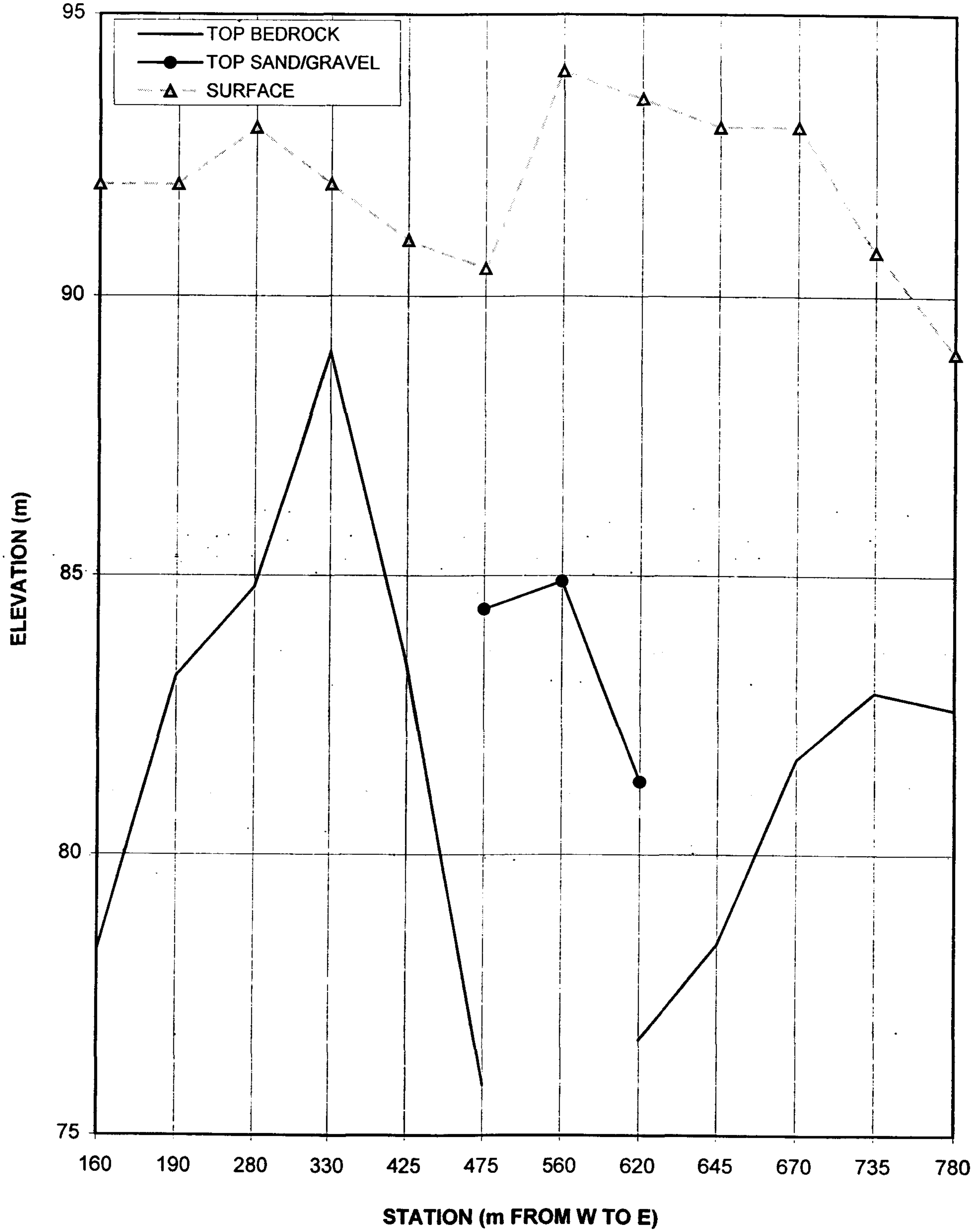
The composition of overburden material varies across the village but some distinct trends can be seen. Wells drilled along the periphery of the till ridges show a stratigraphy consisting of till, boulders, then bedrock as depth increases. Depending upon where the former shoreline was intersected by the well, the stratification varies. The till material, being generally heterogeneous and compact does not yield sufficient quantity of water to be exploited for domestic purposes, especially during drier periods of the year. Shallow dug wells developed into the till can seasonally sustain some domestic water demands (basically because of the large well storage capacity) but when the watertable drops, because of insufficient recharge, these wells are not capable of providing a sufficient supply.

Geological cross sections through the village were developed based on the interpretation of the well records. The majority of the records follow the two main arterial roads within the village (Kenyon Road east and west) and Main Street (north and south). Stations were established beginning at the west end of Kenyon Road (running east) and north end of Main Street (running south). The stations are shown on Figure 2. The cross section from Kenyon Road west to east (Figure 5a) included 12 wells and for Main street north to south (Figure 5b) included 7 wells. The lack of data along Main street is related to the fact that many of the wells are dug wells (which are not shown in the MOEE well records) developed into the shallow gravel which is dominant in the centre and south part of the village. The data between wells is inferred and does not necessarily represent actual conditions.

Each figure shows the variable lithology across the village. The highlights of Figure 5a include:

- bedrock peaks occur at stations 330 (lot 307) and 750 (lot 404) respectively;
- the valley between the bedrock peaks is demarcated by gravel and sand from station 470 (lot 414) to 630 (lot 408);
- re-working of the till mounds has deposited granular materials in the topographic depressions (between bedrock peaks).
- bedrock was not encountered at lot 410 - it is presumed that it would be below 76 m elevation; and
- the bedrock contour and re-working of till has had some influence on the surface contour since the till mounds and the bedrock peaks approximately correspond.

Figure 5a - Geological Cross-Section (Kenyon Street from West to East)



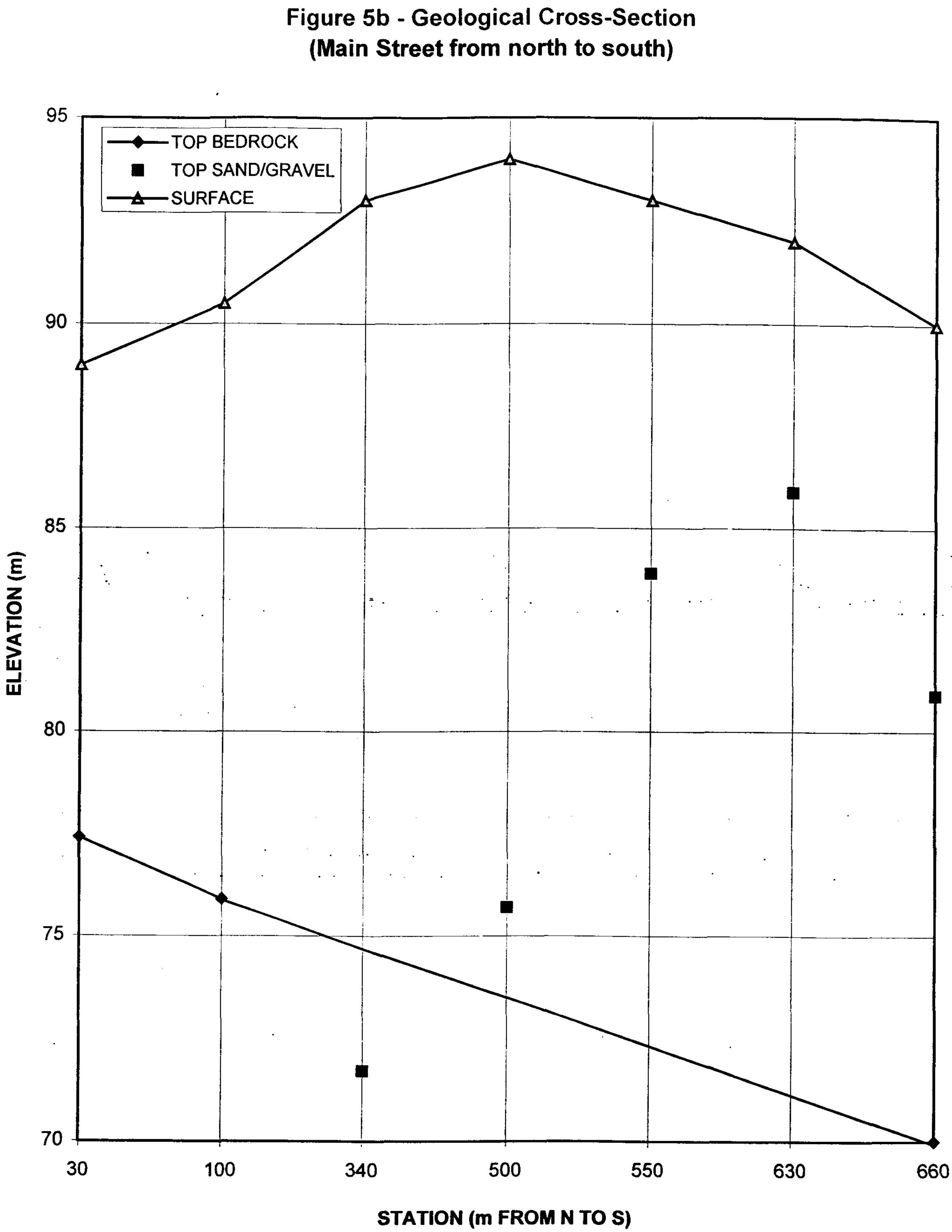


Figure 5b - Geological Cross-Section
(Main Street from north to south)
TOP BEDROCK
TOP SAND/GRAVEL
SURFACE
95
90
85
80
75
70
ELEVATION (m)
30
100
340
500
550
630
660
STATION (m FROM N TO S)

The highlights of Figure 5b include :

- bedrock which dips sharply to the south; and
- a granular seam which rises steeply toward the south and overlies the bedrock.

These results concur with the previously described aerial photo interpretation which emphasizes the existence, extent, and vulnerability of the sand and gravel aquifer which runs through the village and appears to be locally recharged.

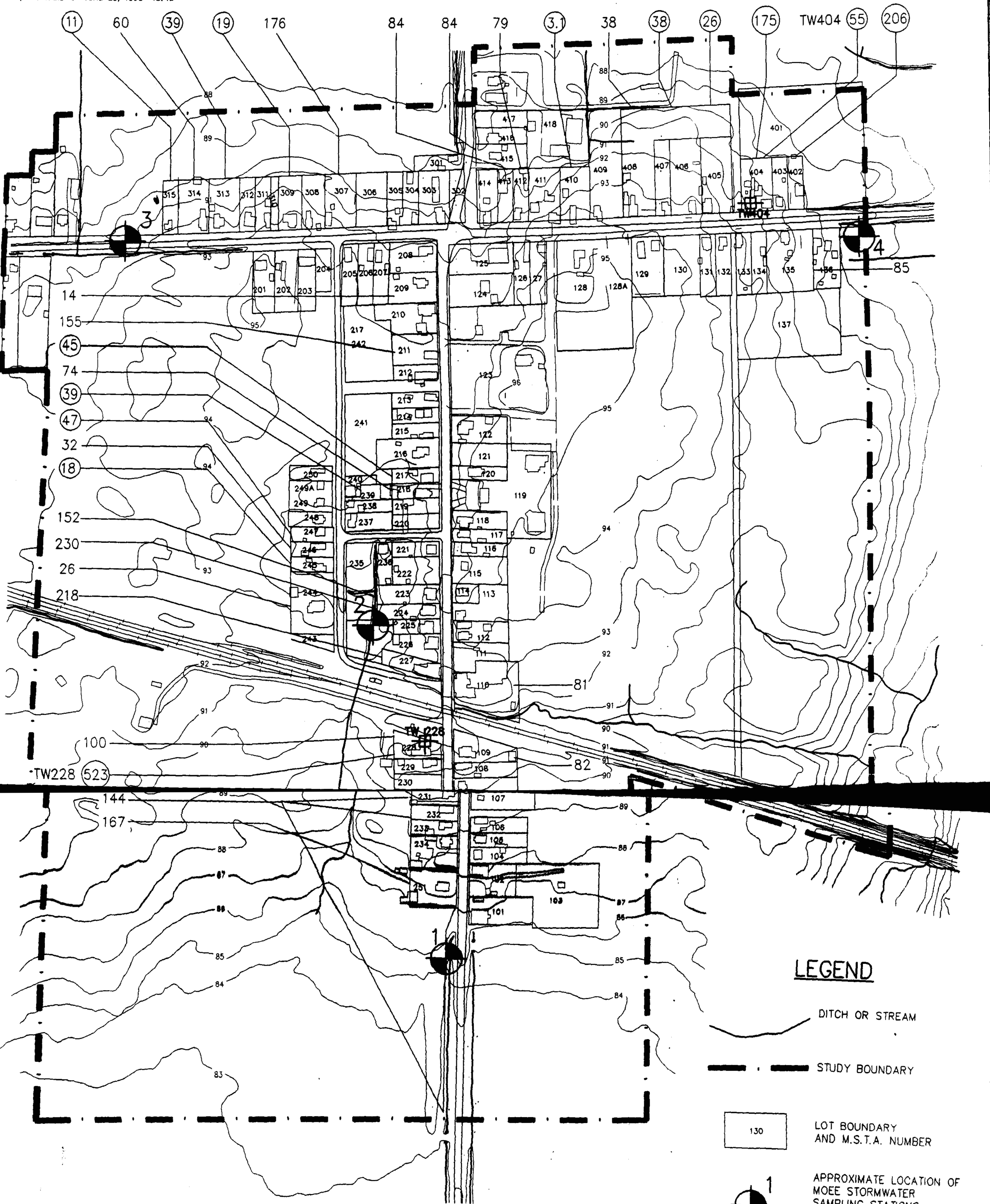
2.5 MOEE Pollution Survey

Much of the existing information pertaining to the problem definition was provided in the Water Pollution Survey Report (MOEE 1992). This report, by the MOEE Cornwall District Office highlights the water quality issues associated with the 1989 and 1990 water sampling programs. The initial sampling was undertaken in June and July of 1989. Follow-up sampling of the "poor" and "unsafe" wells was completed in 1990. The pollution survey extended beyond the Village limits but as indicated, the hamlet boundary forms the limits for this investigation.

The major indicator of water quality was provided by bacteriological testing but some random samples were also collected for chemical analysis of typical health and non-health related parameters (Appendix D). The bacteriological survey included 87 of the 107 wells within the Village of Apple Hill. The original water quality survey (1989) found that 47 percent of the wells (41 wells) were "unsafe", 9 percent (9 wells) were "poor", and 44 percent (37 wells) were "safe". An "unsafe" water supply, from a bacteriological perspective, exists when Total Coliform bacteria counts exceed 10 or if any faecal coliform counts are observed (MOEE 1992).

There were 38 water samples taken for chemical analyses. This included a nitrogen suite, iron, chloride, and conductivity (Appendix D). Using nitrate-N as a reference, there were 4 wells that exceeded the ODWO limit of 10 mg/L. Of these 4, 3 were shallow dug wells in the north part of the village where the bedrock is proximate to the surface. The drilled well depth was not provided. Also, there were 21 of the 38 samples which had elevated concentrations of nitrate-N. Elevated in this definition refers to results which exceed un-impacted background levels, about 0.5 mg/L.

Of the 38 chemical analysis reported, 16 samples had elevated chloride (greater than 75 mg/L) - none exceeded the 250 mg/L ODWO limit. Of the 16 wells, 10 were "dug", 3 were "drilled", and 3 were reported as "unknown". The chloride distribution is shown on Figure 7. The distribution of the elevated results value appears to correspond to those lots fronting onto the County or Township roads which may be related to road salting activity (section 4.2 and 4.3). It is interesting to note that the dug well sample from lot 228 was reported as 100 mg/L during the MOEE survey compared to 523 mg/L (for TW-228) during the pumping test (section 4.3). The discrepancy may be in part due to the difference in depth of these two wells - TW 228 exploits the deeper overburden granular aquifer while the dug well is shallower and setback



LEGEND

DITCH OR STREAM

STUDY BOUNDARY

130	LOT BOUNDARY AND M.S.T.A. NUMBER

APPROXIMATE LOCATION OF MOEE STORMWATER SAMPLING STATIONS

NOTE: SAMPLING LOCATIONS NUMBER 5 AND 6 ARE NOT SHOWN AND ARE LOCATED IN THE JOHN COLEMAN DRAIN NORTH OF THE HAMLET LIMITS

TW 228 TEST WELL LOCATION

32 DESIGNATES DRILLED WELL WITH CHLORIDE CONCENTRATION (mg/L)

(18) DESIGNATES DUG OR UNKNOWN WELL WITH CHLORIDE CONCENTRATION. TW INDICATES TEST WELL

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CONSULTING ENGINEERS
CORNWALL, OTTAWA, KINGSTON

TITLE
MOEE SURVEY AND TEST WELL
CHLORIDE DISTRIBUTION

PROJECT
APPLE HILL
PRIVATE WATER STUDY

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date	NOVEMBER 1994
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FIGURE 7

NORTH

further from the road. This supports the fact that the wells further from the road may not be as susceptible to road salting impacts but the radius of influence of the well must be determined to verify that contaminants would not be "pulled" into the well from further away. TW404 was analyzed to have a chloride of 55 mg/L compared to the MOEE survey result of 175 mg/L (section 4.3). The variation may be related to the season at which the samples were taken.

As part of the MOEE survey, residents were asked about water treatment units and water quality. Some owners employ water softeners, filters, and purifiers (type is unknown). As expected the softeners are used to treat the "hard" water condition which is typical of sedimentary rock aquifers. The water quality complaints included those which are typical of groundwater in Eastern Ontario; that is "buildup on fixtures" (inferred as hardness related); "staining" (inferred as being iron or manganese related) ; "sulfur odour" (inferred as dissolved hydrogen sulfide); "rust" (inferred as a combination of iron staining and corrosion related); and "blackness" (inferred as iron, sulfide, manganese, or sewage related). Water taste and colour problems were also noted which may be related to a number of factors including improper sewage disposal.

There were 7 homeowners who identified that their wells were "undrinkable" or "unsafe". Subsequent discussions with village residents confirmed that many homeowners rely on bottled water or water from wells beyond the village limits for their potable water supply. It is a subjective decision by the homeowner as to why the water would be undrinkable or unsafe; however, it is likely that the owner knows or strongly suspects that the water supply has been compromised and accordingly will not drink it. Sewage contamination is likely the main source of contamination in these cases.

The overburden aquifers generally have better water quality than the bedrock aquifers since reducing conditions exist at depth which is conducive to formation of odour causing dissolved gases (hydrogen sulfide, methane) and dissolved solids (eg iron, manganese) which cause staining. The drawback with utilizing overburden aquifers as a water supply is that they do not afford the same degree of isolation from potential contaminant sources. Based on the MOEE door-to-door survey, there are about 30 dug wells within the village. Of these, 19 reported depths varying from 3 to 23 m, the other 11 did not report depths. Although some dug wells were reported to have been constructed to a depth of 23 m, it has not been confirmed if the deepest wells are in fact dug or drilled.

The nature of the dug well construction is such that the rock-lined wells do not seal off potential contaminant entry through the upper part of the well. Typically these contaminants would be attenuated as they travel deeper into the soil through processes such as biological degradation/transformation, dilution, and soil adsorption. However, the short-circuiting reduces the opportunity for this attenuation and more concentrated contaminants enter the drinking supply.

Of the 19 wells, 4 are between 0 to 5 m deep, 9 are between 6 to 10 m, and 6 exceed a depth of 10 m. This information gives an approximate estimate of the depth to the aquifers. Generally, the degree of isolation of the aquifer from potential contaminant sources is directly related to the depth of the well. This trend is apparent in Apple Hill since all the shallow dug wells (less than 5 m deep) were deemed "unsafe" according to the MOEE survey.

Of the 9 medium depth wells, 6 were "unsafe" and only 3 were rated "safe". Only 2 of the deep dug wells (greater than 10 m) were deemed "safe" and the other 4 were "unsafe". The fact that the deeper dug wells are "unsafe" means either that contaminants are short-circuiting to the well through the upper, more contaminated aquifer(s) or that the deeper aquifers are also contaminated. It may be possible to succesfully continue to exploit the deep sand and gravel aquifer for water supply purposes so long as direct sources of contamination are eliminated (stormwater discharges and improper sewage systems) and each well is properly isolated from the surface to the greatest extent possible.

Of the 28 drilled wells in the MOEE database, 7 were developed into a granular aquifer ranging in depth from 9 to 21 m from the surface. Of these wells, 2 were not sampled, 3 were "safe" and 2 were "unsafe". The remaining 21 wells were drilled to either limestone (18) or shale (3) bedrock. The limestone wells ranged in depth from 11 to 43 m and of these 5 were rated "unsafe", 6 were "safe", and 7 were not sampled . Of the 3 shale wells, 2 were safe and 1 was not sampled. These ranged in depth from 14 to 24 m from the surface. It is unknown if the drilled wells are properly isolated from the contaminant sources.

The MOEE survey and well record data was graphically interpreted and plotted according to the approximate lot location in the village (Figure 6). The data shown on the figure provides the results of the bacteriological and chemical surveys by well type and depth. Each pie is arranged to show the bacteriological survey results for 1989 and 1990 (in the upper left and right parts of the pie respectively) grouped as "safe", "poor" or "unsafe" (wells which were not sampled are also indicated). The final MOEE result of the water quality analyis is shown at the top of the pie for each well. At the bottom right of the pie the chemistry results have been documented using nitrate-N as an indicator since it is a health related parameter and is associated with sanitary wastewater. Values have been plotted for this parameter in three (3) ranges: from less than < 0.02 mg/L (the analytical detection limit for nitrate-N), less than 10 mg/L, and greater than 10 mg/L which is the Ontario Drinking Water Quality Objective for nitrate-N. The well depths and type are shown at the bottom centre and left respectively.

The shading for the pies was chosen such that the darker pies indicate poor quality water. The deep wells (drilled or dug to greater than 17 m) are shown as darker pies. A completely filled pie would thus indicate an "unsafe", deep, drilled well. The distribution of pies shows random "unsafe" or "poor" water quality conditions throughout the village with some notable exceptions.

Certainly the dug wells , on a percentage basis, are the most contaminated but in areas of concentrated development and where the bedrock is shallow, the drilled wells also show "unsafe" conditions. Since some of the deeper wells are contaminated then improper isolation from the near surface contaminants is inferred. Inadequate sewage disposal systems concentrate the contamination over a small area which does not provide proper attenuation (including dilution and biological treatment) of sewage.

Another component part of the MOEE study considered stormwater drain quality sampling at 6 stations surrounding the village (Figure 2). Storm drainage in the community is via a network of open ditches. Stations 5 and 6 were taken from the John Coleman Drain north of the village on the west and east sides of Main Street respectively. These sampling stations are outside the study limits and as such are not shown on Figure 2.

The results of the MOEE survey are provided in Appendix D . These results show several hundred to several thousand fecal coliform counts at all 6 sampling stations. It is impossible to infer the source of the contamination; however, problematic sewage systems or direct discharges cannot be ruled out. Given that the ratio of fecal coliform to fecal streptococcus bacteria at station 1, and 6 exceeds 4 (and station 2 is marginal at 2.5) then the source of the contamination in the surface stream appears to be from human sewage (MOEE 1984). Stations 1 and 2 (Figure 2) are south on Main Street and south on Kennedy Street respectively. Station 6 is in the John Coleman Drain on the west side of Main Street outside the village. Given the widespread contamination in the storm drains then the existence of direct discharges and improperly functioning systems is confirmed.

The intent of this study is not to consider the sewage problems possibly associated with these drains, but rather that the results indicate well impairment to such an extent that sewage disposal to the drains may be affecting well quality. Also, the aesthetic impact of direct discharge cannot be discounted. A problem with discharge to the storm network is not only the localized contamination that this may cause but also the extent that the contaminants may migrate because the storm drains are an effective conveyance route. Since the stormwater flows south from the Kennedy/St. Joseph Street area, this may be an important vector to expedite contaminant migration (the ditch runs parallel to and 100 m west of Main Street). The results of TW-228 (section 4.4) confirm that sewage may be impacting on the regional aquifer by infiltration through the open ditch. Remediation of the direct discharges to the storm sewers through rehabilitation/replacement of the sewage disposal systems should be considered as an integral part of the long-term provision of safe drinking water in the community.

2.6 Sewage Disposal Systems

As mentioned, this private systems study is considering the water component only, but as part of the preliminary information review, lot areas were compiled in order to determine sewage system upgrade potential since numerous homes in the village appear to have inadequate sewage disposal systems and the lot sizes are very small.

The MOEE study identified aging and poorly maintained sewage systems, some of which are inappropriate (eg. pit privies and direct storm discharges). Poorly maintained systems will not operate to their design potential and thus this also contributes to the problem. The type of sewage disposal systems employed in the village are: 96 units (72 %) septic systems; 4 units (3

%) holding tanks; 8 units (6 %) pit privies; and 26 units (19 %) unknown. Of these unknowns, the MOEE report showed that 3 homeowners indicated that their sewage directly discharges to the storm water system although there were likely more direct discharges than reported. The information was subsequently confirmed during the Private Sewage Correction Study (MSTA 1997a).

The Eastern Ontario Health Unit (EOHU) regulates the approvals of sewage disposal systems. The EOHU stipulates that a reserve area must be provided on each lot such that if sewage system failure occurs, a new system can be constructed within the reserve area. In a retrofit situation on small lots, allowance for a reserve area is often difficult or impossible because of individual lot configurations. Some lots are so small that remedial action can only be accomplished by using filter beds or non-conforming tile beds.

It appears to be inevitable that sewage and well corrections as well as water treatment are an integral part of a "safe water" solution for the community. Also, the recent decline in population may be in part attributable to the perception that "poor" water quality is the "rule" rather the "exception" in the community.

To study the sewage system retrofit potential a threshold lot area of 1,000 m^2 (no septic system reserve area) or 1,600 m^2 (reserve area provided) was examined. These lot areas were generated based upon a typical sewage design flow of 1,600 L/day for a 3-bedroom house and the area occupied by the house. No allowance for setbacks to property boundaries, wells, buildings, or wells on neighbouring properties (in accordance with MOEE Reg. 358) can be completed without a detailed lot-by-lot assessment.

Of the approximately 152 lots within the village :

- 59 (39 %) were less than 1,000 m^2 and therefore these lots were not capable of accommodating conventional Class IV septic sytems;
- 60 (40 %) were greater than 1,000 m^2; and
- 33 (21 %) exceeded an area of 1,600 m^2.

Although only 21 % of the lots in Apple Hill meet the current requirements for minimum lot size to support a private well and septic system, this program is intended to correct existing problems. However, before it can be determined if corrections to private wells and septic systems can meet existing legislative requirements (with respect to sizing, separation distances, etc.) and whether these corrections will be an effective solution for both short- and long-term water quality issues, further study is required. A <u>sewage</u> system study should be initiated such that the success of the private well remediation program can be better gauged. The first step is an engineering study to consider characterizing the problem, physical constraints, and hydrogeological data on a lot-by-lot basis. From this data, the feasibility and cost of remedial action can better be determined.

It should be noted that at the time of writing of the initial Water Report, the Council of the

Township of Kenyon requested that a funding request under MAP be made for the Private Sewage Study. This was subsequently approved and undertaken. A separate report addresses the findings (MSTA 1997a).

3.0 Phase I Public Consultation

3.1 Open House

As part of the completion of the phase I investigation, a open house presentation/information session was held on December 7, 1994 at the Apple Hill Community Centre. The meeting was attended by 20 residents from the village. In addition, members of the Township of Kenyon Council, liaison committee, Ontario Clean Water Agency (OWCA), and staff of M.S. Thompson & Associates (MSTA) were in attendance.

The meeting was organized into a formal presentation followed by informal discussion. The presentation included a brief description of the problem(s), the intent of the private systems correction, the project approach, and the results of the phase I investigation.

It was explained that based on the existing information review, 47 % of the wells in the village are unsafe for drinking. The impact on the water supply is believed to be caused by various factors including :

- poor well construction (improper sealing of the well and/or drainage toward the well);
- improper or irregular well maintenance;
- improper or non-existent sewage disposal systems (discharge to storm sewers, pit privies, holding tanks, and under-sized septic beds); and
- poor or irregular sewage system maintenance.

It was explained that the phase II investigation would be undertaken in 1995 to further evaluate water quality problems and possible corrective measures. Pending the findings of this work, private well correction may be recommended in which case lot-by-lot assessments would be completed including detailed corrective measures and their implementation costs.

The cost of private versus communal private well correction was presented. It was explained that the costs were very preliminary since little data was available and that the communal water supply system alternative was beyond the terms of reference for this project. The costs were developed based upon similar projects in the area. There was much discussion about the justification of these costs and reference was made by several residents to typical household costs for municipal sewer and water projects recently completed in nearby municipalities.

3.2 Anecdotal Information

It should also be noted that informal, one-on-one discussions took place between representatives of the consulting firm and village residents during many of the Apple Hill visits.

Although the candid opinions expressed by the residents do not necessary represent overall public opinion or indeed consensus, many people independently commented that sewage disposal problems existed at several locations in the village. It was stated that very offensive odours could be detected just by walking past along the sidewalk (per. comm.). Many people also stated that because of the MOEE water test results or because of anecdotal information they imported their water supply (ie. bottled water).

The consensus based on the public consultation process was that the detailed hydrogeological investigation should be completed in order to more fully address these concerns and in particular further evaluate water supply alternatives and costs.

4.0 Phase II Hydrogeological Investigation

4.1 Rationale

Based on a mandate from the public, recommendation of the liaison committee, and Kenyon Council approval, phase II of the project was initiated in March of 1995. The phase I findings demonstrated that well construction and improper sewage disposal systems appeared to be the main cause of water contamination. The supply aquifers appeared to be suitably isolated from contaminant sources and therefore it was reasoned that proper well construction should provide a safe and productive water supply. It was noted during the many site visits that many wells were not suitably constructed. The well deficiencies included: open grating or wood across the top of the casing; casings mounted flush with the ground surface; and the top of well casing buried.

In order to further evaluate well construction alternatives, test wells were chosen at two strategic locations - the south end of the village in the gravel aquifer (TW-228) and the north end of the village in the shallow bedrock aquifer (TW-404). The gravel aquifer location was chosen since (a) all wells (228 to 234 and 251) on the west side of main street south of the CPR tracks were deemed "unsafe" based on bacteriological results (see section 4.4 and Figure 6), (b) poor water clarity was reported, (c) MOEE well records demonstrated that the gravel aquifer had a good yield (up to 45 L/min), and (d) that groundwater flow (and thus contaminant flow) in this gravel aquifer was south toward this lot from the Kennedy/St. Joseph Street area where population density was relatively high and sewage disposal problems were known to exist.

The north-end test well location was chosen since (a) the bedrock was relatively close to the surface (and contaminants could be short-circuited into the aquifer), (b) it was known that deeper wells in this vicinity had poor yield and had "rotten egg" odour, and (c) other wells in the vicinity were "unsafe" from a bacteriological perspective.

4.2 Test Wells

In order to more fully evaluate the lithology and hydrogeological conditions in the Village of Apple Hill, two test wells were constructed. These wells were evaluated for quality and quantity characteristics by completing individual pumping tests. The test wells were drilled on March 9 and 10, 1995 using an air rotary drill rig supplied by ROYS LBR drilling of Cornwall. The drilling was supervised by Mr. John St. Marseille, MSTA's Senior Environmental Engineer. Following drilling, the wells were disinfected by adding concentrated sodium hypochlorite.

TW228

The first well (TW228) was drilled on lot 228 immediately south of the CPR line (Figure 2). The well was drilled using a 25 cm (10") diameter tricone drill. The test drilling verified that the gravel aquifer is overlain by grey till which is in turn overlain by brown till. The brown till is characterized by compact clay silt with some fine sand. At about 4 m, there was a transition to grey till. The grey till is characterized by silty sand and gravel with the silt fraction decreasing at depth. At about 7 m, dense sub-rounded 60 mm size gravel with sand and minor silt was encountered. The water content also increased. The yield was estimated to be about 10 L/min. The well was terminated at a depth of 12 m. The yield in this same seam was estimated to be about 45 L/min.

Based on the existence of a silt fraction in the aquifer matrix (and noting that the unscreened gravel aquifer wells were reported to be cloudy) an artificially-packed screened well construction method was chosen for this test well. The well was constructed using the "telescoping method" in the following manner (borehole logs are shown Appendix E) :

- Upon completion of the 25 cm diameter drilling to a depth of 11.6 m, a temporary 21 cm diameter steel casing was installed to prevent collapsing of the aquifer. As an additional precaution against collapse, an alkyl ether sulfate (AES) biodegradable surfactant (drilling foam STEOL FS-406™) was used. A 15 cm diameter casing was then lowered inside the larger casing to a depth of 11.6 m using centralizers to maintain a constant clearance. A 0.9 m long[1] (No. 20) stainless steel screen was inserted inside the 15 cm diameter casing using a K-packer attached to a 60 cm long adaptor.

- The annular space between the 21 cm diameter and 15 cm diameter casings was filled with silica-based filter sand to within 7.6 m from the surface. This filter sand is commercially available as Bomix Super Filtration Sand™. It can be described as well sorted, medium-sized sand (1.6 to 99 percent passing between 1.19 to 0.2 mm size sieves respectively).

- The screen was then exposed to the artificial filter pack by retrieving the 15 cm diameter

[1] Although it was known that a 0.9 m long screen would only partially pentrate the 5.5 m thick gravel aquifer (thus increasing the turbulent flow losses around the screen), the well was deemed to be able to produce the necessary yield for domestic supply purposes. A longer screen would make the well construction cost prohibitive for typical domestic demand applications. Based on the Kozeny equation (Driscoll 1989), about 50 percent of the maximum specific capacity (about 60 L/min) could be acheived from this well using multiple screens across the 5.5 m aquifer thickness.

casing about 1.0 m. The 21 cm outer casing was then slowly removed to expose the screen to the aquifer. The artificial filter pack depth was checked and the annular space was backfilled with bentonite seal as the outer casing was withdrawn to the surface. The bentonite seal extended from a 7.6 m depth up to the surface.

In order to promote the bridging of particles within the filter pack, the well was developed using the stop-start air method for 3 hours. The turbidity and conductivity at the beginning of the test was 162 NTU and 2.06 mS/cm respectively. At the duration of development, turbidity was reduced to 42 NTU and conductivity was 2.3 mS/cm.

TW404

The second test well (TW 404) was drilled on lot 404 (Figure 2) to a depth of 12.5 m using a 17 cm diameter carbide-tipped drill. The lithology of the overburden was similar that of TW228 except that the gravel aquifer was not encountered in the overburden. Brown till was encountered from the surface to a depth of 4 m and then grey till was overlying the bedrock to a depth of 8 m. The bedrock consisted of dense grey limestone. The limestone became fractured (angular to sub-angular fragments up to 50 cm in size) and yielded water from a fracture between a 9.2 m and 9.3 m depth.

The borehole was then extended to a depth of 12.5 m. The water yielded was estimated to be 13 L/min. No evidence of odour was noted in the water sample. Since deeper wells in the vicinity were known to be odorous and given that the well had a suitable yield prior to development, drilling was terminated at this point. A 15 cm diameter steel casing with drilling shoe was advanced and sealed to the overburden/bedrock contact using Benseal™. The well was then developed for 2 hours using a surge block. The turbidity dropped from 200 to 100 NTU during this time. The conductivity was constant at 600 uS/cm.

4.3 Pumping Test

The test wells were pumped using a constant rate test on March 29, 1995 to determine the aquifer quality and yield. In each case a 0.37 kW (1/2 HP) submersible pump was used for this purpose. Domestic wells on neighbouring properties were used as observation wells to determine induced drawdown and radius of influence.

TW-228

The pumping rate at test well 228 was increased intermittently to determine an optimum rate for the constant rate test. It was pre-determined that the results of a step- or constant-rate pumping test would be evaluated depending upon well response. The pumping began at 8.5 L/min. which was doubled to 17 L/min. and then almost doubled again to 30 L/min. When pumping was increased to 38 L/min. the well became very cloudy and the yield dropped. The flow rate was decreased to 12 L/min to allow partial recovery. The well was then pumped at an average of 17 L/min for the duration of the test. The static water level was 4.3 m from the top of casing. There was no drawdown in any of the 4 observation wells which ranged in distance from 15 to 30 m from the pumping well.

The maximum drawdown was to 8.68 m which occurred after 4.5 hours of pumping. The well achieved 50 percent and 100 percent recovery within 2 minutes and 59 minutes respectively from the time when the pump was shutdown.

The well recovery was analyzed using the Theis Recovery Method to determine aquifer characteristics (Appendix F). The transmissivity was calculated to be 2.5 m^2/day which for 0.9 m screen height gives a hydraulic conductivity (K) of 3×10^{-5} m/s. This compares well to values the median range of values shown by Freeze and Cherry (1979) which for silty sand and gravel unit ranges from 10^{-6} to 10^{-4} m/s. As indicated, the well yield could be increased substantially by screening off more of the aquifer. The potential impact of this higher pumping rate however would have to be further evaluated.

The radius of influence of this well cannot be exactly calculated since there was no induced drawdown in the observations wells. This could be related to the fact that the private wells used as observation wells may not have intersected the gravel aquifer which the test well was exploited or that the high water storage associated with the dug well may not make it a "good" observation well. However, even the closest observation well (at 15 m) was not influenced. The apparently low radius of influence is certainly controlled by the high storativity and transmissivity of the gravel aquifer and the fact that it is confined. The safe yield of this well is estimated to be 20 L/min which is adequate for typical domestic supply purposes.

The quality of the aquifer was evaluated during the pumping test by frequent well head measurement of: pH, conductivity, turbidity, and chlorine residual (Appendix F) and by detailed laboratory analysis for conventional water quality indicators as well as a suite of inorganic, organic, and bacteriological parameters. A water sample was taken at the beginning ("-1") and the end ("-2") of the pumping test in order to evaluate any temporal change in water quality. The details of the water chemistry analyses are shown in Appendix F but the salient Ontario Drinking Water Quality Objectives (ODWO) transgressions for the steady-state conditions (ie. second sample) were as follows :

Health-related parameters

- 3.4 NTU turbidity (1.0)
- 238 mg/L sodium (20 mg/L[2])

Non-health related parameters

- 523 mg/L chloride (250)

[2] Medical Officer of Health notification level for persons on sodium restricted diets.

- 579 mg/L hardness (80-100)
- 0.095 mg/L manganese (0.05)
- 1,618 mg/L total dissolved solids (500)

There was no measurable chlorine residual in the water samples taken during the pumping test. The elevated background (HPC) bacteria results suggest that additional chlorination may be necessary.

It should be noted that nitrate-N increased from 0.6 to 0.9 mg/L during the pumping test. Although this is not an ODWO exceedence, as discussed, it is suspected that the presence of this contaminant may be an indication of regional aquifer contamination since flow through the gravel aquifer and the surface ditch is south from the main part of the village. Dilution and denitrification may have reduced the contaminant concentrations as they travel through the aquifer. The bacteriological results do not show elevated results (for fecal or total coliform bacteria) but given that nitrate is highly soluble, this is not a surprising result. The concentration of hydrogen-sulfide was reported as non-detect (Appendix F) but toward the latter stages of the pumping, the signature "rotten egg" odour was prevalent. The fact that it was not detectable is attributed to the volatility of hydrogen sulfide even for a preserved water sample. The odour associated with this aquifer would require some treatment to improve its palatability.

The turbidity of well water samples is typically elevated and exceeds 1 NTU since off-gassing and chemical precipitation (usually iron oxides) manifests higher turbidity readings. These are not problematic unless chlorination is employed since trihalomethane (THM) precursors can be formed. Further well development would likely not reduce the turbidity below the 1.0 NTU requirement. The sodium result is significant not only because of its magnitude (critical for water supplies which are utilized for drinking purposes by sodium-restricted diet patients) but also its possible source. As mentioned, the high sodium and chloride results are indicative of possible road-salting impacts. The high sodium and chloride concentrations as well as hardness contribute to the TDS value as well.

TW-404

Test well 404 was pumped at 10 L/min. for 147 minutes. The maximum steady-state drawdown was to 11.05 m which occurred after 4.5 hours of pumping. The well achieved 50 percent and 90 percent recovery after 46 minutes and 195 minutes respectively from the time when the pump was shutdown.

The Theis Recovery Analysis of this data (Appendix F) shows results which are typical of limestone bedrock aquifers. The transmissivity is calculated to be 0.4 m^2/day which corresponds to a hydraulic conductivity of 1×10^{-6} m/s which compares well to the range stated by Freeze and Cherry (1979) for fractured limestone.

The maximum drawdown in the observation well, located at a radius of 22 m from the pumping well, was 0.85 m. The radius of influence of this well was determined to be 40 m based on the pumping test (Appendix F). The deep, narrow profile of this drawdown is typical of low transmissivity, confined aquifers (ie. bedrock aquifers).

The quality of the aquifer was evaluated during the pumping test by frequent well head measurement of: pH, conductivity, turbidity, and chlorine residual (Appendix F) and by detailed laboratory analysis for conventional water quality indicators as well as a suite of inorganic, organic, and bacteriological parameters (Appendix F). A water sample was taken at the beginning ("-1") and the end ("-2") of the pumping test in order to evaluate any temporal change in water quality. As noted previously, hydrogen-sulfide odour was very strong at the well head.

The details of the water chemistry analysis are shown in Appendix A but the salient Ontario Drinking Water Quality Objectives (ODWO) transgressions for the steady-state conditions (ie. second sample) were :

Health-related parameters

- 32.4 NTU turbidity (1.0)
- 23 mg/L sodium[3] (20)
- 12 counts/mL fecal coliform (zero counts)

Non-health related parameters

- 379 mg/L hardness (80-100)
- 574 mg/L total dissolved solids (500)

There was no measurable chlorine residual in the water samples but given the fact that the bacteriological quality worsened during the test is indicative of poor aquifer quality rather than ineffective disinfection. The turbidity was excessive and additional development would be required to improve this condition. Bedrock wells can usually be developed to a point where turbidity is less than 10 NTU but it is difficult to achieve a target of 1.0 NTU. Therefore, filtering would be required.

It should be noted that nitrate-N increased from 0.5 to 1.2 mg/L during the pumping test as did fecal coliform and fecal streptococcus bacteria. These contaminants can be associated with sewage. When the ratio of fecal coliform-to-fecal streptococci exceeds 4 then the contamination source is likely human in origin whereas if this ratio is less than 0.7 then the source is non-human in origin (MOEE 1984). In case of this water sample, the ratio is 0.6 (12/20) which based on the strictest interpretation of this rule would indicate that the contamination is non-human. However, there is overwhelming evidence which shows that human sewage has impacted upon the drinking aquifer because of poor septic systems, poor well construction, and a shallow overburden. The poor water quality in the ditches attests to this. Contaminants are short-

[3] Medical Officer of Health notification level for persons on sodium restricted diets.

circuiting into the aquifer and impacting on water quality. Since the bacteria results are relatively high, the source is likely in close proximity to the well. It may be related to the high concentrations in the John Coleman Drain or the storm sewer which runs along Kenyon Road East.

4.3 Hydrogeological Interpretation

Based on the results of the pumping test, MOEE well records, and the pollution survey there are 2 main aquifers within the village that can be exploited for domestic water supply - overburden and bedrock. The overburden aquifer consists of the granular materials (sand and gravel) which can be exploited by constructing dug or drilled wells depending upon the depth to the aquifer at a given location. The granular deposits exist sporadically throughout the village and are reported as ranging in depth up to 20 m from the surface. Each of these aquifers is confined by the overlying dense till. The degree of confinement however varies according to the depth of till and properties of the aquifer.

The MOEE well records show that the deep overburden aquifer (sand and gravel) typically yields about an order of magnitude more water than the bedrock wells except the very shallow dug wells into the perched aquifers which have seasonal water flow problems and very poor water quality. The test well pumping also confirms this result.

Granular deposits of sand and gravel are predominant along Kennedy Street and toward the south part of the village along Main Street which forms the valley between the two till ridges where wave action would have stratified the till deposits. Drainage of the former sea through the area may have also supplemented the re-working of the sand and gravel deposits. The relatively high hydraulic conductivity of these deposits means that they are potentially good aquifers but it also increases the risk of contaminant movement through the aquifer. An indication of the degree of isolation of the aquifer is given by the confinement - that is the hydraulic head difference between the "water found" and the "static water level". Well records along Main Street (216, 224, 227, TW228, and 231) show confinements of 16.5, 16.2, 5.8, 6.7, 6.7 m respectively. The degree of confinement shows a decreasing trend moving south from the centre of the village. This combined with shallower wells and predominate groundwater (and thus contaminant) flow direction to the south indicates a strong impact potential south of the village.

Near surface granular deposits exist sporadically throughout the village. These deposits were formed in the post-glacial marine environment. Given the permeability of the granular materials, they are adequate yielding aquifers to be exploited using shallow dug wells. These aquifers are so-called "perched aquifers" since they form above the underlying, less permeable glacial till or in some cases include the some more permeable material interbedded in the till. Since the perched aquifer is proximate to the surface and has minimal lateral extent, these dug wells feature minimal yields, poor isolation from contaminant sources, and seasonally dry up.

The bedrock aquifers in the village have little yield and inconsistent quality. The deeper aquifers are more isolated from contaminant sources (as demonstrated by the well confinement values, Appendix C) but their use is prohibited by low yield and poor quality (sulfur, hardness, and iron in particular).

4.4 Chemical Hydrogeology

The groundwater chemistry was analyzed for direct comparison to pertinent drinking water criteria (ODWO) and to corroborate the interpretative results of the physical hydrogeology.

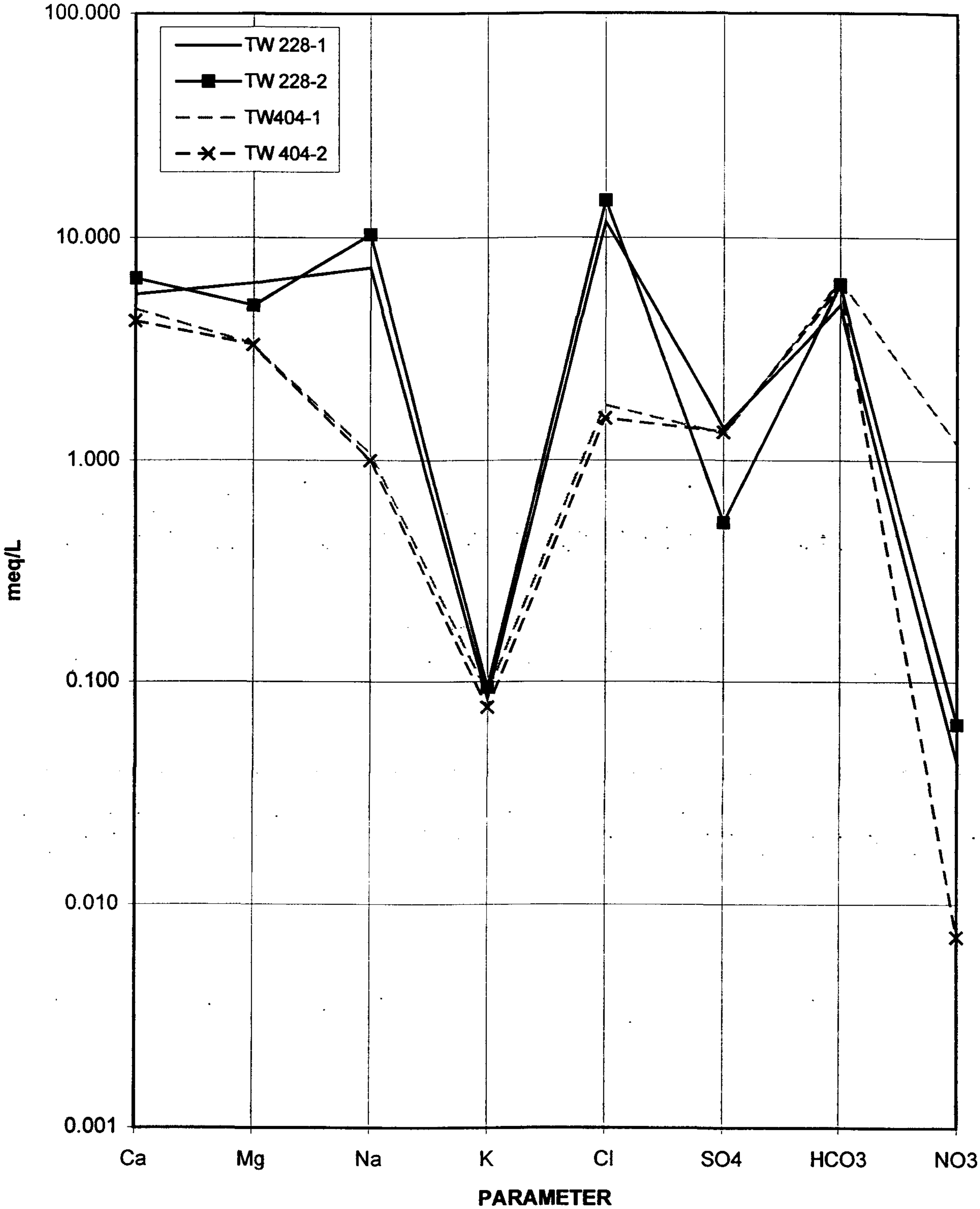
As indicated, the prevalence of chloride throughout the village (and sodium in TW-228) may be the result of road salting impacts since elevated values occur along the arterial roads. The results of the water quality data from the test wells was compared on a major ion basis (Schoeller's Method) to further evaluate this potential problem. The data from TW-404 and TW-228 was plotted on a milliequivalent ion (meq/L) basis for major anions and cations. The graphical interpretation of the data (Figure 8) shows that temporal change in aquifer quality (other than nitrate at TW-404) does not exist (comparing sample "-1" to "-2") but that between TW-228 and TW-404 there is disparity in the sodium and chloride results. This indicates that the water comes from different geologic formations and that one well (TW-228) has been impacted upon by external contaminants since sodium and chloride typically do not occur at these concentrations in the un-impacted overburden aquifers which contain relatively "young" water.

As shown on Figure 6, bacteriological and nitrogen-related contaminants are widespread throughout the community. It was postulated in the phase I report that the quality of the water was directly related to improper well construction and, provided that the regional aquifer was not contaminated, private well correction alone could solve the water problems for the village.

It appears now, based on the additional interpretation of the results of phase II detailed aquifer assessment that well correction alone will <u>not</u> solve the water quality and yield problems in the village. Treatment units would have to be provided since the overburden gravel aquifer has been impacted upon by contaminants and the bedrock aquifer quality is poor. The contaminant sources should be remediated where possible (eg. sewage systems, road salting) to decrease the impact on the aquifer and make the treatment more effective (section 5.0). This necessitates completing a sewage system study. It should be noted that the participation in any type of correction program is voluntary. Thus uncooperative homeowners who have short-circuiting wells or improper sewage systems will continue to contribute to the problem and perhaps jeopardize the success of a private correction program.

The alternative to private correction is the provision of a communal water supply. This would involve a distribution system leading from a communal well(s) or a surface water source. These alternatives are discussed further in section 5.0. This type of solution has the advantage over private correction, since mandatory connection and a long term safe water supply is assured.

Figure 8 - Test Well Water Quality Comparison
(Schoellers Method)



5.0 Evaluation of Water Supply Alternatives

Based on the additional information compiled during the Interim Hydrogeological Investigation, the water supply alternatives were assessed. The alternatives range from "do nothing" to a full communal supply system.

5.1 Do Nothing

As implied, this alternative maintains the status quo. There is no additional cost burden to the homeowner but the water supply problems would continue. Some of the local wells would continue to be used for supplying potable water but other homeowners would continue to import their potable water supply from outside the village (which includes the purchase bottled water). Also, without changes to the sewage disposal situation, public health impacts may occur.

5.2 Private Well Correction

Private well correction, in the absence of sewage correction and the provision of some individual water treatment units, is not a viable community-wide solution the water supply problem. Even though a gravel aquifer, with more than adequate yield for domestic supply purposes, extends through most of the central and south part of the village, this aquifer has been impacted to varying degrees throughout the village by sewage effluent and other contaminants including animal feces and road salt. Improper well construction has allowed the short-circuiting of contaminants not only into the wells but also into the water supply aquifer(s). The bedrock aquifer at the north end of the village does not appear to be suitably isolated from potential contaminants and it also has insufficient yield to sustain multiple wells. It must be noted that in the past MOEE have not supported private corrections when the aquifer was contaminated to the extent that on-going disinfection units would be required.

5.3 Low Capacity Communal System

In order to provide a safe and adequate water supply for the community which is cost-effective, a low capacity water supply system was investigated. This communal system would provide a sufficient supply to meet daily potable water demand but would not allow for extraneous demand such as fire-fighting supply or lawnwatering. Consequently, large communal water storage tanks, high capacity watermains, and booster stations are not required - all at considerable cost savings. The storage component could be facilitated by in-home storage tanks ranging in size from 500 to 1,000 L depending upon the number of persons it services. Water treatment would be facilitated at the system headworks (with a minimum treatment level of disinfection). The water supply source could be a communal well developed from the local gravel aquifer (section 8.0) provided that the aforementioned contaminants could be eliminated (ie. ineffective sewage systems). Improperly constructed wells would be abandoned while properly constructed and maintained wells could be used for lawnwatering or other extraneous water uses.

The average daily demand was determined to be 55,000 L/day (40 L/min) based on a service population of 200 persons. The local gravel aquifer, based on preliminary estimates, is capable of meeting this demand (section 8.0). The protection of the aquifer however must be assured if it is to be exploited for communal supply purposes. This is addressed in the Sewage Investigation Report (MSTA 1997). Since this is a communal system, the requirements of Class Environmental Assessment procedure must be considered. This involves identifying potential water supply aquifers, supply alternatives, and environmental impacts associated with the implementation of an alternative. In terms of operating implications, a communal supply system must be operated and maintained by a suitably qualified staff.

5.4 Full Communal System

A full communal water supply system is similar to the low capacity system described above but includes allowances for firefighting and extraneous flow demand. Storage and distribution systems have to be commensurately larger. The storage would likely have to be elevated to meet the pressure-flow requirements. The components of this system include water supply wells, elevated storage, treatment (disinfection), and the distribution network. Since this is a communal system, the requirements of Class Environmental Assessment procedure must be considered. This involves identifying potential water supply aquifers, supply alternatives, and environmental impacts associated with the implementation of an alternative. The local aquifer would likely not be capable of supplying the demand necessary for this type of system (peak demand up to 16.6 L/s). In terms of operating implications, a communal supply system must be staffed and maintained by a suitably qualified personnel.

The need for replacing sewage systems influences the correction cost. Further study of sewage correction alternatives (eg. semi-communal systems) should provide some insight to identify other cost effective solutions. The implementation of a communal water supply solution does not necessarily have to include sewage correction unless the municipal water supply is locally exploited in which case sewage correction is necessary to ensure the long term integrity of the communal water supply. Suitable aquifers may exist in the till valleys (gravel aquifer) east or west of the village but this would have to be further evaluated.

6.0 Phase II - Public Consultation

As part of the Phase II investigation, a public meeting was held on August 16, 1995. At this meeting, problems with the groundwater supply were presented and it was explained to the residents that since private well correction would not be successful for the entire village a communal water solution may be effective. Groundwater well supply options were presented including :

- do nothing (no private well correction, existing wells utilized and aquifer contamination continues);
- low flow (employing in-home storage to meet peak flow demand);
- full flow (no fire protection); and

- full flow.

The components of each system were explained including costs (capital and operating) and each system's advantages and disadvantages. After some discussion, residents voted over 75 % in favour of "flipping" the project to a communal water project and the full flow (no fire protection) option was selected. It was emphasized that (a) sewage system correction and (b) well abandonment would likely be integral components of the provision of a sustainable safe potable water supply since a communal water supply likely exists in close proximity to the village given the regional geology. A separate sewage project (no. 50-0111-01) was initiated to address these matters. It was also re-iterated that evaluating communal water supply options would require the completion of an Environmental Study Report; however separate funding would have to be approved by MAP through the MOEE for such an undertaking.

The MAP Office was subsequently notified that it was the intention of the Project's Liaison Committee to request "flipping" the project from a private to a communal water investigation. This was additionally supported by the local MOEE Office and Township of Kenyon Council. Although this would require additional funding to complete a detailed Environmental Study Report (which was subsequently requested), it was proposed to utilize the reserve funds from Phases II, IV, and V of the private water project to initiate some preliminary field investigations for siting a test well capable of meeting communal water supply needs (about 40 L/min without fire protection). It was explained that, subject to the groundwater survey review, the test locations would be a maximum of 1 km from the village. It would be important to locate a water supply sufficiently remote from developed areas to minimize groundwater contamination and yet remain cost effective should the water supply be acceptable (ie. minimize the distance to construct a pipeline from the well to the village).

In letter dated September 14, 1995, MAP Office approved the utilization of reserve funds from the Private Water Project for the preliminary investigation of groundwater supplies for a communal water system for the village. The investigative work is described in section 8.0.

7.0 Conclusions and Recommendations (Phase II)

- The village of Apple Hill is situated on a glacial till ridge. The ridge's parent material is heterogenous lodgement and ablation till which consists of silty-sand and clay with boulders and pebbles. Post glacial marine reworking has stratified some of the till ridge leaving an extensive sand and gravel aquifer across the west part of the village. Also, sporadic pockets of surficial sand and gravel have been used for shallow dug wells.

- Based on preliminary information, the groundwater flow is south in the overburden and bedrock aquifers. Improper well construction and inadequate sewage disposal systems cause insufficient attenuation of contaminants thus affecting the water supply.

- Based on the MOEE well records, both dug and drilled wells in the village exploit shallow overburden and bedrock aquifers - about 30 % are dug wells and 70 % are drilled wells. The aquifers range in depth from 3 to 43 m from the surface.

- Of the 87 homes included in the 1989 and 1990 MOEE water quality survey, 48 were deemed "unsafe" for drinking based on bacteriological and chemical analyses. Water quality problems in the village include: hardness; iron and manganese staining; dissolved gases; discolouration; taste; rust; or unpalatability. Some homeowners employ softeners; filters; and purifiers for water treatment.

- The MOEE survey also included sewage disposal systems. Based on the interviews, 96 (72 %) of the homes had septic systems, 4 (3 %) have holding tanks, 8 (6 %) have outside privies, and 26 (19 %) were unknown. Some homes directly discharge raw sewage to the storm sewer network.

- The results of the pumping test show that road salt (sodium and chloride) and sewage effluent (nitrate and bacteria) may be impacting on the test wells. Given that these test wells are properly isolated from surface and shallow aquifer zones, this supports the fact that the bedrock and groundwater aquifers are locally recharged and that the water supply in the village has been compromised as a result of improper well construction, short-circuiting of sewage contaminants into the drinking aquifer(s), and inadequate sewage disposal systems.

- From a yield and well development perspective, a screened well is a suitable construction technique for the sand and gravel aquifer but treatment would have to be provided. The bedrock well (cased to the overburden contact) had a low yield and was not properly isolated from contaminant sources. Turbidity was still high even after well development.

- Individual private well correction cannot be recommended since the supply aquifers have been impacted upon by improper well construction, improper sewage disposal systems, and perhaps road salting activity. Water supply treatment units, including disinfection would have to be employed to ensure safe water quality through the south and central part of the village but the bedrock aquifer in the north end of the village has minimal yield and shows bacteriological contamination which is indicative of human sewage impacts. The low yield may cause water shortages.

- Individual disinfection treatment units would be required which MOEE does not usually accept as a treatment alternative for private well correction programs.

- Since the gravel aquifer appears to be spatially extensive and provides a suitable yield, a semi-communal or communal water distribution employing screened wells may provide an alternative to individual well correction. The location of the supply well(s) would have to be remote from possible contaminant sources. An effective solution could possibly be achieved by providing only potable water supply in the distribution system (ie. elimination of lawnwatering and fire-protection supply). The location and construction of these supply wells would have to be further evaluated.

- An integral part of the safe water supply provision is proper sewage disposal. A sewage study should be undertaken to ensure the success of procuring short- and long-term, plentiful supply of safe water for the community.

8.0 Preliminary Communal Water Supply Evaluation

The preliminary communal water supply evaluation was completed based on components of MOEE's terms of reference Hydrogeologic Study Program for Water Works (Appendix G). Although the Hydrogeologic Study Program is intended for rigorous evaluations as part of an ESR, it was utilized for this application to provide an initial indication of groundwater exploitation potential. More detailed interpretation of the water supply alternatives and impacts would have to be completed as part of the ESR.

The objectives of the Preliminary Communal Water Supply Evaluation was to:

- evaluate the feasibility of developing a communal well water supply to meet the projected water requirements of the community to be serviced;
- complete a series of boreholes within 1 km of the village to verify lithology and groundwater exploitation potential; and
- where an acceptable groundwater water supply is obtained, a follow-up test drilling program that will verify the location and availability of the groundwater supply.

8.1 Groundwater Survey Site Investigation

A field drilling investigation was completed over the period of September 20 to 29, 1995. Well development continued into 1996. To expedite the drilling and maximize the number of testing locations without compromising data gathering ability, an air rotary drill rig was utilized. Property owners were notified and permission was obtained to drill test holes east, west, and southwest of the village. A total of 14 boreholes were constructed around the village (Figure 9) ranging in depths from 6 to 20 m (terminating at bedrock). The bedrock termination depth was chosen since existing hydrogeological information showed that deeper bedrock wells had poor water quality and lower yield compared to deep overburden wells developed into granular aquifers.

Boreholes East of the Village

Boreholes 95-1 to 95-5 (Appendix H) were drilled to bedrock at locations ranging from 300 to 570 m east of Main Street. The overburden geology 95-2 to 95-5 was similar with brown, compact silty till encountered within 2 m of the surface overlying grey silty till with clay to a depth of about 8 m where bedrock was encountered.

At borehole 95-1, located west of the other 4 boreholes, the brown compact till depth was about 5 m where grey silty clay till was encountered. The bedrock was encountered at 11 m. Of the 5 boreholes, this one had the most abundant yield which was estimated to be less than 12 L/min. This was significantly less than the objective well yield (40 L/min) hence no well instrumentation was completed.

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CORNWALL, OTTAWA, KINGSTON

TITLE
BOREHOLE AND TEST WELL LOCATIONS

PROJECT
APPLE HILL PRIVATE WATER SYSTEMS STUDY

scale	1:5,000
date	JANUARY 1997
drawn	DP
job no.	94519
drawing no.	FIGURE 9

NORTH

Boreholes West of the Village

Boreholes 95-6 to 95-10 were drilled to bedrock at locations ranging from 200 to 290 m west of Main Street (Figure 9). The overburden geology was similar to 95-1 with brown compact till encountered to a depth of 3 to 5 m. This till was underlain by grey silty clay till to a 15 m depth at 95-6 and 11 m at 95-7. At 95-8, further to the south, the grey till was underlain by 5 m of fine sand and gravel to the bedrock at 14 m. Yield was estimated to be about 15 L/min. At borehole 95-9, the sand and gravel thickness was about 10 m overlying bedrock which was encountered at 18 m. Borehole 95-10 was drilled to verify whether the same sand and gravel seam extend back to the north. At this location the sand and gravel was about 8 m thick and bedrock was encountered at 17 m. It was reasoned that the development of a well at 95-9 would still be too proximate to the highly developed areas along Kennedy and St. Joseph Streets to minimize contamination risk (even with a properly constructed well). Therefore additional drilling was completed further south.

Boreholes Southwest of the Village

Based on the presence of a granular seam and relatively good yield at 95-9, additional boreholes were drilled further south of 95-9. The next borehole (95-11) was subsequently instrumented with a screen to be developed as a test well (identified as CTW-95, *communal test well 95*) since the yield was estimated to be about 50 L/min. This well was drilled about 160 m west of Main Street and 70 m south of the CPR line.

The well was established at a depth of about 12.8 m which was at the top of bedrock. Well construction was completed in the same manner as at TW-228. That is, the borehole was drilled at 25 cm diameter and an artificial filter pack was placed around the No. 20 slotted stainless steel screen. The major difference in this well construction was that two, 1.2 m screens were used in order to maximize screen exposure across the aquifer depth. The screens were arranged as follows from the base of the well: 0.9 m sump; 1.2 m screen; 0.6 m transition; 1.2 m screen; and 0.9 m transition (Appendix H). The sump and transitions consisted of 15 cm diameter sch. 40 steel pipe. A K-packer gasket completed the connection between the upper transition and the well casing. The top of the upper screen was set at 8.8 m from the surface which meant that the aquifer was effectively screened for about 4 m (from 8.8 to 12.8 m from the surface).

Observation wells were established at three locations from this well - MW95-12 about 55 m west, MW-95-13 about 100 m south west, and MW95-14 about 120 m north. In addition, TW-228, located about 170 m to the east would be used as an observation well at a radius of 180 m from CTW-95.

Each of the observations wells (MW95-12, -13, and -14) was instrumented with a 50 mm diameter PVC screen to permit water quality and level measurements. Each was fitted with a 3 m long screen the base of which was set from 13 to 15 m from the surface. Bedrock was encountered at about 18 m from the surface at each location (Appendix H).

As the test well was pumped as part of development following drilling, the yield was measured to be about 11 L/min. This yield was substantially less than the pre-screen installation rate yield and it was postulated that part of the overlying till may have collapsed around the screen as the filter pack was placed. Accordingly, further well development was necessary to re-establish the yield.

The test well was developed over a period between September 1995 to January 1996. The initial development was completed using stop-start air for a 3 hour period on September 29, 1995. During the initial stages of development, the water was cloudy, an indication that fine suspended particles were being removed (clay and silt) but the yield was still about 11 L/min. On October 11, 1995 jetting was used for development. The jetting tool was slowly rotated and moved up and down across the well screens with a pressure of about 160 psi. The yield improved to 16 L/min after 5 hours of jetting. To improve upon the jetting technique, clean water was pumped into the well from a tanker on November 8, 1995. A total of 8,000 L (2,500 gal) was injected into the well under pressure. Water was then pumped from the well and the yield was increased to 26 L/min. On January 19 a portable submersible pump was installed and the well pumped for about 7 hours for further development. The pump intake was set at 10 m from the surface and the well was pumped at a rate of 30 L/min. The maximum drawdown was 7 m or about 50 percent of the well depth at the end of 7 hours.

On January 24, 1996, the well was pumped again for about 7 hours. The pump intake was set at 12 m from the surface and the well was pumped at a rate of 37 L/min. The maximum drawdown was 7 m or about 50 percent of the well depth at the end of 7 hours. Well head measurements were taken during the test. The results are shown on Table 1.

Table 1 - Well Development Field Measurements (January 24, 1996)

Time Since Pumping Started	Cond (uS/cm)	pH	Turbidity (NTU)
1 min	830	7.3	166
10 min	643	7.37	90
1 hr	551	7.49	134
2 hrs	568	7.45	83
3 hrs	553	7.48	56
4 hrs	563	7.49	41
5 hrs	482	7.49	19
6 hrs	512	7.46	16
7 hrs	553	7.49	20

The field data indicates that the water clarity slowly improved during the test (using turbidity as an indicator). The results of the conductivity tests is also promising since they decreased during the test. Conductivity provides a surrogate indication of water hardness, dissolved solids (including sodium and chloride), and other forms of contaminants. The conductivity result (553 uS/cm) is low compared to 2,300 uS/cm measured at TW-288 (although this was measured on March 29, 1995). The pH data shows that it is within the ODWO range and that it increased slightly from the beginning to the end of the test likely because of CO_2 degassing.

Although the purpose of the pumping was to promote well development, water level measurements were taken at the pumping well and the 4 observation wells (MW95-12, -13, -14, and TW228). The data is summarized on Table 2.

Table 2 - Water Level Measurements (January 24, 1996)

Well	Radius from CTW95 (m)	Static Level (m)	Dynamic Level (m)	Drawdown (m)
CTW-95	---	0.2	7.2	7
TW-228	170	3.2	3	-0.2
MW95-12	55	1.2	2.1	0.9
MW95-13	100	0	0.3	0.3
MW95-14	120	0.6	0.9	0.3

At TW-228, the well actually rose 0.2 m during the test. This may have occurred because the water level was still recovering from drawdown which was induced by pumping of one of the other private wells proximate to this well. Alternatively, given the well's proximity to recharge areas to the north, the static water level in this well may change quickly and more frequently. This would be further evaluated as part of the extended duration pumping test.

As expected, the drawdown was highest at the closest well (0.9 m at MW95-12). It was 0.3 m at 95-13 and 95-14 demonstrating the lesser influence of the radius of drawdown further from the pumping well. The steady-state induced drawdown profile will be evaluated as part of the extended duration pumping test. The radius of influence extends more than 120 m north of CTW95 which encroaches near the more developed area of the village. This highlights the importance of mitigating contamination from sewage systems and establishing a well head protection zone. Alternatively, water supplies further from the village would have to be exploited to ensure the contaminant impact potential is reduced.

8.2 Conclusions and Recommendations (Communal Water Supply Development)

- An evaluation of communal water supply options must be completed as part of the Environmental Study Report.

- The field data shows that the aquifer has a yield which is capable of sustaining a communal water supply for a low flow system.

- Screened wells, in the coarse formation described at CTW95, likely could be equally effective if naturally packed. This will provide ease of construction and development.

- An extended duration pumping test and quality assessment must be completed to determine the radius of influence and the well head protection area. Preliminary indications are that the radius of influence extends at least 120 m north of CTW95 which is near the concentrated development area of the village. Contaminant control, in particular for proper sewage disposal, is necessary in the well head protection area or a more remote location for the communal well.

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Project Manager

Appendix A - Terms Of Reference

TOWNSHIP OF KENYON

APPLE HILL
PRIVATE WATER SYSTEMS PROJECT

(APPENDIX A)

TERMS OF REFERENCE

M.S. Thompson & Associates Ltd.
Consulting Engineers

August 1994

1.0 Preliminary Hydrogeological Evaluation

1.1 Project Initiation Meeting

A multi-agency meeting with officials of the MOEE District Office (Cornwall), Eastern Ontario Health Unit, and the Municipality will be held to discuss:

- study objectives
- problem definition
- study schedule, phasing, time constraints, priorities
- availability of existing information
- study boundaries
- public consultation approaches

Deliverables

This inaugural meeting is important to establish the study objectives and the site boundaries. Information pertaining to existing studies, reports, site plans, surveys, and well records etc. will be noted for future reference since these will form the basis of the preliminary site evaluation (section 1.2). If necessary the project tasks and schedule can be adjusted.

All information reported by the consultant , from project initiation to completion, will be produced using Word Perfect 5.2™. Disks as well as hardcopy will be made available to OCWA and the Municipality.

1.2 Existing Information Review

Further to the site initiation meeting a detailed review of existing information will be completed. This review is crucial since it can provide useful information that will ensure that follow-up investigations are cost-effective. The review will be critical of the protocols and data gathering techniques employed by the various authors to ensure that any data incorporated into the investigation is scientifically defensible.

Deliverables

The results of the existing information review will be incorporated into a preliminary hydrogeological report (Tasks 1.4 and 1.5). The key objectives of the preliminary hydrogeological assessment is to evaluate general trends relating to: contaminant occurrence (eg. in dug vs. drilled wells, temporal and spatial distribution), characteristics of overburden and bedrock geology and hydrogeology (aquifer identification and degree of confinement), well construction (MOEE well records for drilled wells only), and the suitability of the identified aquifers to provide an adequate supply of potable water.

1.3 Private Service Site Restrictions

Based on the preliminary site assessment and in consultation with various approving agencies, the limitations imposed by setbacks or other constraints will be considered in accordance with timing or feasibility of project implementation.

Deliverables

The implications of these setbacks or other constraints with reference to private system development will be incorporated into the preliminary report;

- to determine the reasons for the existing problems including:
  - if pollution problems are due to insufficient lot size, insufficient separation distance (to wells, property boundary, etc.) as specified in the MOEE Regulations (Regulation 374/81 [Rev. 358/90] and 612/84 [Rev. 903/90]), and/or non-compliance with requirements of the "Reasonable Use" Concept;
  - the relative frequency of contaminant occurrence in dug well versus drilled wells (including well depths);
  - if surface water runoff is impacting on the wells;
  - if the poor construction methods (poor well sealing or grouting) have increased the susceptibility for well contamination;

1.4 Develop "Typical" System Layouts

Once the restrictions to the construction of private services have been assessed (Task 1.3), typical layouts for private system solutions will be examined for critical sites to assess whether these lots are large enough to support private connections in accordance with Ontario Regulation 374/81 and 612/84. Depending on the results of this assessment a review of partial private and communal solutions will also be investigated.

Deliverables

An assessment of the suitability of critical lots to support private systems will be incorporated into the report with well data, maps, and drawings.

1.5 Preliminary Hydrogeological Assessment and System Feasibility

Based on the aforementioned site investigation and agency consultation a preliminary hydrogeological assessment and report will be completed. This report will discuss the findings of the existing information review, the implications of some design alternatives, and the feasibility of their implementation. A decision as to whether further investigation (Section 2.0) is needed to better characterize the site will be made at this time.

Deliverables

It is anticipated that at this stage of the work the recommendation will be presented to:

1. Initiate a private well/treatment unit and/or septic system replacement program; or

2. Initiate a communal or partial communal well and/or sewage system program; or

3. Conduct a more detailed hydrogeological study to assess the most appropriate solution.

A preliminary report of conclusions including drawings will be produced detailing some of these options and recommendations for subsequent action or further study.

1.6 Assessment of the Need For A Full Hydrogeological Study and Consultation

The result of the preliminary hydrogeological evaluation will be used to determine whether private systems can be configured for each lot. The necessity or merits of individual treatment systems will also be evaluated. A public meeting will be arranged to explain the preliminary findings of the investigation and to report on the future work program.

Deliverables

A detailed proposal to conduct a full hydrogeological study program including cost estimates will be provided to the Project Supervisor. In addition an open house/public meeting will be held at this time to inform the residents of the preliminary findings and the recommendation for further study or action. Typical costs for private versus communal water correction will be presented at this meeting.

2.0 Detailed Hydrogeological Study Program

2.1 Statement of Purpose

This work would only be undertaken if the phase 1.0 had concluded that private system correction appeared to be feasible but required further detailed hydrogeological support.

The objective of the detailed hydrogeological evaluation is to determine if upgrade or replacement of private well systems is technically feasible to provide a long-term source of potable water for the community. This will be completed by reviewing the existing data and recommending additional site investigation (field work) to fill the data gaps where necessary.

2.2 Detailed Objectives and Terms

To determine the feasibility of the private well systems it is necessary to satisfy some basic objectives. These may have to be augmented by field work as required.

2.2.1 Magnitude and Characteristics of the Contamination Problem

Further to the investigation as to the general nature of the existence of contaminants (Task 1.2) detailed well, aquifer, and contaminant characteristics will be examined.

Deliverables

The completion of the following detailed objectives will form a basis for this task completion.

- statistically categorizing the groundwater quantity and quality characteristics by well type (dug versus drilled), well depth, and well location.

- produce a database of well information (well type, age, static water level, water found, condition, maintenance, contamination, potential for surface water runoff impacts, well pumping rate(s), season changes to quality or quantity, number of well users per occupancy). Some of this data may have to be gathered through field investigation (Task 2.2.2).

- determining the exact nature and extent of pollution problem (inorganic, organic, and/or bacteriological), the extent of the problem (aesthetic vs. health related), and any special need for expediency according to well problems.
- differentiating between the natural groundwater quality characteristics and sewage impacted groundwater quality.

- mapping of groundwater contaminants, geologic units (eg. top of bedrock, overburden, faults, geostructural unconformities), and equipotential contouring of aquifer(s).

At this stage an assessment will be made to determine if additional information is necessary to quantify these issues (Task 2.2.2).

2.2.2 General Groundwater Quantitative and Qualitative Assessment

The characteristics of groundwater quantity and quality will be compiled from available sources of information. Where this information is lacking or not scientifically defensible then field work will be initiated to fill these data gaps. At a minimum, it is likely that additional well quality sampling and a pumping test or tests (where possible using the existing wells) and the monitoring wells (Task 2.2.4) will be necessary. It should be noted that completing pumping tests on existing private wells is difficult since it requires shutting off all pump systems for extended periods (perhaps up to 6 hours or more depending upon well recovery) to ensure that induced drawdown is not effected by external influences. This may be of great inconvenience to the homeowners and therefore not feasible. This being the case, a provision for test well installation was made (Task 2.2.4).

Deliverables

The detailed objectives of this section are to determine:

- the geology and physical hydrogeology of each stratigraphic sequence within the surficial sediment overlying the bedrock, including aquifer identification;
- the type of bedrock aquifer(s) and its depth from ground surface;
- the existence of faults or other geo-structural unconformities which may be preferential pathways for contaminant migration;
- the specific capacity of the dug and drilled wells;
- the nature of the aquifer (s) (confined versus unconfined);
- determine if additional field work is necessary (and to what extent) to fill the data gaps

Well water quality may have to be determined for a representative selection of wells. Static water levels will be measured, and the groundwater flow directions and gradients will be determined. The turbidity, conductivity, pH, and dissolved oxygen (DO)[1] concentrations will be measured in the field since chemical speciation can cause changes in solubility thus affecting the readings which would otherwise be measured in the laboratory. Iron is a good example of a parameter, which in an unfiltered, turbid water sample may show a higher concentration than its field filtered counterpart.

Spatial and temporal variations in water quality will be examined by sampling representative wells (dug and drilled) at least twice during the project (spring and summer if scheduling permits). Through consultation with the project liaison committee the suite of parameters to be analyzed will be determined but the sampling program should include parameters listed on Tables 1, 2, and 3 of the MOEE's Technical Guideline for Water Supply Assessment for Subdivision Developments on Individual Private Wells to be supplemented with pesticide and herbicide analyses since their existence cannot be dismissed in a rural area. This suite of parameters will permit general aesthetic and health related parametric characterization of water quality and identification of key contaminant tracer indicators (eg. NO_3-N, Cl, and conductivity).

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[1] DO is a useful parameter to include in the well head measurements since some remedial options are sensitive to aquifer DO levels (eg. denitrification rate).

Hydrochemical contour maps will be prepared from which the areal distribution of the contaminants in the aquifer(s) will be vividly shown. Groundwater quality data will be quantitatively analyzed using appropriate techniques (eg. Schoeller's Method) to verify aquifer groups by type and quality for representative lots.

Pumping tests will be conducted in accordance with MOEE protocols (Technical Guideline for Water Supply Assessment for Subdivision Developments on Individual Private Wells, July 1992) using representative dug and drilled wells and/or new wells constructed strictly for this purpose. The data will be interpreted to determine aquifer properties (transmissivity, storativity, short and long term yield), well properties specific capacity, well loss), and radius of influence (Task 2.2.4).

2.2.3 Sourcing Water Quality Problems

Further to the review of existing information, field testing may be required to ascertain specific point sources of contamination (eg. septic systems). Positive source identification can be made by tracer dye studies. This involves introducing a coloured dye (eg. fluorescein) into the suspect septic system and noting the breakthrough of the coloured dye in the contaminated well. A tracer dye study will be conducted at two critical sites selected in consultation with the Project manager and the Liaison Committee.

Deliverables

The results of this testing (including time of breakthrough, identification of contaminant pathways, and rate of contaminant movement) and its implications will be incorporated into the final report.

2.2.4 Test Drilling Program

As part of task 2.2.2 the necessity for the drilling of test wells to one of more aquifers may be recommended. These test wells will be used to further characterize water quality and quantity in the respective aquifers which they exploit. The merits of using these aquifers for potable water supply can only be evaluated by completing pump testing and water quality analysis.

The surficial geology in the Apple Hill area is glacial in origin consisting of stratified and unstratified drift. The stratified drift is proglacial marine plain silt, sand, and clay (Ringrose et al) in the low lying areas. The high-lying areas consist of ground moraine till (Ringrose et al) which can be very compact and poorly sorted (lodgement till) or be partially sorted (ablation till) which may feature some relatively high permeability sand and gravel units.

The chemical zonation maps produced by Charron indicate that in the Apple Hill TDS concentrations were 300 mg/L or less. The regional iron concentrations reported by the same author range from 0.25 to 1.0 mg/L. Although this data does not consider overburden aquifer quality it does give a general indication of the ubiquitous nature of the TDS and iron concentrations in the bedrock aquifer. This is typical of aquifer quality in the underlying bedrock which is predominately limestone from the Cobourg Zone of the Ottawa Formation (Wilson).

The general nature of groundwater quality coupled with a review of the local geology can be an effective tool in sourcing groundwater quality and in particular, impairment of groundwater quality.

For example, in our experience the overburden/bedrock contact zone aquifer in Kenyon Township usually has a high yielding, good water quality compared to the bedrock aquifer. The bedrock aquifer is of poorer quality than the overburden aquifer (with respect to Fe, Mn, H_2S, and hardness) by virtue of the reducing conditions which the source water resides in. Consequently, at first glance it would seem reasonable to utilize the overburden aquifer as the single source of potable water supply; however, given the higher potential for contaminant impact on the overburden aquifer (from septic systems for example) then the use of this aquifer may have to be discontinued. This type of assessment will be completed in further detail by reviewing and cross-referencing the existing reports.

Deliverables

The construction of multi-level (ie. overburden and bedrock aquifer(s)) test wells will provide the necessary information to quantify the degree of hydraulic interconnection (or isolation) between aquifers. The data will also be interpreted to determine aquifer properties (transmissivity, storativity, short and long term yield), well properties specific capacity, well loss), and radius of influence as mentioned in Task 2.2.2. Hydraulic gradients (vertical and horizontal) will be used to establish rates of contaminant migration and dilution effects in the various aquifers.

It is anticipated that two multi-level test/production wells will.be constructed for this purpose. Each nested well will include a 15 cm diameter shallow bedrock monitor (no more than 30 m deep) and an overburden aquifer monitor instrumented to a depth typical of the dug wells in the village. The bedrock wells will be fitted with a hand pump to allow the village residents the opportunity to sample and use the water. The wells will be suitably demarcated with a sign.

A pump test will be completed on each bedrock well to determine water quality in accordance with MOEE Tables 1, 2, and 3 for private wells. The analysis will be supplemented by pesticide and herbicide testing since their existence cannot be dismissed in a rural area.

2.2.5 Private Well Remedial Measures

The remediation of problematic wells (either quality, quantity, or both) can only be evaluated once contaminant source problems and suitable alternative groundwater sources are identified (Tasks 2.2.3 and 2.2.4).

Deliverables

The well by well assessment completed as part of Task 2.2.2 will form a basis for the identification of possible remediative measures. The nature of the well problem will be categorized (eg. by type of contaminant, seasonal fluctuations in quality or quantity, aquifer type, etc) and remedial options will be described on a case by case basis. The feasibility of each option will be evaluated according to relative merits of cost, implementation time, overall effectiveness, and perhaps other key restrictions identified through consultation with the homeowners and the reviewing agencies.

Examples of remediative measures include:

- Sealing off existing dug wells and drilling a new well to exploit a deeper aquifer (perhaps a bedrock aquifer);

- Rehabilitating existing dug and drilled wells through proper construction techniques (eg. grouting, casing extensions, well pits, etc.)

- Where the contamination is demonstrated to be mainly nitrate related, preliminary studies (Starr and Gillham, 1993) have shown that denitrification can be augmented by artificially increasing the dissolved organic carbon (DOC) concentration in the aquifer. Glucose is a simple source of organic carbon. The organic carbon component is necessary to provide energy and carbon for denitrifying bacteria cell synthesis. These bacteria consume nitrate and convert it into the recalcitrant pool as molecular nitrogen. This remediative method would have to be further investigated (eg. bench- and pilot-scale tests) to determine its effectiveness.
- Where the contamination is only bacteria related (and not excessive) then it may be possible to systematically dose the wells with disinfectant (eg. sodium hypochlorite) to make the water safe.

- installation of treatment systems (Task 2.2.6).

- installation of private and/or communal sewage system corrections

2.2.6 Water Treatment Systems

Further to the remediative measures identified under 2.2.5, the nature of the contamination may be such that water treatment systems may be more cost-effective than well upgrades or replacement.

Deliverables

A detailed review of state-of-the-art treatment systems will be completed. Included in this assessment will be capital and operating costs along with recommendations for implementation based on water quality analyses. In addition, this assessment will conclude whether the program's objectives have been met, in particular the suitability of this option to provide a permanent potable water supply.

2.2.7 General Recommendations

This section relates to aspects of the project for which overall improvements in groundwater quality are to be recommended.

Deliverables

As part of the preliminary report, recommendations will be made pertaining to overall groundwater quality improvements. Typical examples include improved well-head protection, land use changes (including improved surface drainage, septic system problems), aquifer supplements (eg. organic carbon, disinfectants), and private well pumping rates. A detailed list will be provided based on a review of the state-of-the-art solutions.

2.3 Interim Hydrogeological Report

2.3.1 Preparation

Deliverables

An interim hydrogeological report will be prepared detailing:

- a comprehensive evaluation of the existing information which was reviewed prior to recommending field work.

- identification of data gaps that preclude a comprehensive assessment of the existing information without further investigation.

- tabular summaries of:

  - well characteristics (by well type, location, aquifer type, static water level, etc)
  - verification of contaminant sources (type of contamination, frequency of occurrence, location, trends, etc.)
  - remediation and/or treatment alternatives including capital and operating costs
  - well construction improvements, modifications, and ease of implementation
  - site service restrictions (setbacks)
  - history of well problems
  - analytical water quality data
  - borehole logs (test wells, test pits, etc.)

- details of aquifer characteristics (degree of confinement, water quality, water yield)

- assessment of short- and long-term health risk(s) associated with different source aquifers

- recommendations for

  - further investigations
  - private systems (septic and water) renewal/replacement
  - partial and/or full communal servicing

- cost estimates (operating and capital) for all alternatives which are investigated

2.3.2 Agency Review

Seven (7) copies of the interim hydrogeological report will be submitted to the project supervisor and applicable agencies for review. Following this review, and based on agreement with MSTA's recommendations, the Terms of Reference may be modified if a communal or semi-communal system is the preferred alternative. In this case the Environmental Assessment (EA) requirements will be established.

Deliverables

Seven (7) copies of the comprehensive hydrogeological report will be circulated for agency review.

2.3.3 Preliminary Stage Public Consultation

A public meeting/open house is proposed to allow the Apple Hill residents the opportunity to discuss the implications of water quality, yield, and suitability of the potable water supply pertaining to the production wells.

3.0 Lot-By-Lot Survey Sampling Program/Well Data

Pending the results of the interim hydrogeological report and consultation with various review agencies and the project supervisor supplemental site investigations may have to be preformed.

3.1 Well Sampling Program

If the alterative of private systems (individual or semi-individual) is feasible then detailed water supply sampling may have to be completed. Previous surveys have been conducted by the MOEE in 1989 and 1990. During these surveys, 87 of the 107 wells in Apple Hill were tested for bacteriological quality and 44 wells were tested for chemical quality. Approximately 55 % of the wells were deemed unsafe for drinking purposes based on the bacteriological analyses. Other wells exceeded aesthetic limits for iron, total dissolved solids, and chloride. In consultation with the liaison committee, MSTA will establish which water supplies should be sampled and what analyses should be conducted. The parameters to be tested are those established by the MOEE under the pollution surveys undertaken in 1989 and 1990 (ie. Cl, Conductivity [field measurement], NH_3, NO_2, NO_3, F, and Fe). Prior to undertaking this, MSTA will provide recommendations with respect to the list of parameters and sample locations based on the information obtained from the work.

Deliverables

Chemical and bacteriological analyses will be presented in tabular form. An interpretational report will be included to explain the results. Residents will be notified of water quality results. Re-sampling and analysis will be completed where results are inconclusive.

The consultant will assist OCWA, where possible and deemed desirable, to design a database for lot-by-lot information. This capability exists for any major database and can be used by OCWA in future projects.

3.2 Land Use Summary

Deliverables

A tabular presentation of property sizes, land use, and type and size of dwelling (sample table 1 and 2).

3.3 Drinking Water Supply Summary

Deliverables

A tabular presentation of water supply type (dug vs. drilled), age, depth, condition, surrounding land use, history of problems etc. will be compiled (sample Table 1 and 2).

3.4 Lot Condition Summary

In accordance with section 3.1 of the original terms of reference, a well sampling program would be completed to determine eligibility of the wells that (a) were not sampled as part of the MOEE survey, or (b) were designated "safe" according to the MOEE survey. Therefore, only a fraction of the 107 wells in the village would be surveyed as part of 3.1 and included in the lot condition survey.

The lot condition component, including sewage system locations, setbacks, and conditions has now be upgraded to include all 107 lots to be shown on planimetric drawings. This work will be facilitated by the completion of base mapping for the village (section 3.5).

Deliverables

A tabular presentation of the existing (and history) of lot conditions will be provided. This includes details of water table depth, water found, type of aquifer, drainage problems, soil types, area available for replacement systems, separation distances to future or existing septic systems (sample Table 1 and 2).

3.5 Preparation of Drawings

Deliverables

A visual presentation of the aforementioned lot-by-lot summaries will be compiled in the form of detailed site drawings. The site drawings will be completed using current base mapping. The drawings will be completed in AutoCAD(tm) format. This format is most amenable since it can be developed from various database inputs. A geodetic reference system (horizontal and vertical control grids) will be used throughout. The drawings, at a minimum, will show lot boundaries, dwelling locations, well and septic system locations, major land marks and physical features, political boundaries, extent of contamination, etc. A major advantage of the AutoCAD(tm) format is the ease with which data can be assimilated, edited, or changed to a presentation style to suit the intended audience (eg. project reviewers vs. general public). The minimum setback limits imposed by various agencies or other physical constraints are easily adopted into this format.

4.0 Finalizing Solutions

4.1 Recommend appropriate solutions for each property with water quality or quantity problems.

Deliverables

- Repairing, modifying or replacing an existing water supply system including sealing of abandoned wells
- Providing a treatment unit in cases where it is unlikely that a satisfactory untreated supply can be provided
- Relocating a sewage disposal system (and, if necessary, upgrading to current requirements) to allow for the installation of a well to meet the requirements of Ontario Regulation 612/84
- Providing a water supply system for two or more lots in cases where it is unlikely that satisfactory individual water supply systems can be provided. Information such as land owner, availability of land and the municipality's willingness to operate the system will be included
- Purchasing land to enlarge existing lots so that adequate water supply systems can be installed

4.2 Meet with Project Supervisor, District Manager, Health Unit (if necessary), and Liaison Committee to ensure that recommended improvements are acceptable.

4.3 Prepare and submit 7 copies of the report to the Project Supervisor for co-coordinated Ministry and Medical Officer of Health review containing the following information.

Deliverables

- General description of the program and scope of work
- General description of existing services and conditions (sewage, water, drainage, soils, etc.)
- Description of water quality parameters (bacteriological, chemical, physical and others)
- Description of various methods of correcting water supply problems
- Lot-by-lot summary describing findings, classifications, recommended improvement and associated costs. This will also be listed alphabetically for easy cross-referencing.
- A map or maps showing lot boundaries, location of structures, location of existing and proposed sewage disposal and water supply systems and other factors which may affect the placement of private services (scale 1:500)
- An overall map outlining study area (scale 1:2,000)
- Recommendation on individual water treatment units
- Identify what is eligible for subsidy and estimate for capital and operating costs
- Include all water analysis sheets and individual survey questionnaires as an appendix to the report

4.4 After the Ministry review of the report MSTA will incorporate any revisions and/or suggested changes; 7 copies of the final report are to be provided to the Project Supervisor for distribution.

5.0 Pre-construction

5.1 Once the agency review has been completed MSTA will present the final report to municipal council and residents and complete any changes requested by council and residents and agreed to by the Ministry.

5.2 In addition, MSTA will provide to the Municipality and residents:

- a list of licensed well drillers (and sewage system installers, if necessary)
- the procedures an owner must follow to get subsidy, including quotation forms and eligibility criteria
- the name and telephone number of the appropriate contacts with the Health Unit and/or MOEE staff

Appendix B - MOEE Well Records

Elev. 9 R 0300

Basin 25

Con I
lot 36

ONTARIO

The Water-well Drillers Act, 1954

ONTARIO WATER RESOURCES COMMISSION

Department of Mines

Water-Well Record

County or Territorial District Glengarry Township, Village, Town or City ~~Apple Hill Ont~~ Kenyon

Con I Lot 36 Street and Number (if in Village, Town or City) " "

Owner Leo Andre Address " "

Date completed 10 (day) August (month) 1957 (year)

Pipe and Casing Record		Pumping Test	
Casing diameter(s)	2 in	Static level	12 ft
Length(s)	80 ft	Pumping rate	90 Gal per hr
Type of screen		Pumping level	30 ft
Length of screen		Duration of test	1 hr

Well Log / Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
Clay	0	5			
Gravel & Sand	5	20			
Hard Pan & Bolders	20	80	140		
Lime Stone	80	168		156	FRESH

For what purpose(s) is the water to be used? Drinking House

Is water clear or cloudy? Clear

Is well on upland, in valley, or on hillside? Upland

Drilling firm Roy & Son Reg'd

Address Apple Hill Ont

Name of Driller Leo Roy

Address Apple Hill Ont

Licence Number not received yet

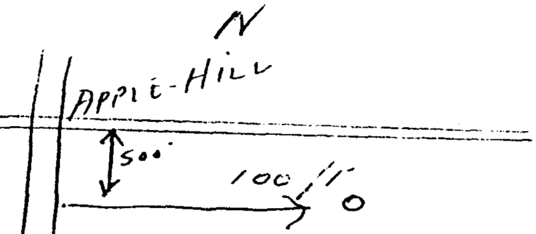
I certify that the foregoing statements of fact are true.

Date Aug 15 Leo Roy
Signature of Licensee

HF

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 5

UTM 18 Z 518300 E
18 R 5006900 N
Elev. 18 R 0300
Basin 2,8,1

The Ontario Water Resources Commission Act

WATER WELL RECORD

GROUND WATER BRANCH No. 23 410
ONTARIO WATER RESOURCES COMMISSION

County or District Glengarry Township, Village, Town or City Kenyon

Con. 1 Lot 36 Date completed 25th (day) Aug. (month) 1960. (year)

Owner Apple Hill Separate School Board (print in block letters) Address Apple Hill, Ontario.

Casing and Screen Record

Inside diameter of casing	5"
Total length of casing	73'
Type of screen	none
Length of screen	
Depth to top of screen	
Diameter of finished hole	5"

Pumping Test

Static level	30'
Test-pumping rate	4 G.P.M.
Pumping level	55'
Duration of test pumping	4 hrs.
Water clear or cloudy at end of test	cloudy
Recommended pumping rate	4 G.P.M.
with pump setting of	60 feet below ground surface

Well Log / Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
gravel	surface	6	90	fresh
dark sandy soil with stones	6	25		
hardpan with large boulders	25	73		
dark grey limestone	73	98		

For what purpose(s) is the water to be used? school

Is well on upland, in valley, or on hillside? hillside

Drilling or Boring Firm Ferguson Thresher Company

Address Maxville, Ontariol

Licence Number 439

Name of Driller or Borer N.D. & J.R. Ferguson

Address Maxville, Ontario.

Date

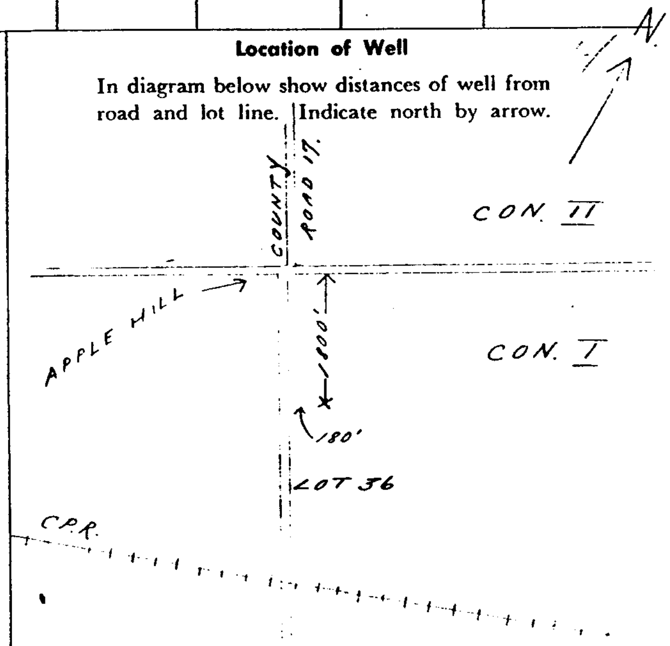
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M Sets 60-5930

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



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Elev. 45 R 0300

23. № 412 C

The Ontario Water Resources Commission Act

WATER WELL RECORD

Basin 25 County or District Glengarry Township, Village, Town or City ~~Lochiel~~ KENYON

Con. I Lot 36 Date completed 10 (day) June (month) 1965 (year)

Owner Department of Public Works Applehill Post office (print in block letters) Address applehill ont

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5	Static level	14'
Total length of casing	59'	Test-pumping rate	6 G.P.M.
Type of screen		Pumping level	24'
Length of screen		Duration of test pumping	1 hr
Depth to top of screen		Water clear or cloudy at end of test	clear
Diameter of finished hole	5"	Recommended pumping rate	6 G.P.M.
		with pump setting of	24' feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Hardpan	0	59		
Lime Stone	59	82	82	Fresh

For what purpose(s) is the water to be used? Post office

Is well on upland, in valley, or on hillside? Valley

Drilling or Boring Firm Roy Son Reg'd

P.O. Box 132

Address 376 Johnston ave

Cornwall ont

Licence Number 1613

Name of Driller or Borer Raymond Snyder

Address Cornwall

Date June 17/65

J. Leduc

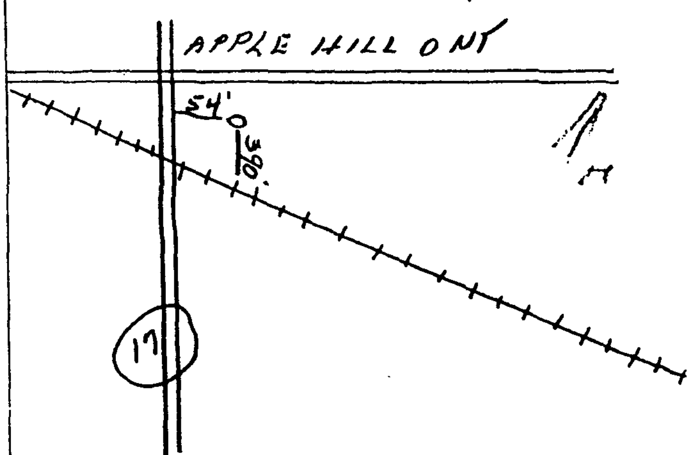
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



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15 5006660 N
Elev. 15 R 0290
Basin 12 B

23 № 413

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District GLENGARY Township, Village, Town or City KENYON

Con. 1 Lot 36 Date completed 18 (day) 12 (month) 1965 (year)

Owner LEONARD BESNER (print in block letters) Address Apple Hill Ont

Casing and Screen Record	
Inside diameter of casing	5 inches
Total length of casing	35'
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5 inches

Pumping Test	
Static level	1
Test-pumping rate	10 G.P.M.
Pumping level	1
Duration of test pumping	15 hours
Water clear or cloudy at end of test	clear
Recommended pumping rate	10 G.P.M.
with pump setting of	25 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Clay and Stone	0	35		FRESH
Gravel.	35	36	35	

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? Valley

Drilling or Boring Firm

Address

Licence Number 1707

Name of Driller or Borer Arsène Bourdon

Address 20 Tencoff Crescent Cornwall

Date 18/12/1965

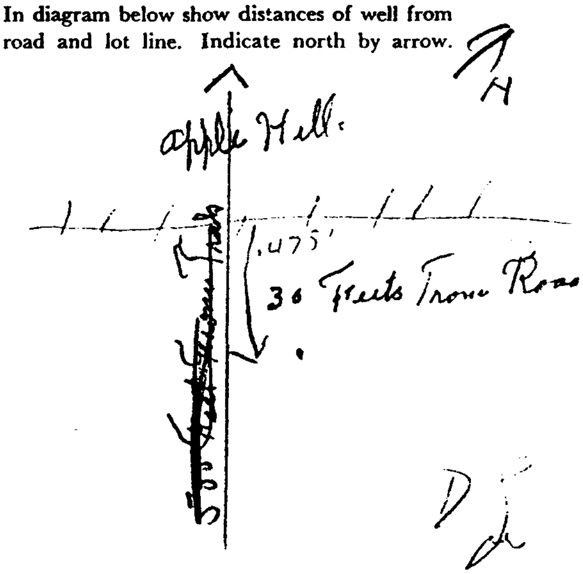
Arsène Bourdon
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

O W R C COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



3162W.

C

23 №. 415

UTM 1 8 z 5 1 8 0 0 0 E

15 R 5 0 0 7 3 0 0 N

The Ontario Water Resources Commission Act

Elev. 18 R 0 3 0 0

WATER WELL RECORD

Basin 25

County or District ~~KENYON~~ GLENGARRY Township, Village, Town or City ~~CHARLOTTENBURG~~ KENYON

Con. 1 Concession Lot 36 Date completed 27 (day) 4 (month) 1966 (year)

Owner ALEX LAGROIX (print in block letters) Address APPEL HILL ONT

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5 inches	Static level	22
Total length of casing	36 feets	Test-pumping rate	8 G.P.M.
Type of screen		Pumping level	27
Length of screen		Duration of test pumping	6 hours
Depth to top of screen		Water clear or cloudy at end of test	clear
Diameter of finished hole	5" inches	Recommended pumping rate	5 G.P.M.
		with pump setting of	30 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Clay and Stone	0	36	35	FRESH
Gravel	36	39		

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? UPLAND

Drilling or Boring Firm

Address

Licence Number 1969

Name of Driller or Borer Arsène Bourdon

Address 20 Tunnell Cresant Cornwall Ont

Date 27 April 1966

Arsène Bourdon

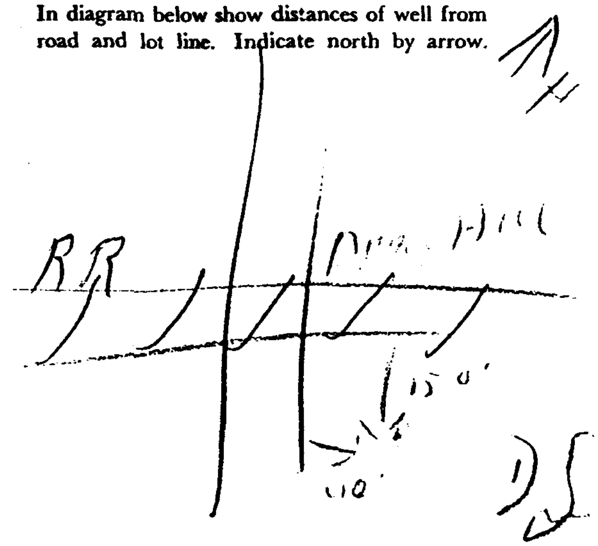
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



3162W. C

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Elev. 8 R 0300
Basin 25

23 № 416

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District ~~KENYON~~ GLENGARRY Township, Village, Town or City ~~CHARLOTTENBURG~~ KENYON

Con. 1 PART Lot 36 Date completed 9 (day) 5 (month) 1966 (year)

Owner D. A. MACDOUGALL (print in block letters) Address APPEL HILL ONT

Casing and Screen Record	
Inside diameter of casing	5 inches
Total length of casing	36 Feet
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5 inches

Pumping Test	
Static level	8
Test-pumping rate	8 G.P.M.
Pumping level	30
Duration of test pumping	2 HOURS
Water clear or cloudy at end of test	clear
Recommended pumping rate	8 G.P.M.
with pump setting of	35 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Clay and Bolders	0	20	30	FRESH
Gravel and clay	20	30		
Gravel	30	38		

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? UPLAND

Drilling or Boring Firm

Address

Licence Number 1969

Name of Driller or Borer Arsene Bourdon

Address 20 Terrell Crescent Cornwall

Date 9/5/1966

Arsene Bourdon

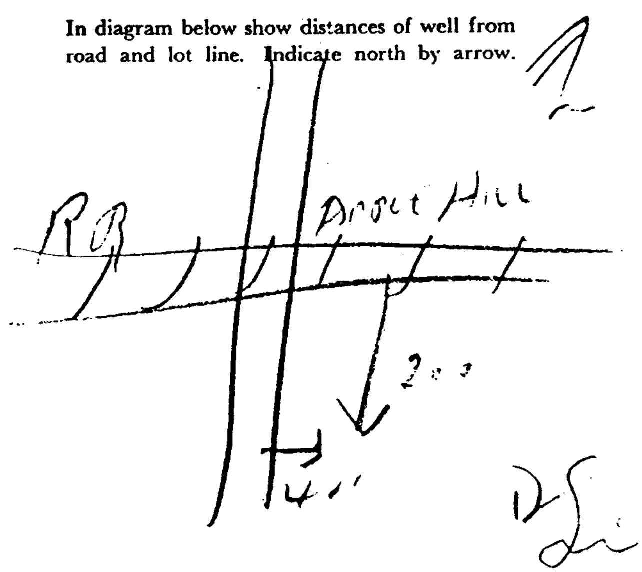
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



31 G2W C

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5 R 5 0 0 7 1 8 0 N
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23 No 414

The Ontario Water Resources Commission Act

WATER WELL RECORD

Basin 7 5
County or District Glengary Township, Village, Town or City Kenyon
Con. V Lot 36 Date completed 27 (day) 8 (month) 1966 (year)
Owner Adrianus Vanputten (print in block letters) Address Apple Hill Ont

Casing and Screen Record	
Inside diameter of casing	5 inches
Total length of casing	33 feets
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5 inches

Pumping Test	
Static level	8
Test-pumping rate	5 G.P.M.
Pumping level	30
Duration of test pumping	5 hours
Water clear or cloudy at end of test	clear
Recommended pumping rate	5 G.P.M.
with pump setting of	30 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Stone and clay	0	38	30	Fresh
gravel	30	38		

For what purpose(s) is the water to be used? House

Is well on upland, in valley, or on hillside? Valley

Drilling or Boring Firm

Address

Licence Number 1969

Name of Driller or Borer Arsene Bourdon

Address 20 Terrell Crescent Cornwall

Date 27/8/1966

Arsene Bourdon

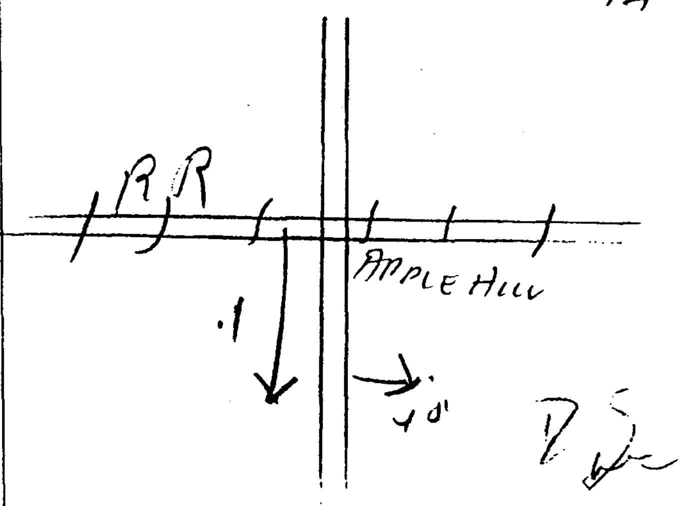
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

O W R C COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



MINISTRY OF THE ENVIRONMENT

The Ontario Water Resources Act

Ontario S.P.M. 316/ZW

WATER WELL RECORD

1 PRINT ONLY IN SPACES PROVIDED
2 CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301938 | MUNICIP 23002 | CON. CON 01

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Glengarry	Kenyon	1	036 N 5

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Decaire, Gerard	Apple-Hill, Ont.	DAY 04 MO Mar. YR 78

21 | ZONE 18 | EASTING 518250 | NORTHING 4906950 | RC 5 | ELEVATION 0280 | RC 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
black	top soil		Loose	0	7
grey	hard-pan		hard	7	77
grey	gravel		"	77	81
white	Limestone		"	81	87

31 | 0007 0277 | 0077 21473 | 0081 211 | 0087 1115

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0085 (85)	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	1.88	0	0081 (84)
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		81	0087 (87)
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

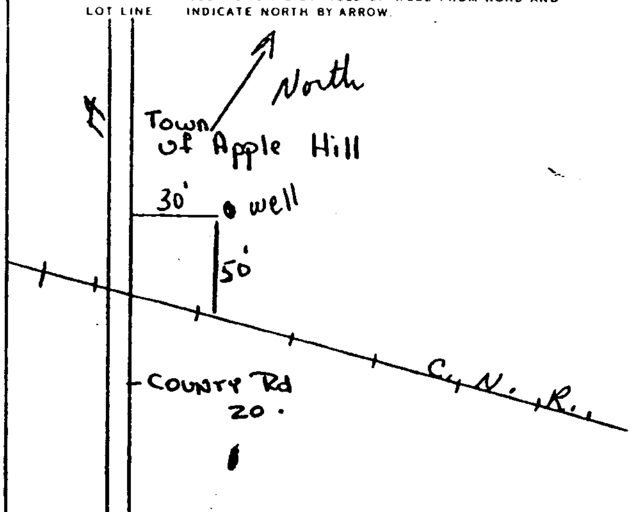
DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	1 ☐ PUMP 2 ☒ BAILER
PUMPING RATE	0010 GPM
DURATION OF PUMPING	01 HOURS 00 MINS
STATIC LEVEL	013 FEET
WATER LEVEL END OF PUMPING	062 FEET
WATER LEVELS DURING	1 ☒ PUMPING 2 ☐ RECOVERY
15 MINUTES	020 FEET
30 MINUTES	055 FEET
45 MINUTES	062 FEET
60 MINUTES	062 FEET
IF FLOWING, GIVE RATE	GPM
PUMP INTAKE SET AT	80 FEET
WATER AT END OF TEST	1 ☐ CLEAR 2 ☒ CLOUDY
RECOMMENDED PUMP TYPE	☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING	080 FEET
RECOMMENDED PUMPING RATE	0002 GPM
50-53	GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

FINAL STATUS OF WELL	1 — 1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED
WATER USE	01 — 1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED
METHOD OF DRILLING	1 — 1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR	LICENCE NUMBER
Gilles Bourgeois	1414

ADDRESS: St-Albert. Ont

NAME OF DRILLER OR BORER

USE ONLY

DATA SOURCE	CONTRACTOR	DATE RECEIVED
1	1414	130678

DATE OF INSPECTION: 18/7/79 | INSPECTOR: D. Wood

Ministry of the Environment
Ontario

The Ontario Water Resources Act 31G 62

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

(11) 2302466 23002 CON 01

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON, BLOCK, TRACT, SURVEY, ETC	LOT
Glengary	Kenyon	1	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Colbourne, Donald	Apple Hill, ONT.	DAY 05 MO 08 YR 80

(21) ZONE 18 EASTING 578199 NORTHING 5007399 RC 5 ELEVATION 0275 RC 5 BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
brown	till	boulders	hard	0	33
grey	rock		hard	33	74

(31) 0033 6 34 13 73 0074 21 2 73

(32)

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0071	1 ☑ FRESH

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06"	1 ☑ STEEL	.188	0	0033
06"	4 ☑ OPEN HOLE		33	0074

SCREEN

SIZE(S) OF OPENING (SLOT NO.) / DIAMETER INCHES / LENGTH FEET / MATERIAL AND TYPE / DEPTH TO TOP OF SCREEN FEET

(61) PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD: 2 ☑ BAILER
PUMPING RATE: 0002 1½ GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

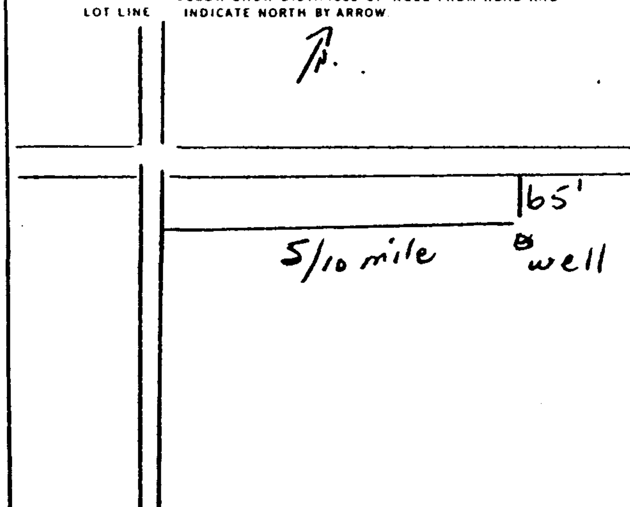
STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
018 FEET	065 FEET	065 FEET	065 FEET	065 FEET	065 FEET

WATER LEVELS DURING: 1 ☑ PUMPING

IF FLOWING GIVE RATE: GPM
PUMP INTAKE SET AT: 70 FEET
WATER AT END OF TEST: 2 ☑ CLOUDY
RECOMMENDED PUMP TYPE: ☑ DEEP
RECOMMENDED PUMP SETTING: 070 FEET
RECOMMENDED PUMPING RATE: 0002 1½ GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

FINAL STATUS OF WELL: 1 — 1 ☑ WATER SUPPLY

WATER USE: 01 — 1 ☑ DOMESTIC

METHOD OF DRILLING: 1 — 1 ☑ CABLE TOOL

NAME OF WELL CONTRACTOR: Gilles Bourgeois
LICENCE NUMBER: 1414

DATA SOURCE: 1 CONTRACTOR: 1414 DATE RECEIVED: 160980
INSPECTOR: K

3167W

UTM 18 Z 5118050 E
19 R 5007025 N
Elev. 19 R 0300
Basin 25

ONTARIO

The Well Drillers Act

Department of Mines, Province of Ontario

RECEIVED 23
AUG 11 1953
GEOLOGICAL BRANCH
DEPARTMENT of MINES

No. ~~447~~

Water Well Record

County or Territorial District: Glengarry Township, ~~Village, Town or City~~: Kenyon (Apple Hill)

Con.: I Lot: 37 Street and Number (if in Village, Town or City):

Owner: Andrew Dancause Address: Apple Hill Ont

Date Completed: May 1 53 (day) (month) (year) Cost of Well (excluding pump): 396

Pipe and Casing Record		Pumping Test	
Casing diameter(s)	5'	Date	May 1
Length(s) of casing(s)	20, 14, 12, 12, 5'	Static level	50'
Type of screen		Pumping level	15'
Length of screen		Pumping rate	300
Distance from top of screen to ground level		Duration of test	2 days
Is well a gravel-wall type?	yes	Distance from cylinder or bowls to ground level	

Water Record

Kind (fresh or mineral): fresh

Quality (hard, soft, contains iron, sulphur, etc.): hard

Appearance (clear, cloudy, coloured): Clear

For what purpose(s) is the water to be used?: house

How far is well from possible source of contamination?: 40'

What is the source of contamination?: Septic Tank

Enclose a copy of any mineral analysis that has been made of water

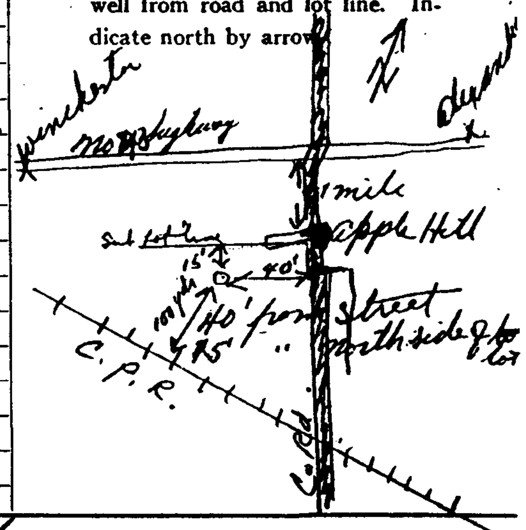
Depth(s) to Water Horizon(s)	Kind of Water	No. of Feet Water Rises
~~[illegible]~~ 60	hard	~~[illegible]~~ 5

Well Log

Overburden and Bedrock Record	From 0 ft.	To ....ft.
Stones and Course gravel	—	18
hard pan	18	35
Blue Clay	35	49
hard pan	49	60
gravel	60	66

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Situation: Is well on upland, in valley, or on hillside?: hillside

Drilling Firm: Munroe Bros

Address: Maxville Ont

Name of Driller: Donald Munroe Address: Maxville Ont

Date: [illegible] Licence Number: 599

MA

31G2W

UTM 1 8 | 5 1 8 0 2 5 E

Con 5 0 7 1 0 P N

Elev 03700

Basin 25

No. 23 502

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District: Glengarry — Township, Village, Town or City: Kenyon

Con. I — Lot 37 — Date completed: 29 (day) 9 (month) 1964 (year)

SEE TOPO

Owner: Soeur Ste Croix (print in block letters) — Address: Apple Hill Ont

Casing and Screen Record	
Inside diameter of casing	5 inches
Total length of casing	69 feets
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5 inches

Pumping Test	
Static level	16 feet
Test-pumping rate	7 G.P.M.
Pumping level	67 feets
Duration of test pumping	1 hour
Water clear or cloudy at end of test	Clear
Recommended pumping rate	7 G.P.M.
with pump setting of	70 feet below ground surface

Well Log / **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Clay	0	30	70	fresh
gravel and clay	30	60		
Sand and clay	60	70		
Coarse gravel	70	77		

For what purpose(s) is the water to be used? House

Is well on upland, in valley, or on hillside? Valley

Drilling or Boring Firm

Address

Licence Number 1242

Name of Driller or Borer Arsene Bourdon

Address 20 [illegible]

Date 29/9/1964

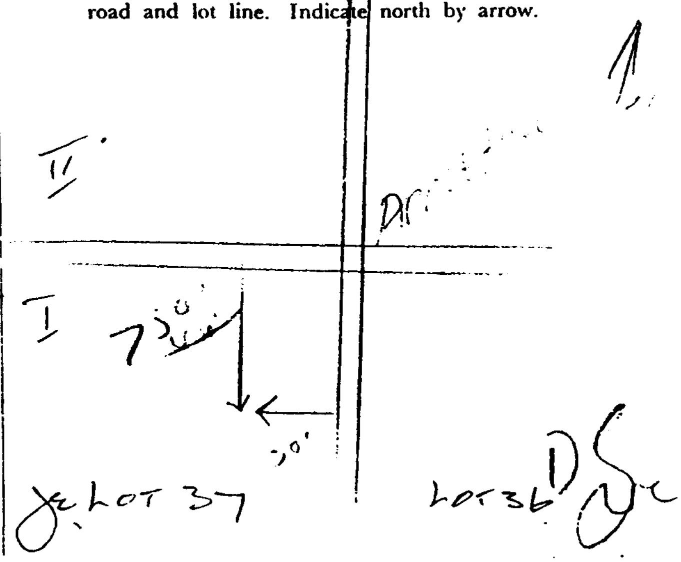
Arsene Bourdon
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



CN 13 31 G 2 W

UTM 18 Z 517850 E

Coor R 5007225 N

Elev R 0800

Basin 25

WATER 23 No 418

The Ontario Water Resources Commission Act

WATER WELL RECORD

ONTARIO WATER RESOURCES COMMISSION

County or District GLENGARRY Township, Village, Town or City KENYON

Con. 1 Lot Part of 37 Date completed 1 (day) 2 (month) 1965 (year)

Owner ALCIDE LALONDE (print in block letters) Address Apple Hill Ont

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5 inches	Static level	31
Total length of casing	30	Test-pumping rate	5 gal. G.P.M.
Type of screen		Pumping level	10
Length of screen		Duration of test pumping	1 hours
Depth to top of screen		Water clear or cloudy at end of test	clear
Diameter of finished hole	5 inches	Recommended pumping rate	5 gal. G.P.M.
		with pump setting of	38 feet below ground surface

Well Log / **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Clay and Stone	0	20	30	Fresh
Hard Pan	20	30		
Soft Rock	30	40		

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? upland

Drilling or Boring Firm

Address

Licence Number 1707

Name of Driller or Borer Irene [illegible]

Address 20 [illegible]

Date 1 . 2 . 1965

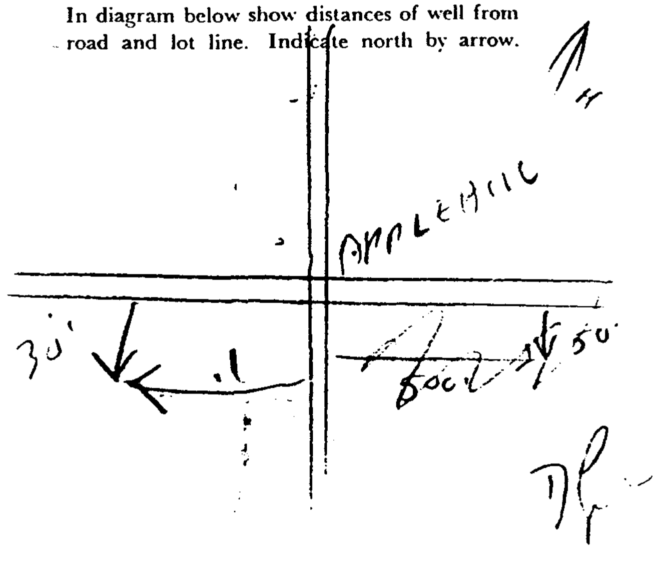
Irene Bourdon
(Signature of Licensed Drilling or Boring Contractor)

Form 7 10M-62-1152

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



31G2W. e

UTM 18 | 5 | 5 0 8 8 ~~6 0~~ 0 7 5 E

15 R | 5 0 0 7 ~~A A 0~~ 8 8 0 N

Elev. 15 R | 0 3 0 0

Basin 28 | GLENGARRY

County or District ~~STORMONT~~ ... Township, Village, Town or City ~~GLENGARRY~~ Kenyon

23 No 420

The Ontario Water Resources Commission Act

WATER WELL RECORD

Con. I ... Lot 37 ... Date completed 25 (day) 10 (month) 1966 (year)

Owner DR GEORGE V. MacDONALD (print in block letters) Address APPEL HILL, ONT

Casing and Screen Record	
Inside diameter of casing	5 inches
Total length of casing	70 Feets
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5 inches

Pumping Test	
Static level	15
Test-pumping rate	9 G.P.M.
Pumping level	60
Duration of test pumping	5 hours
Water clear or cloudy at end of test	clear
Recommended pumping rate	9 G.P.M.
with pump setting of	70 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Sand and Stone	0	30	68	Fresh
Hard Pan	30	60		
Stone and gravel	60	75		

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? UPLAND

Drilling or Boring Firm

Address

Licence Number 1020

Name of Driller or Borer Arsene Bourdon

Address 20 [illegible] Cornwall

Date [illegible]

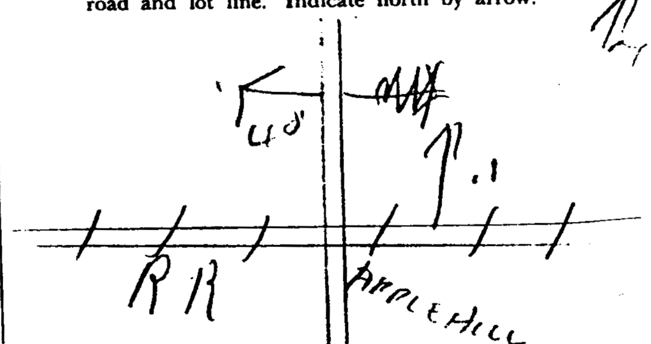
Arsene Bourdon (Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

O W R C COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



DS

316/2W

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

2301160 CODED

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY CHARLOTTENBURG	Kenyon	9 IL I	37 12

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
J. Gervais	RR1 Apple Hill	DAY 31 MO 10 YR 70

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
			hardpan	0	53
			Rock	53	80

1M 18 5118256

4R 5006720

EV. 5R 9300

in 25

WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
76	☒ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL

CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
6"	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.188	0	53
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
	6 INCHES	53 FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN
N.L	N.L FEET

PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☐ PUMP ☒ BAILER	3 GPM	1/2 HOURS ___ MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☐ PUMPING ☒ RECOVERY: 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
21 FEET	55 FEET	21 FEET	21 FEET	21 FEET	21 FEET

IF FLOWING, GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	FEET	☒ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE	RECOMMENDED PUMP SETTING	RECOMMENDED PUMPING RATE
☐ SHALLOW ☒ DEEP	FEET	GPM

FINAL STATUS OF WELL

☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED

WATER USE

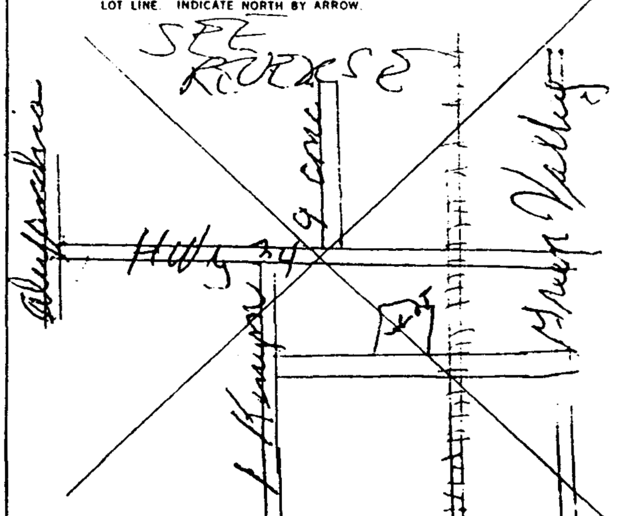
☒ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER ☐ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF DRILLING

☒ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☐ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

CONTRACTOR	
NAME OF WELL CONTRACTOR: Gaston Lefebvre	LICENCE NUMBER: 3302
ADDRESS: St Isidore de Prescott	

USE ONLY: 16 ... 0

CK

UTM 18 Z 517880 E

Con R 5007600 N

Elev 17 R 0295 Lot 36

Basin 151

No. 425

APP

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District GLENGARY   Township, Village, Town or City KENYON

Con. 2 PART Lot 36   Date completed 24 (day) 12 (month) 1964 (year)

Owner Apple Hill Dairy (print in block letters)   Address APPLE HILL ONT

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5 inches	Static level	16
Total length of casing	25 feets	Test-pumping rate	20 G.P.M.
Type of screen		Pumping level	16
Length of screen		Duration of test pumping	2 hours
Depth to top of screen		Water clear or cloudy at end of test	Clear
Diameter of finished hole	5 inches	Recommended pumping rate	20 G.P.M.
		with pump setting of	50 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Clay and Stone	0	25	65	Sulfur
Grey Rock	25	75		

For what purpose(s) is the water to be used? Cheese Factory.

Is well on upland, in valley, or on hillside? Valley

Drilling or Boring Firm

Address

Licence Number 1242

Name of Driller or Borer Arsene Bourdon

Address 20 Pernell Crescent Cornwall Ont

Date 24/12/64

Arsene Bourdon

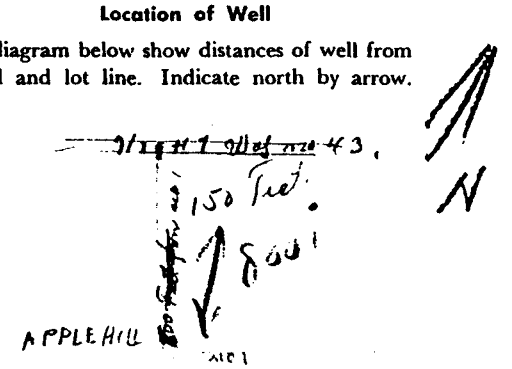
(Signature of Licensed Drilling or Boring Contractor)

Form 7 10M-62-1152

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



UTM 1 18 | 5 1 7 8 0 0 E

1 4 R 5 0 0 7 6 5 0 N

31 G 2 W

23 № 431

e

The Ontario Water Resources Commission Act

Elev. 1 8 R 1 0 3 0 0 1

WATER WELL RECORD

Basin 1 7 5 1

County or District GLENGARRY Township, Village, Town or City KENYON

Con. 2 II Lot 36 Date completed 4 (day) 3 month 1966 year)

Owner FORTUNAT GALLIPOLI (print in block letters) Address APPLE HILL, ONT.

Casing and Screen Record		Pumping Test	
Inside diameter of casing	6" Ø.	Static level	12'
Total length of casing	22	Test-pumping rate	120 g.p.h ~~G.P.M.~~
Type of screen	none	Pumping level	60'
Length of screen	—	Duration of test pumping	1 hour
Depth to top of screen	—	Water clear or cloudy at end of test	CLEAR
Diameter of finished hole	6"	Recommended pumping rate	120 g.p.h G.P.M.
		with pump setting of	60' feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
GREY CLAY	0	10		
" LIMESTONE	10	70	65	FRESH

For what purpose(s) is the water to be used? DOMESTIC

Is well on upland, in valley, or on hillside? UPLAND

Drilling or Boring Firm STEEVES WELL DRILLING REG'D.

Address 396 PHANEUF DORION, QUE

Licence Number 2046

Name of Driller or Borer WELCOME DAVIS

Address SAME

Date DEC. 8. 1966

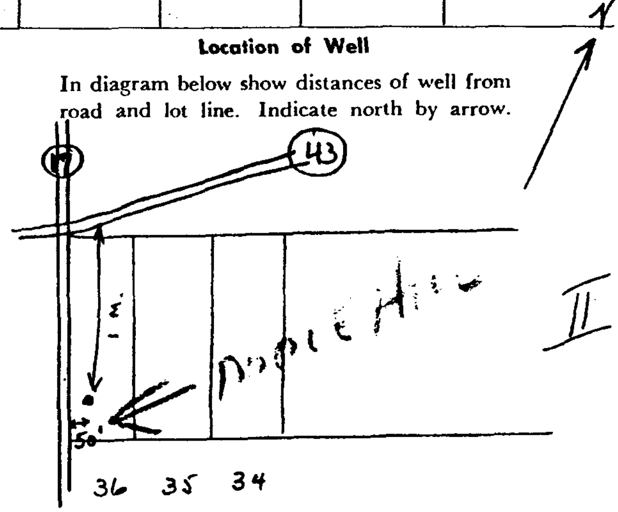
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M Sets 60-5930

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



2 N of 4 Cors.

3162W

e

UTM 1 8 z 5 1 6 8 0 5 5 E

1 8 R 5 0 0 7 4 5 0 N

23 № 430

The Ontario Water Resources Commission Act

Elev. 5 R 0 3 0 0

WATER WELL RECORD

Basin 7 1 GLENGARRY

County or District ~~GLENGARRY~~ .... Township, Village, Town or City ~~GLENGARRY~~ KENYON

Con. ~~4~~ 2 11 Part of Lot 36 .... Date completed 21 (day) 9 month 1966 year)

Owner GEORGE MURRAY (print in block letters) .... Address Apple Hill Ont

Casing and Screen Record	
Inside diameter of casing	5 inches
Total length of casing	66 feets
Type of screen	
Length of screen	
Depth to top of screen	
Diameter of finished hole	5 inches.

Pumping Test	
Static level	11
Test-pumping rate	5 G.P.M.
Pumping level	55 feets
Duration of test pumping	1 hour
Water clear or cloudy at end of test	clear
Recommended pumping rate	5 G.P.M.
with pump setting of	58 feet below ground surface

Well Log / **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Bolders and Sand	0	30	60	Fresh.
Hard Pan and Sand.	30	66		

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? HILLSIDE

Drilling or Boring Firm ....

Address ....

Licence Number 1969

Name of Driller or Borer Arsene Bourdon

Address 20 Fennell Crescent Cornwall -

Date 21/9/1966

Arsene Bourdon

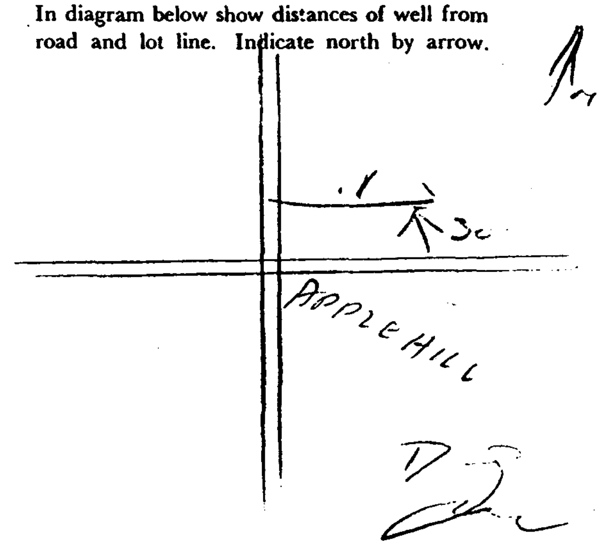
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 230 1116 | MUNICIP 230(...) | CON Kdw | 193

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	~~CALEDONIA~~ KENYON	II	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
APPLE HILL DAIRY LTD.	APPLE HILL ONT	DAY 19 MO 01 YR 70

21 | ZONE 18 | EASTING 517790 | NORTHING 5097520 | R.C. 4 | ELEVATION 0390 | R.C. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
	CLAY			0	8
	SAND	GRAVEL & BOULDERS		8	25
BLUE	LIMESTONE		HARD	25	70
BLUE	LIMESTONE			70	265
YELLOW	LIMESTONE			265	275

APL

31 | 0008 1051 | 0025 10911(3) | 0265315 | 0275515

32 | ~~H WELL~~

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0070	☒ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
0188	☐ FRESH No. ☐ SALTY 5 ☐ SULPHUR ☐ MINERAL
0265	☐ FRESH ☐ SALTY ☒ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
08	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.188	0	0032
188	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☒ OPEN HOLE			0275
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0025	0032	CEMENT GROUT

71 PUMPING TEST

PUMPING TEST METHOD: ☒ PUMP ☐ BAILER | PUMPING RATE 0011 GPM. | DURATION OF PUMPING 04 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
018 FEET	110 FEET	037 FEET	028 FEET	025 FEET	024 FEET

WATER LEVELS DURING: ☐ PUMPING ☒ RECOVERY

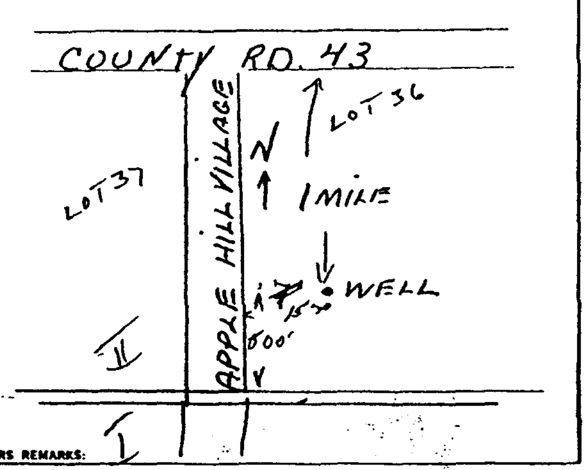
IF FLOWING, GIVE RATE: GPM. | PUMP INTAKE SET AT 115 FEET | WATER AT END OF TEST: ☒ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 220 FEET | RECOMMENDED PUMPING RATE 0011 GPM.

000.1 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL: ☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED

WATER USE 04: ☐ DOMESTIC ☐ STOCK ☐ IRRIGATION ☒ INDUSTRIAL ☐ OTHER ~~COMMERCIAL~~ ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF DRILLING: ☒ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☐ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: MCLEAN WATER SUPPLY LTD | LICENCE NUMBER 3386

ADDRESS: 1532 RAVEN AVE, OTTAWA 3.

NAME OF DRILLER OR BORER | LICENCE NUMBER

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 3504 | DATE RECEIVED 060370

DATE OF INSPECTION | INSPECTOR

REMARKS

31G/2W

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301117 | MUNICIP. 23002 | CON CON | 10 2

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	~~CALEDONIA~~. Kenyon	II	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
APPLE HILL DAIRY LTD.	APPLE HILL, ONT	DAY 09 MO 01 YR 70

21 | ZONE 18 | EASTING 517940 | NORTHING 5007500 | RC. 4 | ELEVATION 0390 | RC. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
	CLAY			0	8
	SAND	GRAVEL + BOULDERS		8	25
BLUE	LIMESTONE			25	70
BLUE	LIMESTONE			70	95

31 | 0008 105 | 0025 191113 | 0095315

32 | #2 WELL

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0070	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
08"	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	0032 (~~32~~)
08"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		32	0095 (~~95~~)
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0025	0032	CEMENT GROUT

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☒ BAILER | PUMPING RATE 0001 GPM. | DURATION OF PUMPING 00 HOURS 30 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
018 FEET	085 FEET	075 FEET	065 FEET	058 FEET	054 FEET

WATER LEVELS DURING: 1 ☐ PUMPING 2 ☒ RECOVERY

IF FLOWING, GIVE RATE ____ GPM. | PUMP INTAKE SET AT ____ FEET | WATER AT END OF TEST: 1 ☐ CLEAR 2 ☒ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING ____ FEET | RECOMMENDED PUMPING RATE ____ GPM.

000.0 GPM./FT. SPECIFIC CAPACITY

FINAL STATUS OF WELL

1 ☐ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☒ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE

~~05~~ 09

1 ☐ ~~DOMESTIC~~ 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ ~~INDUSTRIAL~~ ☐ OTHER 5 ☐ ~~COMMERCIAL~~ 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☒ NOT USED

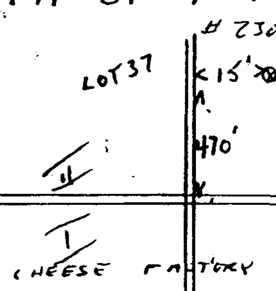
METHOD OF DRILLING

1 ☒ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

This Well IS 15 FT. South of #1 Well.



DRILLERS REMARKS:

NAME OF WELL CONTRACTOR | LICENCE NUMBER | DATA | CONTRACTOR | DATE RECEIVED

316 2W

The Ontario Water Resources Commission Act

WATER WELL RECORD

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301322 | MUNICIP. 23002 | CON. CON | 02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	II	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
APPLE HILL CHEESE FAC.	APPLE HILL	DAY 02 MO. SEP. YR. 71

21	ZONE	EASTING	NORTHING	RC.	ELEVATION	RC.	BASIN CODE
	18	517995	5007550	4	0310	5	21

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
BROWN	HARD PAN	BOULDERS	HARD	0	22
GREY	LIMESTONE		HARD	22	300

31 | 0022014/13 | 0300015

32 | NO !

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
[redacted]	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
06 6¼	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0025 ~~25~~
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		25	0300 ~~300~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☐ BAILER | PUMPING RATE ____ GPM. | DURATION OF PUMPING ____ HOURS ____ MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING (1 ☐ PUMPING 2 ☐ RECOVERY): 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
FEET	FEET	FEET	FEET	FEET	FEET

IF FLOWING, GIVE RATE ____ GPM. | PUMP INTAKE SET AT ____ FEET | WATER AT END OF TEST: 1 ☐ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING ____ FEET | RECOMMENDED PUMPING RATE ____ GPM.

____ GPM./FT. SPECIFIC CAPACITY

NO

FINAL STATUS OF WELL

1 ☒ ~~WATER SUPPLY~~ 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☒ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE

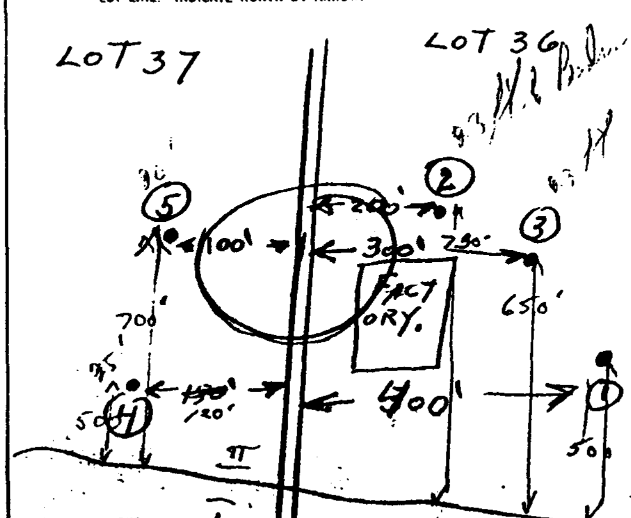
1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☒ ~~INDUSTRIAL~~ ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING

1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR	LICENCE NUMBER
ROY & SON REG'D	

ADDRESS: CORNWALL

NAME OF DRILLER OR BORER | LICENCE NUMBER

OFFICE USE ONLY

DATA SOURCE	CONTRACTOR	DATE RECEIVED
1	4609	140272

DATE OF INSPECTION | INSPECTOR: Km

REMARKS

COUNTY OR DISTRICT: GLENGARRY
TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE: KENYON
CON., BLOCK, TRACT, SURVEY, ETC: II
LOT: 036
OWNER (SURNAME FIRST): APPLE HILL CHEESE FACT.
ADDRESS: APPLE HILL
DATE COMPLETED: DAY 08 MO SEPT YR 71

21 | UTM ZONE 18 | EASTING 512900 | NORTHING 5007580 | RC 4 | ELEVATION 0300 | RC 5 | BASIN CODE 2S

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
BROWN	HARD PAN	BOULDERS	HARD	0	23
GREY	LIMESTONE		HARD	23	320

31 | 0023 14 13 | 0320 2 15
32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
06 (~~6¼~~)	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0026 (~~26~~)
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		26	0320 (~~320~~)
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☐ BAILER
PUMPING RATE ___ GPM
DURATION OF PUMPING ___ HOURS ___ MINS.
STATIC LEVEL ___ FEET
WATER LEVEL END OF PUMPING ___ FEET
WATER LEVELS DURING: 1 ☐ PUMPING 2 ☐ RECOVERY
15 MINUTES ___ FEET | 30 MINUTES ___ FEET | 45 MINUTES ___ FEET | 60 MINUTES ___ FEET
IF FLOWING, GIVE RATE ___ GPM
PUMP INTAKE SET AT ___ FEET
WATER AT END OF TEST: 1 ☐ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☐ DEEP
RECOMMENDED PUMP SETTING ___ FEET
RECOMMENDED PUMPING RATE ___ GPM
___ GPM./FT. SPECIFIC CAPACITY

N/A

FINAL STATUS OF WELL

1 ☐ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☒ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE

1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☒ ~~INDUSTRIAL~~
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

2

DRILLERS REMARKS:

CONTRACTOR

NAME OF WELL CONTRACTOR: ROY & SON REG'D
LICENCE NUMBER:
ADDRESS: CORNWALL
NAME OF DRILLER OR BORER: R A ROY
LICENCE NUMBER:
SIGNATURE OF CONTRACTOR: Leo Roy.
SUBMISSION DATE: DAY ___ MO ___ YR ___

OFFICE USE ONLY

DATA SOURCE: 1
CONTRACTOR: 4609
DATE RECEIVED: 140272
DATE OF INSPECTION:
INSPECTOR: Km
REMARKS: PLOTTED AS Q
P
WI

OWRC COPY

The Ontario Water Resources Commission Act

WATER WELL RECORD

3162W

Water management in Ontario 1. PRINT ONLY IN SPACES PROVIDED 2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301324 | MUNICIP 23202 | CON CON 08

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	II	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
APPLE HILL CHEESE FACT.	APPLE HILL	DAY 14 MO SEPT YR 71

21 | ZONE 18 | EASTING 517950 | NORTHING 5007600 | RC. 4 | ELEVATION 0300 | RC. 5 | BASIN CODE R5

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
BROWN	HARD PAN	BOULDERS	HARD	0	23
GREY	LIMESTONE		HARD	23	320

31 | 0023 1443 | 0320 215

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06 (6¼)	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE		0	0025 (25)
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE		25	0320 (320)
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD 1 ☐ PUMP 2 ☐ BAILER | PUMPING RATE GPM. | DURATION OF PUMPING HOURS MINS.

STATIC LEVEL FEET | WATER LEVEL END OF PUMPING FEET | WATER LEVELS DURING 1 ☐ PUMPING 2 ☐ RECOVERY: 15 MINUTES FEET, 30 MINUTES FEET, 45 MINUTES FEET, 60 MINUTES FEET

IF FLOWING, GIVE RATE GPM. | PUMP INTAKE SET AT FEET | WATER AT END OF TEST 1 ☐ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE ☐ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING FEET | RECOMMENDED PUMPING RATE GPM.

GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

3

DRILLERS REMARKS:

FINAL STATUS OF WELL
1 ☐ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☒ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE
1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☒ ~~INDUSTRIAL~~
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING
1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: ROY & SON REG'D | LICENCE NUMBER
ADDRESS: CORNWALL
NAME OF DRILLER OR BORER | LICENCE NUMBER

USE ONLY
DATA SOURCE: 1 | CONTRACTOR: 4609 | DATE RECEIVED: 140272
DATE OF INSPECTION | INSPECTOR: Km
REMARKS

The Ontario Water Resources Commission Act

WATER WELL RECORD

3192 W

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301306 | MUNICIP 23002 | CON CON 03

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC	LOT
GLENGARRY	CHARLOTTENBURG (Lenom)	II	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
[illegible] Fabien FILION O.	Appl Hill	DAY 17 MO. Sept YR 71

21 | ZONE 18 | EASTING 518050 | NORTHING 5007350 | RC. 4 | ELEVATION 0300 | RC. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
Brown	Hard Pan	Boulders.	Hard	0	31
GREY	QuickSAND		Soft	31	56
" "	LIME STONE		HARD	56	63

31 | 0031 HAA 13 | 0056 107 | 0063 215
32 |

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0060	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
06 ~~6¼~~	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0056 ~~56~~
06"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		56	0063 ~~63~~
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER | PUMPING RATE 0001 GPM | DURATION OF PUMPING 01 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
020	060 FEET	035 FEET	050 FEET	060 FEET	060 FEET

1 ☒ PUMPING 2 ☐ RECOVERY

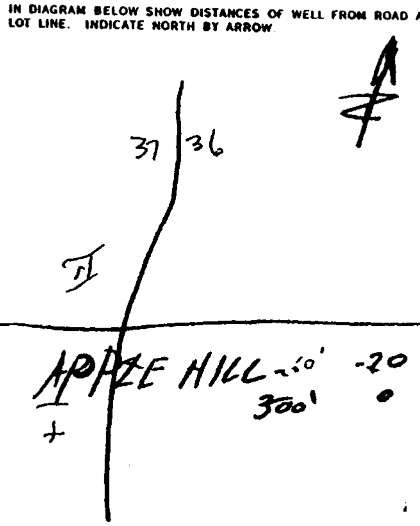
IF FLOWING, GIVE RATE: GPM | PUMP INTAKE SET AT 63 FEET | WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 060 FEET | RECOMMENDED PUMPING RATE 0001 GPM.

000.0 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW



FINAL STATUS OF WELL: 1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01: 1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING: 1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

DRILLERS REMARKS

NAME OF WELL CONTRACTOR | LICENCE NUMBER | DATA | DATE RECEIVED

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

Ontario

31/G/2 W
ED. 4

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK [X] CORRECT BOX WHERE APPLICABLE

11 | 2301560 | MUNICIP 23002 | CON CON | 02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	2	036 / 36

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
COLBOURNE, DON	APPLE-HILL ONT.	DAY 18 MO 09 YR 74

21 | ZONE 18 | EASTING 517905 | NORTHING 5007620 | RC 4 | ELEVATION 0295 | RC 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
BROWN	HARD PAN	BOULDERS	HARD	0	20
" "	GRAVE	" "	LOOSE	20	38
GREY	LIMESTONE			38	100
					38'
					100'

31 | 0020614 13 | 0038611 13 | 0100 2 15

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0095	1 [X] FRESH 3 [ ] SULPHUR 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR 2 [ ] SALTY 4 [ ] MINERAL
	1 [ ] FRESH 3 [ ] SULPHUR 2 [ ] SALTY 4 [ ] MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06 / 6¼	1 [X] STEEL 2 [ ] GALVANIZED 3 [ ] CONCRETE 4 [ ] OPEN HOLE	.188	0	0040 / 40
06	1 [ ] STEEL 2 [ ] GALVANIZED 3 [ ] CONCRETE 4 [X] OPEN HOLE		40	0100 / 100
	1 [ ] STEEL 2 [ ] GALVANIZED 3 [ ] CONCRETE 4 [ ] OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

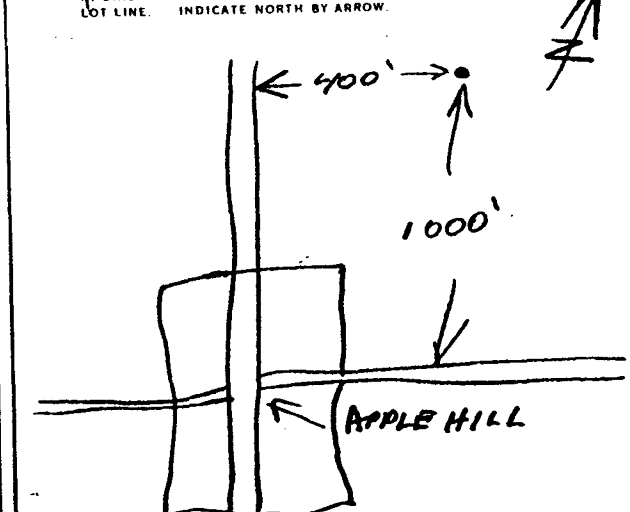
PUMPING TEST METHOD: 1 [X] PUMP 2 [ ] BAILER
PUMPING RATE: 0001 GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL: 008 FEET
WATER LEVEL END OF PUMPING: 68 FEET
WATER LEVELS DURING: 1 [X] PUMPING 2 [ ] RECOVERY
15 MINUTES: 028 / 28 FEET; 30 MINUTES: 047 / 47 FEET; 45 MINUTES: 053 FEET; 60 MINUTES: 068 FEET
IF FLOWING GIVE RATE: GPM
PUMP INTAKE SET AT: 100 FEET
WATER AT END OF TEST: 1 [X] CLEAR 2 [ ] CLOUDY
RECOMMENDED PUMP TYPE: [ ] SHALLOW [X] DEEP
RECOMMENDED PUMP SETTING: 090 FEET
RECOMMENDED PUMPING RATE: 0001 GPM
000.0 GPM/FT. SPECIFIC CAPACITY

LOCATION OF WELL

1707

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL 1
1 [X] WATER SUPPLY 2 [ ] OBSERVATION WELL 3 [ ] TEST HOLE 4 [ ] RECHARGE WELL 5 [ ] ABANDONED, INSUFFICIENT SUPPLY 6 [ ] ABANDONED, POOR QUALITY 7 [ ] UNFINISHED

WATER USE 02
1 [ ] DOMESTIC 2 [X] STOCK 3 [ ] IRRIGATION 4 [ ] INDUSTRIAL [ ] OTHER 5 [ ] COMMERCIAL 6 [ ] MUNICIPAL 7 [ ] PUBLIC SUPPLY 8 [ ] COOLING OR AIR CONDITIONING 9 [ ] NOT USED

METHOD OF DRILLING 1
1 [X] CABLE TOOL 2 [ ] ROTARY (CONVENTIONAL) 3 [ ] ROTARY (REVERSE) 4 [ ] ROTARY (AIR) 5 [ ] AIR PERCUSSION 6 [ ] BORING 7 [ ] DIAMOND 8 [ ] JETTING 9 [ ] DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: ROY'S MACHINE SHOP
LICENCE NUMBER: 4609
ADDRESS: 410-7th ST W. CORNWALL ONT
R. D. ROY
LICENCE NUMBER

USE ONLY
DATA SOURCE: 1 | CONTRACTOR: 4609 | DATE: 06 06 75
DATE OF INSPECTION: 18-3-76 | INSPECTOR: WS
REMARKS: P. 1. A

Ministry of the Environment

Ontario

The Ontario Water Resources Act

WATER WELL RECORD

3167W 2

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

(11) 2302360 MUNICIP. 23002 CON. CON 102

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	2	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
RUTH SINGLETON, RUTH	APPLE HILL	DAY 02 MO 08 YR 79

(21) ZONE 18 EASTING 518199 NORTHING 5007599 RC 5 ELEVATION 0275 RC 5 BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	SAND	—	SOFT	0	5
~~HAP~~					
GREY	HARD PAN	STONES	HARD	5	40
" "	FINE SAND		SOFT	40	51
" "	GRAVEL	STONES	PACKED	51	55
" "	LIMESTONE		LAYERED	55	85

(31) 0005628851 | 00402111273 | 0051208851 | 00552111279 | 00852157 4

32

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0080	☒ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR ☐ SALTY ☐ MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06 ~~6¼~~	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	188	0	0055
06	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☒ OPEN HOLE		55	0085
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
	INCHES	FEET

MATERIAL AND TYPE — DEPTH TO TOP OF SCREEN: FEET

(61) PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☒ PUMP ☐ BAILER	0002 ~~15~~ GPM	01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
025 FEET	075 FEET	045 FEET	055 FEET	065 FEET	075 FEET

WATER LEVELS DURING: ☒ PUMPING ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: 75 FEET

WATER AT END OF TEST: ☒ CLEAR ☐ CLOUDY

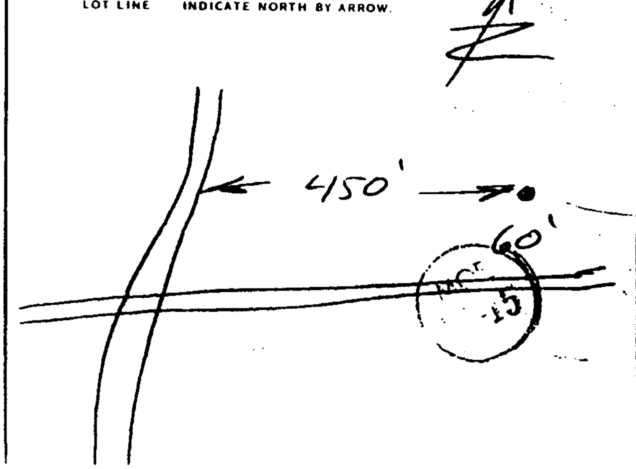
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 075 FEET

RECOMMENDED PUMPING RATE: 0002 ~~15~~ GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



FINAL STATUS OF WELL	1
☒ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL	☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☐ UNFINISHED

WATER USE	01
☒ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER	☐ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF: ☐ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ BORING ☐ DIAMOND

Ministry of the Environment
Ontario

The Ontario Water Resources Act 3162

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

(11) 2302361 MUNICIP 23002 CON CON 02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	II	036

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
~~DONALD~~ McMILLAN, DONALD	APPLE HILL	DAY 27 MO 03 YR 79

(21) ZONE 18 EASTING 517999 NORTHING 5007499 RC 5 ELEVATION 0275 RC 5 BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	SAND	STONE	SOFT	0	10
GREY	QUICKSAND		SOFT	10	37
BLACK	LIMESTONE		HARD-SULPHUR	37	38
GREY	LIMESTONE	SAND	BROKEN	38	60

(31) 0010628285 0037209785 0038815573 0060921528711

32

(41) WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0055	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
0058	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

(51) CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06 / 6¼	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	0037
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE		37	0060
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
	INCHES	FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN	FEET

(51) PLUGGING & SEALING RECORD

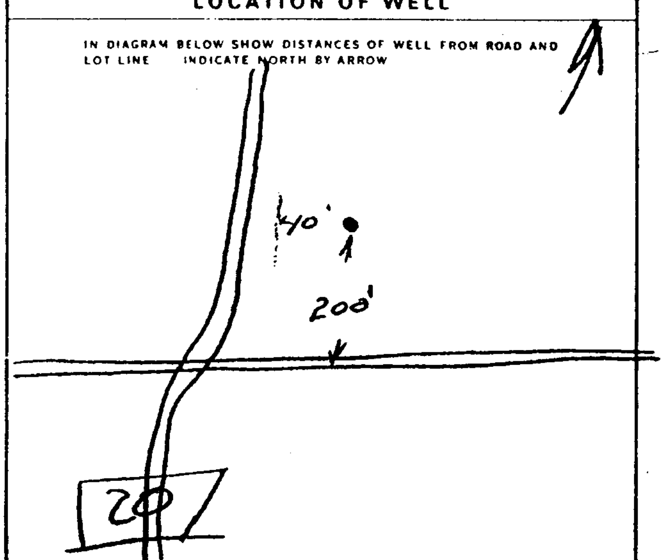
DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

(71) PUMPING TEST

PUMPING TEST METHOD	1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE	0005 GPM
DURATION OF PUMPING	02 HOURS 00 MINS
STATIC LEVEL	010 FEET
WATER LEVEL END OF PUMPING	035 FEET
WATER LEVELS DURING	1 ☒ PUMPING 2 ☐ RECOVERY
15 MINUTES	015 FEET
30 MINUTES	020 FEET
45 MINUTES	025 FEET
60 MINUTES	030 FEET
IF FLOWING GIVE RATE	GPM
PUMP INTAKE SET AT	60 FEET
WATER AT END OF TEST	1 ☐ CLEAR 2 ☒ CLOUDY
RECOMMENDED PUMP TYPE	☒ SHALLOW ☐ DEEP
RECOMMENDED PUMP SETTING	035 FEET
RECOMMENDED PUMPING RATE	0005 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW



DRILLERS REMARKS

FINAL STATUS OF WELL 1
1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING 4
1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: Ray Machin [illegible] — LICENCE NUMBER 4609
ADDRESS: Cornwall
NAME OF DRILLER OR BORER — LICENCE NUMBER

OFFICE USE ONLY
DATA SOURCE 1 — CONTRACTOR 4609 — DATE RECEIVED 201279
DATE OF INSPECTION — INSPECTOR Km
REMARKS

UTM 1|8 z 5|1|7|9|0|0 E   31 G 2W   C

5 R 5|0|0|7|3|4|0 N   23 № 432

Elev. 5 R 0|3|0|0

Basin 2|3|1

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District GLENGARRY   Township, Village, Town or City KENYON

Con. 2 / 11   Lot 37   Date completed 26 (day) NOV (month) 66 (year)

Owner ALAN MUNRO (print in block letters)   Address APPLE HILL

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5	Static level	9
Total length of casing	45	Test-pumping rate	6 G.P.M.
Type of screen		Pumping level	14
Length of screen		Duration of test pumping	1 HR
Depth to top of screen		Water clear or cloudy at end of test	CLEAR
Diameter of finished hole	5	Recommended pumping rate	5 G.P.M.
		with pump setting of 45 feet below ground surface	

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
CLAY + BOULDERS	0	25		
LIMESTONE	25	60	47	FRESH

For what purpose(s) is the water to be used? Home

Is well on upland, in valley, or on hillside?

Drilling or Boring Firm ARSENE BOURDON

Address CORNWALL

Licence Number 1969

Name of Driller or Borer SIMON

Address

Date Nov 30

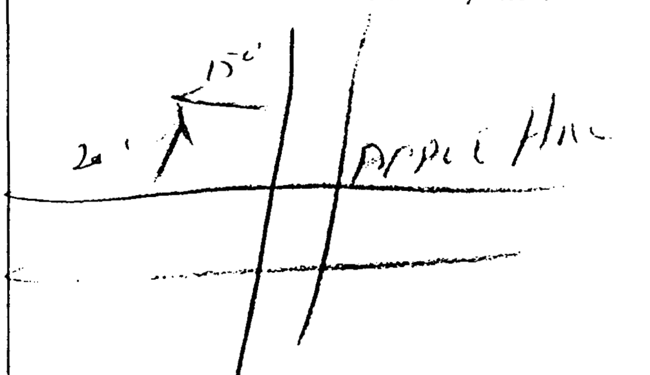
Arsene Bourdon (Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



DS

The Ontario Water Resources Commission Act

WATER WELL RECORD

31620

Water management in Ontario 1. PRINT ONLY IN SPACES PROVIDED 2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301325 | MUNICIP 23002 | CON CdM ... 03

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	II	037

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
APPLE HILL CHEESE FACT.	APPLE HILL	DAY 17 MO SEPT YR 71

21 | UTM ZONE 18 | EASTING 517820 | NORTHING 5007450 | RC. 4 | ELEVATION 0300 | RC. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	TO
BROWN	HARD	PAN BOULDERS	HARD	0	25
GREY	LIMESTONE		HARD	28	200

31 | 0025014A13 | 0200015

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	TO
06 6¼	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET

MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD 1 ☐ PUMP 2 ☐ BAILER | PUMPING RATE GPM. | DURATION OF PUMPING HOURS MINS.

STATIC LEVEL FEET | WATER LEVEL END OF PUMPING FEET | WATER LEVELS DURING 1 ☐ PUMPING 2 ☐ RECOVERY: 15 MINUTES FEET, 30 MINUTES FEET, 45 MINUTES FEET, 60 MINUTES FEET

IF FLOWING, GIVE RATE GPM | PUMP INTAKE SET AT FEET | WATER AT END OF TEST 1 ☐ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE ☐ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING FEET | RECOMMENDED PUMPING RATE GPM.

GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

4

DRILLERS REMARKS:

FINAL STATUS OF WELL
1 ☐ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☒ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE
1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING
1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: ROY & SON RECD | LICENCE NUMBER
ADDRESS: CORNWALL
NAME OF DRILLER OR BORER | LICENCE NUMBER

USE ONLY
DATA SOURCE 1 | CONTRACTOR 4609 | DATE RECEIVED 140272
DATE OF INSPECTION | INSPECTOR Km
REMARKS

The Ontario Water Resources Commission Act

WATER WELL RECORD

31G2W

Water management in Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301326 | MUNICIP. 23002 | CON. CON | 02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC	LOT
GLENGARRY	KENYON	II	037

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
APPLE HILL CHEESE FACT.	APPLE HILL	DAY 23 MO. SEPT YR. 71

21 | ZONE 18 | EASTING 517800 | NORTHING 5007530 | RC. | ELEVATION 0300 | RC. 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH – FEET FROM	DEPTH – FEET TO
BROWN	HARD PAN	BOULDERS	HARD	0	26
GREY	LIMESTONE		HARD	29	185

31 | 0026 11 13 | 0185 2 15

32

41 WATER RECORD

WATER FOUND AT – FEET	KIND OF WATER
0035	☒ FRESH
0170	☒ FRESH

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH – FEET FROM	DEPTH – FEET TO
06	☒ STEEL	.188	0	0030
06	☒ OPEN HOLE		30	0185

SCREEN: SIZE(S) OF OPENING (SLOT NO.) | DIAMETER | LENGTH | MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN

61 PLUGGING & SEALING RECORD

DEPTH SET AT – FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: ☒ PUMP ☐ BAILER

PUMPING RATE: 0006 GPM

DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL: 010 FEET

WATER LEVEL END OF PUMPING: 170 FEET

WATER LEVELS DURING: ☒ PUMPING ☐ RECOVERY

15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
050 FEET	090 FEET	130 FEET	170 FEET

IF FLOWING, GIVE RATE: GPM.

PUMP INTAKE SET AT: 185 FEET

WATER AT END OF TEST: ☒ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 170 FEET

RECOMMENDED PUMPING RATE: 0005 GPM.

000.0 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.

5

FINAL STATUS OF WELL

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 04

1 ☐ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☒ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING

1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

DRILLERS REMARKS:

NAME OF WELL CONTRACTOR

MINISTRY OF THE ENVIRONMENT

The Ontario Water Resources Act

WATER WELL RECORD

31 G/2 W
ED. 4

Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 12301577 | MUN 23002 | CON | CON 102

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	~~12 (ILL)~~ 2	037

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
SAUVÉ - ARMAND	Apple Hill Ont	DAY 21 MO. 10 YR. 74

21 | ZONE 18 | EASTING 517684 | NORTHING 5007241 | RC 4 | ELEVATION 0295 | RC 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	TOP SOIL	STONES	SOFT	0	2
" "	HARD PAN	" "	DENSE	2	15
GREY	QUICKSAND	" "	LOOSE	15	46
" "	GRAVEL	" "	~~LOOSE~~ DENSE	46	67'
" "	" "	" "	LOOSE	67	70'

31 | 0002602112 | 0015611412 | 0046207112 | 0067211112 | 0070211112

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0070	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	0069 ~~69~~
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		69	0070 70
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE: 0005 GPM.
DURATION OF PUMPING: 01 HOURS 08 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
007 FEET	027 FEET	012 FEET	017 FEET	022 FEET	027 FEET

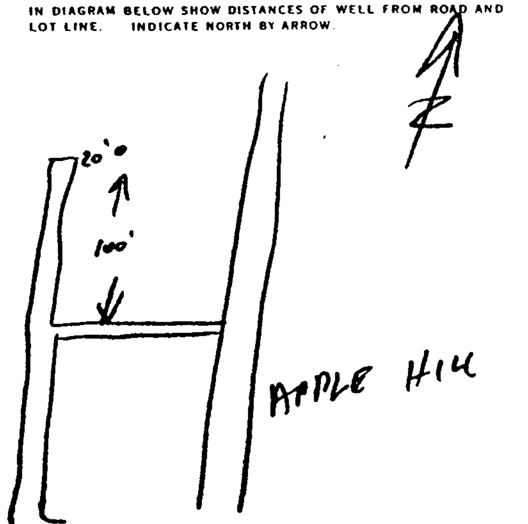
WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: 70 FEET
WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☒ SHALLOW ☐ DEEP
RECOMMENDED PUMP SETTING: 035 FEET
RECOMMENDED PUMPING RATE: 0005 GPM.
000.3 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL 1707

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL 1
1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 4
1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR
NAME OF WELL CONTRACTOR: ROY'S MACHINE SHOP
LICENCE NUMBER: 4609
ADDRESS: 410 - 7th ST W. CORNWALL ONT
NAME OF DRILLER OR BORER: R. A. ROY
LICENCE NUMBER:

USE ONLY
DATA SOURCE: 1
CONTRACTOR: 4609
DATE RECEIVED: 75
DATE OF INSPECTION: 29-3-76
INSPECTOR: [illegible]
REMARKS:

31 G/2W
EA 3

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301629 | MUNICIP 23002 | CON CON | 02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
Glengarry	~~Charlottenburg~~ Kenyon	2	

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Harken Florence	Apple Hill Ont.	DAY 03 MO 11 YR 75

21 | ZONE 18 | EASTING 517705 | NORTHING 5007189 | RC 4 | ELEVATION 10300 | RC 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
grey	hard pan		hard	0	40
"	Gravel		"	40	45
black	Rock		"	45	50

31 | 0040214 | 0045211 | 0050826
32 |

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0047	1 ☑ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06"	1 ☑ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	1.88	0	0045
06"	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☑ OPEN HOLE		45	0050
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

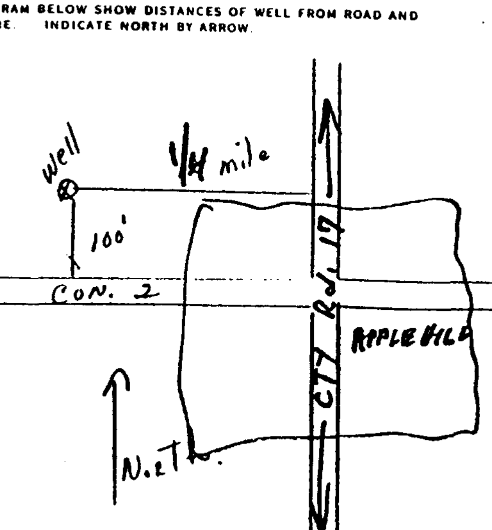
PUMPING TEST METHOD: 1 ☐ PUMP 2 ☑ BAILER
PUMPING RATE: 0010 GPM
DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
015 FEET	015 FEET	015 FEET	015 FEET	015 FEET	015 FEET

WATER LEVELS DURING: 1 ☑ PUMPING 2 ☐ RECOVERY
IF FLOWING, GIVE RATE: GPM
PUMP INTAKE SET AT: 25 FEET
WATER AT END OF TEST: 1 ☑ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☑ SHALLOW ☐ DEEP
RECOMMENDED PUMP SETTING: 025 FEET
RECOMMENDED PUMPING RATE: 0005 GPM
002.0 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

FINAL STATUS OF WELL 1
1 ☑ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01
1 ☑ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 1
1 ☑ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☐ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

NAME OF WELL CONTRACTOR | LICENCE NUMBER | DATE | CONTRACTOR | DATE RECEIVED

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

31 G/2 W
EO. 4

Ontario

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301546 | MUNICIP. 23002 | CON. 102

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC	LOT
Glengarry	Kenyon	2.	037 / 37.

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Mrs. John Berry	Apple Hill, Ontario.	DAY 31 MO. 03 YR. 75.

21 | ZONE 18 | EASTING 516876 | NORTHING 5008852 | RC 4 | ELEVATION 0310 | RC 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
Brown	Topsoil		Loose packed	0	1
Grey	Clay	Boulders	Cemented	1	35
Grey	Clay	Gravel , Sand	Coarse	35	49
Grey	Limestone	Rock	Hard	49	92.

31 | 0001602 | 0035205131 | 0049205128 | 0092215

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0084	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0050
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0092
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☒ PUMP 2 ☐ BAILER

PUMPING RATE: 0001 ~~60 G.P.H.~~ GPM

DURATION OF PUMPING: 01 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
015 FEET	090 FEET	090	090	090 FEET	090 FEET

WATER LEVELS DURING: 1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

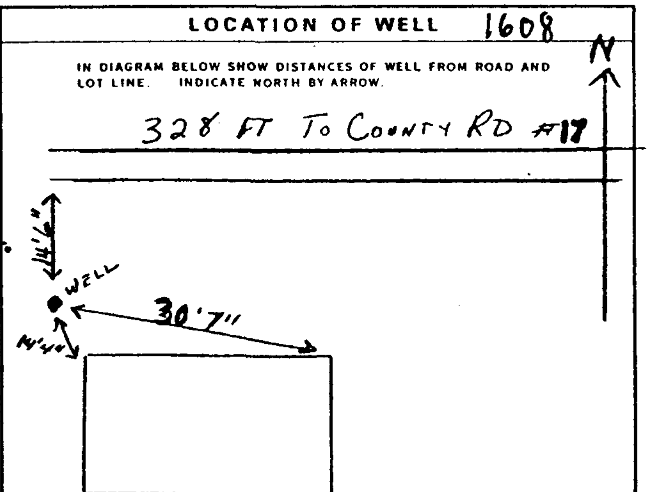
RECOMMENDED PUMP SETTING: 080 FEET

RECOMMENDED PUMPING RATE: 0001 ~~60 G.P.H.~~ GPM

000.0 45 ft. with 35 ft. of tailpipe.

LOCATION OF WELL 1608

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY
2 ☐ OBSERVATION WELL
3 ☐ TEST HOLE
4 ☐ RECHARGE WELL
5 ☐ ABANDONED, INSUFFICIENT SUPPLY
6 ☐ ABANDONED, POOR QUALITY
7 ☐ UNFINISHED

WATER USE 01

1 ☒ DOMESTIC
2 ☐ STOCK
3 ☐ IRRIGATION
4 ☐ INDUSTRIAL
☐ OTHER
5 ☐ COMMERCIAL
6 ☐ MUNICIPAL
7 ☐ PUBLIC SUPPLY
8 ☐ COOLING OR AIR CONDITIONING
9 ☐ NOT USED

METHOD OF DRILLING 4

1 ☐ CABLE TOOL
2 ☐ ROTARY (CONVENTIONAL)
3 ☐ ROTARY (REVERSE)
4 ☒ ROTARY (AIR)
5 ☐ AIR PERCUSSION
6 ☐ BORING
7 ☐ DIAMOND
8 ☐ JETTING
9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR	LICENCE NUMBER
Damon A. Casselman	1505

ADDRESS: Williamsburg, Ontario

NAME OF DRILLER OR BORER | LICENCE NUMBER

MINISTRY USE ONLY

DATA SOURCE	CONTRACTOR	DATE RECEIVED
1	1505	080475

DATE OF INSPECTION: 18-3-76

INSPECTOR: [illegible]

REMARKS:

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

31G/2W

Ontario S.P.M.

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301833 | MUNICIP 23002 | CON. CON 02

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC	LOT
Glengarry	Kenyon	Concession 2 ✓	037

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
MARGERRISON, G — George Margerrison	Apple Hill, Ontario Box 8	DAY 05 MONTH 07 YR 71

21	ZONE	EASTING	NORTHING	RC	ELEVATION	RC	BASIN CODE
	18	516900	4908700	5	0315	5	25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
brown	hard pan			0	20
	gravel + boulders			20	27
grey	limestone			27	71

31 | 0020611 | 00271113 | 00711215

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0065	☒ 1 FRESH ☐ 3 SULPHUR ☐ 2 SALTY ☐ 4 MINERAL
	☐ 1 FRESH ☐ 3 SULPHUR ☐ 2 SALTY ☐ 4 MINERAL
	☐ 1 FRESH ☐ 3 SULPHUR ☐ 2 SALTY ☐ 4 MINERAL
	☐ 1 FRESH ☐ 3 SULPHUR ☐ 2 SALTY ☐ 4 MINERAL
	☐ 1 FRESH ☐ 3 SULPHUR ☐ 2 SALTY ☐ 4 MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06	☒ 1 STEEL ☐ 2 GALVANIZED ☐ 3 CONCRETE ☐ 4 OPEN HOLE	188	0	0029
	☐ 1 STEEL ☐ 2 GALVANIZED ☐ 3 CONCRETE ☐ 4 OPEN HOLE			
	☐ 1 STEEL ☐ 2 GALVANIZED ☐ 3 CONCRETE ☐ 4 OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: ☐ 1 PUMP ☒ 2 BAILER | PUMPING RATE 0005 GPM | DURATION OF PUMPING 01 HOURS 00 MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
008 FEET	060 FEET	020 FEET	020 FEET	035 FEET	060 FEET

☒ 1 PUMPING ☐ 2 RECOVERY

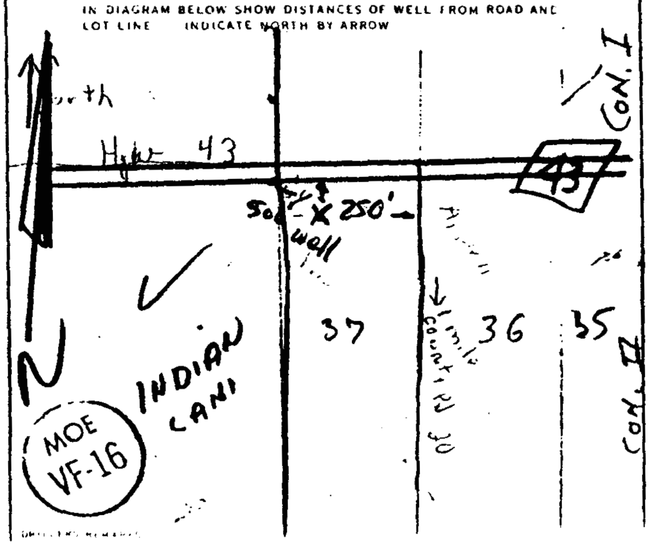
IF FLOWING GIVE RATE: GPM | PUMP INTAKE SET AT 60 FEET | WATER AT END OF TEST: ☒ 1 CLEAR ☐ 2 CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING 060 FEET | RECOMMENDED PUMPING RATE 0004 GPM

GPM/FT SPECIFIC CAPACITY

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW



FINAL STATUS OF WELL 1	☒ 1 WATER SUPPLY ☐ 2 OBSERVATION WELL ☐ 3 TEST HOLE ☐ 4 RECHARGE WELL ☐ 5 ABANDONED, INSUFFICIENT SUPPLY ☐ 6 ABANDONED, POOR QUALITY ☐ 7 UNFINISHED
WATER USE 02	☐ 1 DOMESTIC ☒ 2 STOCK ☐ 3 IRRIGATION ☐ 4 INDUSTRIAL ☐ OTHER ☐ 5 COMMERCIAL ☐ 6 MUNICIPAL ☐ 7 PUBLIC SUPPLY ☐ 8 COOLING OR AIR CONDITIONING ☐ 9 NOT USED
METHOD OF DRILLING 1	☒ 1 CABLE TOOL ☐ 2 ROTARY (CONVENTIONAL) ☐ 3 ROTARY (REVERSE) ☐ 4 ROTARY (AIR) ☐ 5 AIR PERCUSSION ☐ 6 BORING ☐ 7 DIAMOND ☐ 8 JETTING ☐ 9 DRIVING

DRILLERS REMARKS

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

ONTARIO

3/ G/2 W
EO. 4

1 PRINT ONLY IN SPACES PROVIDED
2 CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2301430 | MUNICIP. 23002 | CON. CON | 011

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARY	KENYON	1	037 37

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
JOSEPH REINHART	APPLE HILL	DAY 24 MO. 05 YR. 73

21 | ZONE 18 | EASTING 517944 | NORTHING 5007081 | RC. 4 | ELEVATION 0305 | RC. 5 | BASIN CODE RST

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	TOP SOIL			0	4
BROWN	HARD PAN	BOULDERS		4	40
GREY	SAND			40	50
GREY	LIMESTONE	SOFT		50	66
				66	75

31 | 0004602 | 0040611613 | 0050228 | 0066215 | 0075126
32 |

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0074	1 ☐ FRESH 3 ☑ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06	1 ☑ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	66 0066
06	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE			0075
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN: SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET | MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD: 1 ☐ PUMP 2 ☑ BAILER | PUMPING RATE 0010 GPM | DURATION OF PUMPING 01 HOURS 15 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING: 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
010 FEET	050 FEET	030 FEET	035 FEET	040 FEET	050 FEET

1 ☒ PUMPING 2 ☐ RECOVERY

IF FLOWING GIVE RATE ___ GPM | PUMP INTAKE SET AT 60 FEET | WATER AT END OF TEST: 1 ☐ CLEAR 2 ☑ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☑ DEEP | RECOMMENDED PUMP SETTING 060 FEET | RECOMMENDED PUMPING RATE 0005 GPM

000.3 GPM/FT SPECIFIC CAPACITY

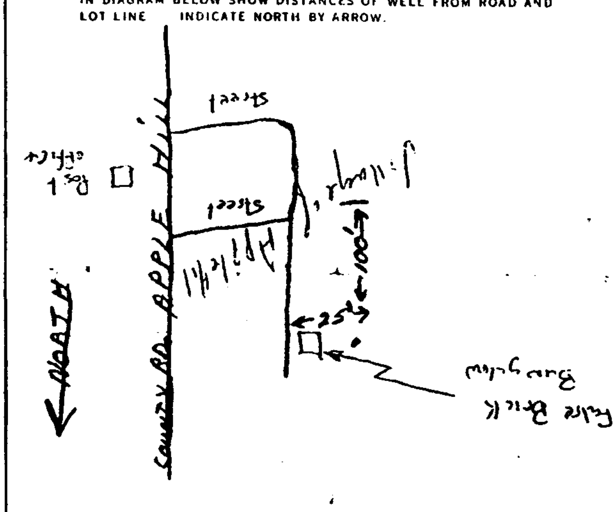
FINAL STATUS OF WELL 1 — 1 ☑ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01 — 1 ☑ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING 1 — 1 ☑ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☐ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

LOCATION OF WELL 1707

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

NAME OF WELL CONTRACTOR | DATE | CONTRACTOR | DATE RECEIVED 091078

Ministry of the Environment

Ontario

316/2W

The Ontario Water Resources Act

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2302149 | MUNICIP 23002 | CON | 01

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
GLENGARRY	KENYON	1	037

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
MARLEAU, T.	APPLE HILL	DAY 27 MO 07 YR 78

21 | ZONE 18 | EASTING 517950 | NORTHING 4906909 | RC 5 | ELEVATION 0285 | RC 5 | BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
BROWN	HARPAN	STONE	HARD	0	15
GREY	" "	" "	" "	15	55
" "	GRAVEL	" "	LOOSE	55	61

31 | 0015 6 14 1273 | 0055 2 14 1273 | 0061 2 11 1277

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0060	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
06	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	0061
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET

MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE	0010 GPM
DURATION OF PUMPING	01 HOURS 00 MINS
STATIC LEVEL	015' FEET
WATER LEVEL END OF PUMPING	021 FEET
WATER LEVELS DURING	1 ☒ PUMPING 2 ☐ RECOVERY
15 MINUTES	015 FEET
30 MINUTES	020 FEET
45 MINUTES	021 FEET
60 MINUTES	021 FEET
IF FLOWING, GIVE RATE	GPM
PUMP INTAKE SET AT	61 FEET
WATER AT END OF TEST	1 ☐ CLEAR 2 ☒ CLOUDY
RECOMMENDED PUMP TYPE	☒ SHALLOW ☐ DEEP
RECOMMENDED PUMP SETTING	030 FEET
RECOMMENDED PUMPING RATE	0010 GPM

FINAL STATUS OF WELL 1

1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01

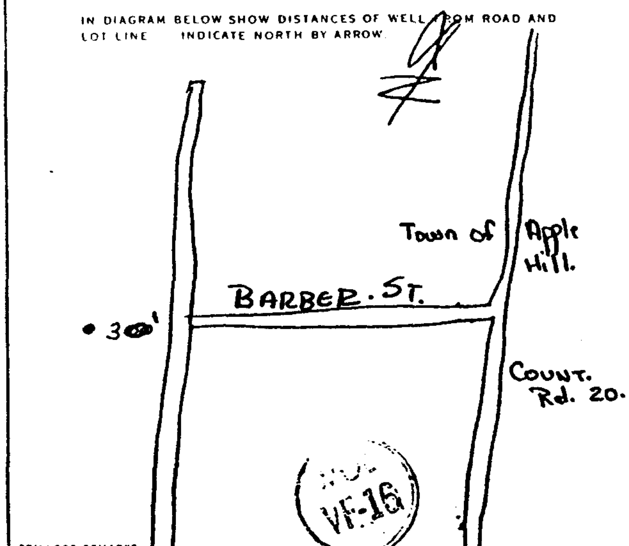
1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING 4

1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

CONTRACTOR	
NAME OF WELL CONTRACTOR	Ray's Machine Shop
LICENCE NUMBER	4609
ADDRESS	Cornwall

OFFICE USE ONLY	
DATA SOURCE	1
CONTRACTOR	4609
DATE RECEIVED	200179
DATE OF INSPECTION	1/1/79
INSPECTOR	D. West

Ministry of the Environment

Ontario

The Ontario Water Resources Act 316/2W

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 2302180 MUNICIP 23002 CON CON 01

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON, BLOCK, TRACT, SURVEY, ETC	
GLENGARRY	KENYON	I	037 36
OWNER (SURNAME FIRST): WILFRED ROZON	ADDRESS: APPLE HILL		DATE COMPLETED: DAY 02 MO DEC 12 YR 78

21 ZONE 18 EASTING 517900 NORTHING 4907250 RC 5 ELEVATION 0290 RC 5 BASIN CODE 25

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
		DUG WELL		0	20
GREY	SAND		SOFT	20	40
" "	HARD PAN	STONES	HARD	40	48
" "	LIMESTONE		LAYERED	48	60

31 0020 23 | 0040 2885 | 0048 1411273 | 0060 21574

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0058 58	1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
06 6¼	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	188	0	0048 48
06 6	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☒ OPEN HOLE		48	0060 60
	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

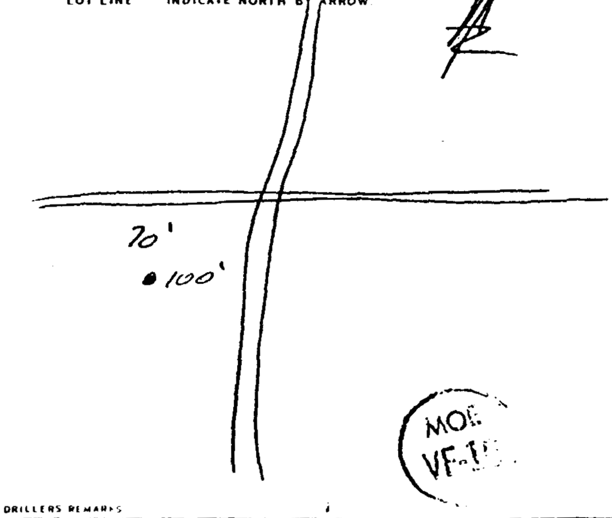
DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)

71 PUMPING TEST

PUMPING TEST METHOD	1 ☒ PUMP 2 ☐ BAILER
PUMPING RATE	0002 GPM
DURATION OF PUMPING	01 HOURS 00 MINS
STATIC LEVEL	020 FEET
WATER LEVEL END OF PUMPING	050 FEET
WATER LEVELS DURING	1 ☒ PUMPING 2 ☐ RECOVERY
15 MINUTES	030 FEET
30 MINUTES	040 FEET
45 MINUTES	045 FEET
60 MINUTES	050 FEET
IF FLOWING GIVE RATE	GPM
PUMP INTAKE SET AT	60 FEET
WATER AT END OF TEST	1 ☒ CLEAR 2 ☐ CLOUDY
RECOMMENDED PUMP TYPE	☐ SHALLOW ☒ DEEP
RECOMMENDED PUMP SETTING	050 FEET
RECOMMENDED PUMPING RATE	0002 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

FINAL STATUS OF WELL 1
1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING 4
1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

NAME OF WELL CONTRACTOR: Ray Machingllys. LICENCE NUMBER: 4609

DATA SOURCE 1 | CONTRACTOR 4609 | DATE RECEIVED 260179

MOE VF-1

UTM 18 | 5 1 8 2 2 0 E
CON 11 18 R | 5 0 0 7 5 5 0 N
Elev. 18 R | 0 2 9 0
Basin 25

31 G 2 W

ONTARIO

The Water-well Drillers Act, 1954

Department of Mines

Water-Well Record

County or ~~Territorial~~ District: Glengarry — Township, Village, Town or City: Kenyon

Con.: 11 — Lot: 36 — Street and Number (if in Village, Town or City):

Owner: Mrs. J. Pitre — Address: Cornwall, Ontario.

Date completed: 30st (day) April (month) 1958. (year)

Pipe and Casing Record		Pumping Test	
Casing diameter(s)	5"	Static level	4'
Length(s)	21'	Pumping rate	250 g.p.h.
Type of screen	none	Pumping level	25'
Length of screen	-	Duration of test	1 hr.

Well Log — **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	No. of feet water rises	Kind of water (fresh, salty, or sulphur)
sand		6	37	33	sulphur
hardpan	6	21			
hard limestone	21	38			

For what purpose(s) is the water to be used? domestic

Is water clear or cloudy? clear

Is well on upland, in valley, or on hillside? upland

Drilling firm: J.R. Ferguson

Address: Maxville, Ontario.

Name of Driller: J.R. & R.D. Ferguson

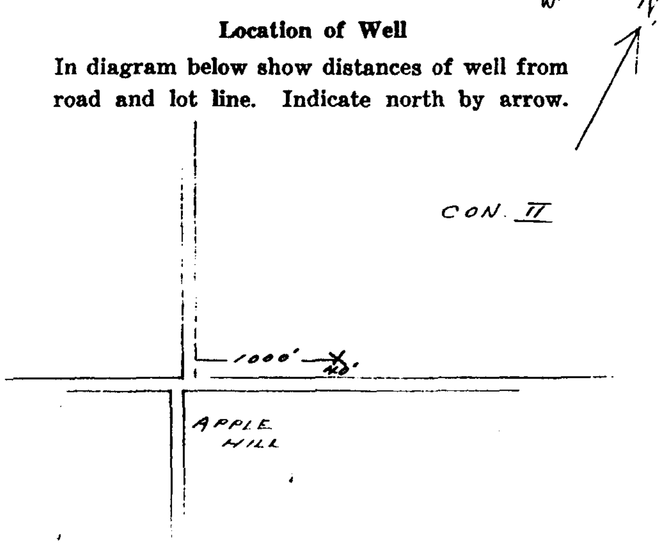
Address: Maxville, Ontario.

Licence Number: 762

I certify that the foregoing statements of fact are true.

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



A1G2W

UTM 18 Z 518075 E
5007450 N
Elev 0300
Basin 25 Glengarry

The Ontario Water Resources Commission Act

WATER WELL RECORD

GROUND WATER BRANCH
23 MAR 19 1963 No 441
ONTARIO WATER RESOURCES COMMISSION

County or District Glengarry — Township, Village, Town or City ~~Apple Hill~~ (Kenyon)

Con. II — Lot 36 — Date completed 2nd (day) Nov. (month) 1962 (year)

SEE SKETCH

Owner P. Illingworth (print in block letters) — Address Dalhousie, Ontario.

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5"	Static level	12'
Total length of casing	37'	Test-pumping rate	40 G.P.H. G.P.M.
Type of screen	none	Pumping level	53'
Length of screen		Duration of test pumping	4 hrs.
Depth to top of screen		Water clear or cloudy at end of test	clear
Diameter of finished hole	5"	Recommended pumping rate	40 G.P.H. G.P.M.
		with pump setting of	50 feet below ground surface

Well Log: Overburden and Bedrock Record	From ft.	To ft.	Water Record: Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
sandy loam	surface	7	49	fresh
hardpan, stones	7	37		
grey limestone	37	53		

For what purpose(s) is the water to be used? house

Is well on upland, in valley, or on hillside? hillside

Drilling or Boring Firm Ferguson Thresher Company

Address Maxville, Ontario

Licence Number 625 unknown

Name of Driller or Borer J.R. & N.D. Ferguson

Address Maxville, Ontario

Date March 5th 1963.

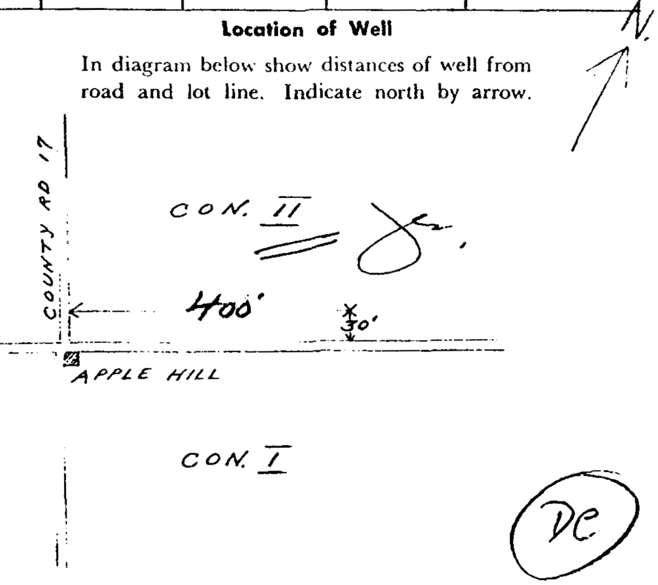
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M Sets 60-5930

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



DC

UTM 18 Z 517925 E

Con 5 N 5007800 N

Elev. 15 R 0295

Lot 36

Basin 25 | ?

31G2W

427

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District: Glengary. Township, Village, Town or City: Kenyon

Con. 2 11 Part Lot 36 Date completed 8 (day) June (month) 1963 (year)

Owner: Jean Grindon (print in block letters) Address: Apple Hill Ont

Casing and Screen Record		Pumping Test	
Inside diameter of casing	5 inches.	Static level	10
Total length of casing	36 feet.	Test-pumping rate	8 G.P.M.
Type of screen		Pumping level	10
Length of screen		Duration of test pumping	1 hour
Depth to top of screen		Water clear or cloudy at end of test	Clear
Diameter of finished hole	5 inches.	Recommended pumping rate	8 G.P.M.
		with pump setting of	35 feet below ground surface

Well Log / **Water Record**

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Blue clay.	0	10	36	fresh
clay and Stones	10	20		
gravel and Stones	20	36		
Black Rock. ?	36	49		

For what purpose(s) is the water to be used? house

Is well on upland, in valley, or on hillside? Valley.

Drilling or Boring Firm

Address

Licence Number 800

Name of Driller or Borer Arsene Bourdon

Address 20 Fennell Crescent Cornwall

Date 8 June 1963

Arsene Bourdon

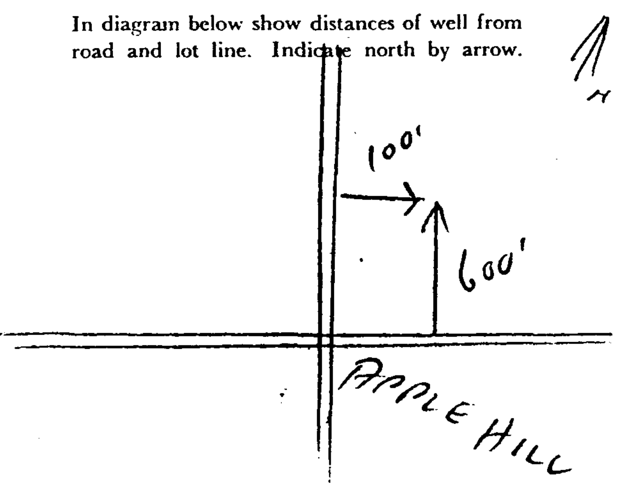
(Signature of Licensed Drilling or Boring Contractor)

Form 7 15M-60-4138

OWRC COPY

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



UTM 18 517825 E
5007550 N
Elev 00300
Basin 25
County or District
Twp. 12 11 LINGARY

The Ontario Water Resources Commission Act

WATER WELL RECORD

31 G 2 W.

Lot PART OF LOT 36 Township, Village, Town or City CHARLOTTENBURG

Owner J H MUIR (print in block letters) Date completed 24 (day) 9 (month) 1963 (year)

Address SEE SKETCH & APPLE HILL ONT.

Casing and Screen Record

Inside diameter of casing 5 inches
Total length of casing 46 feets
Type of screen
Length of screen
Depth to top of screen
Diameter of finished hole 5 inches.

Pumping Test

Static level 6
Test-pumping rate 8 G.P.M.
Pumping level 12
Duration of test pumping 1 hour
Water clear or cloudy at end of test clear
Recommended pumping rate 8 G.P.M.
with pump setting of 40 feet below ground surface

Well Log

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Blue clay	0	20		
gravel and clay	20	30	42	fresh
Black Rock and gravel.	30	48		

For what purpose(s) is the water to be used? house

Is well on upland, in valley, or on hillside? upland

Drilling or Boring Firm

Address

Licence Number 00

Name of Driller or Borer Arsène Boundon

Address Crescent Cornwall

Date Oct 1963

Boundon
(Signature of Licensed Drilling or Boring Contractor)

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.

800 feet from corner

APPLE HILL

3

UTM 18 Z 518150 E

Cor. R 5007525 N

Elev. R 302 95

Basin 25

31G2W

The Ontario Water Resources Commission Act

WATER WELL RECORD

County or District Glengarry Township, Village, Town or City KENYON

Con. 2 Part Lot 36 Date completed 18 (day) June (month) 1963 (year)

Owner HAMILTON SHERLOCK (print in block letters) Address Apple Hill. Ont

Casing and Screen Record

Inside diameter of casing 5 inches

Total length of casing 49 feet

Type of screen

Length of screen

Depth to top of screen

Diameter of finished hole 5 inches

Pumping Test

Static level 16

Test-pumping rate 5 G.P.M.

Pumping level 16

Duration of test pumping 1 hour

Water clear or cloudy at end of test clear

Recommended pumping rate 5 G.P.M.

with pump setting of 45 feet below ground surface

Well Log / Water Record

Overburden and Bedrock Record	From ft.	To ft.	Depth(s) at which water(s) found	Kind of water (fresh, salty, sulphur)
Sand and Stone	0	18	48	fresh
clay and gravel	18	30		
gravel	30	48		
Black Rock	48	61		

For what purpose(s) is the water to be used? HOUSE

Is well on upland, in valley, or on hillside? hillside.

Drilling or Boring Firm

Address

Licence Number 800

Name of Driller or Borer Arsene Bourdon

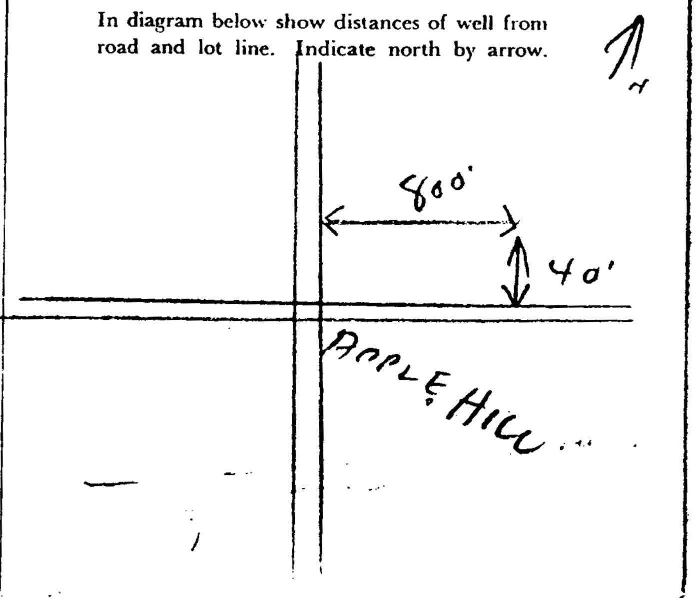
Address 20 [illegible] Crescent Cornwall

Date 18 June 1963

Arsene Bourdon
(Signature of Licensed Drilling or Boring Contractor)

Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.



Form 7 15M-60-4138

OWRC COPY

Appendix C - Comprehensive Water Quality and Well Record Data

MSTA'S No.	MOEE Well No.	Lot	EAST	NORTH	Date	Driller	Dia. (in)	Water Found (ft)	Elev (m)	Static (ft)	Elev (m)	Confin. (m)	Pump (ft)	Rate (gpm)	Time	Owner Current	Lithology	encounter (ft)	(m)	Elev (m)	Surface Elev. (m)
301																					89
302																					91
303	89	37	517900	5007340	11/68	1411	5	48	76.4	9	88.3	11.9	14	6	1/00	MUNRO A	clay, boulders				91
																	limestone	25	7.6	83.4	
304	87															NEVILLE M					91.5
305																					91.5
306	83															FOBERT A					92
307		36	517600	5007650	03/66	4834	6	65	72.2	12	88.3	16.2	60	2	1/00	GALLIPOLI F	grey clay				92
																	grey limestone	10	3.0	89.0	
308	79															MURRAY L					93
309	85	37	516900	4908700	07/77	1517	6	65	73.2	8	90.6	17.4	60	5	1/00	HATHOWAY C	brown hardpan				93
																	gravel, boulders	20	6.1	86.9	
																	grey limestone	27	8.2	84.8	
310																					93
311	101	37	518075	5007000	10/66	1411	5	68	72.3	15	88.4	16.2	60	8	5/00	MACDONALD G					93
312	69															BINGLEY P					92.5
313	71															MURRAY C					92
314	49	37			11/67	1414	6	80	67.6	17	86.8	19.2	60	8	1/00	Benton Brian	brown till				92
																	shale	29	8.8	83.2	
315	67	37	517705	5007169	11/75	1414	6	47	77.7	15	87.4	9.8	15	10	1/00	HARKEN F	grey hardpan				92
																	grey gravel	40	12.2	79.8	
																	shale	45	13.7	78.3	
401																					89.5
402	111	36	518220	5007550	04/56	2112	5	37	77.7	4	87.8	10.1	25	4	1/00	BISSONNETTE A	sand				89
																	hardpan	6	1.8	87.2	
																	limestone	21	6.4	82.6	
403	22															FOBERT L					90
404	107															MCBAIN M					90.5
405	105															MACDONALD A					92.5
406	103	36	518075	5007450	11/82	2112	5	49	78.1	12	89.3	11.3	53	1	4/00	LAPOINTE M	sandy loam				93
																	hardpan, stones	7	2.1	90.9	
																	grey limestone	37	11.3	81.7	
407		36	518150	5007525	08/63	1411	5	48	78.4	16	88.1	9.8	16	5	1/00	SHERLOCK H	sand, stone				93
																	clay, gravel	10	3.0	90.0	
																	gravel	30	9.1	83.9	
																	shale	48	14.6	78.4	
408	99	36	518199	5007599	02/79	4609	6	80	69.1	25	85.9	16.8	75	2	1/00	SINGLETON R	brown sand				93.5
																	grey hardpan	5	1.5	92.0	
																	grey fine sand	40	12.2	81.3	
																	grey gravel	51	15.5	78.0	
																	grey limestone	55	16.8	76.7	
409																					94
410	95	36	518055	5007450	09/66	1411	5	60	75.7	11	90.6	14.9	55	5	1/00	NEVILLE M	boulders, sand				94
																	hardpan, sand	30	9.1	84.9	
411	93															KERR G					93
412	91															JENSEN A					92
413	48															LACELLE M					90
414	46	37	517900	4907250	12/78	4609	6	58	72.8	20	84.4	11.6	50	2	1/00	ROZON W	dug well				90.5
																	grey sand	20	6.1	84.4	
																	grey hardpan	40	12.2	78.3	
																	grey limestone	48	14.6	75.9	
415	48															LACELLE M					89.5
416		36	517999	5007499	03/78	4609	6	55	72.2	10	86.0	13.7	35	5	2/00	MCMILLAN D	brown sand				89
																	grey quicksand	10	3.0	86.0	
																	shale	37	11.3	77.7	
																	grey limestone	38	11.6	77.4	
417																					89
418		36	517925	5007500	06/63	1411	5	36	78.5	10	86.5	7.9	10	8	1/00	GUIDON J	blue clay				89.5
																	clay, stone	10	3.0	86.5	
																	gravel, stone	20	6.1	83.4	
																	shale	36	11.0	78.5	

MSTA'S No.	ot Area (m2)	Well Type	1989	1990	Final	1990 Date	6 Back-Ground	260 Total	0 Fecal	DATE	Fe	Cl	Cond.	NH3	NO2	NO3	F		Depth	TRMT.	Age	Dry	Problem
301	743.3																						
302	834.1																						
303	1625.9	DRILLED	UNSAFE	N/S	UNSAFE	1989	170	110000	0												15	NIL	SUL
304	852.9	DRILLED	SAFE	N/S	SAFE	1989	0	0	0												15	NIL	SUL
305	773																						
306	1625.9	DUG	UNSAFE	UNSAFE	UNSAFE	1989	800	2100	5	1989	0.1	176.3	1179	1.7	0.03	10.77	0.12	6	20		16	YES	
						1990	39	360	1														
307	1625.9																						
308	1212.9	DRILLED	SAFE	N/S	SAFE	1989	0	7000	0									18	60	NONE	10	NIL	
309	1219.5	DRILLED	SAFE	N/S	SAFE	1989	0	0	0	1989	1	19.1	462	0.15	0.002	<0.02	0.19			FIL.		YES	SUL, RU
310	406.5																						
311	813	UNKNOWN	SAFE	N/S	SAFE	1989	0	10	0													NIL	
312	813	DRILLED	UNSAFE	N/S	UNSAFE	1989	1000	>15000	100											SOFT.		NIL	I
313	1625.9	DRILLED	SAFE	N/S	SAFE	1989	0	850	0	1989	1.5	38.9	704	0.05	0.002	<0.02	0.17	11	37		10	NIL	
314	1625.9	DUG	SAFE	N/S	SAFE	1989	0	330	0	1989	0.65	59.9	741	0.16	0.002	<0.02	0.21			NONE		NIL	SUL
315	813	DRILLED	SAFE	N.S	SAFE	1989	0	240	0	1989	0.65	10.8	462	<0.01	0.002	<0.02	0.24			NONE	10	NIL	RU
401	8970.7																						
402	813	DUG	UNSAFE	N/S	UNSAFE	1989	2200	8200	43	1989	<0.05	205.8	1320	<0.01	<0.002	4.6	<0.1	7	23		17	YES	Q
403	813	UNKNOWN	UNSAFE	N/S	UNSAFE	1989	86	350	42													NIL	
						1990	7	1600	0														
404	1658.5	DRILLED	UNSAFE	UNSAFE	UNSAFE	1989	12	>150	0	1989	0.1	175.22	1139	0.15	0.184	1.56		11	35	NONE	20	NIL	
						1990	17	36	14														
405	1625.9	DRILLED	SAFE	N/S	SAFE	1989	0	0	0	1989	<0.05	26	576	0.15	0.002	<0.02	0.3	19	62	NONE		NIL	SUL
406	1625.9	DUG	SAFE	N/S	SAFE	1989	0	55	0	1989	<0.05	36.3	562	<0.01	<0.002	4.3				NONE	15	NIL	
407	813																						
408	7604.7	UNKNOWN	UNSAFE	UNSAFE	UNSAFE	1989	190	>150	0	1989	<0.05	36.1	787	<0.01	0.004	1.82						NIL	
						1990	200	1600	0														
409	3730.1																						
410	3528.4	DRILLED	SAFE	N/S	SAFE	1989	0	0	0	1989	0.1	3.1	569	<0.01	<0.002	0.24	<0.1	29	96	NONE	6	NIL	
411	1658.5	DUG	UNSAFE	N/S	UNSAFE	1989	112	170	67									4	14	NONE	19	YES	
412	813	UNKNOWN	UNSAFE	N/S	UNSAFE	1989	114	270	0	1989	0.08	78.5	877	0.01	0.002	0.458	0.15				7	NIL	
413	813	DUG	SAFE	N/S	SAFE	1989	0	0	0	1989	<0.05	83.8	1102	<0.01	0.008	8.99	0.12	3	10	NONE	60	NIL	
414	1055.2	DRILLED	UNSAFE	UNSAFE	UNSAFE	1989	12	170	0									24	79	NONE	13	NIL	SAND
						1990	36	1200	0														
415	919.8	DUG	SAFE	N/S	SAFE	1989	0	0	0	1989	<0.05	83.8	1102	<0.01	0.008	8.99	0.12			NONE		NIL	SUL
416	919.8																						
417	1658.5																						
418	3207																						

LEGEND

I = IRON
ST = STAINING
H = HARD
SUL = SULFUR
RU = RUST
BL = BLACK
OD = ODOUR
Q = QUANTITY
TA = TASTE
CO = COLOUR
SOFT. = SOFTENER
PUR. = PURIFIER
FIL. = FILTER

MSTA'S No.	MOEE Well No.	Lot	EAST	NORTH	Date	Driller	Diam. (in)	Water Found (ft)	Elev (m)	Static (ft)	Elev (m)	Confin. (m)	Pump	Rate	Time	Owner	Lithology	encounter (ft)	encounter (m)	Elev (m)
101																				
102																				
103																				
104	8															MACCULLOUCH D				
105																				
106																				
107	10															OULETTE P				
108	12															LAPIERRE G				
109	14															DEVEAU E				
110	16															HOTEL				
111																				
112	18	36	516050	5007350	09/71	4609	6	60	75.7	20	87.9	12.2	60	1	1/00	FILION L	brown hardpan			
																	grey quicksand	31	9.5	64.5
																	grey limestone	56	17.1	76.9
112a	20															DEVILN S				
113																				
114																				
115	26	36	516200	5007960	06/65	4609	5	82	70.0	14	90.7	20.7	24	6	1/00	POST OFFICE	hardpan			
																	limestone	59	18.0	77.0
116	51	36	516050	5007210	08/57	4609	2	140	52.3	12	91.3	39.0	30	2	1/00	MACMILLAN A	clay			
																	gravel, sand	5	1.5	93.5
																	hard pan, boulders	20	6.1	88.9
																	limestone	80	24.4	70.6
117																				
118	32															STIRLING E				
119	34															MEDICAL CLINIC				
120	36															MCMILLAN W				
121		36	516300	5006900	08/60	2112	5	90	67.6	30	85.9	18.3	55	4	4/00	APPLE HILL SCHL	gravel			
																	sand, stones	6	1.8	93.2
																	hardpan, boulders	25	7.6	87.4
																	limestone	73	22.3	72.7
122	38															MARLEAU L				
123	40															ST.ANTHONY PRSH				
124	42															QUESNEL G				
125	44															FIRE DEPT.				
126	60															LAPIERRE T				
127																				
128	64															UNITED MANSE				
128a	86															UNITED CHURCH				
129	88															MODLER D				
130																				
131																				
132	92															MURRAY V				
133	94															MCINTOSH G				
134	55	36	518199	5007399	08/80	1414	6	71	89.9	19	86.0	18.2	65	2	1/00	COLBOURNE D	brown till			
																	grey limestone	33	10.1	81.4
	55	36	517905	5007620	09/74	4609	6	95	62.5	8	-2.4	-65.0	66	1	1/00	COLBOURNE D	brown hardpan		0.0	
																	brown gravel	20	6.1	
																	grey limestone	38	11.6	
	55	36			07/88	1414	6	50	78.3	5	-1.5	-77.8	50	2	1/00	Colbourne Donald	brown till		0.0	
																	grey till	18	5.5	
																	grey gravel	30	9.1	
																	grey limestone	32	9.8	
135	96																			
136																BENTON L				
137																				

MSTA'S No.	Surface Elev. (m)	Lot Area (m2)	Well Type	1989	1990	Final	Date	Back-Ground	Total	Fecal	DATE	Fe	Cl	Cond.	NH3	NO2	NO3	F	Depth (m)	Depth (ft)	TRMT.	Age	Dry	Problem
101	87	909.2																						
102	87.5	393.7																						
103	87	599.2																						
104	88	966.6	UNKNOWN	POOR	SAFE	SAFE	1989	5	5400	3													NIL	
							1990	0	0	0														
105	88.5	966.6																						
106	89	966.6																						
107	90	904.7	UNKNOWN	SAFE	N/S	SAFE	1989	0	0	0													NIL	
108	91	966.6	DRILLED	SAFE	N/S	SAFE	1989	0	0	0									14	47	NONE	60	NIL	
109	91.5	515.9	DUG	SAFE	N/S	SAFE	1989	0	90	0	1989	<0.05	82.3	984	<0.01	0.002	4.8		15	50	NONE	60	NIL	
110	93.5	423.8	DRILLED	POOR	SAFE	SAFE	1989	3	740	0	1989	0.03	80.9	585	0.27	<0.002	0.02	1.08	23	77	SOFT.	3	NIL	
							1990	0	45	0														
111	93.5	260.7																						
112	94	204.1	DRILLED	SAFE	N/S	SAFE	1989	0	6	0									27	90		30	NIL	NO WELL
112a	•	•	DRILLED	SAFE	N/S	SAFE	1989	0	5	0									27	90	NONE		NIL	NO WELL
113	94.5	1480																						
114	95	73.8																						
115	95	05.2	UNKNOWN	SAFE	N/S	SAFE	1989	0	310	0													NIL	
116	95	63.9	UNKNOWN	SAFE	UNSAFE	UNSAFE	1989	0	0	0													NIL	
							1990	33	270	0														
117	95	55.3																						
118	94.5	03.4	DUG	SAFE	N/S	SAFE	1989	0	0	0									11	35		90	NIL	Od, Sul
119	95.5	88.7	UNKNOWN	POOR	UNSAFE	UNSAFE	1989	6	5	0													NIL	
							1990	1	1	0														
120	95.5	81.1	DUG	UNSAFE	UNSAFE	UNSAFE	1989	120	670	1									18	60		90	NIL	SHARED
							1990	22	370	0														
121	95	298																						
122	94.5	5.2	UNKNOWN	UNSAFE	UNSAFE	UNSAFE	1989	46	3000	0	1989	0.1	25.3	753	0.03	0.002	0.98	0.18			NONE		NIL	
							1990	200	3300	0														
123	96	300	DRILLED	UNSAFE	UNSAFE	UNSAFE	1989	51	7150	0	1989	<0.05	19.7	717	<0.01	<0.002	2		16	60			NIL	
							1990	31	1600	0														
124	92.5	3.8	UNKNOWN	SAFE	N/S	SAFE	1989	0	0	0											NONE		NIL	
125	92.5	336																					NIL	
126	93	9.5	DRILLED	SAFE	N/S	SAFE	1989	0	52	0											NONE	15	YES	
127	94	9.5																						
128	95	8.2	DUG	UNSAFE	UNSAFE	UNSAFE	1989	21	52	2	1989	<0.05	41.1	631	0.01	0.003	2.6	<0.1	23	75	NONE	12	NIL	SHARED
							1990	27	1200	0														
128a	•	•																					NIL	SHARED
129	94.5	2.5	UNKNOWN	SAFE	N/S	SAFE					1989	<0.05	48.6	909	0.02	<0.02	5		10	32			NIL	
130	94	4.1																						
131	93	3.8																						
132	92.5	5.5	DUG	UNSAFE	SAFE	UNSAFE	1989	1300	2500	0	1989	0.25	24.5	576	0.03	0.006	<0.02				NONE	30	NIL	BL, SUL
							1989	0	24	0														
							1990	0	1	0														
133	92	.3	DRILLED	SAFE	N/S	SAFE	1989	1	37	0	1989	0.1	19.7	629	0.03	0.004	1.8		16	53	NONE	8	YES	Q
134	91.5	.3	DRILLED	SAFE	N/S	SAFE	1989	0	0	0												30	NIL	I, SUL
135	90	.8	DUG	UNSAFE	N/S	UNSAFE	1989	700	500	3	1989	<0.05	84.9	1158	0.02	0.002	6.8	<0.1	8	25	NONE	15	NIL	
136	89	.9																						
137	90.5	.4																						

MSTA'S No.	MOEE Well No.	Lot	EAST	NORTH	Date	Driller	Dia. (in.)	Water Found	Elev (m)	Static (ft)	Elev (m)	Confin. (m)	Pump (ft)	Rate (gpm)	Time	Owner Current	Lithology	encounter (ft)	encounter (m)	Elev (m)	Surface Elev. (m)	Lot Area (m2)	Well Type	1989	1990	Final	Date	Back-Ground	Total	Fecal	DATE	Fe	Cl	Cond.	NH3	NO2	NO3	F		Depth	TRMT.	Age	Dry	Problem
201	64															BURTON M					94	13[illegible]20	UNKNOWN	POOR	POOR	UNSAFE	1989	1	20	0											SOFT.	14	NIL	
																											1990	3	32	0														
202	66															LAVIGNE G					94	13[illegible]20	DRILLED	POOR	UNSAFE	UNSAFE	1989	2	36000	0											FIL.	5	NIL	
																											1990	39	280	4														
203	68															RUSSELL S					93.5	127[illegible].3	DUG	POOR	UNSAFE	UNSAFE	1989	12	1800	1									8	26	NONE	10	NIL	
																											1990	3	1100	2														
204																					93	86[illegible].5																							
205																					93	91[illegible].9																							
206		37	516876	5008852	03/75	1505	6	84	66.9	15	87.9	21.0	90	1	1/00	PERRY J	topsoil				92.5	91[illegible].5																							
																	grey clay, boulder	1	0.3	92.2																									
																	grey clay, gravel,	35	10.7	81.8																									
																	grey limestone	49	14.9	77.8																									
207	74															NOLAN J					92	92[illegible].4	DUG	DRY	N/S	N/A																	NIL	OIL
208	76															BENTON E					92	143[illegible].1	DRILLED	UNSAFE	UNSAFE	UNSAFE	1989	400	40000	0									9	30	NONE	5	NIL	
																											1990	60	1100	0														
209	43															FRASER C					92.5	136[illegible].3	DUG	SAFE	N/S	SAFE	1989	0	20	0	1989	<0.05	13.9	742	<0.01	0.018	6.8		9	28	PUR.	40	NIL	
210	41															RAYMOND B					93	162[illegible].9	DUG	UNSAFE	UNSAFE	UNSAFE	1989	120	0	0									11	35		25	NIL	I
																											1990	4	800	1														
211	39															TOURIGNY D					93	130[illegible].7	DUG	UNSAFE	UNSAFE	UNSAFE	1989	220	1100	0	1989	<0.05	154.1	1195	0.23	0.052	4.75	0.13	9	25		20	NIL	
																											1990	21	230000	61														
212	37															ANDRE S					93.5	80[illegible].8	UNKNOWN	SAFE	N/S	SAFE	1989	0	0	0													NIL	
213	35															BOSSE A					93.5	80[illegible].8	DRILLED	POOR	POOR	UNSAFE	1989	5	180	0									18	60			NIL	RU
																											1990	4	8500	0														
214	33															DORE G/VALADE A					93.5	80[illegible].8	UNKNOWN	UNSAFE	UNSAFE	UNSAFE	1989	13	24	0													NIL	
																											1990	5	10	1														
215																					93	80[illegible].6																							
216		37	518025	5007100	09/84	1411	5	70	71.7	16	88.1	16.5	61	7	1/00	STE CROIX S	clay				93	185[illegible].2																							
																	gravel, clay	30	9.1	83.9																									
																	sand, clay	60	18.3	74.7																									
																	coarse gravel	70	21.3	71.7																									
217	29															GRANT L					93	80[illegible].8	DRILLED	SAFE	N/S	SAFE	1989	0	0	0	1989	0.08	44.8	735	0.11	0.002	<0.02	0.3	23	75	FIL.	7	NIL	I
218	27															LALONDE R					93	80[illegible].8	DUG	UNSAFE	UNSAFE	UNSAFE	1989	100	>15000	0	1989	<0.05	73.6	1057	0.03	0.002	2.4		6	20	NONE	75	NIL	
																											1990	100	1100	13														
219	27															LALONDE R					93	80[illegible].8	•	•	•	•	•	•	•	•	•	•	•						6	20	NONE	75	NIL	
220	27															LALONDE R					93	80[illegible].8	•	•	•	•	•	•	•	•	•	•	•						6	20	NONE	75	NIL	
221	25															MUNRO J					93	80[illegible].8	DUG	SAFE	N/S	SAFE	1989	0	23	0									8	25		25	NIL	
222																					92	12[illegible]3																							
223	23															34 MAIN					93.5	111[illegible].8	UNKNOWN	POOR	UNSAFE	UNSAFE	1989	1	8	0	1989	<0.05	151.9	943	0.08	8.09	2.6						NIL	
																											1990	160	5500	77														
224	21															MCDONALD E	sand, stone				93	92[illegible].1	DRILLED	UNSAFE	UNSAFE	UNSAFE	1989	0	240	0	1989	0.8	229.8	1480	0.03	0.002	0.018	0.22			SOFT.		NIL	H, I
																	hardpan	30	9.1	83.9							1990	190	900	30														
																	stone, gravel	60	18.3	74.7			DUG	SHARED WITH 225			1989	240	1100	5														
225	19															MARLEAU N					93	80[illegible].9	DUG	UNSAFE	UNSAFE	UNSAFE	1989	46	130000	1											NONE	20	NIL	ST
																											1990	13	3	1														
226	17															MARTEL L					92.5	282[illegible].2	DUG	UNSAFE	UNSAFE	UNSAFE	1989	29	3100	1									8	28	NONE	20	NIL	ST
																											1990	39	360	1														
227	15	36	518100	5007350	05/86	1411	5	30	83.9	8	90.6	6.7	30	8	2/00	MACDOUGALL D	clay, boulders				93	92[illegible].1	UNKNOWN	SAFE	N/S	SAFE	1989	0	31	0	1989	7.2	216.2	1033	0.13	0.008	0.012	0.16					NIL	TA, CO
																	gravel, clay	20	6.1	86.9																									
																	gravel	30	9.1	83.9																									
228																					92	12[illegible]	DUG	UNSAFE	POOR	UNSAFE	1989	350	2800	36	1990	<0.05	99.6	1004	<0.01	0.002	8.5	0.12						
																											1990	3	1600	0														
229																					91.5	80[illegible]	DUG	UNSAFE	N/S	UNSAFE	1989	43	300	0														
230	11															WELSH C					90.5	80[illegible]	•	•	•	•	•	•	•										6	20	NONE	21	NIL	
231	9	36	518160	5007180	08/86	1411	5	30	80.9	8	87.6	6.7	30	5	5/00	VAN PUTTEN C	stone, clay				88	80[illegible]	DUG	UNSAFE	POOR	UNSAFE	1989	110	300	0	1989	0.05	143.8	672	0.04	0.018	1.5	0.13			NONE	8	NIL	
232																	gravel	30	9.1	80.9							1990	6	210	0														
233	5															CULLIER R					89.5	80[illegible]	DUG	UNSAFE	N/S	UNSAFE	1989	230	150	0									5	18	NONE	25	NIL	ST
234	3															MICHAUD R					88	80[illegible]	DUG	UNSAFE	UNSAFE	UNSAFE	1989	52	380	2											NONE		NIL	I
																					88	151[illegible]					1990	20	1800	1														
235																																												
236																					91.5	2322[illegible]																							
237	125																				92	80[illegible]																							
																COXEN R					92.5	80[illegible]	DUG	UNSAFE	UNSAFE	UNSAFE	1989	1200	1100	1												12	NIL	
																											1990	30	>150	7														
238																																												
239	28																				92.5	567[illegible]																					NIL	
240	121	37	517684	5007240	10/74	4609	6	70	71.7	7	90.9	19.2	27	5	1/00	WILLIAMS V					92.5	613[illegible]	DRILLED	UNSAFE	N/S	UNSAFE	1989	38	5	0	1989	0.08	38.6	948	0.03	0.002	13.14	0.14	28	67		15	NIL	SUL, RU
																SAUVE A	top soil				93	40[illegible]	DRILLED	SAFE	N/S	SAFE	1989	0	0	0														
																	brown hardpan	2	0.6	92.4																									
																	grey quicksand	15	4.6	88.4																									
																	dense grey gravel	46	14.0	79.0																									
																	loose grey gravel	67	20.4	72.6																									
241																																												
242																																												
243																					93.5	3767[illegible]																							
244	134																				93.5	3251[illegible]																							
																					91	748[illegible]																							
																LEA R					92	2536[illegible]	DUG	UNSAFE	UNSAFE	UNSAFE	1989	25	81	0	1989	<0.05	25.7	586	<0.01	<0.002	3.4	0.19			NONE	4	NIL	
																											1990	11	250	0														
245	130																																									7	NIL	
246	132															BISSONNETTE O					92.5	614[illegible]	DRILLED	SAFE	N/S	SAFE	1989	0	86	0	1989	0.5	17.9	430	0.27	0.002	<0.02	0.19	27	88			YES	Q
																VALADE P					92.5	634[illegible]	DUG	UNSAFE	UNSAFE	UNSAFE	1989	1200	1100	0	1989	0.1	31.9	650	0.02	<0.002	4.4	<0.1	5	15				
																											1990	3100	>15000	0														
247	128	37	517950	4996900	07/79	4609	6	60	74.2	15	87.9	13.7	21	10	1/00	MARLEAU T	brown hardpan				92.5	634[illegible]	DRILLED	UNSAFE	POOR	UNSAFE	1989	100	3300	0	1989	0.3	47.1	724	0.02	<0.002	<0.02	<0.1			NONE	12	NIL	
																	grey hardpan	15	4.6	87.9							1990	5	85	0														
248	126																gravel	55	16.8	75.7																					NONE		NIL	RU, SUL
249	124															HUTCHINSON I					92.5	647[illegible]	DRILLED	SAFE	N/S	SAFE	1989	0	0	0									8	26	NONE	5	NIL	SUL
																MATIVESTKY I					93	1281[illegible]	DUG	UNSAFE	POOR	UNSAFE	1989	100	>15000	0														
249a																											1990	3	1500	0														
250		37	517944	5007081	05/73	1517	6	74	70.4	10	90.0	19.5	50	10	1/15	REINHART J	topsoil				93																								
																	hardpan	4	1.2		93	634[illegible]																							
251	1																sand	40	12.2	80.8																									
																	limestone	50	15.2	77.8																									
																DEBELLEFEUILLE G					88		DUG	UNSAFE	POOR	UNSAFE	1989	18	180	0	1989	2.1	167.4	1242	0.05	0.002	<0.02	0.13	11	35	NONE	50	NIL	

Appendix D - MOEE Pollution Survey Report

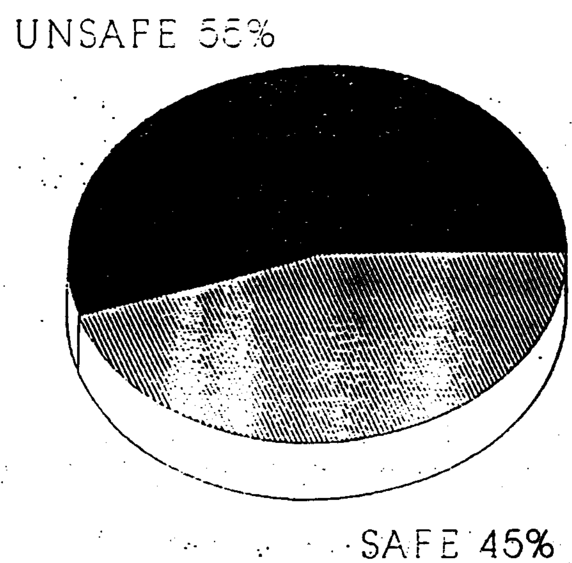
Ministry of the Environment
Ministère de l'Environnement
Ontario

Southeastern Region
Région du Sud-Est

205 Amelia Street
Cornwall Ontario
K6H 3P3
613/933-7402

205, rue Amelia
Cornwall (Ontario)
K6H 3P3
613 933-7402

WATER POLLUTION SURVEY
COMMUNITY OF APPLE HILL



MINISTRY OF THE ENVIRONMENT
1991

Ministry of the Environment | Ministère de l'Environnement
Ontario
Southeastern Region | Région du Sud-Est
205 Amelia Street
Cornwall Ontario
K6H 3P3
613 933-7402
205, rue Amelia
Cornwall (Ontario)
K6H 3P3
613 933-7402

March 26, 1992

94519 P

Township of Kenyon
R. R. 5
Alexandria, Ontario
K0C 1A0

Attention: Mary McCuaig, Clerk-Treasurer

RE: Township of Kenyon - Community of Apple Hill Water Pollution Survey Report

Please find enclosed two copies of the above-noted report prepared by the Ministry of the Environment. Feel free to photocopy excerpts for distribution to council.

Water samples collected in 1989 and 1990 and data compiled from resident interviews and various technical sources reveal that septic tank systems and individual wells in Apple Hill are seriously substandard. Approximately 55 percent of drinking water supplies in Apple Hill are classified as unsafe for drinking.

All residents were notified of unsafe water conditions and were advised to disinfect their systems.

Your attention is directed to the summary and conclusions of the report and recommendations offered on Page 10. It is recommended that the municipality apply for a direct grant from this ministry to upgrade or replace wells and septic tank systems.

Also enclosed is an information pamphlet on Ontario's Water and Sewage Systems Direct Grants. To apply for funding, Council must pass a resolution requesting funds to develop a private systems grant program to resolve individual water supply and sewage disposal problems in the community of Apple Hill.

It is also suggested that Council pass a separate resolution requesting project management services from the Ministry of the Environment for the duration of the program, and another appointing an engineering firm as the Township of Kenyon's project consultant.

ABSTRACT

This report contains information on private well water supplies and sewage disposal systems in the community of Apple Hill. Water samples collected in 1989 and 1990 and data compiled from resident interviews and various technical sources reveal that septic tank systems and individual wells are seriously substandard. Fifty-five percent of drinking water supplies are classified as unsafe for drinking. A Direct Grant program is recommended to upgrade or replace the systems.

If you have any questions or comments concerning this matter, please do not hesitate to contact this office.

Yours truly,

Larry L. Benoit
Encl.

MINISTRY OF THE ENVIRONMENT

APPLE HILL POLLUTION SURVEY

INTRODUCTION

As a result of concerns expressed by the municipality for well contamination and stormwater pollution problems, Ministry of the Environment Abatement staff conducted a pollution survey of Apple Hill. Initial sampling was done in June and July 1989, and verification samples of "unsafe" and "poor" wells was done in July 1990. The purpose of the survey is to assess drinking water quality in private wells and to identify surface water pollution problems in the community.

GENERAL INFORMATION

The village of Apple Hill is situated in the Township of Kenyon approximately 25 km northeast of Cornwall. The 1986 enumerations determined that the population is 257. This is a slight decrease from 1976 when the population was 271.

Development in Apple Hill is mainly residential with a few small commercial and institutional establishments.

The village proper has the following establishments:

- Residential: 98 single family dwellings
- Industrial : Railtech Manufacturing
Guindon Tire and Fuel Outlet
- Institutional: Medical Clinic
Post Office
Fire Station
2 Churches
- Commercial: General store
Mini Mart Convenience Store
King Edward Hotel
2 Hairdressing Establishments

The village is surrounded entirely by farmland. County Road No. 20 runs north and south through the village, and the Montreal/Toronto CP railway cuts across the south quarter of the community.

INDEX

APPENDICES

TOPOGRAPHICAL AND GEOLOGICAL SUMMARY

Apple Hill is located in an undrumlinized part of the Glengarry till plain, and the surface is undulating to gently rolling. Bedrock is overlain by a thin permeable layer of sand and gravel over a 3- to 10-m thickness of clay and glacial till.

In high-lying areas, the till has been washed to leave moderately high permeable sand and gravel deposits near the surface. In some of the highest areas, till may be absent, leaving bedrock at or near the surface; however, rock outcrops were not identified during the survey.

In low-lying areas, the rock or till is covered by impermeable deposits of marine clay (source: Ontario Water Well Records for Kenyon Township-Apple Hill, Appendix H of working copy only).

WATER SUPPLY

Water systems in Apple Hill are typically drilled wells, 20 to 25 m deep, and dug wells, 7 to 10 m deep. The survey questionnaire showed that more than 50 percent of the wells are more than 20 years old. (Water supply data is summarized in Appendix B).

Resident interviews revealed that 15 percent of the homeowners experience staining of plumbing fixtures, dishes, and clothing due to iron in the water.

A few cases of dry wells were reported. Shortage occurs in 9 percent of the wells in an isolated area on Kenyon Street east. Sulphur water is reported in 15 percent of the wells, (86 percent of which are drilled wells), and carbon filters are used by 4 percent of the population.

There are also a few unoccupied establishments and dwellings without water supplies. Three occupants refused to participate in the survey.

Bacteriological Water Quality

Approximately 78 percent, or 87 of the estimated 107 wells in Apple Hill, were sampled for bacteriological determination. Initial sample results indicated that 47 percent were considered "unsafe", 9 percent were "poor", and 44 percent were "safe." Following re-sampling of "unsafe" and "poor" samples in 1990, it is concluded **that 55 percent of the wells in Apple Hill are unsafe for drinking,**

(see Table 1).

Table 1

BACTERIOLOGICAL SURVEY

NO.	NAME	WELL TYPE	STATUS		
			1989	1990	FINAL
1	HARRY NEILD	DUG	UNSAFE	POOR	UNSAFE
3	ROGER MICHAUD	DUG	UNSAFE	UNSAFE	UNSAFE
4	AURORE BESNER	DRILLED	UNSAFE	N/S	UNSAFE
5	ROMEO CUILLIER	DUG	UNSAFE	N/S	UNSAFE
9	C.VAN PUTTEN	DUG	UNSAFE	POOR	UNSAFE
11	CATHERINE WELSH	DUG	UNSAFE	N/S	UNSAFE
13	GEORGE BENTON	DUG	UNSAFE	POOR	UNSAFE
17	LANCE MARTEL	DUG	UNSAFE	UNSAFE	UNSAFE
19	NANCY MARLEAU	DUG	UNSAFE	UNSAFE	UNSAFE
21	EVELYN MCDONALD	DRILLED	UNSAFE	UNSAFE	UNSAFE
22	LARRY FOBERT	UNKNOWN	UNSAFE	N/S	UNSAFE
23	34 MAIN	UNKNOWN	POOR	UNSAFE	UNSAFE
27	RAY LALONDE	DUG	UNSAFE	UNSAFE	UNSAFE
28	VIVIAN WILLIAMS	DRILLED	UNSAFE	N/S	UNSAFE
33	G.DORE/A.VALADE	UNKNOWN	UNSAFE	UNSAFE	UNSAFE
34	MED.CLINIC	UNKNOWN	POOR	UNSAFE	UNSAFE
35	ALPHONSE BOSSE	DRILLED	POOR	POOR	UNSAFE
36	WILLIAM MCMILLAN	DUG	UNSAFE	UNSAFE	UNSAFE
38	LOUISE MARLEAU	UNKNOWN	UNSAFE	UNSAFE	UNSAFE
39	DAN TOURIGNY	DUG	UNSAFE	UNSAFE	UNSAFE
40	ST.A.PARISH	DRILLED	UNSAFE	UNSAFE	UNSAFE
41	BERNARD RAYMOND	DUG	UNSAFE	UNSAFE	UNSAFE
46	WILFRED ROZON	DRILLED	UNSAFE	UNSAFE	UNSAFE
51	ALLAN MACMILLAN	UNKNOWN	SAFE	UNSAFE	UNSAFE
60	JAMES MCINTYRE	DUG	UNSAFE	UNSAFE	UNSAFE
61	MARVIN MCPHAIL	DUG	UNSAFE	UNSAFE	UNSAFE
64	MARY BURTON	UNKNOWN	POOR	POOR	UNSAFE
66	GUY LAVIGNE	DRILLED	POOR	UNSAFE	UNSAFE
68	STEPHEN RUSSELL	DUG	UNSAFE	UNSAFE	UNSAFE
69	PATRICK BINGLEY	DRILLED	UNSAFE	N/S	UNSAFE

(continued)

76	EDNA BENTON	DRILLED	UNSAFE	UNSAFE	UNSAFE
82	ANDRE LALONDE	DRILLED	POOR	POOR	UNSAFE
83	ALLAN FOBERT	DUG	UNSAFE	UNSAFE	UNSAFE
84	JOAN FILION	DUG	UNSAFE	UNSAFE	UNSAFE
89	ALLAN MUNRO	DRILLED	UNSAFE	N/S	UNSAFE
92	VINCENT MURRAY	DUG	UNSAFE	SAFE	UNSAFE
92	ALLAN JENSEN	UNKNOWN	UNSAFE	N/S	UNSAFE
93	GEORGE KERR	DUG	UNSAFE	N/S	UNSAFE
96	ALLAN BENTON	DUG	UNSAFE	N/S	UNSAFE
99	BOB SINGLETON	UNKNOWN	UNSAFE	UNSAFE	UNSAFE
107	MARY MCBAIN	DRILLED	UNSAFE	UNSAFE	UNSAFE
111	A.BISSONETTE	DUG	UNSAFE	N/S	UNSAFE
124	I.MATIVESTKY	DUG	UNSAFE	POOR	UNSAFE
125	RITA COXEN	DUG	UNSAFE	UNSAFE	UNSAFE
128	THERESA MARLEAU	DRILLED	UNSAFE	POOR	UNSAFE
132	PETER VALADE	DUG	UNSAFE	UNSAFE	UNSAFE
134	RONALD LEA	DUG	UNSAFE	UNSAFE	UNSAFE
8	D.MACCULLOUCH	UNKNOWN	POOR	SAFE	SAFE
10	PIERRE OULETTE	UNKNOWN	SAFE	N/S	SAFE
12	G.LAPIERRE	DRILLED	SAFE	N/S	SAFE
14	ELIZABETH DEVEAU	DUG	SAFE	N/S	SAFE
15	SANDRA MCDOUGAL	UNKNOWN	SAFE	N/S	SAFE
16	HOTEL	DRILLED	POOR	SAFE	SAFE
18	AMY FILION	DRILLED	SAFE	N/S	SAFE
20	SUSAN DEVLIN	DRILLED	SAFE	N/S	SAFE
25	JOHN W. MUNRO	DUG	SAFE	N/S	SAFE
26	POST OFFICE	UNKNOWN	SAFE	N/S	SAFE
29	LUCILLE GRANT	DRILLED	SAFE	N/S	SAFE
32	E. STIRLING	DUG	SAFE	N/S	SAFE
37	SERGE ANDRE	UNKNOWN	SAFE	N/S	SAFE
42	GERALD QUESNEL	UNKNOWN	SAFE	N/S	SAFE
43	C. FRASER	DUG	SAFE	N/S	SAFE
48	MICHEL LACELLE	DUG	SAFE	N/S	SAFE

(continued)

49	J.WENSHIRE	DUG	SAFE	N/S	SAFE
52	SAMPLE 52	UNKNOWN	SAFE	N/S	SAFE
53	DALLAS MCINTOSH	DRILLED	SAFE	N/S	SAFE
55	DONALD COLBOURNE	DRILLED	SAFE	N/S	SAFE
56	RAILTECH	UNKNOWN	SAFE	N/S	SAFE
65	KEN TYO	DRILLED	SAFE	N/S	SAFE
67	FLORENCE HARKIN	DRILLED	SAFE	N/S	SAFE
71	CATHY MURRAY	DRILLED	SAFE	N/S	SAFE
72	DONALD LAVIGNE	DRILLED	SAFE	N/S	SAFE
79	LESTER MURRAY	DRILLED	SAFE	N/S	SAFE
80	TED LAPIERRE	DRILLED	SAFE	N/S	SAFE
85	CHERYL HATHOWAY	DRILLED	SAFE	N/S	SAFE
87	MARY NEVILLE	DRILLED	SAFE	N/S	SAFE
88	DOUG MODLER	UNKNOWN	SAFE	N/S	SAFE
94	GARRY MCINTOSH	DRILLED	SAFE	N/S	SAFE
95	MICHEAL NEVILLE	DRILLED	SAFE	N/S	SAFE
101	R.MCDONALD	UNKNOWN	SAFE	N/S	SAFE
103	MARC LAPOINTE	DUG	SAFE	N/S	SAFE
105	ALLAN MACDONALD	DRILLED	SAFE	N/S	SAFE
121	ARMAND SAUVE	DRILLED	SAFE	N/S	SAFE
126	I.HUTCHINGSON	DRILLED	SAFE	N/S	SAFE
130	OSIAS BISSONETTE	DRILLED	SAFE	N/S	SAFE
74	JAMES NOLAN	DUG	(dry)	N/S	N/A
90	NOT KNOWN	DUG	(dry)	N/S	N/A
SUMMARY		DUG WELLS	78 PERCENT UNSAFE		
		ALL WELLS	55 PERCENT UNSAFE		

All residents were advised of unsafe sample results and instructed to disinfect their systems. However, persistence of unsafe conditions over two summers is strong evidence that problems are ongoing and that periodic shock disinfection with chlorine is not a permanent solution.

Contamination was distributed throughout the community, (see map on page 11), and was prominent in dug wells.

Water is considered "unsafe" for drinking when the total coliform count is greater than 10 per 100 mL of the sample, or fecal coliforms are present. A "doubtful" or "poor" indication is assigned when fecal coliforms are absent and total coliforms are between 2 and 10 per 100 mL of the sample.

Water is considered to be free of disease-causing bacteria and safe for drinking if pollution indicator bacteria are absent. Indicator bacteria are identified and reported as total coliforms and fecal coliforms per 100 mL of the sample. These bacteria are normally found in the intestines of humans and animals and are associated with disease-causing pathogens found in feces. In this manner, indicator bacteria provide a quick test for the possible presence of pathogens in water.

Chemical Water Quality

Approximately 39 percent, or 44 wells, were sampled for chemical analysis and comparison to Ontario Drinking Water Objectives.

As indicated in Table 2 of this report, about 30 percent of the wells have iron levels greater than the Maximum Desirable Concentration (MDC) of 0.3 mg/L.

Table 2

WELL WATER CHEMISTRY - APPLE HILL							
NO.	IRON .30 mg/L	CHLORIDE 250 mg/L	CONDUCTIVITY no limit	AMMONIA no limit	NITRATE 10 mg/L	NITRITE 1mg/L	FLUORIDE 2.4mg/L
1	2.1	167.4	1242	0.05	0.02	0.002	0.13
4	0.08	197.2	1152	0.03	0.02	0.002	0.22
9	0.05	143.8	672	0.04	1.5	0.018	0.13
13	0.05	99.6	1004	0.01	8.5	0.002	0.12
14	0.05	82.3	984	0.01	4.8	0.008	
15	7.2	216.2	1033	0.13	0.012	0.002	0.16
17	0.05	60.9	585	0.27	0.02	0.002	1.08
21	0.8	279.8	1480	0.03	0.018	0.09	0.22
23	0.05	151.9	943	0.06	2.6	0.002	
27	0.05	73.6	1057	0.03	2.4	0.062	
28	0.08	38.6	948	0.03	13.14	0.002	0.14
29	0.08	44.8	735	0.11	0.02	0.002	0.3
38	0.1	25.3	753	0.03	0.98	0.052	0.18

	Fe	Cl	Cond.	Amm	Nitrate	Nitrite	F
39	0.05	154.1	1195	0.23	4.75	0.002	0.13
40	0.05	19.7	717	0.01	2	0.018	
43	0.05	13.9	742	0.01	6.8	0.008	
48	0.05	83.8	1102	0.01	9.99	0.002	0.12
49	0.65	59.9	741	0.16	0.02	0.004	0.21
55	1.2	129.6	1084	0.14	0.02	0.002	0.25
56	0.33	127.2	1122	0.01	0.02	0.006	0.21
60	5	4.7	750	0.26	0.02	0.002	
61	2	126.8	1017	0.13	0.02	0.002	0.26
67	0.85	10.8	462	0.01	0.02	0.002	0.24
71	1.5	38.9	704	0.05	0.02	0.004	0.17
82	2.5	30.6	470	0.01	0.4	0.03	
83	0.1	176.3	1179	1.7	10.77	0.003	0.12
84	0.05	41.1	631	0.01	2.6	0.002	0.1
85	1	19.1	462	0.15	0.02	0.002	0.19
88	0.05	48.6	909	0.02	5	0.002	
91	0.08	78.5	877	0.01	0.458	0.006	0.15
92	0.25	24.5	576	0.03	0.02	0.006	
94	0.1	19.7	629	0.03	1.8	0.004	
95	0.1	3.1	569	0.01	0.24	0.002	0.1
96	0.05	84.9	1158	0.02	6.8	0.002	0.1
103		0.05	36.3	562	0.01	4.3	0.002
105		0.05	26	576	0.15	0.02	0.002
107		0.1	175.22	1139	0.15	1.56	0.184
109		0.05	38.1	787	0.01	1.82	0.004
111		0.05	205.8	1320	0.01	4.6	0.002
128		0.3	47.1	724	0.02	0.02	0.002
130		0.5	17.9	430	0.27	0.02	0.002
132		0.1	31.9	650	0.02	4.4	0.002
134		0.05	25.7	566	0.01	3.4	0.002
AVERA	0.65	80.96	847.40	0.10	0.08	2.46	0.20
* - IRON - 30 PERCENT EXCEED THE LIMIT							
** - BASED ON CONDUCTIVITY LEVELS, TOTAL DISSOLVED SOLIDS ARE EXCEEDED							
IN 52 % OF THE WELLS. AVERAGE T.D.S. IS CALCULATED TO BE 548 mg/L.							

(continued)

Conductivity results show that 52 percent of supplies contain total dissolved solids over the MDC limit of 500 mg/L, which represents an approximate conductivity of 750 umhos per cm. These parameters are aesthetic problems and are not considered of health significance.

Less than 2 percent of the wells have chlorides above the MDC level of 250 mg/L.

In terms of Maximum Acceptable Concentrations (MAC) prescribed by the Objectives, nitrate-nitrogen and fluoride tests were done. Only 2 water supplies were found to exceed the limit of 10 mg/L for nitrate. Average fluoride content was .2 mg/L, and none of the wells were over the MAC of 2.4.

Laboratory sample submission sheets can be found in Appendix E of this report.

SEWAGE DISPOSAL SYSTEMS

In the absence of municipal sanitary sewers in Apple Hill, conventional septic tank systems serve most houses, but there are also a number of direct discharges of domestic sewage to storm sewers and open ditches on Kenyon and Kennedy Streets.

From interviews, 72 percent of the establishments are on septic tanks, 3 percent holding tanks, 6 percent outside privy houses, and the rest are unknown. Several direct discharges are suspected in this last group.

Operational malfunctions are rare according to questionnaire results. However, an unusually high 65 percent of occupants stated that their sewage systems had been cleaned out within the past 2 years. This frequency differs significantly from normal, and, as such, is likely symptomatic of problems.

Sixty-five percent of sewage systems are older than 10 years, 26 percent are over 20 years old, and the average age is greater than 15 years; (See appendix B for a summary of sewage system information).

STORM WATER SYSTEM

During the survey, there were only 6 reports of system breakdown by the residents interviewed. However, ditch and stream samples indicate that there are significant contamination problems in the storm water system. Table 3 summarizes the laboratory analyses, and the map on page 12 shows the sample locations.

Table 3

STORM WATER SYSTEM SAMPLE RESULTS-APPLE HILL						
STATION	1	2	3	4	5	6
PARAMETER	SOUTH SEWER	CENTRE DITCH	WEST DITCH	EAST OUTFALL	NORTH STREAM	NORTH OUTFALL
FEC. COL.	4,900	4,000	200	1,200	400	>15000
FEC.STREP	700	1,600	2,800	1,200	1,100	200
BOD	4	4	<4	2	2	10
SS	28	7	3	5	8	14
NITROGEN	3.0	2.77	1.47	1.23	2.39	2.82
PHOS.	0.28	0.36	0.20	0.08	0.54	0.98
AMMONIA	1.0	1.5	.3	.15	.95	.6
NITRITE	.10	.10	.06	.04	.05	.10
NITRATE	2.7	1.9	1.94	2.36	.95	1.9

Bacteriological determinations indicate that fecal coliforms were present in all streams and sewer outfalls sampled during the spring thaw of April 1989. With the exception of the small tributary of River Baudet north of the village, the drainage network was dry during both sampling periods.

In 1990, as part of a complaint investigation, a sample collected near Station 6 contained fecal coliforms; therefore, confirming continuing pollution.

SUMMARY AND CONCLUSIONS

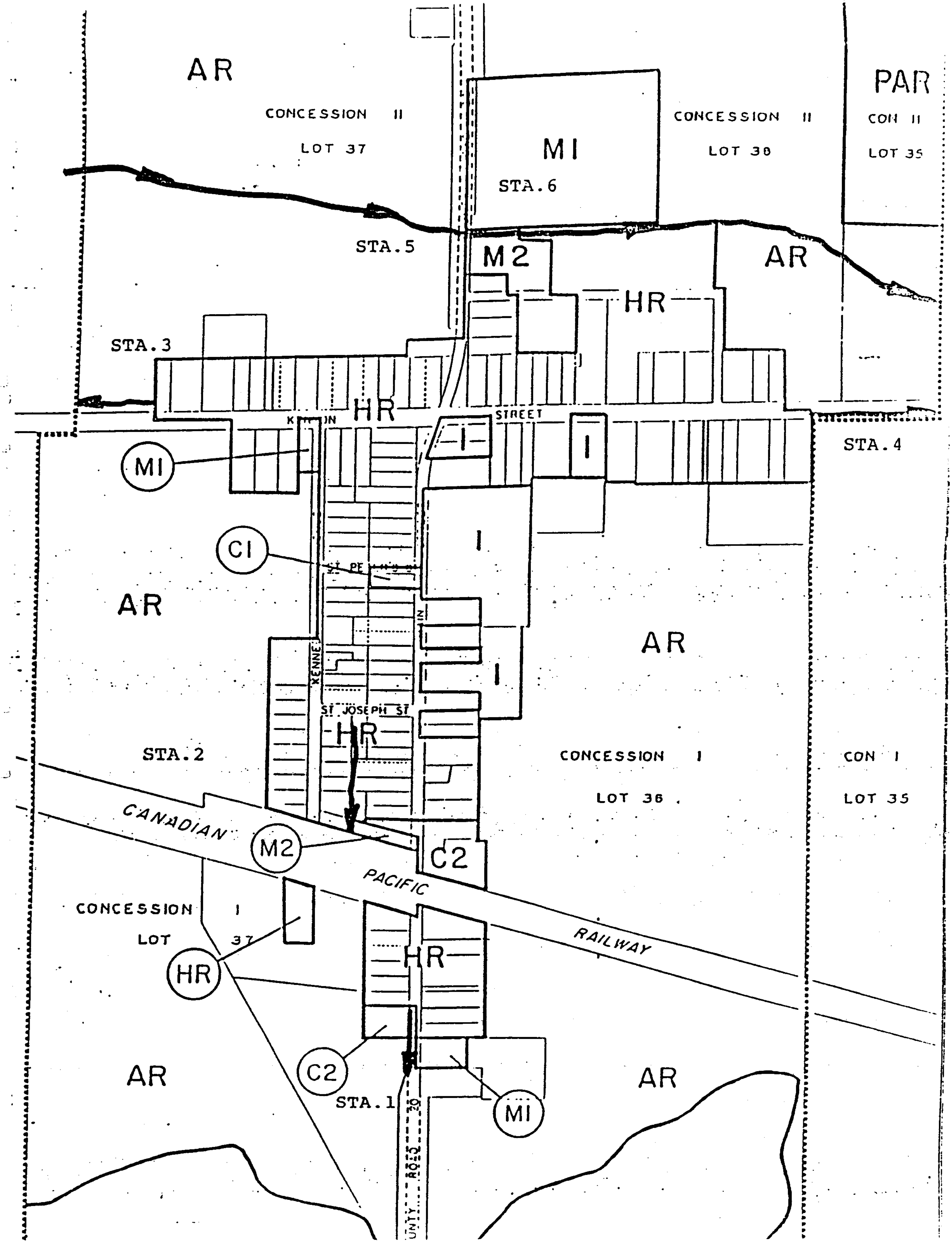
A private systems pollution survey was performed by the Ministry of the Environment in the community of Apple Hill in July 1989, and follow-up sampling was completed in July and August 1990.

All establishments were visited and 87 occupants were interviewed.

Approximately 81 percent of the wells were sampled for bacteriological determination. The survey revealed that 55 percent of wells were "unsafe" for drinking.

Bacteriological contamination occurs mainly in dug wells and is widespread throughout the village.

There were also 44 samples collected and analyzed for chemical water quality. The results indicate that approximately 30 percent of the wells have an elevated level of iron, and that total dissolved solids are above the Maximum Desirable Concentration in 52 percent of the water supplies.



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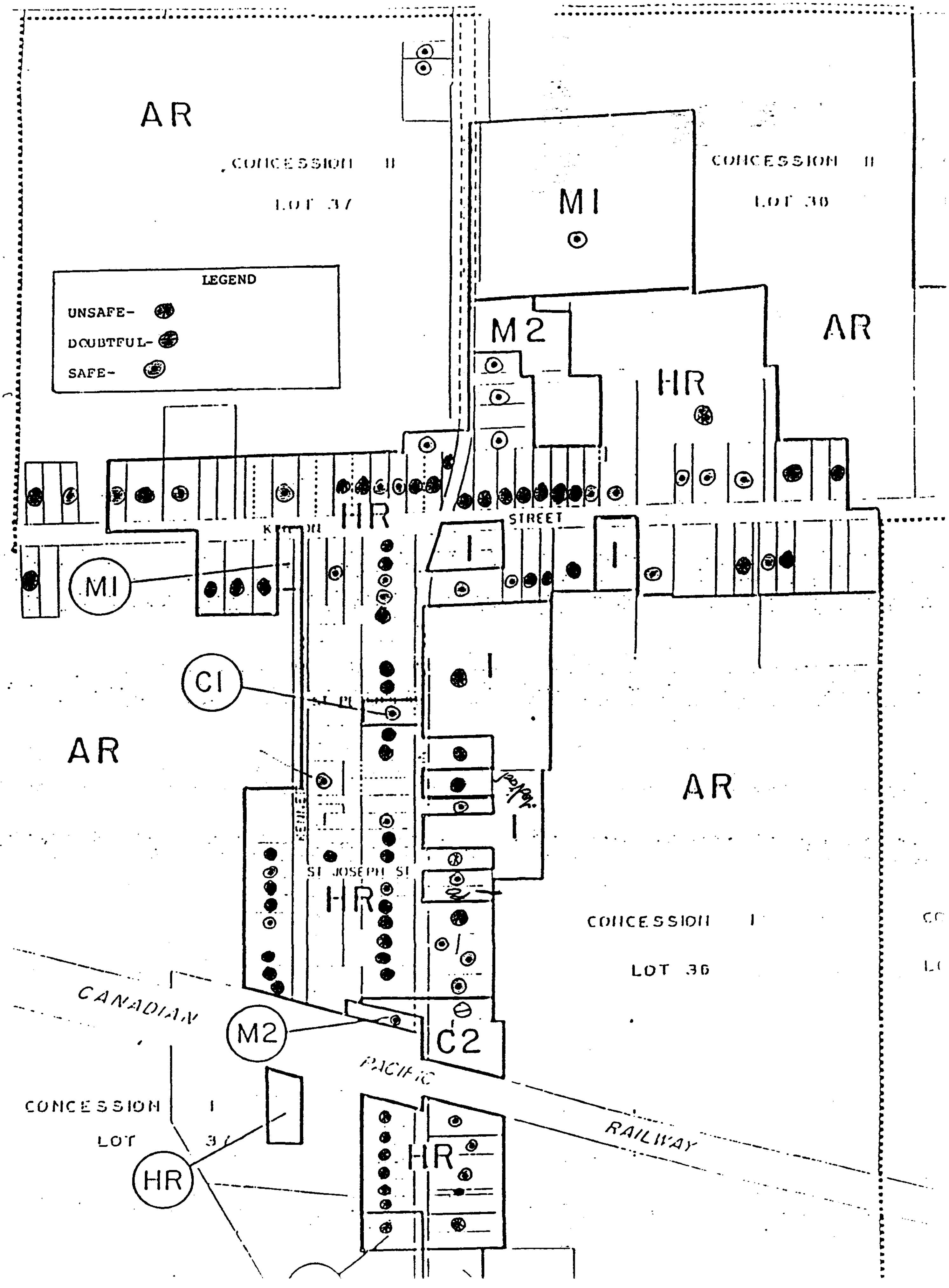
APPENDIX A

APPLE HILL
ESTABLISHMENT/OCCUPANT LIST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CANADIAN
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PACIFIC
CONCESSION I
LOT 37
RAILWAY
HR
HR

The Maximum Acceptable Concentration for nitrate is exceeded in only 2 wells, and fluoride levels in all wells are acceptable.

Operational malfunctions are rare according to questionnaire results; however, the average age of sewage systems is greater than 15 years. The high clean-out frequency reported may be a symptom of tired old substandard systems.

Storm sewer and stream samples display the presence of human and animal waste inputs indicating that there are direct discharges to the storm sewer systems.

RECOMMENDATIONS

Because of bacteriological contamination, generally poor well water chemistry, and the relatively old age of private water and sewage disposal systems in Apple Hill, it is recommended that the municipality of the Township of Kenyon initiate action to resolve the problems. It is recommended that the municipality apply for a Private System Funding Program.

Appendix E - Well Record (test wells)

DATUM: ELEVATION AT TOP OF STEEL CASING = 92.53 m
GROUND SURFACE ELEVATION = 92.00 m

DRILLING DATE: March 9, 1995

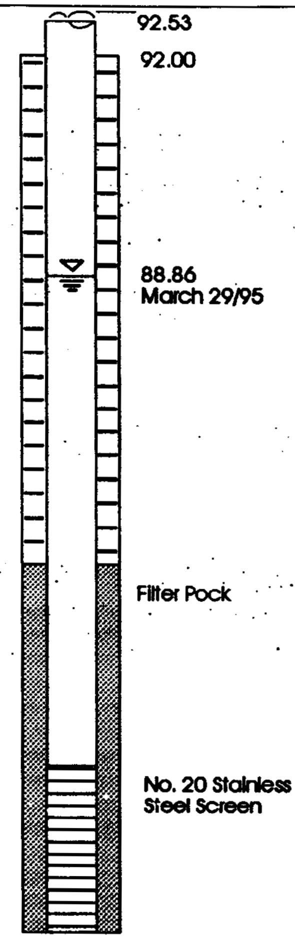
HOLE #: **TW228**

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface	92.00					0.0	92.00
Brown compact clay silt and sand with cobbles-TILL.	88.00					2.0	90.00
Grey compact silty sand with cobbles and clay with more gravel and becoming moist at depth.	85.90					4.0	88.00
Wet grey sand and gravel with minor silt. Yield estimated to be 45 L/min.	79.80					6.0	86.00
						8.0	84.00
						10.0	82.00
Borehole Terminated						12.0	80.00

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE	BOREHOLE LOG LOT 228
JOB	APPLE HILL PRIVATE WATER CORRECTION
DATE	JUNE 1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

DATUM: ELEVATION AT TOP OF STEEL CASING = 91.54 m
GROUND SURFACE ELEVATION = 90.80 m

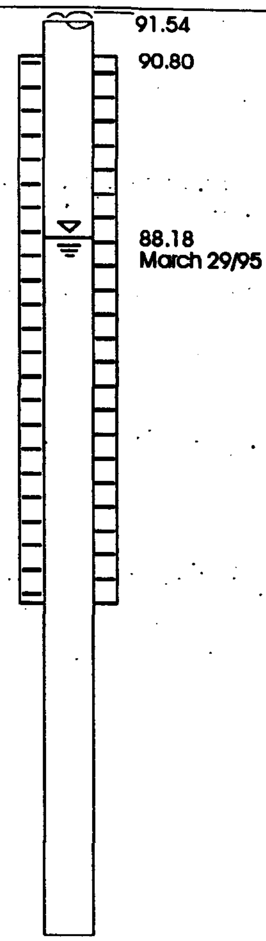
DRILLING DATE: March 10, 1995

HOLE #: **TW404**

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface	90.80					0.0	90.80	
Brown, compact clay silt and sand with cobbles-Till.	86.80					2.0	88.80	
Grey compact silty sand with cobbles and clay-TILL.	82.90					4.0	86.80	
Dense grey limestone, fractured at 81.6 to 81.7 m yielding water at 10 - 13 L/min.	78.60					6.0	84.80	
Borehole Terminated						8.0	82.80	
						10.0	80.80	
						12.0	78.80	



M.S. THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS	FIGURE TITLE: BOREHOLE LOG LOT 404	DATE	JUNE 1995
		SCALE	NOT TO SCALE
	JOB: APPLE HILL PRIVATE WATER CORRECTION	DRAWN	JASB
		JOB No.	94519

Appendix F - Test Well Evaluation

REPORT OF ANALYSIS

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

LABORATORY I.D.:	300395-1	CLIENTS JOB NUMBER:	MSTA, Apple Hill Private
SAMPLE MATRIX:	Well Water	DATE SUBMITTED:	30-03-95
REPORT NUMBER:	3532104	DATE REPORTED:	21-04-95

SUBDIVISION WELL WATER	UNITS	RESULTS				
PARAMETERS		M.D.L.	TW404-1	TW404-2	TW228-1	TW228-2
Colour	T.C.U.	1	1	1	3	2
Hardness($CaCO_3$)	mg/L	1	408	379	594	579
Alkalinity($CaCO_3$)	mg/L	0.1	321	304	250	310
Turbidity	N.T.U.	0.1	14.1	32.4	27.2	3.4
Conductivity	uS/cm	1	45	820	1855	2210
pH		0.00-14.00	7.28	7.27	7.25	7.20
Fluoride	mg/L	0.1	0.4	0.4	<0.1	<0.1
Chloride	mg/L	1.0	63.0	55.0	419	523
Nitrite (N)	mg/L	0.1	<0.1	<0.1	<0.1	<0.1
Nitrate (N)	mg/L	0.1	0.5	1.2	0.6	0.9
Sulphate	mg/L	1.0	63.1	64.5	67.3	68.6
Calcium	mg/L	0.2	96.4	85.0	112	132
Magnesium	mg/L	0.2	40.6	40.4	76.5	60.6
Sodium	mg/L	0.3	24.7	23.0	169	238
Potassium	mg/L	0.4	3.5	3.0	3.3	3.7
Ammonia (N)	mg/L	0.03	0.07	0.11	0.13	0.07
TKN	mg/L	0.05	0.12	0.22	0.19	0.16
Iron	mg/L	0.01	0.13	0.05	0.02	<0.01
Manganese	mg/L	0.005	0.047	0.028	0.102	0.095
Phenols	mg/L	0.002	<0.002	<0.002	<0.002	<0.002
Hydrogen Sulphide	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Tannin/Lignin	mg/L	0.1	1.1	0.7	1.3	1.4
Silica(Si)	mg/L	0.08	16.8	17.5	15.3	13.8
TOC	mg/L	1	1	1	3	3

REPORT OF ANALYSIS

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

LABORATORY I.D.:	300395-1	CLIENTS JOB NUMBER:	MSTA, Apple Hill Private
SAMPLE MATRIX:	Well Water	DATE SUBMITTED:	30-03-95
REPORT NUMBER:	3532104	DATE REPORTED:	21-04-95

SUBDIVISION WELL WATER	UNITS	RESULTS				
PARAMETERS		M.D.L	TW404-1	TW404-2	TW228-1	TW228-2
Total Coliform	/100ml		7	0	0	0
Fecal Coliform	/100ml		0	12	0	0
HPC	/1ml		22	19	74	78
Fecal Step.	/100ml		4	20	0	0
Anion Sum	meq/L		9.66	9.36	18.41	22.66
Cation Sum	meq/L		9.32	8.65	19.33	22.02
% Difference	%		1.81	3.95	2.43	1.43
Ion Ratio	AS/CS		1.04	1.08	0.95	1.03
Conductivity (calc.)	uS/cm		979	918	2171	2588
TDS (ion sum calc.)	mg/L		612	574	1357	1618
SAR			0.53	0.51	3.02	4.30
Langelier Index	S.I.		0.20	0.12	0.10	0.26

NOTE: Method Detection Limits (M.D.L.) are set up to meet M.O.E. requirements. Actual Instrument Detection Limits (I.D.L.) may be lower in some instances.

Certified by
Greg Clarkin, B.Sc., C.Chem
Lab Manager

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
Gregory Clarkin
CHEMIST

REPORT OF ANALYSIS

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

LABORATORY I.D.: 300395-1
SAMPLE MATRIX: Water
REPORT NUMBER: 3532104

CLIENTS JOB NUMBER: Apple Hill Private
DATE SUBMITTED: 30-01-95
DATE REPORTED: 05-05-95

PARAMETERS	UNITS	RESULTS	
PESTICIDES/HERBICIDES OC/OP/PHENOXY ACID		**MDL**	**TW 228-2**
Aldrin	ppb	0.05	nd
Alpha BHC	ppb	0.05	nd
Beta BHC	ppb	0.1	nd
Delta BHC	ppb	0.05	nd
Gamma BHC (Lindane)	ppb	0.05	nd
Chlordane	ppb	0.1	nd
4,4°-DDD	ppb	0.1	nd
4,4°-DDE	ppb	0.1	nd
4,4°-DDT	ppb	0.1	nd
Dieldrin	ppb	0.1	nd
Endosulfan I	ppb	0.2	nd
Endosulfan II	ppb	0.5	nd
Endosulfan Sulphate	ppb	0.1	nd
Endrin	ppb	0.5	nd
Endrin Aldehyde	ppb	0.5	nd
Carbaryl	ppb	0.09	nd
Diazinon	ppb	0.01	nd
Methyl Parathion	ppb	0.01	nd
Parathion	ppb	0.01	nd
2,4-D	ppb	10	nd
2,4,5-T	ppb	2	nd

MDL = Method Detection Limit nd= not detected

Certified by,
Greg Clarkin, B.Sc., C.Chem
Lab Manager

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
Gregory Clarkin
CHEMIST

CERTIFICATE OF ANALYSIS

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

CLIENT:	MS Thompson & Associates 1345 Rosemount Ave. Cornwall, ON K6J 3E5	DATE SUBMITTED: DATE ANALYZED: DATE REPORTED: CLIENT JOB NUMBER: LOCATION:	30-03-95 02-04-95 21-04-95 MSTA Apple Hill Private
ATTN:	John St. Marseille	SAMPLED BY:	John St. Marseille

Analysis Performed: **Total Extractable Petroleum Hydrocarbons (Diesel Range, C_{10}-C_{28})**

REFERENCE: USEPA/API, "Method for Determination of Diesel Range Organics", Rev.2, 2/5/92

1. Scope and Application

1.1 Analytes

1.1.1 This method is designed to measure the concentration of diesel range organics in water and soil. This corresponds to an alkane range of C_{10}-C_{28} and a boiling point range between approximately 170°C and 430°C.

1.1.2 The method is designed to measure mid-range petroleum products such as diesel or fuel oil. Components greater than C_{28} present in products such as motor oils or lubricating oils are detectable under the conditions of the method. If, based on a review of the chromatogram, the presence of these product types is suspected, additional efforts may be performed including analysis of additional reference materials.

1.2 Quantitation Limits

1.2.1 Quantitation Limits for water are 0.10 mg/L and for soil are 5.0 ug/g when compared to a diesel #2 standard.

2. Method Summary

2.1 500ml of water or 25 grams of soil is spiked with a surrogate compound and extracted with hexane. The extract is dried and concentrated to a volume of 1.0ml. The extract is injected into a capillary column gas chromatograph equipped with a flame ionization detector (FID).

Instrumentation: • Varian 3400 GC/FID SPB-1, 0.75mm, 1.00um, 60m

Analytical Results: Refer to attached Report of Analysis

REPORT OF ANALYSIS

AREC0 CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

LABORATORY I.D.:	300395-1	CLIENTS JOB NUMBER:	MSTA
SAMPLE MATRIX:	Water	DATE SUBMITTED:	30-03-95
DATE EXTRACTED:	02-04-95	DATE ANALYSED:	02-04-95
REPORT NUMBER:	3532104	DATE REPORTED:	21-04-95
LOCATION:	Apple Hill Private		

METHOD: TPH IN WATER BY GC-FID (C_{10}-C_{28}) - Total Extractable Petroleum Hydrocarbons

SAMPLE I.D.	TPH (ppm)	COMMENTS
TW228-2	nd	-

Method Detection Limit = 0.1 ppm (mg/L)

nd = not detected

Analysed by
Anne Landry
Lab Technologist

Certified by
Greg Clarkin, B.Sc., C.Chem
Lab Manager

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
Gregory Clarkin
CHEMIST

CERTIFICATE OF ANALYSIS

AREO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

CLIENT:	MS Thompson & Assoc	DATE SUBMITTED:	30-03-95
	1345 Rosemount Ave.	DATE ANALYZED:	13-04-95
	Cornwall, Ontario	DATE REPORTED:	21-04-95
	K6J 3E5	CLIENT JOB NUMBER:	MSTA
		LOCATION:	Apple Hill Private
ATTN:	John St. Marseille	SAMPLED BY:	John St. Marseille

Analysis Performed: **BTEX and Total Purgeable Hydrocarbons by Purge & Trap GC/MS**

The analytical protocol was based upon U.S. EPA Methods SW846 #5030 and #8260.

• **Low Level Method:** A subsample of the soil is placed in a purging vessel and inert helium gas is purged over the surface of the sample. The volatile organics are absorbed on a carbon-based trap and subsequently desorbed and separated by capillary column gas chromatography mass spectrometry.

• **High Level Method:** A subsample of the soil is extracted with methanol. The methanol extract is subsequently spiked into a blank water sample. The resulting sample is then purged with helium and analyzed by capillary column gas chromatography mass spectrometry.

• **Water Method:** 5ml of sample is placed in a purging vessel, purged with helium and analyzed by capillary column gas chromatography mass spectrometry.

• **Screening Method:** Samples are screened using a headspace GC/PID and GC/FID technique to determine the level of contaminants.

Instrumentation:
• Varian Saturn System (3400 with ITD) DB-624 0.53mm, 75m
• Tekmar LSC 2000 Purge & Trap

Analytical Results: Refer to attached Report of Analysis

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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CHEMIST

AREKO CANADA INC., 40 CAMELOT DRIVE, NEPEAN, ONTARIO, K2G 5X8
TELEPHONE: (613) 228 1145 FAX: (613) 228 1148

LABORATORY I.D.:	300395-1	CLIENTS JOB NUMBER:	MSTA
SITE:	Apple Hille Private	DATE SUBMITTED:	30-03-95
		DATE ANALYSED:	13-04-95
REPORT NUMBER:	3532104	DATE REPORTED:	21-04-95

METHOD: BTEX/TPH IN WATER BY PURGE & TRAP GC-MS

PARAMETERS	PQL	RESULTS				
BTEX		TW228-2				
Benzene	0.0004	nd				
Toluene	0.0003	nd				
Ethylbenzene	0.0004	nd				
m,p - Xylene	0.0010	nd				
o-Xylene	0.0005	nd				
Surrogate % Recovery						
Toluene-d8	-	83.3				
4-Bromofluorobenzene	-	94.7				

PQL = Practical Quantitation Limit
All results in ppm unless stated otherwise
<T = Less than PQL but greater than Method Detection Limit

nd = not detected

Analysed by
Anne Landry
Lab Technologist

Certified by
Greg Clarkin, B.Sc., C.Chem
Lab Manager

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
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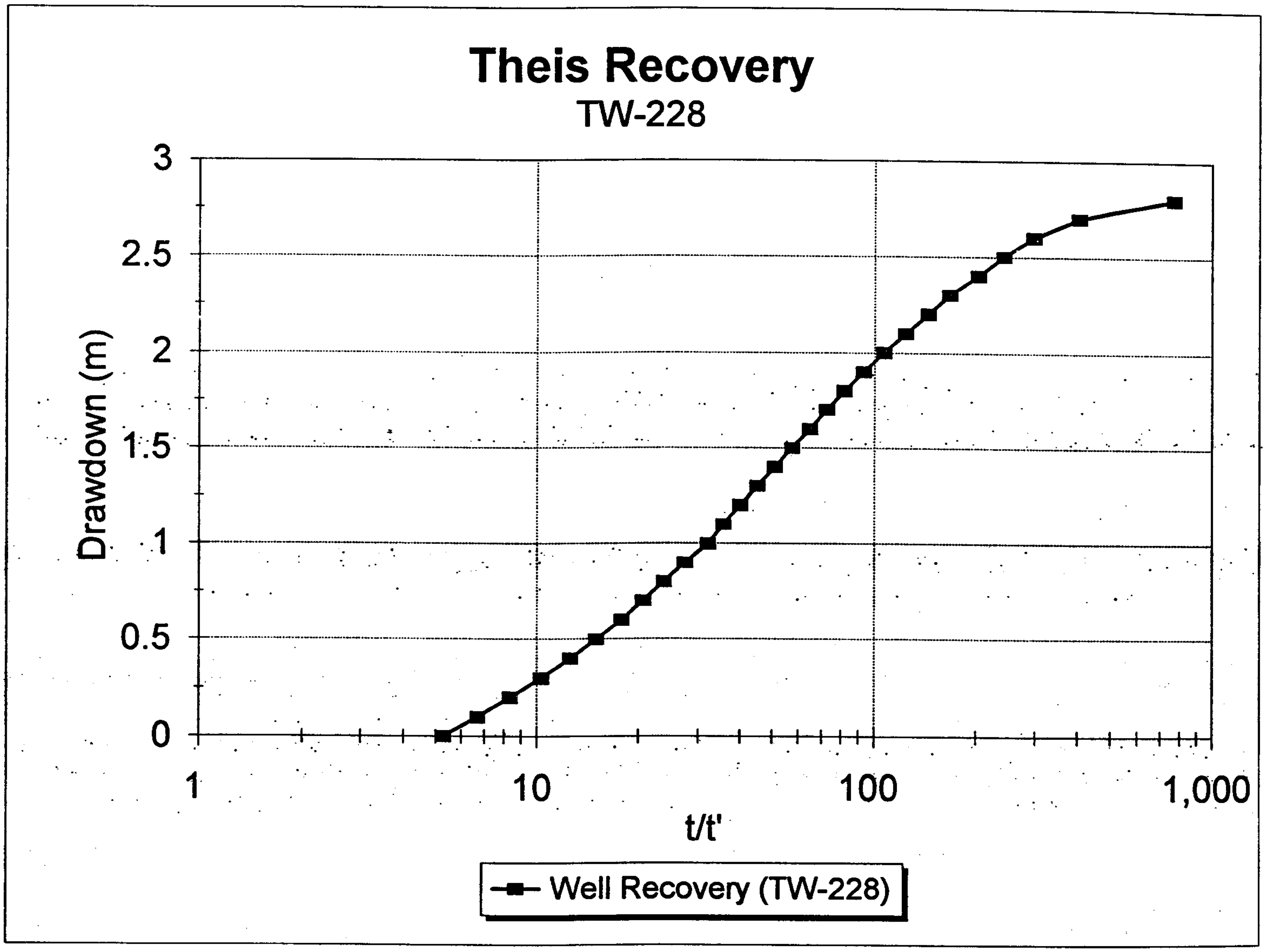
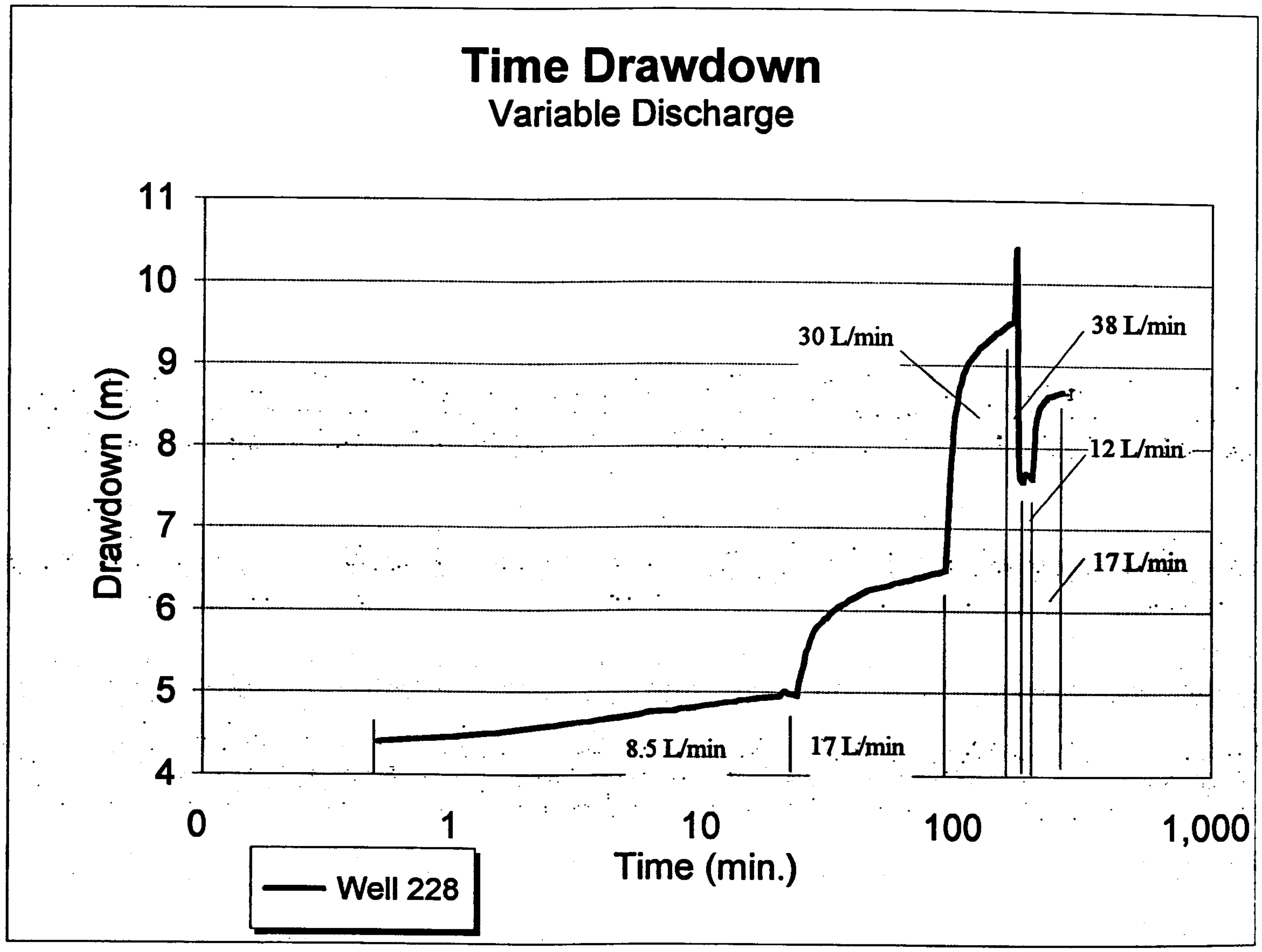
CHEMIST



Theis Recovery
TW-228
Drawdown (m)
3
2.5
2
1.5
1
0.5
0
1
10
100
1,000
t/t'
Well Recovery (TW-228)



Time Drawdown
Variable Discharge
Drawdown (m)
11
10
9
8
7
6
5
4
0
1
10
100
1,000
Time (min.)
Well 228
8.5 L/min
17 L/min
30 L/min
38 L/min
12 L/min
17 L/min

APPLE HILL PUMPING TEST
MARCH 29, 1995

PUMPING WELL TW228					OBSERVATION WELL						
TIME				DRAW	TIME			Benton	Welch K	Lalonde	Benton
H	M	S		(m)	H	M	S				
0	0	30		4.30	11	24	0	3.67	1.05	3.03	1.13
0	1	0	0.5	4.40	12	5	0		1.06	3.03	1.13
0	1	30	1	4.46	13	16	0		1.06	3.04	1.12
0	2	0	1.5	4.51	13	52	0		1.06	3.04	1.11
0	2	30	2	4.56	14	30	0		1.06	3.05	1.12
0	3	0	2.5	4.59	15	10	0		1.06	3.05	1.12
0	3	30	3	4.63	15	44	0		1.06	3.05	1.12
0	4	0	3.5	4.65							
0	4	30	4	4.68							
0	5	0	4.5	4.70							
0	5	30	5	4.72							
0	6	0	5.5	4.74							
0	6	30	6	4.76							
0	7	0	6.5	4.77							
0	7	30	7	4.77							
0	8	0	7.5	4.78							
0	8	30	8	4.80							
0	9	0	8.5	4.81							
0	9	30	9	4.82							
0	10	0	9.5	4.83							
0	10	30	10	4.84							
0	11	0	10.5	4.85							
0	11	30	11	4.86							
0	12	0	11.5	4.87							
0	12	30	12	4.88							
0	13	0	12.5	4.88							
0	13	30	13	4.89							
0	14	0	13.5	4.91							
0	14	30	14	4.91							
0	15	0	14.5	4.91							
0	15	30	15	4.92							
0	16	0	15.5	4.92							
0	16	30	16	4.93							
0	17	0	16.5	4.93							
0	17	30	17	4.94							
0	18	0	17.5	4.94							
0	18	30	18	4.95							
0	19	0	18.5	4.95							
0	19	30	19	4.95							

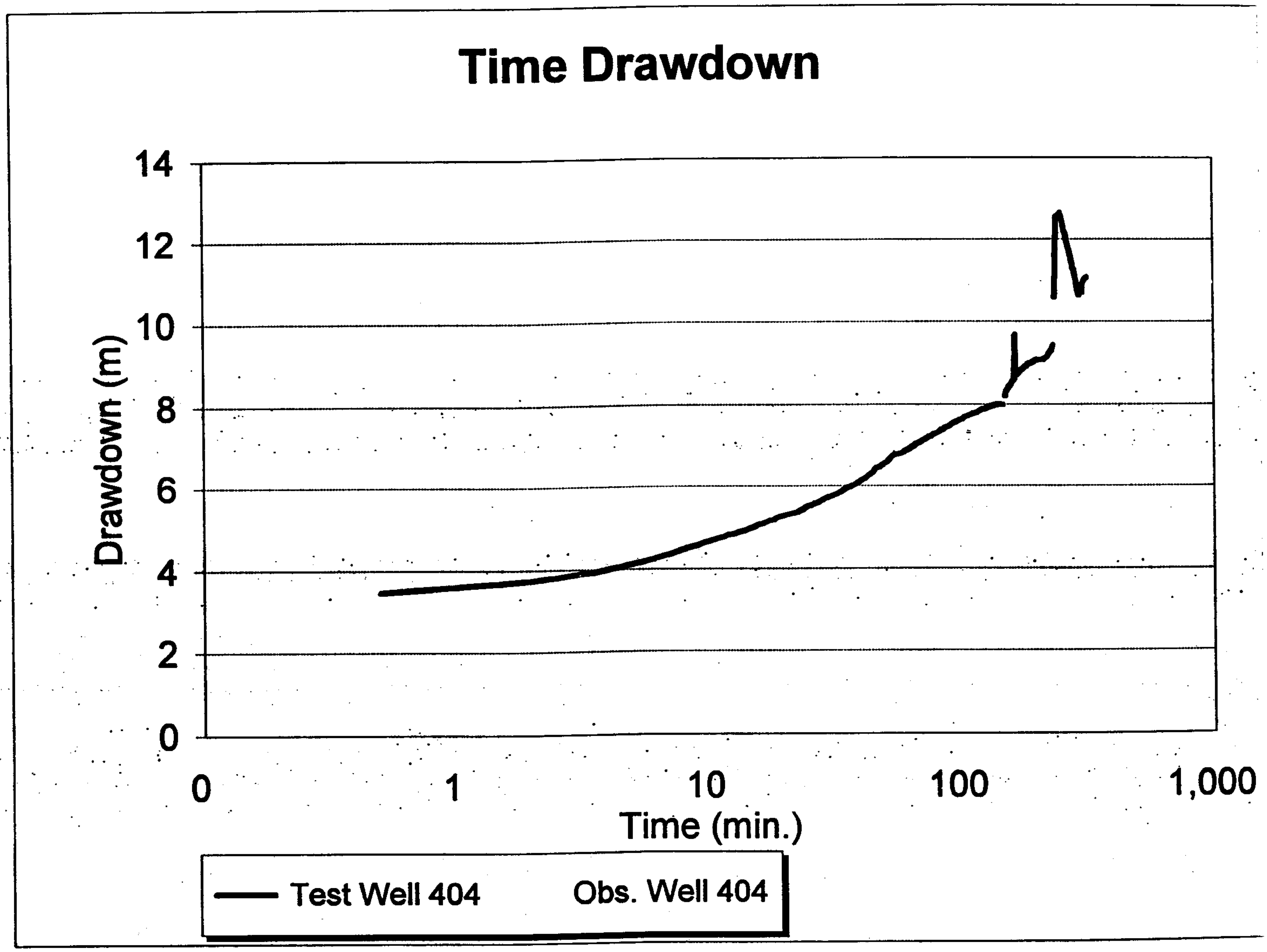
0	20	0	19.5	4.96							
0	20	30	20	5.00							
0	21	0	20.5	5.01							
0	21	30	21	4.99							
0	22	0	21.5	4.98							
0	22	30	22	4.98							
0	23	0	22.5	4.97							
0	23	30	23	4.96							
0	24	0	23.5	5.14			11	48	0	707.5	Increas
0	24	30	24	5.24							
0	25	0	24.5	5.36							
0	25	30	25	5.49							
0	26	0	25.5	5.56							
0	26	30	26	5.64							
0	27	0	26.5	5.70							
0	27	30	27	5.76							
0	28	0	27.5	5.80							
0	28	30	28	5.82							
0	29	0	28.5	5.85							
0	29	30	29	5.87							
0	30	0	29.5	5.90							
0	30	30	30	5.91							
0	31	0	30.5	5.93							
0	31	30	31	5.96							
0	32	0	31.5	5.98							
0	32	30	32	6.00							
0	33	0	32.5	6.01							
0	33	30	33	6.03							
0	34	0	33.5	6.05							
0	34	30	34	6.05							
0	35	0	34.5	6.07							
0	35	30	35	6.08							
0	36	0	35.5	6.09							
0	36	30	36	6.10							
0	37	0	36.5	6.12							
0	44	0	43.5	6.24							
0	44	30	44	6.25							
0	45	0	44.5	6.25							
0	50	0	49.5	6.28							
0	51	0	50.5	6.29							
0	52	0	51.5	6.30							
0	53	0	52.5	6.30							
0	54	0	53.5	6.31							
0	55	0	54.5	6.32							
0	56	0	55.5	6.33							
0	57	0	56.5	6.33							
0	58	0	57.5	6.34							

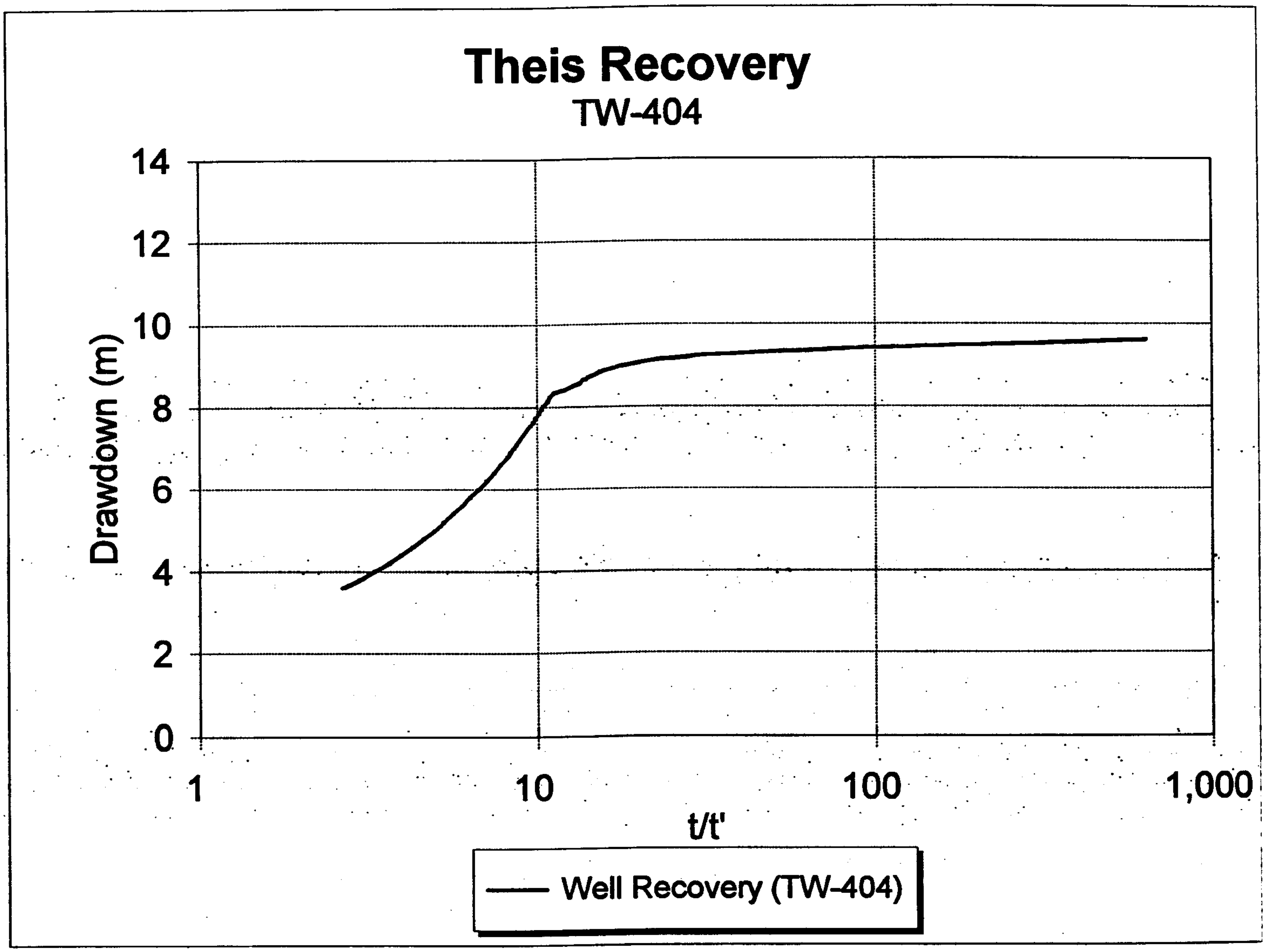
0	59	0	58.5	6.35							
0	60	0	59.5	6.35							
0	61	0	60.5	6.36							
0	62	0	61.5	6.36							
0	65	0	64.5	6.38							
0	68	0	67.5	6.40							
0	69	0	68.5	6.40							
0	70	0	69.5	6.40							
0	80	0	79.5	6.45							
0	85	0	84.5	6.47							
0	90	0	89.5	6.49							
0	92	0	91.5	7.17							
0	92	30	92	7.35							
0	93	0	92.5	7.50							
0	93	30	93	7.65							
0	94	0	93.5	7.78							
0	94	30	94	7.89							
0	95	0	94.5	7.98							
0	95	30	95	8.09							
0	96	0	95.5	8.15							
0	96	30	96	8.22							
0	97	0	96.5	8.29							
0	97	30	97	8.38							
0	98	0	97.5	8.41							
0	99	0	98.5	8.49							
0	100	0	99.5	8.60							
0	101	0	100.5	8.67							
0	102	0	101.5	8.73							
0	103	0	102.5	8.79							
0	104	0	103.5	8.84							
0	105	0	104.5	8.88							
0	106	0	105.5	8.92							
0	107	0	106.5	8.95							
0	108	0	107.5	8.98							
0	109	0	108.5	9.01							
0	110	0	109.5	9.04							
0	120	0	119.5	9.19							
0	121	0	120.5	9.21							
0	130	0	129.5	9.29							
0	131	0	130.5	9.30							
0	135	0	134.5	9.34							
0	140	0	139.5	9.38							
0	142	0	141.5	9.40							
0	145	0	144.5	9.41							
0	152	0	151.5	9.46							
0	157	0	156.5	9.50							
0	159	0	158.5	9.51							

0	160	0	159.5	9.51							
0	166	0	165.5	9.54							
0	168	0	167.5	9.96							
0	168	30	168	10.10			2	12	0	131.5	Increas
0	169	0	168.5	10.25							
0	170	0	169.5	10.41			2	14	30	134	Dirty, P
0	170	30	170	10.42						-0.5	Decreas
0	172	30	172	8.55							
0	173	30	173	8.15							
0	174	0	173.5	8.00							
0	175	0	174.5	7.76						-0.5	Increas
0	176	0	175.5	7.65							
0	177	0	176.5	7.62							
0	178	0	177.5	7.63							
0	179	0	178.5	7.61							
0	180	0	179.5	7.58							
0	181	0	180.5	7.58							
0	182	0	181.5	7.62							
0	184	0	183.5	7.68							
0	185	0	184.5	7.68						-0.5	Decreas
0	191	0	190.5	7.66							
0	197	0	196.5	7.62						-0.5	Increas
0	199	0	198.5	7.91							
0	200	0	199.5	8.04							
0	201	0	200.5	8.14							
0	202	0	201.5	8.22							
0	205	0	204.5	8.37							
0	206	0	205.5	8.40							
0	207	0	206.5	8.43							
0	208	0	207.5	8.46							
0	209	0	208.5	8.47							
0	210	0	209.5	8.49							
0	211	0	210.5	8.50							
0	212	0	211.5	8.52							
0	213	0	212.5	8.53							
0	214	0	213.5	8.54							
0	220	0	219.5	8.59							
0	224	0	223.5	8.61							
0	225	0	224.5	8.62							
0	234	0	233.5	8.64							
0	235	0	234.5	8.64							
0	240	0	239.5	8.65							
0	257	0	256.5	8.68							

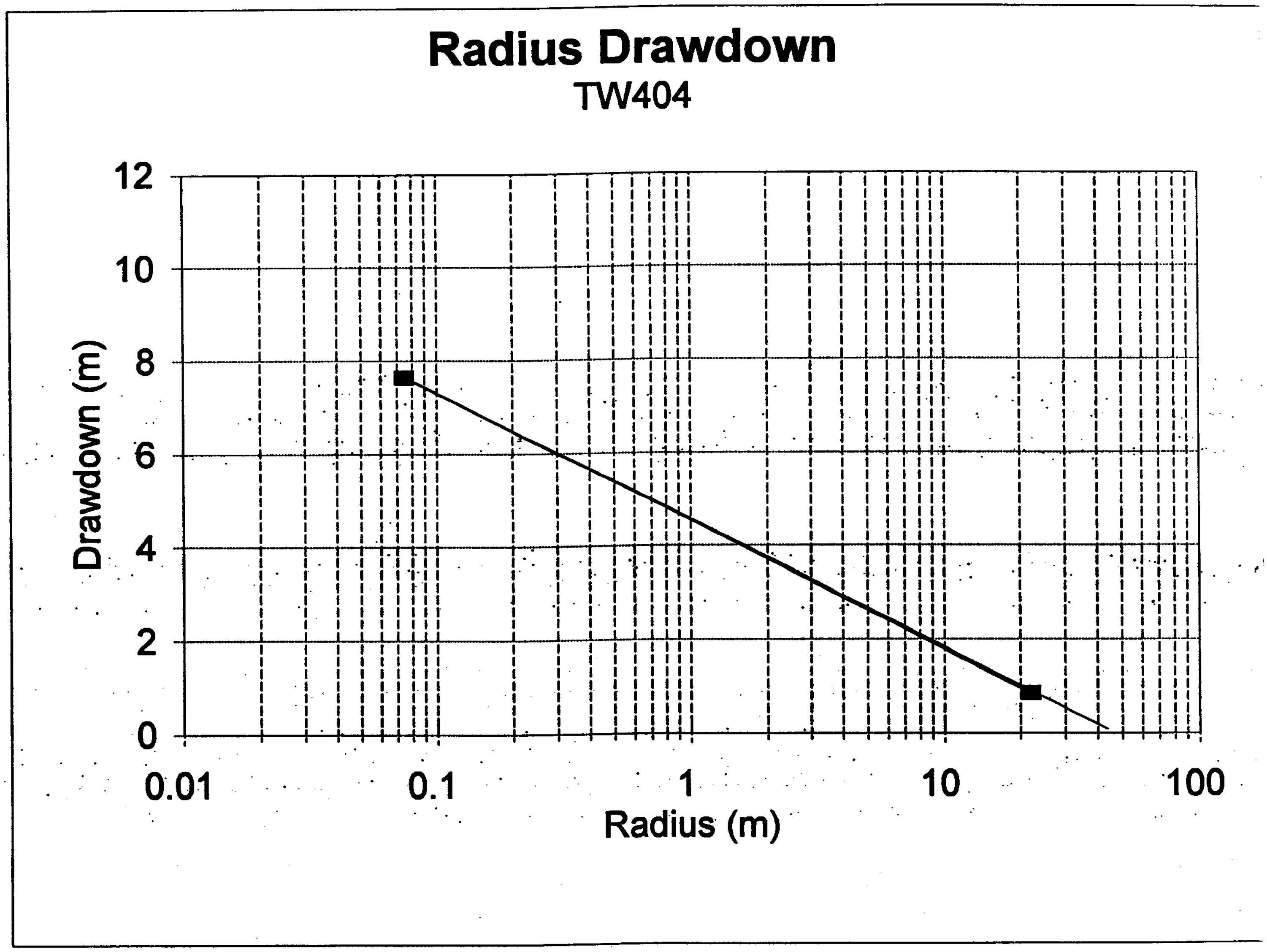
APPLE HILL PUMP TEST - RECOVERY
MARCH 29, 1995

PUMPING WELL TW228								
ELAPSED TIME							Recover	Draw
H	M	S	t'		t	t/t'	(m)	(m)
			min.		min.			
0	0	0			257		7.2	2.90
0	0	20	0.3		257	772	7.1	2.80
0	0	18	0.6		258	407	7	2.70
0	0	14	0.9		258	298	6.9	2.60
0	0	12	1.1		258	242	6.8	2.50
0	0	12	1.3		258	204	6.7	2.40
0	0	16	1.5		259	169	6.6	2.30
0	0	15	1.8		259	145	6.5	2.20
0	0	18	2.1		259	124	6.4	2.10
0	0	20	2.4		259	107	6.3	2.00
0	0	22	2.8		260	93	6.2	1.90
0	0	23	3.2		260	82	6.1	1.80
0	0	24	3.6		261	73	6	1.70
0	0	27	4.0		261	65	5.9	1.60
0	0	31	4.5		262	58	5.8	1.50
0	0	36	5.1		262	51	5.7	1.40
0	0	40	5.8		263	45	5.6	1.30
0	0	45	6.6		264	40	5.5	1.20
0	0	50	7.4		264	36	5.4	1.10
0	0	50	8.2		265	32	5.3	1.00
0	1	28	9.7		267	28	5.2	0.90
0	1	31	11.2		268	24	5.1	0.80
0	1	50	13.0		270	21	5	0.70
0	2	12	15.2		272	18	4.9	0.60
0	3	8	18.4		275	15	4.8	0.50
0	3	48	22.2		279	13	4.7	0.40
0	5	20	27.5		285	10	4.6	0.30
0	7	20	34.8		292	8	4.5	0.20
0	10	10	45.0		302	7	4.4	0.10
0	14	39	59.7		317	5	4.3	0.00


Time Drawdown
Drawdown (m)
14
12
10
8
6
4
2
0
0
1
10
100
1,000
Time (min.)
Test Well 404
Obs. Well 404



Theis Recovery
TW-404
Drawdown (m)
14
12
10
8
6
4
2
0
1
10
100
1,000
t/t'
Well Recovery (TW-404)



Radius Drawdown
TW404
Drawdown (m)
12
10
8
6
4
2
0
0.01
0.1
1
10
100
Radius (m)

APPLE HILL PUMP TEST
MARCH 29, 1995

PUMPING WELL TW403						Comments	OBS WELL 403			
TIME				DRAW	Flow		TIME			DRAW
h	m	s	min.	(m)	m3/day		h	m	s	(m)
9	51	0	0	3.360	0		9	50	0	
9	51	30	0.5	3.470	9.76					2.620
9	52	0	1.0	3.590	9.76					
9	52	30	1.5	3.670	9.76					
9	53	0	2.0	3.740	9.76					
9	53	30	2.5	3.810	9.76					
9	54	0	3.0	3.880	9.76					
9	54	30	3.5	3.930	9.76					
9	55	0	4.0	4.000	9.76					
9	55	30	4.5	4.050	9.76					
9	56	0	5.0	4.120	9.76					
9	56	30	5.5	4.180	9.76					
9	57	0	6.0	4.240	9.76					
9	57	30	6.5	4.300	9.76					
9	58	0	7.0	4.360	9.76					
9	58	30	7.5	4.420	9.76					
9	59	0	8.0	4.470	9.76					
9	59	30	8.5	4.530	9.76					
10	0	0	9.0	4.570	9.76					
10	0	30	9.5	4.620	9.76					
10	1	0	10.0	4.670	9.76					
10	1	30	10.5	4.700	9.76					
10	2	0	11.0	4.740	9.76					
10	2	30	11.5	4.770	9.76					
10	3	0	12.0	4.810	9.76					
10	3	30	12.5	4.840	9.76					
10	4	0	13.0	4.870	9.76					
10	4	30	13.5	4.900	9.76					
10	5	0	14.0	4.930	9.76					
10	5	30	14.5	4.960	9.76					
10	6	0	15.0	5.000	9.76					
10	6	30	15.5	5.030	9.76					
10	7	0	16.0	5.060	9.76					
10	7	30	16.5	5.090	9.76					
10	8	0	17.0	5.120	9.76					
10	8	30	17.5	5.150	9.76					
10	9	0	18.0	5.170	9.76					
10	9	30	18.5	5.200	9.76					
10	10	0	19.0	5.230	9.76		10	12	0	2.490

10	13	30	22.5	5.360	9.76					
10	14	0	23.0	5.390	9.76					
10	14	30	23.5	5.420	9.76					
10	15	0	24.0	5.450	9.76					
10	15	30	24.5	5.480	9.76					
10	16	0	25.0		9.76	PUMP SLO				
10	16	0	25.0	5.500	9.76					
10	16	30	25.5	5.520	9.76					
10	17	0	26.0	5.540	9.76					
10	17	30	26.5	5.570	9.76					
10	18	0	27.0	5.590	9.76					
10	18	30	27.5	5.610	9.76					
10	19	0	28.0	5.630	9.76					
10	19	30	28.5	5.660	9.76					
10	20	0	29.0	5.690	9.76					
10	20	30	29.5	5.700	9.76					
10	21	0	30.0	5.720	9.76					
10	21	30	30.5	5.740	9.76					
10	22	0	31.0	5.750	9.76					
10	22	30	31.5	5.780	9.76					
10	23	0	32.0	5.790	9.76					
10	23	30	32.5	5.820	9.76					
10	24	0	33.0	5.840	9.76		10	25	0	2.490
10	26	0	35.0	5.940	9.76					
10	26	30	35.5	5.960	9.76					
10	27	30	36.5	5.970	9.76					
10	28	0	37.0	6.000	9.76					
10	28	30	37.5	6.010	9.76					
10	29	0	38.0	6.030	9.76					
10	29	30	38.5	6.050	9.76					
10	30	0	39.0	6.070	9.76					
10	30	30	39.5	6.090	9.76					
10	31	0	40.0	6.120	9.76					
10	31	30	40.5	6.140	9.76					
10	32	0	41.0	6.160	9.76					
10	32	30	41.5	6.180	9.76					
10	33	0	42.0	6.200	9.76					
10	33	30	42.5	6.230	9.76					
10	34	0	43.0	6.250	9.76					
10	34	30	43.5	6.280	9.76					
10	35	0	44.0	6.300	9.76					
10	35	30	44.5	6.320	9.76					
10	36	0	45.0	6.340	9.76		10	36	0	2.520
10	37	0	46.0	6.430	9.76					
10	37	30	46.5	6.440	9.76					
10	38	0	47.0	6.450	9.76					
10	38	30	47.5	6.470	9.76					

10	39	0	48.0	6.490	9.76					
10	39	30	48.5	6.510	9.76					
10	40	0	49.0	6.520	9.76					
10	40	30	49.5	6.540	9.76					
10	41	0	50.0	6.560	9.76					
10	41	30	50.5	6.570	9.76					
10	42	0	51.0	6.590	9.76					
10	42	30	51.5	6.620	9.76					
10	43	0	52.0	6.650	9.76					
10	43	30	52.5	6.680	9.76					
10	44	0	53.0	6.710	9.76					
10	44	30	53.5	6.740	9.76		10	48	0	2.590
10	49	0	58.0	6.800	9.76					
10	50	0	59.0	6.820	9.76					
10	51	0	60.0	6.850	9.76					
10	52	0	61.0	6.870	9.76					
10	53	0	62.0	6.900	9.76					
10	54	0	63.0	6.920	9.76					
10	55	0	64.0	6.950	9.76					
10	56	0	65.0	6.970	9.76					
10	57	0	66.0	7.000	9.76					
10	58	0	67.0	7.020	9.76					
10	59	0	68.0	7.040	9.76		11	0	0	2.600
11	2	0	71.0	7.110	9.76					
11	3	0	72.0	7.130	9.76					
11	4	0	73.0	7.150	9.76					
11	5	0	74.0	7.170	9.76					
11	6	0	75.0	7.190	9.76					
11	7	0	76.0	7.210	9.76					
11	8	0	77.0	7.230	9.76					
11	9	0	78.0	7.250	9.76					
11	10	0	79.0	7.270	9.76					
11	11	0	80.0	7.290	9.76					
11	12	0	81.0	7.310	9.76		11	13	0	2.590
11	15	0	84.0	7.360	9.76					
11	16	0	85.0	7.380	9.76					
11	17	0	86.0	7.400	9.76					
11	18	0	87.0	7.420	9.76					
11	19	0	88.0	7.430	9.76					
11	20	0	89.0	7.450	9.76					
11	21	0	90.0	7.470	9.76					
11	22	0	91.0	7.480	9.76					
11	23	0	92.0	7.500	9.76					
11	24	0	93.0	7.520	9.76					
11	25	0	94.0	7.530	9.76		11	26	0	2.600
11	28	0	97.0	7.580	9.76					
11	29	0	98.0	7.590	9.76					

11	30	0	99.0	7.610	9.76					
11	31	0	100.0	7.620	9.76					
11	32	0	101.0	7.630	9.76					
11	33	0	102.0	7.650	9.76					
11	34	0	103.0	7.660	9.76					
11	35	0	104.0	7.680	9.76					
11	36	0	105.0	7.690	9.76					
11	37	0	106.0	7.700	9.76					
11	38	0	107.0	7.710	9.76					
11	41	0	110.0	7.750	9.76		11	39	0	2.630
11	42	0	111.0	7.760	9.76					
11	43	0	112.0	7.770	9.76					
11	44	0	113.0	7.780	9.76					
11	45	0	114.0	7.790	9.76					
11	46	0	115.0	7.800	9.76					
11	47	0	116.0	7.810	9.76					
11	48	0	117.0	7.820	9.76					
11	49	0	118.0	7.830	9.76					
11	50	0	119.0	7.840	9.76					
11	51	0	120.0	7.850	9.76		11	51	0	2.630
11	55	0	124.0	7.890	9.76					
11	56	0	125.0	7.890	9.76					
11	57	0	126.0	7.900	9.76					
11	58	0	127.0	7.910	9.76					
11	59	0	128.0	7.920	9.76					
12	0	0	129.0	7.920	9.76					
12	1	0	130.0	7.930	9.76					
12	2	0	131.0	7.940	9.76					
12	3	0	132.0	7.940	9.76					
12	4	0	133.0	7.950	9.76					
12	5	0	134.0	7.960	9.76					
12	6	0	135.0	7.970	9.76		12	7	0	2.670
12	9	0	138.0	7.990	9.76					
12	10	0	139.0	7.990	9.76					
12	11	0	140.0	7.990	9.76					
12	12	0	141.0	7.990	9.76					
12	13	0	142.0	7.990	9.76					
12	14	0	143.0	7.990	9.76					
12	15	0	144.0	7.990	9.76					
12	16	0	145.0	7.990	9.76					
12	17	0	146.0	7.990	9.76					
12	18	0	147.0	7.990	9.76		12	19	0	2.710
12	21	0	150.0		15.7	Increase Flo				
12	22	0	151.0	8.200	15.7					
12	23	0	152.0	8.340	15.7					
12	24	0	153.0	8.340	15.7					
12	25	0	154.0	8.370	15.7					

12	26	0	155.0	8.400	15.7					
12	27	0	156.0	8.430	15.7					
12	28	0	157.0	8.450	15.7					
12	29	0	158.0	8.480	15.7					
12	30	0	159.0	8.490	15.7					
12	31	0	160.0	8.520	15.7					
12	32	0	161.0	8.540	15.7		12	33	0	2.780
12	36	0	165.0	8.650	15.7					
12	37	0	166.0	9.680	15.7					
12	38	0	167.0	8.700	15.7					
12	39	0	168.0	8.730	15.7					
12	40	0	169.0	8.750	15.7					
12	41	0	170.0	8.770	15.7					
12	42	0	171.0	8.790	15.7					
12	43	0	172.0	8.800	15.7					
12	44	0	173.0	8.820	15.7					
12	45	0	174.0	8.840	15.7					
12	46	0	175.0	8.850	15.7		12	47	0	2.890
12	50	0	179.0	8.890	15.7					
12	51	0	180.0	8.910	15.7					
12	52	0	181.0	8.920	15.7					
12	53	0	182.0	8.930	15.7					
12	54	0	183.0	8.930	15.7					
12	55	0	184.0	8.940	15.7					
12	56	0	185.0	8.950	15.7					
12	57	0	186.0	8.970	15.7					
12	58	0	187.0	8.970	15.7					
12	59	0	188.0	8.980	15.7					
13	0	0	189.0	8.990	15.7		1	1	0	3.050
13	3	0	192.0	9.010	15.7					
13	4	0	193.0	9.020	15.7					
13	5	0	194.0	9.030	15.7					
13	6	0	195.0	9.030	15.7					
13	7	0	196.0	9.040	15.7					
13	8	0	197.0	9.050	15.7					
13	9	0	198.0	9.050	15.7					
13	10	0	199.0	9.060	15.7					
13	11	0	200.0	9.070	15.7					
13	12	0	201.0	9.080	15.7					
13	13	0	202.0	9.080	15.7					
13	16	0	205.0	9.080	15.7					
13	24	0	213.0	9.080	15.7					
13	25	0	214.0		12.6	Increase Flo				
13	25	30	214.5	9.090	12.6					
13	26	0	215.0	9.095	12.6					
13	26	30	215.5	9.100	12.6					
13	27	0	216.0	9.115	12.6					

13	28	0	217.0	9.120	12.6					
13	31	0	220.0	9.155	12.6					
13	32	0	221.0	9.160	12.6					
13	33	0	222.0	9.165	12.6					
13	33	0	222.0		17.9	Increase Flo				
13	34	0	223.0	9.190	17.9					
13	35	0	224.0	9.210	17.9					
13	36	0	225.0	9.230	17.9					
13	37	0	226.0	9.250	17.9					
13	38	0	227.0	9.270	17.9					
13	39	0	228.0	9.290	17.9					
13	40	0	229.0	9.300	17.9					
13	41	0	230.0	9.320	17.9					
13	42	0	231.0	9.335	17.9					
13	43	0	232.0	9.350	17.9		1	44	0	3.490
13	46	0	235.0	9.425	17.9					
13	47	0	236.0		37.7	Increase Flo				
13	48	0	237.0	10.580	37.7					
13	49	0	238.0	10.650	37.7					
13	51	0	240.0	11.480	37.7					
13	52	0	241.0	11.910	37.7					
13	53	0	242.0	12.250	37.7					
13	54	0	243.0	12.560	37.7					
13	55	0	244.0		10.7	Decreased				
13	59	0	248.0	12.620	10.7					
14	1	0	250,0		10.7	Estimated C				
14	1	0	250.0	12.635	10.7					
14	2	0	251.0	12.645	10.7					
14	5	0	254.0	12.520	10.7		2	8	0	3.400
14	9	0	258.0	12.340	10.7					
14	10	0	259.0	12.320	10.7					
14	11	0	260.0	12.275	10.7					
14	12	0	261.0	12.200	10.7					
14	13	0	262.0	12.180	10.7					
14	15	0	264.0	12.110	10.7					
14	16	0	265.0	12.035	10.7					
14	17	0	266.0	11.980	10.7					
14	20	0	269.0	11.870	10.7		2	21	0	3.450
14	24	0	273.0	11.680	10.7					
14	25	0	274.0	11.630	10.7					
14	26	0	275.0	11.600	10.7					
14	27	0	276.0	11.560	10.7					
14	28	0	277.0	11.510	10.7					
14	29	0	278.0	11.450	10.7					
14	30	0	279.0	11.420	10.7					
14	31	0	280.0	11.390	10.7					
14	32	0	281.0	11.340	10.7					

14	33	0	282.0	11.300	10.7					
14	34	0	283.0	11.265	10.7		2	35	0	3.510
14	37	0	286.0	11.120	10.7					
14	38	0	287.0	11.090	10.7					
14	39	0	288.0	11.040	10.7					
14	40	0	289.0	10.990	10.7					
14	42	0	291.0	10.920	10.7					
14	43	0	292.0	10.860	10.7					
14	44	0	293.0	10.780	10.7					
14	45	0	294.0	10.750	10.7					
14	46	0	295.0	10.680	10.7					
14	47	0	296.0	10.630	10.7					
14	48	0	297.0		10.9	Increased Fl	2	48	0	3.470
14	52	0	301.0	10.780	10.9					
14	53	0	302.0	10.790	10.9					
14	54	0	303.0	10.690	10.9					
14	55	0	304.0	10.700	10.9					
14	57	0	306.0	10.940	10.9					
15	5	0	314.0	11.030	10.9		3	7	0	3.470
15	9	0	318.0	11.055	10.9					

APPLE HILL PUMP TEST - RECOVERY
MARCH 29, 1995

PUMPING WELL TW403								OBS WELL 403			
TIME						DRAW		TIME			DRAW
H	M	S	t'	t	t/t'	(m)		H	M	S	(m)
			(min)								
15	12	0	0	318		9.790		3	7	0	3.470
15	12	30	0.5	319	637.0	9.610	6.25				
15	13	0	1.0	319	319.0	9.530	6.17				
15	13	30	1.5	320	213.0	9.480	6.12				
15	14	0	2.0	320	160.0	9.460	6.1				
15	14	30	2.5	321	128.2	9.435	6.075				
15	15	0	3.0	321	107.0	9.420	6.06				
15	15	30	3.5	322	91.9	9.400	6.04				
15	16	0	4.0	322	80.5	9.380	6.02				
15	16	30	4.5	323	71.7	9.360	6				
15	17	0	5.0	323	64.6	9.350	5.99				
15	17	30	5.5	324	58.8	9.340	5.98				
15	18	0	6.0	324	54.0	9.330	5.97				
15	18	30	6.5	325	49.9	9.310	5.95				
15	19	0	7.0	325	46.4	9.300	5.94				
15	19	30	7.5	326	43.4	9.290	5.93				
15	20	0	8.0	326	40.8	9.280	5.92				
15	20	30	8.5	327	38.4	9.270	5.91				
15	21	0	9.0	327	36.3	9.260	5.9				
15	21	30	9.5	328	34.5	9.250	5.89				
15	22	0	10.0	328	32.8	9.240	5.88				
15	22	30	10.5	329	31.3	9.230	5.87				
15	23	0	11.0	329	29.9	9.220	5.86				
15	23	30	11.5	330	28.7	9.200	5.84				
15	24	0	12.0	330	27.5	9.190	5.83				
15	24	30	12.5	331	26.4	9.180	5.82				
15	25	0	13.0	331	25.5	9.165	5.805				
15	25	30	13.5	332	24.6	9.150	5.79				
15	26	0	14.0	332	23.7	9.140	5.78				
15	26	30	14.5	333	22.9	9.125	5.765				
15	27	0	15.0	333	22.2	9.115	5.755	3	28	0	3.490
15	30	0	18.0	336	18.7	9.020	5.66				
15	30	30	18.5	337	18.2	9.000	5.64				
15	31	0	19.0	337	17.7	8.980	5.62				
15	31	30	19.5	338	17.3	8.960	5.6				
15	32	0	20.0	338	16.9	8.940	5.58				
15	32	30	20.5	339	16.5	8.910	5.55				
15	33	0	21.0	339	16.1	8.890	5.53				
15	33	30	21.5	340	15.8	8.865	5.505				
15	34	0	22.0	340	15.5	8.840	5.48				

15	34	30	22.5	341	15.1	8.800	5.44				
15	35	0	23.0	341	14.8	8.770	5.41				
15	35	30	23.5	342	14.5	8.740	5.38				
15	36	0	24.0	342	14.3	8.710	5.35				
15	36	30	24.5	343	14.0	8.660	5.3				
15	37	0	25.0	343	13.7	8.640	5.28				
15	37	30	25.5	344	13.5	8.570	5.21				
15	38	0	26.0	344	13.2	8.550	5.19				
15	38	30	26.5	345	13.0	8.530	5.17				
15	39	30	27.5	346	12.6	8.470	5.11				
15	40	0	28.0	346	12.4	8.450	5.09				
15	40	30	28.5	347	12.2	8.410	5.05				
15	41	0	29.0	347	12.0	8.400	5.04				
15	42	0	30.0	348	11.6	8.370	5.01				
15	42	30	30.5	349	11.4	8.340	4.98				
15	43	0	31.0	349	11.3	8.330	4.97				
15	44	0	32.0	350	10.9	8.230	4.87				
15	44	30	32.5	351	10.8	8.130	4.77				
15	45	30	33.5	352	10.5	8.030	4.67				
15	46	0	34.0	352	10.4	7.930	4.57				
15	46	40	34.7	353	10.2	7.830	4.47				
15	47	30	35.5	354	10.0	7.730	4.37				
15	48	10	36.2	354	9.8	7.630	4.27				
15	49	0	37.0	355	9.6	7.530	4.17	3	50	0	3.510
15	53	0	41.0	359	8.8	7.100	3.74				
15	54	0	42.0	360	8.6	7.000	3.64				
15	55	0	43.0	361	8.4	6.900	3.54				
15	56	0	44.0	362	8.2	6.800	3.44				
15	58	30	46.5	365	7.8	6.600	3.24				
16	1	0	49.0	367	7.5	6.400	3.04				
16	4	0	52.0	370	7.1	6.200	2.84				
16	7	30	55.5	374	6.7	6.000	2.64	4	8	0	3.490
16	11	20	59.3	377	6.4	5.800	2.44				
16	15	30	63.5	382	6.0	5.600	2.24				
16	20	10	68.2	386	5.7	5.400	2.04				
16	25	45	73.8	392	5.3	5.200	1.84				
16	32	0	80.0	398	5.0	5.000	1.64				
16	39	40	87.7	406	4.6	4.800	1.44				
16	48	30	96.5	415	4.3	4.600	1.24				
16	59	10	107.2	425	4.0	4.400	1.04	5	0	0	3.410
17	12	30	120.5	439	3.6	4.200	0.84				
17	30	10	138.2	456	3.3	4.000	0.64				
17	52	30	160.5	479	3.0	3.800	0.44				
18	24	0	192.0	510	2.7	3.600	0.24				

Appendix G - Hydrogeological Study Program for Water Works

APPENDIX "A"

TO THE AGREEMENT FOR ENGINEERING SERVICES

TERMS OF REFERENCE

NAME OF MUNICIPALITY ~

NAME OF COMMUNITY ~ WATER PROJECT NO. ~

GENERAL REQUIREMENTS

The Consulting Engineer is to undertake tasks related to the requirements defined and outlined in the MEA Class Environmental Assessment for the Municipal Water and Wastewater Projects (June 1993) which generally include: identifying the problem(s); the collection, review and analyses of data; notifying government agencies and affected municipalities/public and interested parties about the problem(s) and the alternative solutions; identifying and evaluating alternative solutions to the problem and alternative designs before determining the recommended solution; convening and participating at public information meetings for all interested parties; and confirming the preferred solution. For Schedule C projects, the Consulting Engineer shall also prepare the Environmental Study Report (ESR) referred to in the MEA Class Environmental Assessment Document (incorporate previous reports when necessary).

It is to be noted that these Terms of Reference have been developed on the assumption that the preferred solution will be a Schedule C activity and that an Environmental Study Report (ESR) will be required. The requirement for an ESR, however, will only be confirmed at the end of Phase 2.

The ESR is to detail the planning and design process for a (name of project) ~ for the (Municipality) ~. It should also be sufficiently detailed to permit the municipality to obtain a Conditional Certificate of Approval from the Ministry of Environment and Energy (the "Ministry") for the required works after the 30-day public review period, as well as to facilitate the arrangement of financing for the program.

It is important that the problem(s) to be addressed in the study be defined in consultation with the (Municipality) ~ and the Ministry. Accordingly, it is necessary to review all previous reports and other pertinent data relating to problems and deficiencies with the present (system description) ~, as well as recommending any investigations required to obtain additional information.

In this regard, the formation of a Liaison Committee is proposed, to consist of representatives from the Municipality, the Ministry, the Ontario Clean Water Agency (the "Agency"), and the Consulting Engineer. The Liaison Committee would provide direction to the Consulting Engineer on the nature and scope of assigned tasks.

In carrying out the study, the Consulting Engineer should refer to the applicable section(s) of the Ministry's "Guidelines for the Design of Sanitary Sewage Works, Storm Sewers (Interim), Water Distribution Systems, Water Storage Facilities, Servicing of Areas Subject to Adverse Conditions, Water Supply for Small Residential Developments, Seasonally Operated Water Supplies and the associated Appendices" as well as the Ministry's "Guidelines for the Design of Water and Sewage Treatment Works".

In addition, for the demand management portion of the study, the Consulting Engineer should refer to the "Water Conservation Guidebook for Small and Medium-Sized Utilities" (August 1993) published by the AWWA, Pacific Northwest Section (PNWS) Water Conservation Committee.

The Consulting Engineer is required to maintain a complete project file, as outlined in Chapter 6.1 of the MEA Class EA for Municipal and Wastewater Projects document for projects of all Schedules. The intent of the Project File is to provide a chronological record of all activities, background and new information received, and the decision-making process throughout the course of the Class EA work. The Project File is not intended to be a polished document but forms the basis from which the Phases 1 & 2 Report and the ESR are derived. By maintaining a Project File, the amount of background and secondary information normally contained in these reports can be reduced. This should result in a more streamlined Phase 1 & 2 Report and/or ESR.

WORK PROGRAM FOR PHASE 1 AND PHASE 2

Note: The numbering in this work program corresponds with the various "Phases" and "Steps" outlined in the MEA Class EA for Municipal Water and Wastewater Projects.

PHASE 1

1.1.0 Meet with the Agency's Project Manager and Liaison Committee to review the Terms of Reference and the Consulting Engineer's proposed work program.

1.1.1 Meet with staff of the Ministry District Office and the local Health Unit to review all previous reports, surveys, and other pertinent data and useful sources of information.

1.1.2 Identify and confirm the problems to be addressed, some of which are:

* - current problems (quality and/or quantity) being experienced with existing individual private water systems
* - current problems being experienced with communal water distribution system (e.g., inadequate working pressure, etc.)
* - water storage requirements
* - need for fire protection
* - current problems being experienced at the existing water treatment facility (e.g., disposal of treatment wastes, plant inefficiency, inadequate treatment capacity, etc.)
* - ~

1.1.3 Comment on:
- restrictions on the installation of private water supplies
- areas which could or could not support private water supply replacement or upgrading
- present and future options on fire protection.

*Delete if inapplicable ~

1.1.4 Define problem area(s) to be serviced:

- initially
- potentially in the future (20 years).

1.1.5 Determine whether further information is required to finalize the problem identification and obtain concurrence through the Agency's Project Manager.

1.1.6 Discuss with Liaison Committee regarding public input, scope of study and existing problems and attempt to identify potential future problem areas. Determine whether or not discretionary public consultation is required; and if not, finalize the problem identification.

1.2.0 If discretionary public consultation is deemed necessary, determine in discussions with Liaison Committee what form or degree of public consultation should be undertaken. A notice advertised in a local paper briefly outlining problem definition, planning process, scope of study and a request for interest in the project may be sufficient at this point.

1.2.1 Undertake the public consultation process to present the problems identified and seek input from the public and/or review agencies. Receive and evaluate all input from the public and all concerned review agencies. ***(This discretionary public consultation can also be undertaken after 2.1.1.)***

1.2.2 Finalize the problem identification.

END OF PHASE 1

PHASE 2

2.1.0 Identify alternative solutions including but not limited to the following:

- correction of individual private water systems in accordance with the Ontario Water Resources Act, R.S.O. 1990, c.O.40 and Ontario Regulation 903
- * - undertaking a system optimization program to help improve the efficiency of the existing water treatment facility
- * - undertaking a demand management program on existing water systems
- * - connect to an existing "Area" water supply system
- * - construct a communal water supply and treatment facility utilizing *groundwater/surface water source
- * - construct a communal water storage facility
  (a) inground, with and without fire protection
  (b) elevated, with and without fire protection
- * - construct a communal water distribution system with or without meters
- * - combination of communal and private systems
- limit community growth
- do nothing.

2.1.1 Review alternative solutions identified and determine whether the project falls under Schedule A. If the project is a Schedule A activity, no further work under the Class EA is required. If the project is either a Schedule B or C activity, continue with work plan.

2.1.2 Determine the mandatory contacts and review agencies in accordance with Section 5.1.4 and Appendix 3 of the MEA Class EA for Municipal Water and Wastewater Projects document and submit list of mandatory contacts and review agencies to the Agency's Project Manager and the Liaison Committee for review comments.

2.2.0 Define population projections (20 years), annual rate of population growth, flow and water demand projections and storage requirements (with and without fireflow) associated with the existing/new works and identify constraints. The project must support development which is in line with the provincial Growth and Settlement Guidelines and the municipality's official plan. The project should also encourage intensification; that is, further develop areas which already have services in place.

*** Delete if inapplicable.**

2.2.1 Potable water produced by the recommended solution must meet the Ministry's Drinking Water Objectives of Ontario.

2.2.2 Define flow reduction methodologies to be evaluated, consistent with the AWWA -PNWS "Water Conservation Guidebook" dated August 1993, the extent of evaluation, and impact of the alternatives on the natural, social and economic environment, for the following:

- installation of individual water meters at each point of water usage, and charging on the basis of volume of water used;

- establish a charge structure to discourage excessive water use which will mean the utilization of a constant rate charge or an increasing block rate price structure;

- implement a peak use surcharge where excessive peaking is occurring, especially for residential users, to encourage reasonable water use;

- develop and implement an information program aimed at encouraging water users to use water wisely, to use landscaping that is drought tolerant and to install water efficient equipment;

- provide audits and/or financially assist water users with the replacement of existing toilets, showerheads and faucet aerators with ultra low flow (6 litre/flush) toilets and water and energy efficient showerheads and faucet aerators in order to reduce per capita water flows;

- provide audits and financially assist the retrofit of water use fixtures and equipment in the premises of commercial, industrial and institutional water users in order to deliver the same service but use less water;

- adopt and enforce municipal by-laws to reduce water use, particularly during summer peaks (e.g., lawn watering restrictions, ban on use of once-through water cooled air conditioning);

- ensure that all water and wastewater costs are included in the consumer's water bill and that they are itemized and readily understandable;

-* reduce loss of water from existing mains and pipes to industry accepted standards.

2.2.3 Define water distribution system alternatives to be evaluated, extent of evaluation, and impact of each of the alternatives on the natural, social and economic environment.

*Assess the impact of a communal water distribution system on the existing individual private sewage disposal systems in the proposed service area.

2.2.4 Define alternatives for water storage (e.g., ground or elevated, and with or without fire protection) to be evaluated, extent of evaluation, and impact of each of the alternatives on the natural, social and economic environment.

2.2.5 Define alternative water supply/treatment methods to be evaluated. The requirements of treatability studies, disposal of treatment wastes and/or groundwater hydrogeologic studies are also to be addressed.

Carry out a hydrological study by a qualified hydrogeologist in accordance with Part 1 of Appendix C attached hereto to obtain sufficient information to address the option of using groundwater as a supply for a communal system.

Define the extent of the evaluation, and impact of the alternative on the natural, social and economic environment for each alternative treatment method and site investigated.

The evaluation methods for the various alternatives and sites considered under items 2.2.2 to 2.2.5 inclusive shall be carried out in accordance with the report entitled "Evaluation Methods in Environmental Assessment (August 1990)" prepared for the Ministry's Environmental Assessment Branch.

Include alternative cost comparison scenarios for each option considered (i.e., system optimization and/or water efficiency program vs. capital cost of expansion) and show the impact on the water bill of a typical homeowner and industry of the rate increase to fund the project over the amortization period of the most expensive option).

*** Delete if inapplicable**

2.3.0 Detail the additional information and data required to identify the impact of each of the alternatives on the environment in order to adequately evaluate the alternatives identified in 2.2.2 to 2.2.5, complete with work schedule and costs for each component.

2.3.1 In consultation with the Liaison Committee, finalize the additional information and data requirements on the alternatives to be evaluated.

2.4.0 After compiling all necessary information and data and input from any previous contacts with review agencies and the public, evaluate the identified alternative solutions including the impact of the alternatives on the environment and identify a recommended alternative.

2.4.1 Review 2.4.0 with Ministry staff through the Agency's Project Manager and with Liaison Committee.

2.4.2 With information from 2.4.0 consider the necessity of, and make recommendation on, optioning land.

2.4.3 Prepare a preliminary Phase 1 & 2 Report. The format and content of the Phase 1 & 2 Report should be consistent with that outlined in the Section 6.2 of the MEA Class EA for Municipal Water and Wastewater Projects document.

Items to be included are:
- introduction and background
- documentation of the problem
- alternative solutions to the problem
- environmental and economic impacts of each of the alternative solutions
- evaluation of each of the alternative solutions
- identification of recommended solution(s)
- identification of EA category (Schedule B or C activity) of the recommended solution.

2.4.4 Submit the preliminary Phase 1 & 2 Report and the list of mandatory contacts for review and comments to the Agency's Project Manager and the Liaison Committee.

2.4.5 Present preliminary Phase 1 & 2 Report to the Municipal Council outlining the following:

- documentation of the problem
- service area information
- water distribution system alternatives
- water storage alternatives and sites considered
- water treatment alternatives and sites considered
- need for property options, easements, etc.
- environmental and economic impacts of each of the alternative solutions
- recommendations for the preferred solution
- identification of EA category (Schedule B or C activity) of the recommended solution.

2.4.6 Upon concurrence of Municipal Council in form of a resolution, assist in obtaining options on any required land and/or easements. Preparation of a property report may be necessary.

2.5.0 Circulate the preliminary Phase 1 & 2 Report to the mandatory contacts and to any interested and/or affected other government agencies and public, requesting input and comments within a specified time-frame. *(Obtain concurrence of the Agency's Project Manager regarding the specified time-frame.)*

2.5.1 Prepare a "Notice of Public Meeting" for publication in the local newspaper, and arrange for a public information meeting or open house to be held in order to present:

- outline of the problem
- planning done to date
- service area information
- water distribution system alternatives
- water storage alternatives and sites considered
- water treatment alternatives and sites considered
- need for property option, easements, etc.
- environmental and economic impact of each of the alternative solutions
- recommendations for the preferred solution
- identification of EA category (Schedule B or C activity) of the recommended solution.

2.6.0 Review comments from 2.5.0 and 2.5.1 with the Agency's Project Manager and the Liaison Committee.

2.6.1 Select preferred solution(s) and confirm EA category.

- If project is a Schedule C activity, subject to receiving a resolution of authorization from Municipal Council, proceed directly to Phase 3 work plan.
- If project is a Schedule B activity, proceed with the next step in the work plan.

2.6.2 Update the Phase 1 & 2 Report to indicate preferred solution(s) and include all comments received from 2.5.0 and 2.5.1, and file the Report with Project Manager and Municipal Clerk.

2.6.3 Advertise the Notice of Completion on two separate occasions, one week apart, in the same newspaper having general circulation in the Municipality, and allow for a minimum of 30 calendar days for comment and input.

2.6.4 Complete the Phase 1 & 2 Report incorporating any comments received during the 30-day public review and the resulting responses to the comments.

2.6.5 Obtain formal acceptance of the final Phase 1 & 2 Report in the form of a Council resolution.

2.6.6 Forward the Phase 1 & 2 Report together with a copy of a Ministry's Application for Approval of Water Works to the Ministry's appropriate District Office and Approvals Branch to obtain a Conditional Certificate of Approval. *(In most cases, a Design Report will be required, along with the Phase 1 & 2 Report for a Conditional Certificate of Approval to be issued. The provision of a Design Report (if required) should be considered as part of this work plan.)*

END OF PHASE 2

WORK PROGRAM FOR PHASE 3 AND PHASE 4

Note: **This part of the Terms of Reference applies only when the preferred solution is a Schedule C activity. Obtain approval from the Agency's Project Manager before proceeding.**

PHASE 3

3.1.0 Identify and describe the alternative designs for each component of the preferred solution to be evaluated (e.g., water distribution system, water storage facility, treatment facility and intake).

3.2.0 Prepare a detailed inventory of the natural, social, technical and economic environments, consulting with review agencies where appropriate.

3.3.0 Identify the impact of each alternative design on the environment inventoried in 3.2.0, identifying appropriate mitigating measures.

3.4.0 Conduct a detailed evaluation of water distribution design alternatives, if the preferred solution is a communal system.

3.4.1 Conduct a detailed evaluation of water storage design alternatives.

3.4.2 Conduct a detailed evaluation of water treatment facility alternative designs of the preferred solution, based on treatability studies and/or groundwater studies as required.

3.4.3 Consult with review agencies where appropriate.

3.4.4 Make preliminary selection of the recommended design concept.

3.4.5 Prepare a general/master plan(s) showing the areas to be serviced, the service area limits, land requirements, existing buildings and the layout of the existing distribution system, if any, with respective pipe sizes.

3.4.6 Prepare a summary of the design parameters utilized in sizing of the water distribution system and storage facility. These parameters should include but not be limited to the existing and design population, the design water consumption for domestic, commercial, industrial, institutional and other users, and fireflow requirements, if applicable.

3.4.7 Prepare a master plan showing the proposed distribution system with respective pipe sizes for the recommended design concept, and the results of a hydraulic analysis undertaken to confirm the adequacy of the proposed watermains with flows and residual pressures noted on the drawing at key locations/nodes throughout the distribution system.

3.4.8 Prepare a proposed by-law governing the usage of the municipal water supply and distribution system within the service area.

3.4.9 Investigate in detail the recommended water supply/treatment facility site location and the recommended water storage site(s) including:

- hydrogeology/soils
- mapping
- site plan preparation
- site ecology
- site archaeology

3.4.10 Prepare a summary of the design parameters utilized in sizing the water supply/treatment facility and intake. These parameters should include but not be limited to the existing and design population, design water flows, and disposal of treatment wastes.

3.4.11 Prepare a preliminary layout of the water supply/treatment facility of recommended design concept including the recommended intake route and termination point.

3.4.12 Provide detailed capital and annual operating cost estimates on the recommended design concept.

3.4.13 Consider financial implication of project with respect to:

- capital cost and annual operating cost
- available subsidies

- cost per connection based on gross and net capital costs
- proposed rates and average homeowner charges, taking current interest rate and annual operating costs into account
- annual revenue and expenditure statement.

3.4.14 Prepare a preliminary ESR. The format and content of the preliminary ESR should be consistent with that outlined in Section 6.2 of the MEA Class EA for Municipal Water and Wastewater Projects document. Items to be included are:

- alternative designs that have been considered for the preferred solution
- project description outlining servicing details
- details of water distribution system including impacts on environment
- details of water storage facility including impacts on environment
- details of water supply/treatment facility, including impacts on environment
- financing of project and proposed by-laws to recover revenue including proposed rates and annual homeowner charges
- monitoring program designed to be carried out during and after construction of the project.

3.4.15 Identify any new mandatory contacts based on the recommended design concept that have to be made, especially with the public. Be sure to include Government agencies, special interest groups, and members of the public which have previously requested further involvement.

3.4.16 Submit the preliminary ESR and list of mandatory contacts to the Agency's Project Manager and Liaison Committee for review and comments.

3.4.17 Present the preliminary ESR to the Municipal Council.

3.5.0 Circulate the preliminary ESR to review agencies, new mandatory contacts and interested and/or affected public requesting comments within a specified time-frame. *(Obtain concurrence of the Agency's Project Manager regarding the specified time-frame.)*

3.5.1 Prepare a "Notice of Public Meeting" for publication in accordance with Appendix 4 of the MEA Class EA for Municipal Water and Wastewater Projects document, and arrange for a public information meeting or open house to be held in order to present:

- alternative designs that have been considered for the preferred solution
- project description outlining servicing details
- details of water distribution system including impacts on environment
- details of water storage facility including impacts on environment
- details of water supply/treatment facility including impacts on environment
- financing of projects, proposed by-laws to recover costs including proposed rates and average homeowner charges.

3.6.0 Evaluate feedback from 3.5.0 and 3.5.1 and discuss with the Agency's Project Manager and Liaison Committee.

3.6.1 Select preferred design and confirm project status.

3.7.0 Finalize preliminary design work for preferred design including all mitigating measures required to minimize the impact on the environment.

3.7.1 Upon concurrence of the Agency's Project Manager and the Municipal Council, in the form of a resolution, assist in acquiring any required land and/or easements. An update of previous property reports may be required.

END OF PHASE 3

PHASE 4

4.1.0 Update the ESR to indicate the preferred design and include all comments received from 3.5.0 and 3.5.1 and the resulting responses to those comments.

4.2.0 File the ESR with the Agency's Project Manager, the Municipal Clerk and the local municipal public library where the ESR may be viewed by the public outside normal office hours.

4.2.1 Prepare a "Notice of Completion of ESR" in accordance with Appendix 4 of the MEA Class EA for Municipal Water and Wastewater Projects document, arrange for its advertisement in the same newspaper having general circulation in the Municipality on two separate occasions, one week apart, and allow for a minimum of 30 calendar days for comment and input.

4.2.2 If no "bump-up" is received, complete the ESR incorporating any comments received during the public review period and any resulting responses to those comments, and then proceed to 4.4.0. If a request for "Bump-up" is received, proceed to 4.3.0.

4.3.0 In conjunction with the Agency's Project Manager and the Liaison Committee, attempt to resolve the concerns raised by the objector(s).

4.3.1 Submit a copy of the completed ESR and Project File, if requested, to the Ministry's Environment Assessment Branch.

4.3.2 Once "bump-up" is resolved, either by the objector agreeing to withdraw the "bump-up" or the Minister ruling on the "bump-up" request, complete the ESR by incorporating the following:

- comments and "bump-up" requests received during the public review period
- responses to the comments and "bump-up" requests
- any changes to the preferred design or additional mitigative measures as a result of comments and/or "bump-up" requests
- a copy of the Minister's decision along with how any conditions imposed by the Minister will be incorporated into the project.

4.4.0 Obtain formal acceptance of the final ESR in the form of a Council resolution.

4.4.1 Forward the ESR together with a copy of a Ministry's Application for Approval of Water Works to the Ministry's appropriate District Office and Approvals Branch to obtain a Conditional Certificate of Approval. *(In most cases, a Design Report will be required along with the ESR in order for a Conditional Certificate to be issued. The provision of a Design Report (if required) should be considered as part of this work plan.)*

END OF PHASE 4

Appendix H - Communal Water Supply Borehole Logs

DATUM: TOPOGRAPHIC MAPPING
EAST-HALF LOT 36 CONC. 1
(ABOUT 300m EAST OF MAIN STREET)

DRILLING DATE: September 20,1995

HOLE #: BH-1

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface	90.0					0.0	90.0	
Till-Brown compact silt and clay with cobbles and some sand						2.0	88.0	
	85.4					4.0	86.0	
Till-Grey compact silty clay with cobbles. Some seams of sand and gravel. Wet below 8m, yield less than 12 L/min.						6.0	84.0	
						8.0	82.0	
	79.6					10.0	80.0	
Bedrock-Dense grey limestone.						12.0	78.0	
						14.0	76.0	
						16.0	74.0	
						18.0	72.0	
						20.0	70.0	

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CONSULTING ENGINEERS

FIGURE TITLE	BOREHOLE LOG	DATE	1995
		SCALE	NOT TO SCALE
JOB	APPLE HILL WATER PROJECT	DRAWN	JASB
		JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
EAST-HALF LOT 36 CONC. 1
(ABOUT 400m EAST OF MAIN STREET)

DRILLING DATE: September 20,1995

HOLE #: BH-2

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 84.5					0.0	84.5	
Till-Brown compact silt and clay with cobbles and some sand. 83.0							
Till-Grey compact silty clay with cobbles and some gravel. Some water below 6m, yield less than 10 L/min. 76.3					2.0	82.5	
					4.0	80.5	
					6.0	78.5	
					8.0	76.5	
Bedrock-Dense grey limestone.					10.0	74.5	
					12.0	72.5	
					14.0	70.5	
					16.0	68.5	
					18.0	66.5	
					20.0	64.5	

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CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE	1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 35 CONC. 1
(ABOUT 570m EAST OF MAIN STREET)

DRILLING DATE: September 20,1995

HOLE #: BH-3

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 91.5					0.0	91.5	
Till-Brown silty sand with pebbles and cobbles. 90.0					2.0	89.5	
Till-Grey silty sand and clay. More clay encoutered at depth. 83.0					4.0	87.5	
					6.0	85.5	
					8.0	83.5	
Bedrock-Dense grey limestone.					10.0	81.5	
					12.0	79.5	
					14.0	77.5	
					16.0	75.5	
					18.0	73.5	
					20.0	71.5	

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CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE 1995

SCALE NOT TO SCALE

DRAWN JASB

JOB No. 94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 35 CONC. 1
(ABOUT 570m EAST OF MAIN STREET)

DRILLING DATE: September 20,1995

HOLE #: BH-4

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 87.0					0.0	87.0	
Till-Brown silty sand with pebbles and cobbles. 85.5					2.0	85.0	
Till-Grey silty sand and clay. More clay encoutered at depth. Some water below 5m, yield about 10 L/min. 80.9					4.0	83.0	
					6.0	81.0	
					8.0	79.0	
Bedrock-Broken near surface then dense grey limestone at depth..					10.0	77.0	
					12.0	75.0	
					14.0	73.0	
					16.0	71.0	
					18.0	69.0	
					20.0	67.0	

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FIGURE TITLE	BOREHOLE LOG	DATE	1995
		SCALE	NOT TO SCALE
JOB	APPLE HILL WATER PROJECT	DRAWN	JASB
		JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 35 CONC. 1
(ABOUT 570m EAST OF MAIN STREET)

DRILLING DATE: September 20,1995

HOLE #: BH-5

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 87.0					0.0	87.0	
Till-Brown silty sand with few cobbles. 84.0					2.0	85.0	
Till-Grey silty sand and clay. Yield less than 8 L/min.					4.0	83.0	
80.9					6.0	81.0	
Bedrock-Broken limestone near surface then dense grey at depth.					8.0	79.0	
					10.0	77.0	
					12.0	75.0	
					14.0	73.0	
					16.0	71.0	
					18.0	69.0	
					20.0	67.0	

M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE 1995

SCALE NOT TO SCALE

DRAWN JASB

JOB No. 94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 37 CONC. 1
(ABOUT 210m WEST OF MAIN STREET)

DRILLING DATE: September 21,1995

HOLE #: BH-6

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 94.0					0.0	94.0	
Till-Brown compact silt and sand with cobbles. Boulders below 4m.					2.0	92.0	
					4.0	90.0	
89.1							
Till-Grey compact clay and silt with cobbles. Some sand and gravel seams below 13m. Yield less than 12 L/min.					6.0	88.0	
					8.0	86.0	
					10.0	84.0	
					12.0	82.0	
					14.0	80.0	
78.8							
Bedrock-Broken limestone becoming dense below 16m. Yield less than 15 L/min.					16.0	78.0	
					18.0	76.0	
					20.0	74.0	

M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE	1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

DATUM:	TOPOGRAPHIC MAPPING WEST-HALF LOT 37 CONC. 1 (ABOUT 290m WEST OF MAIN STREET)	DRILLING DATE:	September 21,1995
		HOLE #:	BH-7

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface	92.5					0.0	92.5	
Till-Brown compact silt and sand with cobbles. Boulders below 3.5m.						2.0	90.5	
	88.2					4.0	88.5	
Till-Grey compact clay and silt with cobbles. Some sand and gravel seams below 13m. Yield less than 12 L/min.						6.0	86.5	
						8.0	84.5	
						10.0	82.5	
	80.9							
Bedrock-Broken limestone becoming dense below 16m. Yield less than 10 L/min.						12.0	80.5	
						14.0	78.5	
						16.0	76.5	
						18.0	74.5	
						20.0	72.5	

M.S. THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS	FIGURE TITLE BOREHOLE LOG	DATE	1995
		SCALE	NOT TO SCALE
	JOB APPLE HILL WATER PROJECT	DRAWN	JASB
		JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 37 CONC. 1
(ABOUT 250m WEST OF MAIN STREET)

DRILLING DATE: September 21,1995

HOLE #: BH-8

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 92.5							
Till-Brown compact silt and sand with cobbles. Boulders below 3.5m.					0.0	92.5	
					2.0	90.5	
88.2					4.0	88.5	Static water level 89.5 Sept. 22/95 (Open hole)
Till-Grey compact clay and silt with cobbles. Some sand and gravel seams below 13m. Yield less than 12 L/min.					6.0	86.5	
					8.0	84.5	
Wet grey silt, fine sand and gravel.					10.0	82.5	
					12.0	80.5	
78.5					14.0	78.5	
Bedrock-Compact grey limestone. Yield about 15 L/min.					16.0	76.5	
					18.0	74.5	
					20.0	72.5	

M.S. THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS	FIGURE TITLE: BOREHOLE LOG	DATE: 1995
		SCALE: NOT TO SCALE
	JOB: APPLE HILL WATER PROJECT	DRAWN: JASB
		JOB No. 94519

DATUM:	TOPOGRAPHIC MAPPING WEST-HALF LOT 37 CONC. 1 (ABOUT 200m WEST OF MAIN STREET)	DRILLING DATE:	September 21,1995
		HOLE #:	BH-9
REMARKS:			
BORING BY:	Air Rotary		

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 92.0							
Till-Brown compact silt and sand with cobbles. Boulders below 3.5m. 88.7					0.0	92.0	
					2.0	90.0	
Till-Grey compact clay and silt with cobbles. Some sand and gravel seams below 13m. Yield less than 124 minutes. 84.4					4.0	88.0	Static water level 89.0 Sept. 22/95 (Open hole)
					6.0	86.0	
Wet grey silt, fine sand, and gravel. Some layers of clay. Yield about 15 L/min. 73.7					8.0	84.0	
					10.0	82.0	
					12.0	80.0	
					14.0	78.0	
					16.0	76.0	
					18.0	74.0	
Bedrock-Compact grey limestone.					20.0	72.0	

M.S. THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS	FIGURE TITLE BOREHOLE LOG	DATE	1995
		SCALE	NOT TO SCALE
	JOB APPLE HILL WATER PROJECT	DRAWN	JASB
		JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 37 CONC. 1
(ABOUT 200m WEST OF MAIN STREET)

DRILLING DATE: September 22,1995

HOLE #: BH-10

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 94.0					0.0	94.0	
Till-Brown compact silt and sand with cobbles. Boulders below 4m.					2.0	92.0	
					4.0	90.0	
88.2							
Till-Grey compact clay and silt with cobbles.					6.0	88.0	
					8.0	86.0	
83.6					10.0	84.0	
Wet grey silt, fine sand, and gravel. Some layers of clay. Yield about 20 L/min.					12.0	82.0	
					14.0	80.0	
					16.0	78.0	
76.6							
Bedrock-Broken limestone becoming dense below 18m.					18.0	76.0	
					20.0	74.0	

M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE		
BOREHOLE LOG	DATE	1995
	SCALE	NOT TO SCALE
JOB: APPLE HILL WATER PROJECT	DRAWN	JASB
	JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 37 CONC. 1
(ABOUT 160m WEST OF MAIN STREET)

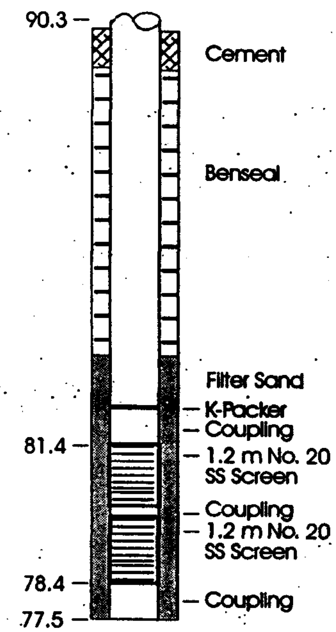
DRILLING DATE: September 22,1995

HOLE #: CTW-95 (BH-11)

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)	WELL DETAILS
Ground Surface 90.3					0.0	90.3	
Till-Brown compact silt and sand with cobbles. Boulders below 4m.					2.0	88.3	
85.7					4.0	86.3	
Till-Grey compact clay and silt with cobbles.							
83.6					6.0	84.3	
Wet grey silt, fine sand, and gravel. Some layers of clay. Yield about 20 L/min.					8.0	82.3	
					10.0	80.3	
77.5					12.0	78.3	
Borehole Terminated.					14.0	76.3	
					16.0	74.3	
					18.0	72.3	
					20.0	70.3	



M.S. THOMPSON & ASSOCIATES LTD.
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FIGURE TITLE
BOREHOLE LOG
CTW-95 (BH-11)

JOB
APPLE HILL WATER PROJECT

DATE 1997

SCALE NOT TO SCALE

DRAWN JASB

JOB No. 94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 27 CONC. 1
(ABOUT 260m WEST OF MAIN STREET)

DRILLING DATE: September 25, 1995

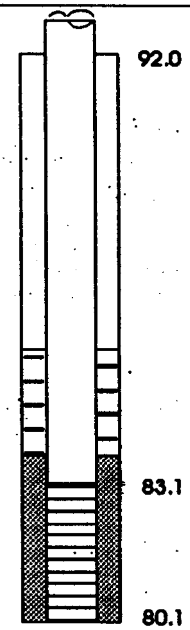
HOLE #: MW-12

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 92.0					0.0	92.0
Till-Brown compact silt and sand with cobbles. Boulders 4m.					2.0	90.0
					4.0	88.0
86.8						
Till-Grey compact clay and silt with cobbles.					6.0	86.0
84.4						
Wet grey silt, fine sand, and gravel.					8.0	84.0
					10.0	82.0
					12.0	80.0
					14.0	78.0
					16.0	76.0
					18.0	74.0
73.1						
Bedrock-Dense grey limestone.					20.0	72.0

WELL DETAILS



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CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

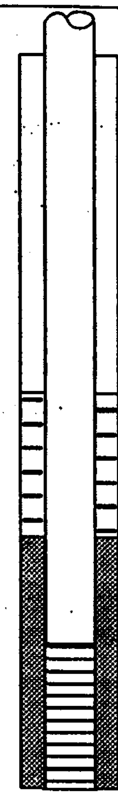
JOB
APPLE HILL WATER PROJECT

DATE	1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

DATUM:	TOPOGRAPHIC MAPPING WEST-HALF LOT 27 CONC. 1 (ABOUT 130m WEST OF MAIN STREET)	DRILLING DATE:	September 25,1995
		HOLE #:	MW-13
REMARKS:			
BORING BY:	Air Rotary		

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 89.2					0.0	89.2
Till-Brown compact silt and sand with cobbles. Boulders 4m.					2.0	87.2
84.9					4.0	85.2
Till-Grey compact clay and silt with cobbles.					6.0	83.2
80.7					8.0	81.2
Wet grey silt, fine sand, and gravel.			SS-1		10.0	79.2
					12.0	77.2
					14.0	75.2
					16.0	73.2
74.0					18.0	71.2
Bedrock-Dense grey limestone.					20.0	69.2

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE	BOREHOLE LOG
JOB	APPLE HILL WATER PROJECT
DATE	1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 27 CONC. 1
(ABOUT 160m WEST OF MAIN STREET)

DRILLING DATE: September 29,1995

HOLE #: **MW-14**

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 91.3					0.0	91.3
Till-Brown compact silt and sand with cobbles. Boulders 4m.					2.0	89.3
87.6					4.0	87.3
Till-Grey compact clay and silt with cobbles.					6.0	85.3
84.0					8.0	83.3
Wet grey silt, fine sand, and gravel.					10.0	81.3
					12.0	79.3
					14.0	77.3
					16.0	75.3
					18.0	73.3
73.6						
Bedrock-Dense grey limestone.					20.0	71.3

WELL DETAILS

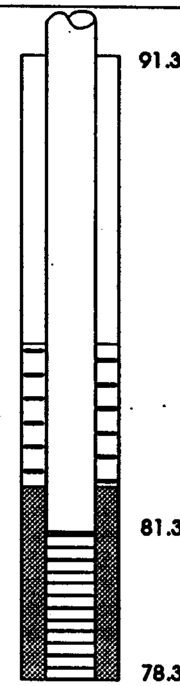


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FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE	1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

APPENDIX C

Apple Hill Communal Water System
Hydrogeological Investigation
Phase III Hydrogeological Report
(MSTA 1999)

Apple Hill Communal Water System Hydrogeological Investigation

Township of North Glengarry

September 1999

M.S. Thompson & Associates Ltd.
Consulting Engineers

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1.0 Introduction

M.S. Thompson & Associates (MSTA) was retained by the Township of Kenyon (now the Township of North Glengarry) to undertake an Environmental Study of communal water supply alternatives. Previous studies identified bacteriological and chemical contamination in private wells in the hamlet of Apple Hill, and provided remedial alternatives (MOE 1992). The initial Private Water Systems Renewal/Replacement Program (PWSRR) study provided evidence of a sustainable potable water supply in the hamlet. Additional site investigations as described in MSTA's April 1997 report entitled *Phase II Private Well Hydrogeological and Preliminary Communal Well Evaluation* identified a potentially suitable supply aquifer in the southwest part of the hamlet.

This further study assesses the potential of the aquifer underlying the hamlet to satisfy the long-term water supply requirements of the hamlet of Apple Hill.

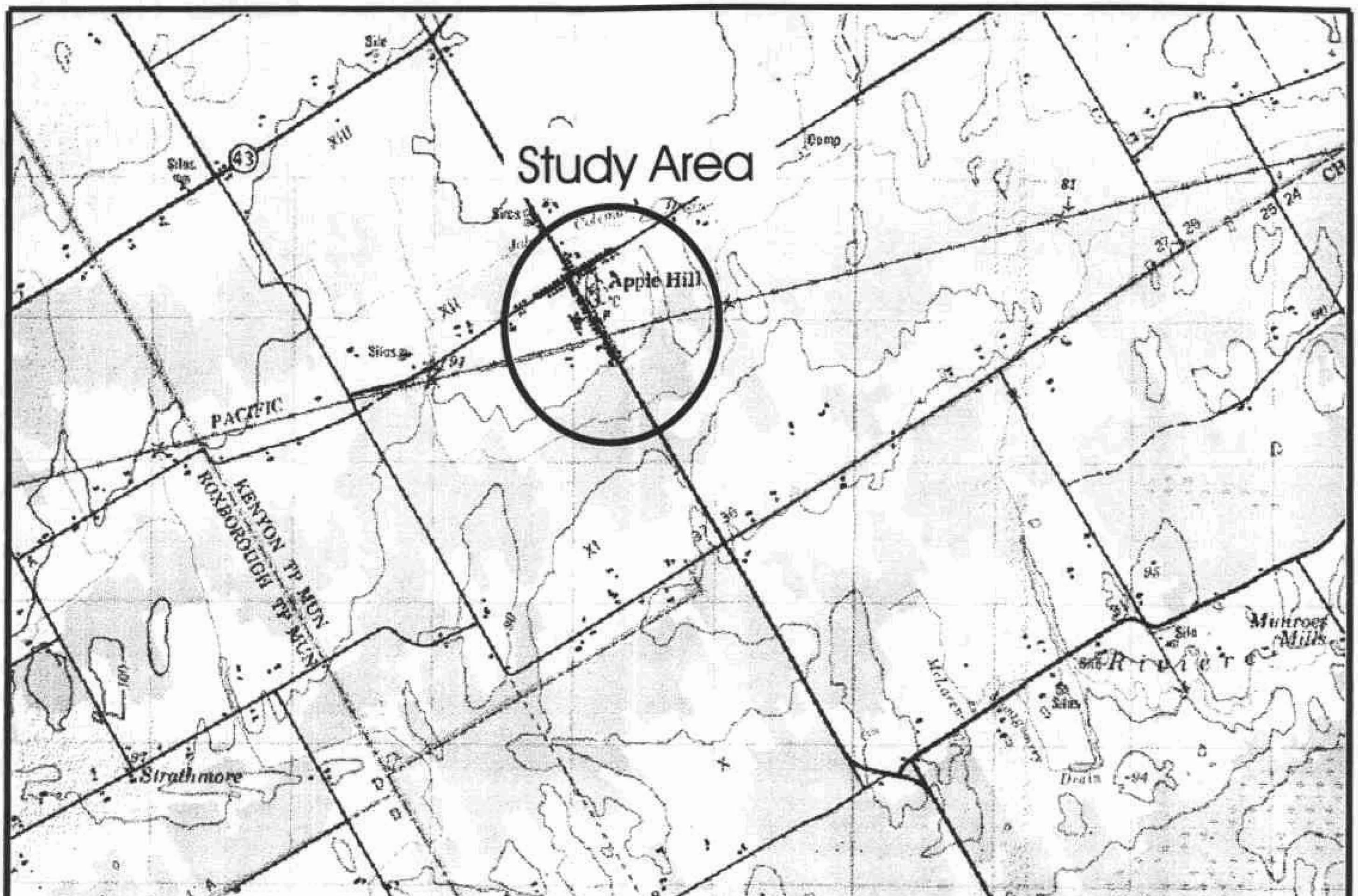
1.1 Background

The hamlet of Apple Hill is located in North Glengarry Township, about 25 km northeast of the City of Cornwall (Figure 1). During the last 20 years or so, the population has been declining, as shown by census data. The 1991 population was 195 compared to 257 in 1986 and 271 in 1976. There are 91 homes within the village, some of which have been divided into sections to provide rental units (which number about 12). There are 5 commercial and 5 institutional properties within the village including two churches, a hotel and tavern, medical clinic, post office, fire station, general store, convenience store, hairdressing salon, and pool chemical retail outlet.

Detailed topographic information was provided from the Ministry of Natural Resources base mapping (MNR 1993). Contours and physical features are displayed on a 1:5,000 scale topographical map developed from 1992 aerial photography. The contour interval is 1 m and all elevations are geodetic (Figure 2). The latest assessment mapping was superimposed on the topographic plan. From this drawing and using the municipality's assessment roll numbers, property owners were identified. This facilitated the cross-referencing of well records and water quality analysis to a lot location within the village. In this way water quality, geology, and other hydrogeological data could be spatially analysed.

As part of the supporting documentation for the Environmental Study Report (ESR), MSTA undertook a hydrogeological investigation to support the communal water study. The purpose of this hydrogeological investigation was to ascertain if wells developed in the south-west part of the hamlet area could provide additional yield and further separation from contaminant sources. The evaluation of the groundwater supply was completed in accordance with the following guidelines:

- *Guidance Document For The Review of Certificate of Approval and Permit To Take Water Applications For Communal Water Supplies*
- Regional Guideline for *Water Quality Assessments For Communal Wells*



M.S. THOMPSON & ASSOCIATES LTD. consulting engineers CORNWALL KINGSTON	APPLE HILL PHASE III HYDROGEOLOGICAL STUDY	scale 1:50,000
		date March 1999
		drawn JBH
The THOMPSON ROSEMOUNT Group		job no. 94519
	KEY PLAN	drawing no. FIGURE 1

x:\1994\94519\cdr\keyplan.cdr 6-24-99 10:00 am EST

M.S. THOMPSON & ASSOCIATES LTD. consulting engineers CORNWALL KINGSTON	APPLE HILL PHASE III HYDROGEOLOGICAL STUDY	scale 1:5,000	NORTH
		date MARCH 1999	
		drawn DP	
		job no. 94519	
The THOMPSON ROSEMOUNT Group	SITE PLAN & LOCAL TOPOGRAPHY	drawing no. FIG. 2	

- Policy 15-15-01 *Treatment Requirements For Municipal And Communal Water Works Using Ground Water Sources*
- *Ontario Drinking Water Objectives (1994)*

1.2 Purpose

The purpose of this report is to provide:

- A detailed characterization of the area hydrogeology
- Assess the yield of the aquifer for communal supply purposes
- Characterize the raw water quality and describe treatment
- Description of test well construction
- Provide recommendations for well head protection zone
- Comment on the regional versus local well recharge

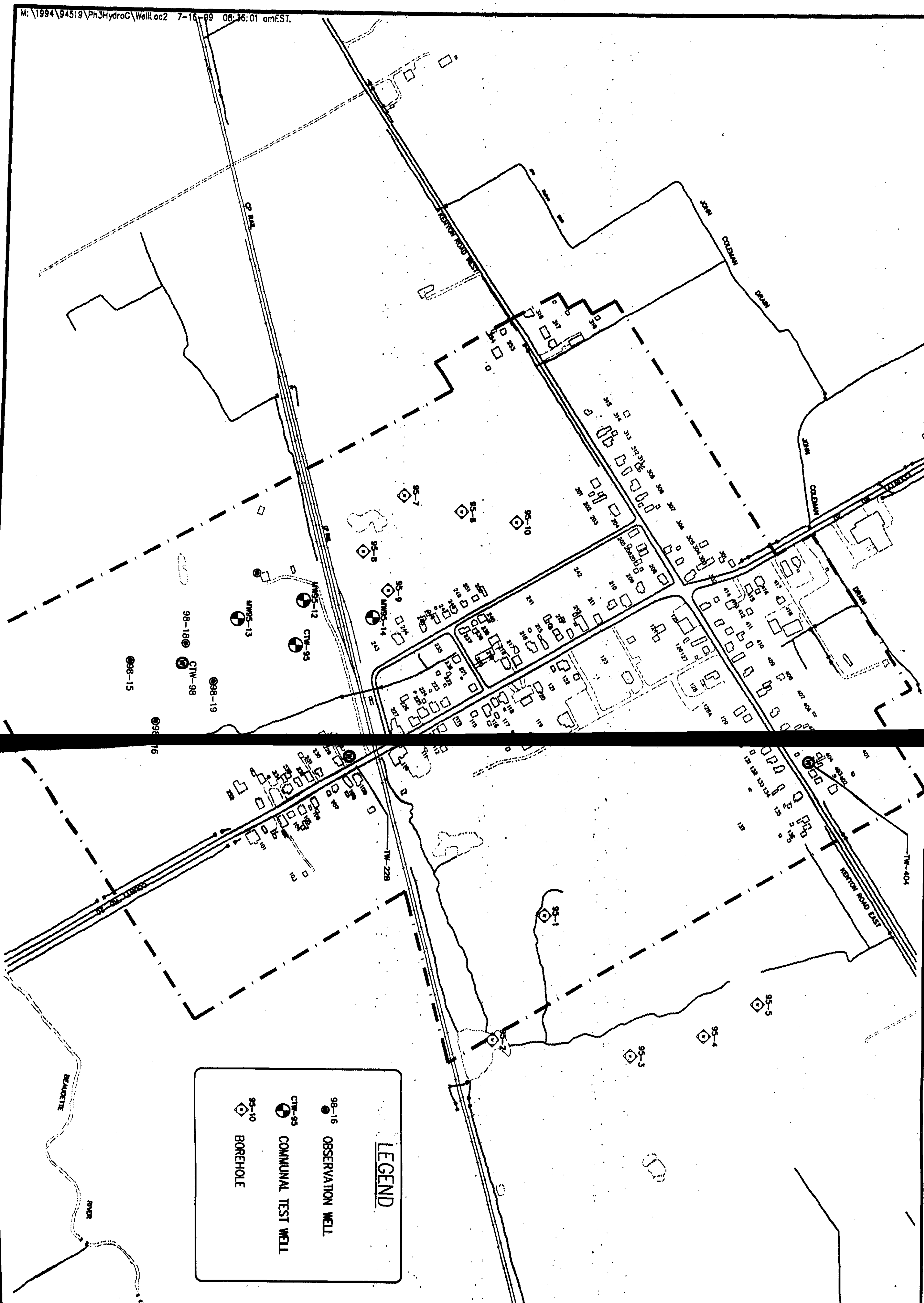
2.0 Existing Information

2.1 Hydrogeological Characterization

The April 1997 MSTA report entitled *Phase II Private Well Hydrogeological Study and Preliminary Communal Well Evaluation* evaluated the feasibility of a communal water supply within 1 km of the hamlet of Apple Hill. As a result, a suitable confined aquifer was located toward the southwest part of the hamlet and a test well and observation wells were installed. Through quality and yield testing, the aquifer was identified as being suitable for a communal water supply. The location of communal test well (CTW95) and the 3 observation wells (MW95-12, -13, and -14) are shown in Figure 3. The interpretation of pumping test data provided a rationale for the next part of the hydrogeological investigation (Phase III). A separate study was concurrently completed which addressed the issue of private well abandonment and septic system impacts.

2.2 Regional Setting

The surficial geology of the St. Lawrence River area of Eastern Ontario was studied as part of the characterization work for the St. Lawrence Seaway project (Terasame 1962) and subsequent engineering terrain mapping work (Ringrose et al 1992). The surficial geology of this area, as with most of Eastern Ontario, is dominated by glacial till. According to Terasmae (1962), this differs significantly from typical surficial deposits because it is physically and lithologically heterogeneous with unsorted and unstratified pockets of granular material. The compaction and preconsolidation by successive glacial advances renders it more impervious to groundwater movement. At high and low topographic relief, the till may be continuous. The till consists of stratified and unstratified drift. The stratified drift is proglacial marine silt, sand, and clay in the low-lying areas (Ringrose et al). The high-ground consists of ground moraine till which can be very compact and poorly sorted (lodgement till) or partially sorted (ablation till) which may feature some relatively high permeability sand and gravel units. Terasmae (1962) described the till as two distinct units. The upper or Fort Covington till, is compact grey (or buff when oxidized) sandy till which includes bouldery washed till on the slopes



M.S. THOMPSON & ASSOCIATES LTD.
consulting engineers
CORNWALL KINGSTON

The THOMPSON ROSEMOUNT Group

APPLE HILL
PHASE III HYDROGEOLOGICAL STUDY

LOCATION OF TEST WELLS, BOREHOLES AND OBSERVATION WELLS

scale	1:5,000
date	MARCH 1999
drawn	DP
job no.	94519
drawing no.	FIG. 3

NORTH

and hills. The lower unit, Malone till is very compact, blue silty-gray clay matrix with boulders and cobbles depending on the proximity and character of the underlying bedrock. Most of the pebbles tend to be Palaeozoic sedimentary rocks (Terasmae 1962).

In some locations along the St. Lawrence River, stratified granular deposits have been noted lying in between the two till units. These glacial-fluvial materials were deposited during the waning of the Malone ice-sheet. These stratified deposits were termed middle till complex (Terasmae 1962) and range up to 10 m thick. Owing to their stratified composition they may yield relatively high quantities of water depending upon their thickness. The stratified material may contain embedded cobbles and boulders as described below. The lithology from the test well logs and MOE well records indicate that the intertill does not exist (or is very thin) in the study area.

The upper, youngest till is termed Fort Covington. It was deposited by a different glacial advance, is thinner, and has more sand than the Malone till. Fort Covington till was deposited by glaciers flowing from northwest to southeast. This till is less compact than the Malone till and has a larger portion of (non-native) igneous rocks which is indicative of transported soil. Outcrops of Fort Covington till, on ridges, tend to be oxidized buff-to-brown colour to a depth of about 6 m.

The Malone till, associated with the initial glacial advance from the northeast, contains a more silty-clay matrix with pebbles, cobbles, and boulders. The fragments are residual sedimentary rocks which were derived from the local bedrock as the glacier advanced and scoured its surface.

2.2.1 Topography and Surface Drainage

The hamlet of Apple Hill is located on distinct ridge. The local relief ranges from an elevation of about 95m near the centre of the hamlet to 82m at the Beaudette River to the south (Figure 2). The 50-year flood plain elevation for the Beaudette River south and west of Apple Hill is also shown on Figure 2. To the north, the relief ranges to about 87m near the John Coleman Drain.

Storm drains and ditches convey runoff north and south to these two main drainage channels. Storm water samples taken from these drains in 1989 and 1990 showed bacteriological contamination, which provided an impetus for the companion sewage system study (MSTA, 1995-98).

2.2.2 Groundwater Use

The groundwater use in the hamlet of Apple Hill has been well documented (MSTA, MOE). Based on the MOE well records, both dug and drilled wells in the village exploit shallow overburden and bedrock aquifers - about 30 % are dug wells and 70 % are drilled wells. The wells range in depth from 3 to 43 m from the surface.

Of the 87 homes included in the 1989 and 1990 MOE water quality survey, 48 were deemed "unsafe" for drinking based on bacteriological and chemical analyses. Water quality problems in the village include: hardness; iron and manganese staining; dissolved gases; discolouration; taste; rust; or unpalatability. Some homeowners employ softeners, filters, purifiers or combinations thereof for water treatment. The approximate locations of the wells and monitors under study are shown on Figure 3.

2.2.3 Local Geology

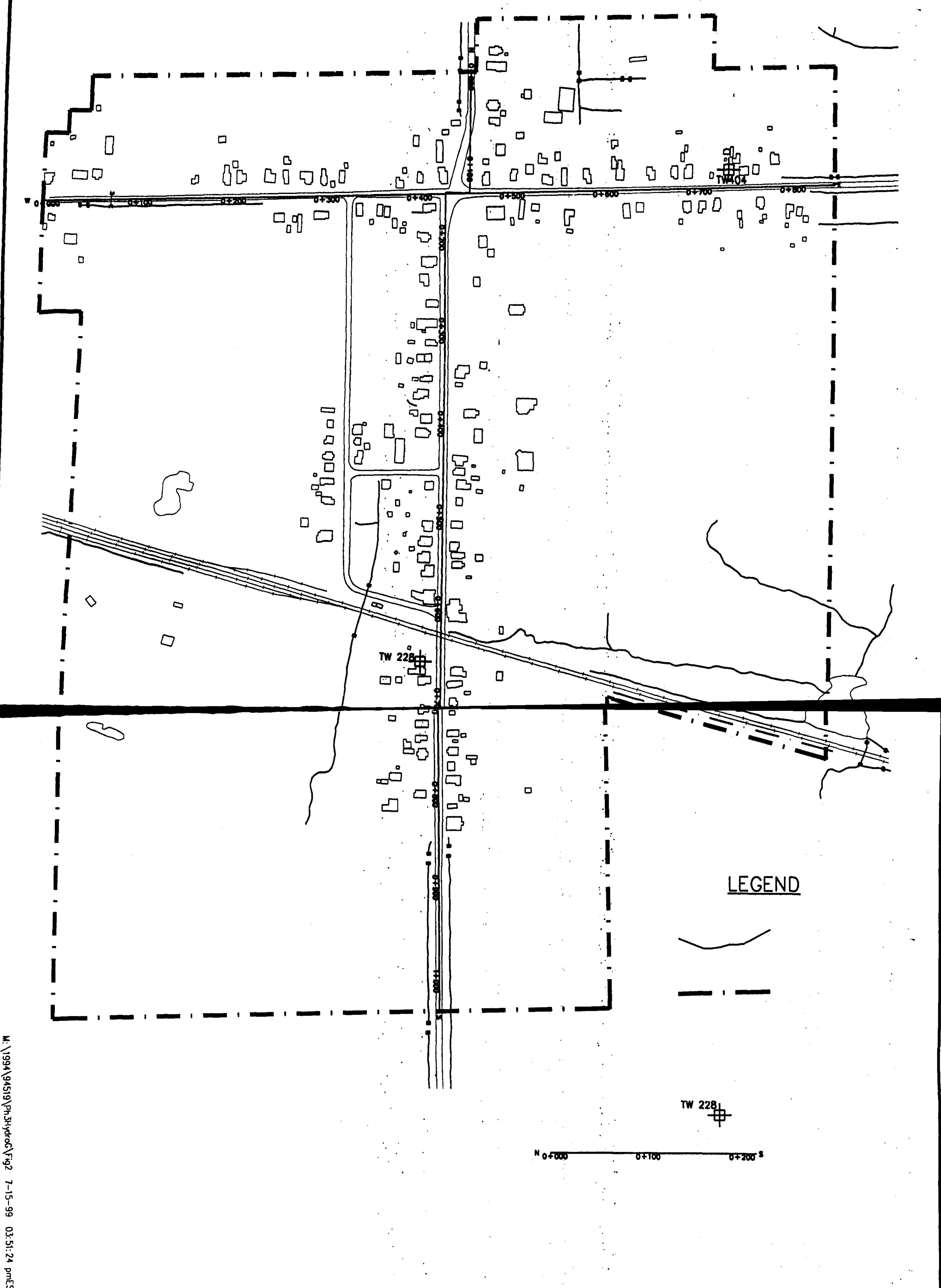
The composition of overburden material varies across the village but some distinct trends can be seen. Wells drilled along the periphery of the till ridges show a stratigraphy consisting of till, boulders, then bedrock as depth increases. Depending upon where the former shoreline was intersected by the well, the stratification varies. The till material, being generally heterogeneous and compact does not yield sufficient quantity of water to be exploited for domestic purposes, especially during drier periods of the year. Shallow dug wells developed into the till can seasonally sustain some domestic water demands (basically because of the large well storage capacity) but when the water table drops, because of insufficient recharge, these wells are not capable of providing a sufficient supply.

Geological cross sections through the village were developed based on the interpretation of the well records. The majority of the records follow the two main arterial roads within the village (Kenyon Road east and west) and Main Street (north and south). Stations were established beginning at the west end of Kenyon Road (running east) and north end of Main Street (running south). The stations are shown on Figure 4. The cross section from Kenyon Road west to east (Figure 5a) included 12 wells and for Main street north to south (Figure 5b) included 7 wells. The lack of data along Main street is related to the fact that many of the wells are dug wells (which are not shown in the MOE well records) developed into the shallow gravel which is dominant in the centre and south part of the village. The data between wells is inferred and does not necessarily represent actual conditions. Each figure shows the variable lithology across the village. The highlights of Figure 5a include:

- bedrock peaks occur at stations 330 (lot 307) and 750 (lot 404) respectively;
- the valley between the bedrock peaks is demarcated by gravel and sand from station 470 (lot 414) to 630 (lot 408);
- re-working of the till mounds has deposited granular materials in the topographic depressions (between bedrock peaks).
- bedrock was not encountered at lot 410 - it is presumed that it would be below 76 m elevation; and
- the bedrock contour and re-working of till has had some influence on the surface contour since the till mounds and the bedrock peaks approximately correspond.

The highlights of Figure 5b include:

- bedrock which dips sharply to the south; and
- a granular seam which rises steeply toward the south and overlies the bedrock.



M:\1994\94519\Ph3HydroG\Fig2 7-15-99 03:51:24 pmEST.

M.S. THOMPSON & ASSOCIATES LTD. consulting engineers CORNWALL KINGSTON	APPLE HILL PHASE III HYDROGEOLOGICAL STUDY	scale 1:4,000	
The THOMPSON ROSEMOUNT Group		date MARCH 1999	
		drawn DP	
		job no. 94519	
	STATIONING OF LITHOLOGY	drawing no. FIG. 4	

Figure 5a - Geological Cross-Section
(Kenyon Street from West to East)

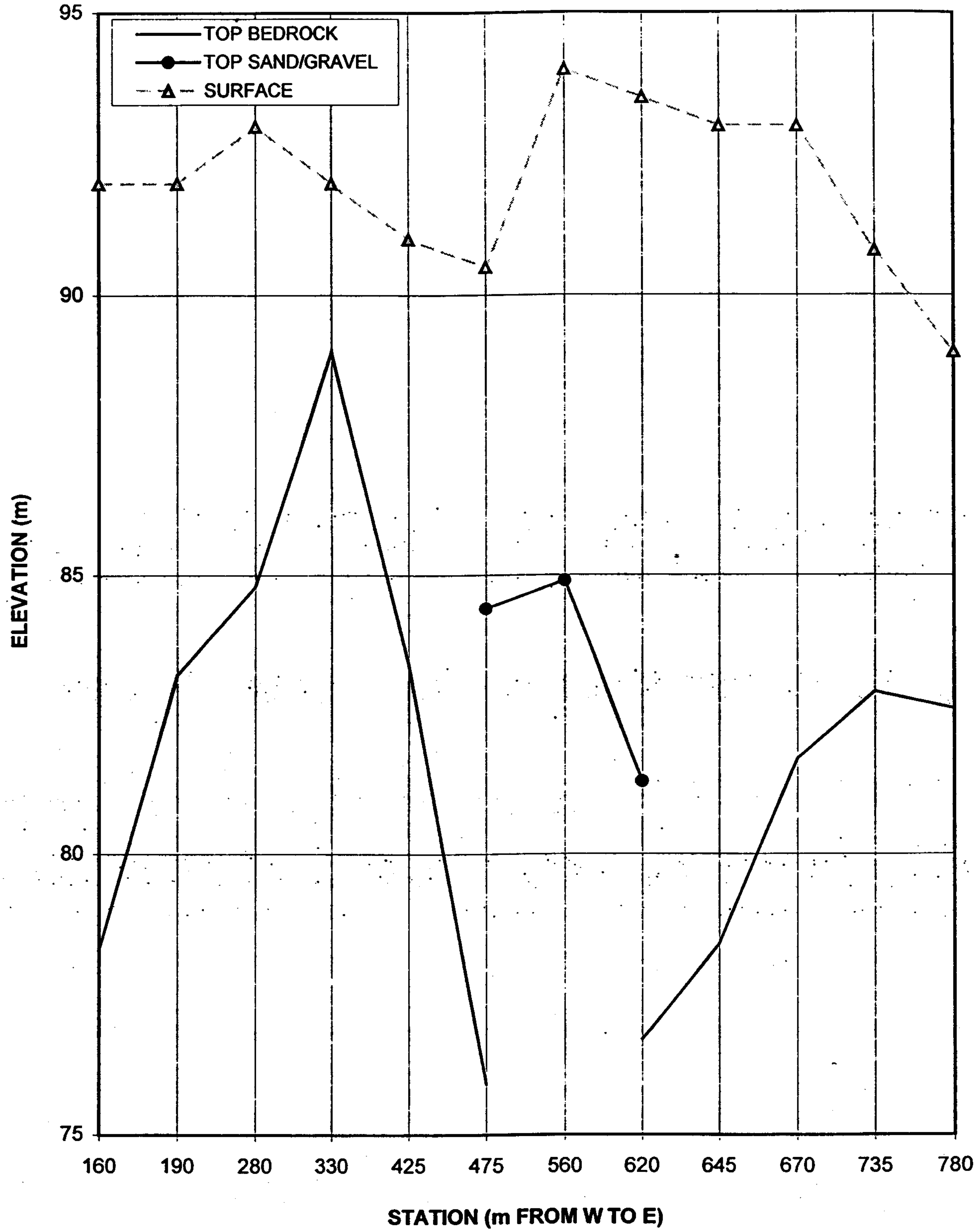
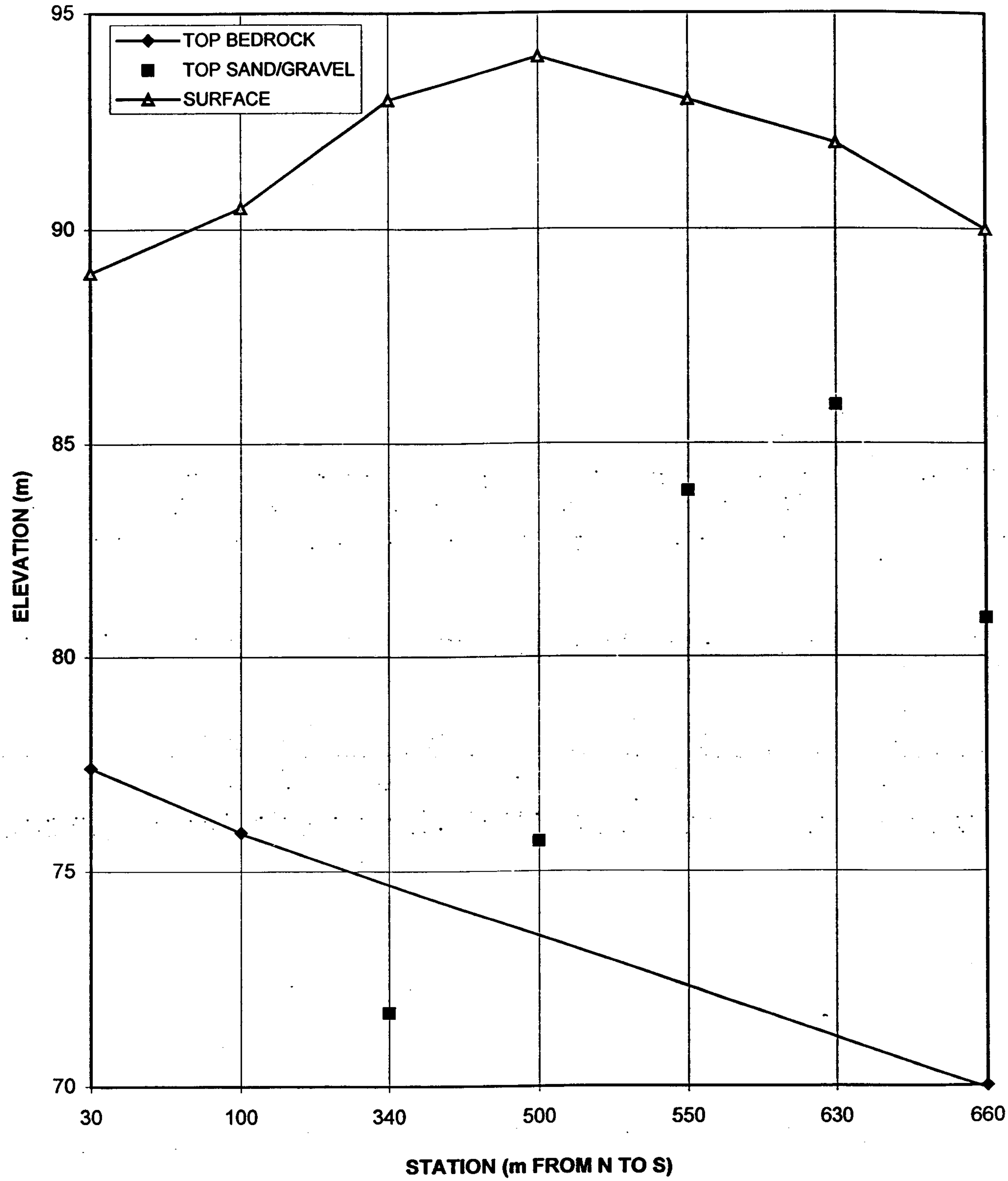


Figure 5b - Geological Cross-Section
(Main Street from north to south)



These results concur with the previously described aerial photo interpretation which emphasizes the existence, extent, and vulnerability of the sand and gravel aquifer which runs through the village.

More detail on the site geology can be found in the numerous reports previously written on this site (see references).

3.0 Site Investigation

3.1 Test Wells

Based on the results of the 1995 borehole and test well investigations, test drilling was completed in 1998 in the southwest part of the hamlet area. The purpose was to ascertain whether wells developed in this area could provide additional yield and further separation from contaminant sources. Before drilling, written permission was obtained from the landowner.

A licensed well driller was retained and an air rotary drill rig was mobilised on July 15, 1998 to facilitate the latest site investigation. A total of 5 boreholes were drilled in an area about 200m south of TW95 (Figure 3). The boreholes 98-15, -16, -18, and -19 were instrumented with 50 mm PVC slotted screens (1.5 m long) to be used as observation wells. Borehole 98-17 was developed as a test well (CTW-98) using a 150 mm casing terminating in the shallow fractured bedrock. It was postulated that greater well yield could be accomplished compared to the screened well (CTW95). The observation wells were strategically located in a radial pattern surrounding CTW-98 at distances ranging from 30 to 200 m.

The stratigraphy encountered was similar in all boreholes. Hard-packed clay till with boulders was encountered to a depth of 8.5 to 9.1 m from the surface. At this contact depth, sand and gravel was encountered. The sand and gravel overlaid fractured bedrock to a depth of 14 to 16 m. The boreholes ranged in depth from 14 to 16 m and were developed in the gravel and fractured bedrock formation. The well was disinfected by the driller using HTH tablets. The borehole logs for all the monitors constructed in 1998 are provided in Appendix A. Grainsize distribution charts from the cuttings are provided in Appendix B. A technical surveyor was retained to survey all wells for both vertical and horizontal geodetic reference.

Following the drilling of July 15 and 16, 1998, the test well was developed by installing a submersible 0.37 KW (½ HP) pump. The well was pumped for 320 minutes at 40 L/min on July 16, 1998. On July 21, CTW-98 was pumped for 310 minutes at 50 L/min. During this development, the turbidity dropped from 177 to 13 NTU. During the same period, conductivity increased from 496 to 549 uS/cm. The conductivity for the last 5 hours of the test stabilised between 530 and 549 uS/cm (Table 1), indicating that the well had been developed.

3.2 Physical Hydrogeology

The static water level of all monitoring wells was recorded and compared to the aquifer depth. The height of the static water level in the wells indicated that the aquifer was confined. The potentiometric elevations were contoured using data from the wells constructed between 1995 and 1998 (Figure 6). The groundwater flow direction, inferred as being perpendicular to the potentiometric contours, is southeast. The average horizontal hydraulic gradient was calculated to be 0.03 m/m. Following development, the aquifer yield was evaluated by completing step and constant rate pumping tests.

On August 6, a step pumping test was completed. The test began at 30 L/min and the pumping rate increased by 10 L/min every 60 minutes. The highest pumping rate that the 0.37 KW pump could achieve was 60 L/min, although the well yield was higher. Recovery was measured for 110 minutes. The results of this test are graphically displayed in Appendix E.

On August 10, a constant rate test was completed for 330 minutes at a rate of 60 L/min to establish the upper limit of the well yield. Turbidity was 49.6 NTU at the beginning at this test and 7.6 NTU at the end. Conductivity ranged from 656 to 649 uS/cm. The well was disinfected once again following this pumping test. The time-drawdown graph for this test is shown following the August 6th data set in Appendix E.

On August 11, a 26-hour pumping test was initiated. The measurements included static and dynamic water levels of all observations wells, two private wells, and field readings of pH, temperature, conductivity, turbidity, and chlorine residual. CTW-98 was pumped at a constant rate of 50 L/min for this test. Pumping was started at 8:05 am on August 11 and completed at 9:45 am on August 12 (1,540 minutes total pumping). Recovery measurements were made for 480 minutes (95 % recovery). Water samples were taken for laboratory analysis in accordance with Tables 1, 2, and 3 of the ODWO. This is discussed in Section 3.2 and 3.3.

3.2.1 Transmissivity and Storativity

The drawdown and recovery data from the pumping tests described above was used to analyze the aquifer characteristics including transmissivity and storativity. The calculated values are summarized in Table 2.

NORTH
scale 1:5,000
date MARCH 1999
drawn DP
job no. 94519
drawing no.
FIG. 6
APPLE HILL
PHASE III HYDROGEOLOGICAL STUDY
POTENTIOMETRIC CONTOURS AND FLOW
DIRECTION OF OVERBURDEN AQUIFER
M.S. THOMPSON & ASSOCIATES LTD.
consulting engineers
CORNWALL
KINGSTON
The THOMPSON ROSEMOUNT Group
KENYON ROAD EAST
KENYON ROAD WEST
CP RAIL
COUNTY RD 20
BEAUDETTE
RIVER
TW-404
TW-228
95-1
95-2
95-3
95-4
95-5
95-6
95-7
95-8
95-9
95-10
MW95-12
MW95-13
MW95-14
CTW-95
CTW-98
98-15
98-16
98-18
98-19
86
87
88
89

Table 2 – Aquifer Characteristics

Method	Monitor	Date	Pumping Rate	Storativity	Trans-missivity	Specific Capacity	Radius from CTW-98
			L/min	$m^3/m^3 \times 10^{-5}$	m^2/day	m^3/m.day	m
Cooper and Jacob Time-Drawdown							
	MW95-13	Aug 12	50	29	12.2		96
	MW98-15	Aug 12	50	2.6	4.3		69
	MW98-16	Aug 12	50	4.6	4.4		90
	MW98-18	Aug 12	50	7.5	3.6		27
	MW98-19	Aug 12	50	11	5.1		49
Theis and Jacob Recovery Method							
	CTW-98	Aug 12	50		4.2		
Well Performance Test							
	CTW-98	Aug 6	30, 40, 50, 60			6.2	
Cooper and Jacob Distance–Drawdown							
	All MW	Aug 10	60		4.3		
	All MW	Aug 12	50		3.2		

The interpretation of this data indicates that the geometric mean transmissivity is about 4.7 m^2/day. The data in Table 2 also illustrates that the storativity is calculated to be 1×10^{-4} m^3/m^3 based on the observation well data. The transmissivity value compares well to that calculated using CTW95 (4 m^2/day). The drawdown data is summarized in Table 2, while the pumping test analysis data is plotted in Appendix E.

The physical hydrogeological data and the pumping test result were used to evaluate the design of the proposed production wells. The safe yield (Q_{20}) was used to determine the number of wells and the principle of superposition (Driscoll 1986) to determine well spacing.

The 20-year safe yield is defined by (Golder, 1995):

$$Q_{20} = 0.7TH$$

Q_{20} = 20-year safe yield (m^3/day)
T = transmissivity (m^2/day)
H = total available drawdown (m)

Based on an average calculated transmissivity (T) of 4.7 m^2/day and an available drawdown (H) of 15 m, the 20-year safe yield was calculated to be 49 m^3/day (34 L/min).

The well was tested at a maximum rate of 86 m^3/day (60 L/min) during the step pump test. The 24-hour pumping test was conducted at a rate of 72 m^3/day (50 L/min).

Based on the maximum demand of the water supply (220 m^3/day, Section 6 of the ESR, MSTA 1999), a minimum of 5 wells (having similar characteristics to the test well) would be required. Each well would have to yield at least 44 m^3/day (220/5) which is less than the 20-year safe yield (49 m^3/day). The proposed production wells could be located further to the south (downgradient) of the test well field but not within the floodplain (Figure 7). It should be noted fewer than 5 wells may be possible subject to the field conditions encountered and the actual well yield.

3.2.2 Well Locations

Although the number and location of production wells must verified during their installation, the spacing of the wells has been evaluated using the principle of superposition and Cooper's method (Driscoll 1986).

The drawdown (s) at an observation well a given distance from a pumping well is estimated by Cooper's method :

$$s \quad \frac{2.3Q}{4\pi T} \log \frac{2.25Tt}{r^2 S}$$

where :

r= radius between observation point and the well (m)
Q= pumping rate (m^3/day)
T= transmissivity (m^2/day)
S= storativity (m^3/ m^3)
t = pumping time (days)

By applying this equation and the principle of superposition to each well, the sum of the induced drawdown at each well corresponds to the total drawdown induced in the well.

Several iterations of well spacing were completed using the safe yield of rate of 49 m^3/day. The total drawdown in each ranged from 9.6 to 11.2 m when the wells were configured as shown on Figure 7. The middle well (no. 3) was located 100 m from wells 2 and 4 which in turn were 50 m from wells 1 and 5.

Table 3 – Calculated Drawdown of Proposed Production Wells

	Well 1	Well 2	Well 3	Well 2	Well 3	Total
Flow (m^3/day)	49	49	49	49	49	245
Transmissivity (m^2/day)			4.7			
Storativity			1.1×10^{-4}			
Total Drawdown (m)	9.6	11	11.2	11	9.6	

3.3 Water Supply

An integral component of the Phase III work was to determine whether the groundwater supply for the hamlet of Apple Hill is derived from local or regional recharge. In terms of water resource management and water supply protection, the origin of groundwater supply for the (communal) wells in Apple Hill is essential.

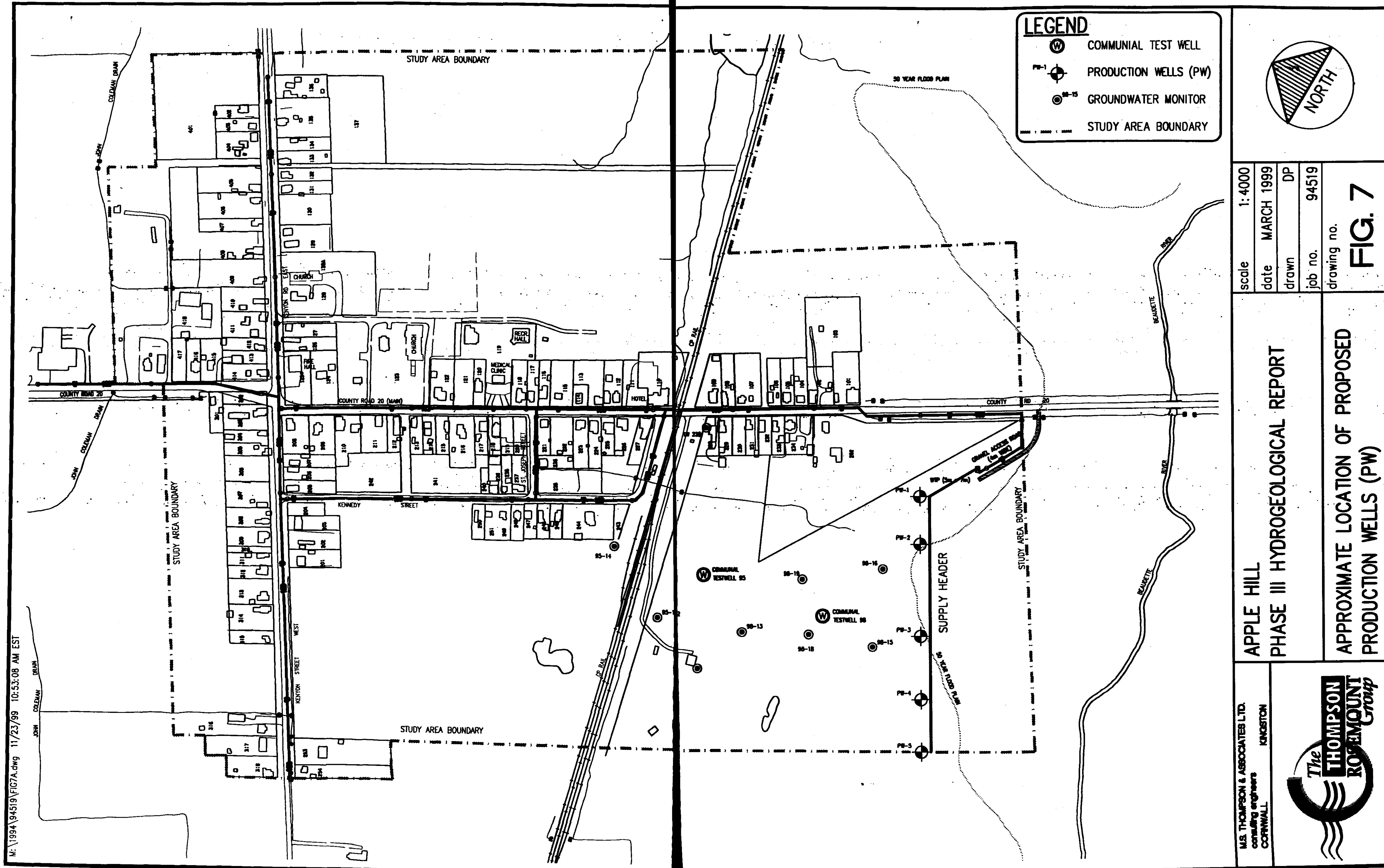
Consequently, MSTA retained Waterloo Hydrogeologic Inc. (WHI) to provide additional interpretation and modelling of the groundwater flow system. WHI analysed the groundwater flow system through the simulation of steady state groundwater flow using:

- a three-dimensional finite difference model MODFLOW (McDonald and Harbaugh, 1996); and
- a particle trace analysis package MODPATH (Pollock, 1994).

Employing site characterization developed by MSTA, WHI refined a conceptual flow model of the flow domain. This conceptual model represents the stratigraphy, lithology, hydraulic and chemical characteristics throughout the study area (Apple Hill). Using modelling techniques, WHI developed a suite of possible conceptual models of groundwater flow. Based on their work, WHI concluded the following in their February 1999 report entitled *Origin of Groundwater Recharge for the Town of Apple Hill* (Appendix G);

- It is unlikely that all of the water pumped from communal well 98 (CTW-98) is derived from local recharge;
- An estimate of the proportion of water that originates locally versus regionally that is pumped at CTW-98 is 18% locally and 82% regionally;
- The regional flow component that supplies CTW-98 has a travel time in excess of five years;
- The local flow component that supplies CTW-98 has a travel time in excess of 1,000 years, provided the till/clay layer is continuous and not heavily fractured; and
- Further study is necessary to assess the regional contribution to the Apple Hill groundwater flow system and its susceptibility to contamination (i.e. protection of the recharge zone(s)). This is discussed in the following section.

Localised recharge of the overburden aquifer is believed to account for less than 20% of the aquifer storage (WHI, 1999), from areas north and west of the hamlet. Localised



LEGEND
COMMUNIAL TEST WELL
PRODUCTION WELLS (PW)
GROUNDWATER MONITOR
STUDY AREA BOUNDARY
NORTH
STUDY AREA BOUNDARY
COUNTY ROAD 20
COUNTY ROAD 20 (MAIN)
COUNTY RD 20
KENYON RD EST
KENYON STREET WEST
KENNEDY STREET
ST. JOSEPH STREET
CHURCH
FIRE HALL
RECR HALL
MEDICAL CLINIC
HOTEL
CP RAIL
JOHN COLEMAN DRAIN
BEAUDETTE RIVER
50 YEAR FLOOD PLAIN
SUPPLY HEADER
GRAVEL ACCESS ROAD
PW-1
PW-2
PW-3
PW-4
PW-5
COMMUNAL TESTWELL 95
COMMUNAL TESTWELL 98
95-14
98-13
98-15
98-16
M:\1994\94519\FIG7A.dwg 11/23/99 10:53:08 AM EST
M.S. THOMPSON & ASSOCIATES LTD.
consulting engineers
CORNWALL KINGSTON
The THOMPSON ROSEMOUNT Group
APPLE HILL
PHASE III HYDROGEOLOGICAL REPORT
APPROXIMATE LOCATION OF PROPOSED PRODUCTION WELLS (PW)
scale 1:4000
date MARCH 1999
drawn DP
job no. 94519
drawing no.
FIG. 7

discharge of groundwater is evident in ponds at locations west of 95-8 and 98-18. Although the till and clay affords good aquifer protection from potential contaminants, the fact that old and poorly constructed wells exist in the hamlet, as well as the demonstrated aquifer contamination in the hamlet, re-affirms that wells should be abandoned so that contaminant short-circuiting does not compromise the proposed supply aquifer.

3.4 Surface Water Impact

The proposed groundwater taking was evaluated to ascertain possible influences on surface water recharge to the Beaudette River. The Beaudette River traverses the south part of Apple Hill flowing from west to east. The headwaters of the Beaudette River are located about 5 km west of Apple Hill (DeLeuw Cather, 1977) as shown in Figure 8. The recharge to the Beaudette River was determined based on interpretation of the potentiometric surface and the local geology since there are no stream gauges on the upper part of its watershed.

A conceptual model of the recharge is shown on Figure 9 wherein the confined aquifer discharges to the Beaudette River via the permeable deposits (sand and gravel). The potentiometric gradient corresponds to the non-flooding elevation of the Beaudette River (elev. 81.9 m on Dec. 2/89). The geological interpretation of the borehole data in the Apple Hill area indicates that a minimum of 5 km of the river is recharged by groundwater. This is based on the potentiometric gradient and the presence of permeable deposits (sand and gravel). A conservative estimate of the groundwater recharge to the Beaudette River (Q_g= 700 m^3/day) was calculated using Darcy's Law (Q=Kia) where K=0.9 m/day (10^{-5} m/s) for the deep overburden aquifer, i = 0.03 m/m (measured), and A=recharge area (perpendicular to groundwater flow=5 m aquifer thickness x 5,000 m).

The 700 m^3/day recharge in the Apple Hill area was compared to the proposed maximum groundwater extraction rate (220 m^3/day) less the 70 m^3/day estimated existing private well extraction rate (200 persons x 290 L/cap.day + 20 % for ICI) since it is proposed to abandon the private wells. Therefore, the net difference in groundwater recharge at Apple Hill is about 150 m^3/day, or 20 %. Considering that this is a conservative estimate and that additional stream recharge will occur over its 64 km length, both upstream and downstream of Apple Hill, this change is acceptable. It should be noted that the proposed average day water taking (73 m^3/day) is about equivalent to the existing water taking hence no recharge change would occur.

3.5 Groundwater Protection Strategy

As concluded by WHI in their February 1999 report, more than 80% of the aquifer recharge for the aquifer supply is not local (section 3.3 and Appendix F). The implication for a safe water supply for Apple Hill thus requires that both the wellhead area and the aquifer recharge area be protected.

A review of regional groundwater studies (Charron 1978, Porter 1996) show that groundwater recharge in Stormont and Glengarry Counties approximately corresponds to the topographic highland areas (surface elevation greater than 90 m asl). Thus, based on topographic interpretation, the recharge zone for Apple Hill is about 10 km northwest near Maxville. The topographic interpretation suggests that the recharge zone may include a radius of about 3 km from the Maxville area.

Although the delineation of the recharge area groundwater protection zone is beyond the context of this study, the elements of a groundwater protection strategy have been included.

The purpose of the groundwater protection strategy is to limit the risk to groundwater resources from historic or existing land uses, and secondly, minimize the risk from future land uses. The components that should be considered include :

1. Community consultation and awareness,
2. Water resources definition,
3. Contaminant inventory,
4. Monitoring and management of water quality,
5. Data management,
6. Policy development, and
7. Contingency planning.

Since many of these components have regional groundwater as well as surface water implications, guidance from the Eastern Ontario Water Resource Management Study would be prudent. Certainly, public education and awareness of groundwater quality protection are critical. The formation of a Water Resources Protection Committee, consisting of members of the public and municipal staff should be considered.

As discussed in section 3.5, the possible impact of poorly constructed wells and substandard sewage treatment systems will continue to impact on the groundwater supply. Hence, proper well abandonment and rehabilitation of replacement of on-site sewage systems is necessary (MSTA, 1999).

3.6 Chemical Hydrogeology

Groundwater samples were collected four (4) times during the 24-hour pumping test (constant rate of 50 L/min). Field measurements of the collected groundwater included pH, temperature and conductivity. The samples were placed in appropriate laboratory prepared sample jars (and field filtered for metals analysis) and packed in coolers and shipped the same day to Areco Laboratories in Ottawa for analysis for the suite of parameters. The results were compared to the ODWO Table 1, 2, and 3. The detailed organic scan was completed on the fourth sample.

The samples were taken as follows :

- Sample 1 – 0840 hours (August 11)

- Sample 2 – 1450 hours (August 11)
- Sample 3 – 2045 hours (August 11)
- Sample 4 – 0945 hours (August 12)

The results of the groundwater monitoring were tabulated (Table 1) and compared to the applicable Ontario Drinking Water Quality Objectives (ODWO) and the exceedences were shaded.

The ODWO quality exceedences have been summarized:

- Turbidity of 5.9 NTU at the end of the pumping test;
- H_2S values of 0.85 to 2.70 mg/L; and
- Hardness results between 161 and 251 mg/L (as $CaCO_3$).

The groundwater quality was evaluated by completing well-head measurements of water quality indicators pH, conductivity, turbidity, and temperature.

To determine temporal changes in water quality, water samples were also collected at the beginning and near the end of the pumping test. Sample 1 was taken at 0820 and sample 2 at 1455 hrs for laboratory analysis. This data is also illustrated in Table 1. The results show that apart from the exceedences discussed, the water quality was comparable between events which indicates that the well is reasonably developed (although turbidity values suggest that some additional development should be conducted). The lowest turbidity measured at the well head was 6.9 NTU. The elevated laboratory measurement of turbidity is attributable to precipitation of iron.

The other notable water quality indicator is hardness, which was measured between 161 and 251 mg/L (as $CaCO_3$). Although the desirable level of water hardness is subjective, the measured concentration exceeds the ODWO aesthetic criteria of 100 mg/L, which suggests that softening would be required. Sulphur odour was noted throughout the 24-hour pumping test and H_2S values of 0.85 to 2.70 mg/L confirm the sulphur concentrations.

3.7 Water Treatment

The communal water treatment plant (WTP) proposed to accommodate the requirements of Apple Hill was designed to rectify the water quality issues discussed above. A process flow schematic of the proposed WTP is shown in Section 6 of the ESR. As such, a 0.37 KW (½ HP) submersible pump will be installed in each of the five supply wells constructed south of the hamlet. Each pump will easily be capable of providing 50 L/min (capacity).

At the WTP, a flow meter and in-line micronizer (for aeration) will be installed on each well inlet line. Flow from the well pumps will be directed to a polyethylene tank, which will be utilised for H_2S oxidation and sparging. Disinfection of the groundwater is accomplished by use of sodium hypochlorite (NaOCl) delivered by one of two neat chemical feed pumps. The chlorinated water will be stored in a wet well to provide a minimum 30-minute chlorine contact time based on maximum daily flow.

Pressurization of the distribution system will be accomplished by high-lift pumps drawing from the wet well. A peak flow pump and spare pump, each capable of 700 L/min, will be supplemented by a duty pump capable of 150 L/min. Pumped flows to the distribution system will be measured immediately prior to leaving the WTP. The distribution system, serving about 100 dwellings, will consist of 100 mm DR18 PVC.

3.8 Recommended Well Construction Technique

As discussed in Section 3.1, test well CTW-98 was constructed using a 150 mm casing terminating in the shallow fractured bedrock. Greater well yield was demonstrated with this well construction methodology in comparison to the stainless steel screen employed in test well (CTW95). Although the construction of the (5) proposed production wells may be modified subject to geologic conditions encountered, an open casing terminating in the shallow fractured bedrock is the recommended well construction technique.

The Permit To Take Water Application should be competed subject to the number of wells constructed and their actual yield.

4.0 Conclusions

- Field investigations have demonstrated that a suitable supply aquifer exists in the south west part of Apple Hill to meet the demand of a communal water system.
- It is estimated that the supply at CTW-98 is contributed about 18% and 82% from local and regional water supplies respectively.
- Although most of the recharge does not originate locally and the local aquifer is confined and protected by dense till, ageing wells and improper sewage systems may be short-circuiting contaminants into the supply aquifer.
- The 20-year safe yield was calculated to be 49 m^3/day based upon completion of a step test and a 24-hour constant rate pumping test. The test well (CTW-98) was pumped at a maximum of 86 m^3/day (60 L/min) using a 0.37 kW submersible pump.
- The analysis of water sampling from CTW-98 indicates compliance with the ODWO Table 1, 2 and 3 criteria, except for H_2S, Fe, hardness, and bacteriological organisms. Treatment is required for H_2S and bacteria.
- The proposed WTP and five supply wells can supply a sustainable yield to the community of Apple Hill.
- Surface water recharge to the Beaudette River will not be adversely affected by the proposed water taking considering that the existing private wells, which deplete potential surface water recharge, will be abandoned.

5.0 Recommendations

1. Application for funding from all levels of government should be sought to assist the municipality with the capital costs required to implement a communal water supply in the hamlet.
2. Construction of the five (5) proposed production wells using an open casing terminating in the shallow fractured bedrock is recommended, provided that each can yield the supply as determined in this investigation.
3. Since allowance for lawn watering has been configured with the proposed communal water supply, private wells in the hamlet should be abandoned.
4. Private sewage systems should be replaced or rehabilitated.
5. The regional recharge contribution to the Apple Hill area, its susceptibility to contamination and the need for recharge protection areas should be assessed.

This information may be available from the regional water resources study currently being completed.

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Environmental Technologist

John St. Marseille, M.Sc., P.Eng.
Senior Environmental Engineer

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Appendix A –Borehole Logs

DATUM: Geodetic Bench Mark No. GD 513-G elevation = 97.099 m on Catholic Church

DATE: July 15, 1998

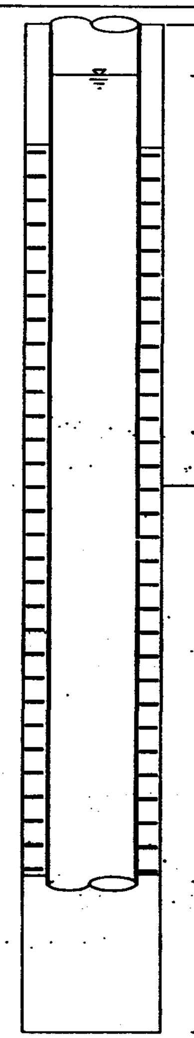
HOLE #: CTW98

REMARKS:

BORING BY: AIR ROTARY DRILL

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface	86.93						
TILL, brown, packed with boulders.						0.0	86.93
						1.5	85.43
						3.0	83.93
						4.5	82.43
						6.0	80.93
						7.5	79.43
	78.40						
GRAVEL, packed.						9.0	77.93
						10.5	76.43
						12.0	74.93
						13.5	73.43
	72.91						
LIMESTONE, layered.							
	71.69					15.0	71.93
Borehole terminated.							
						16.5	70.43
R - Splitspoon Refused							

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE	AUGUST 1998
SCALE	NOT TO SCALE
DRAWN	JBH
JOB No.	94519

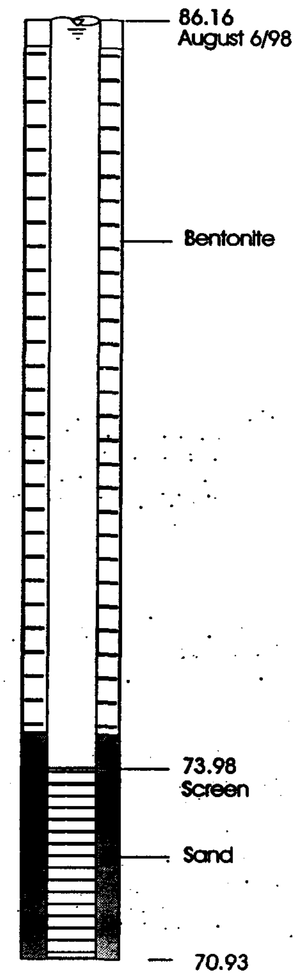
DATUM:	Geodetic Bench Mark No. GD 513-G elevation = 97.099 m on Catholic Church		DATE:	July 16, 1998
REMARKS:			HOLE #:	98-15
BORING BY:	AIR ROTARY DRILL			

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value
Ground Surface	85.26				
TILL, brown, packed with gravel.					
	76.12				
GRAVEL, packed.					
	71.85				
LIMESTONE, layered.					
	70.93				
Borehole terminated.					

R - Splitspoon Refused

DEPTH (m)	ELEV. (m)
0.0	85.26
1.5	83.76
3.0	82.26
4.5	80.76
6.0	79.26
7.5	77.76
9.0	76.26
10.5	74.76
12.0	73.26
13.5	71.76
15.0	70.26
16.5	68.76

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE	BOREHOLE LOG	DATE	AUGUST 1998
		SCALE	NOT TO SCALE
JOB	APPLE HILL WATER PROJECT	DRAWN	JBH
		JOB No.	94519

DATUM: Geodetic Bench Mark No.
GD 513-G elevation = 97.099 m
on Catholic Church

DATE: July 16, 1998

HOLE #: 98-16

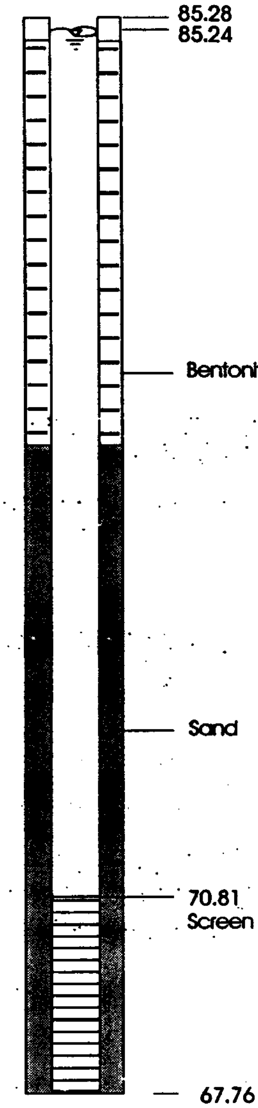
REMARKS:

BORING BY: AIR ROTARY DRILL

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value
Ground Surface	84.22				
TILL, brown, packed with boulders.	75.08				
GRAVEL, packed.	69.59				
LIMESTONE, layered.	67.76				
Borehole terminated.					
R - Splitspoon Refused					

DEPTH (m)	ELEV. (m)
0.0	84.22
1.5	82.72
3.0	81.22
4.5	79.72
6.0	78.22
7.5	76.72
9.0	75.22
10.5	73.72
12.0	72.22
13.5	70.72
15.0	69.22
16.5	67.72

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

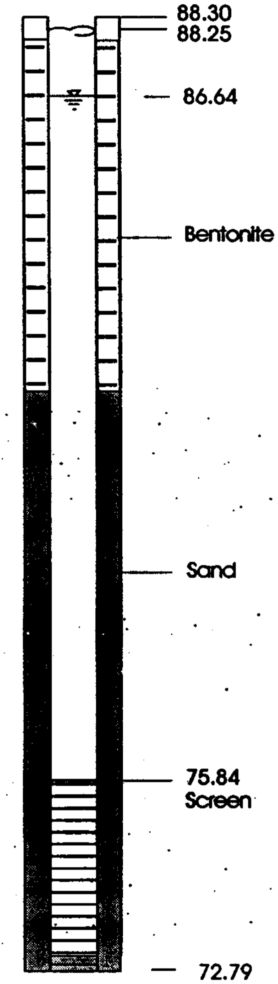
FIGURE TITLE	BOREHOLE LOG
JOB	APPLE HILL WATER PROJECT
DATE	AUGUST 1998
SCALE	NOT TO SCALE
DRAWN	JBH
JOB No.	94519

DATUM:	Geodetic Bench Mark No. GD 513-G elevation = 97.099 m on Catholic Church
DATE:	July 16, 1998
HOLE #:	98-18
REMARKS:	
BORING BY:	AIR ROTARY DRILL

SOIL DESCRIPTION		STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value
Ground Surface	87.42				
TILL, brown, packed with gravel.	78.89				
GRAVEL, packed.	74.01				
LIMESTONE, layered.	72.79				
Borehole terminated.					

DEPTH (m)	ELEV. (m)
0.0	87.42
1.5	85.92
3.0	84.42
4.5	82.92
6.0	81.42
7.5	79.92
9.0	78.42
10.5	76.92
12.0	75.42
13.5	73.92
15.0	72.42
16.5	70.92

WELL DETAILS



R - Splitspoon Refused

M.S. THOMPSON & ASSOCIATES LTD. CONSULTING ENGINEERS	FIGURE TITLE BOREHOLE LOG	DATE	AUGUST 1998
		SCALE	NOT TO SCALE
	JOB APPLE HILL WATER PROJECT	DRAWN	JBH
		JOB No.	94519

DATUM: Geodetic Bench Mark No.
GD 513-G elevation = 97.099 m
on Catholic Church

DATE: July 16, 1998

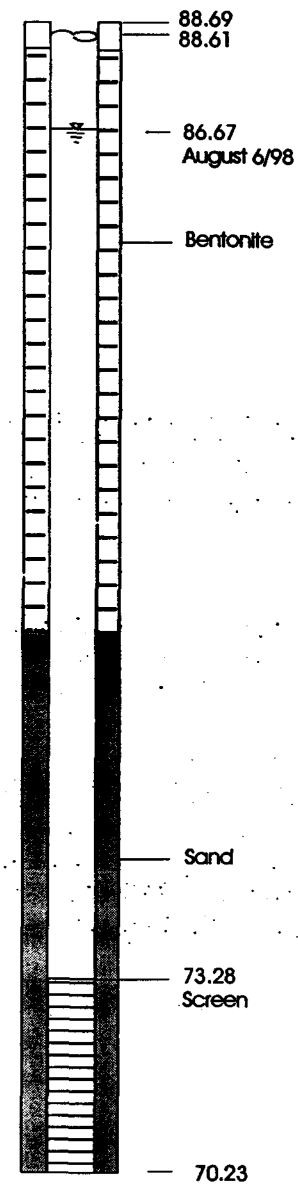
HOLE #: 98-19

REMARKS:

BORING BY: AIR ROTARY DRILL

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 87.91					0.0	87.91
CLAY, brown, dense.						
86.39						
TILL, packed, with some gravel.					1.5	86.41
					3.0	84.91
					4.5	83.41
					6.0	81.91
					7.5	80.41
78.77						
GRAVEL, packed.					9.0	78.91
					10.5	77.41
					12.0	75.91
					13.5	74.41
					15.0	72.91
72.07						
LIMESTONE, layered.					16.5	71.41
70.23						
Borehole terminated.						

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG

JOB
APPLE HILL WATER PROJECT

DATE	AUGUST 1998
SCALE	NOT TO SCALE
DRAWN	JBH
JOB No.	94519

DATUM: TOPOGRAPHIC MAPPING
WEST-HALF LOT 37 CONC. 1
(ABOUT 160m WEST OF MAIN STREET)

DRILLING DATE: September 22,1995

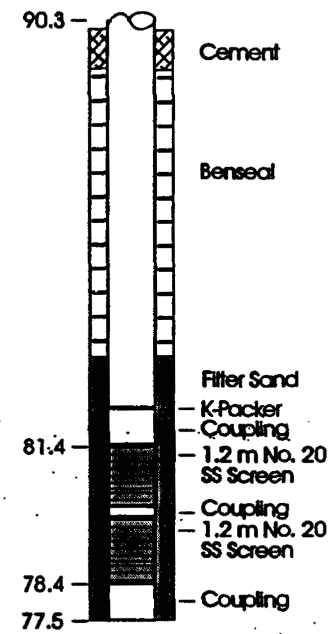
HOLE #: CTW-95 (BH-11)

REMARKS:

BORING BY: AIR ROTARY DRILL

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 90.3					0.0	90.3
Till-Brown compact silt and sand with cobbles. Boulders below 4m.					2.0	88.3
85.7					4.0	86.3
Till-Grey compact clay and silt with cobbles.						
83.6					6.0	84.3
Wet grey silt, fine sand, and gravel. Some layers of clay. Yield about 20 L/min.					8.0	82.3
					10.0	80.3
77.5					12.0	78.3
Borehole Terminated.					14.0	76.3
					16.0	74.3
					18.0	72.3
					20.0	70.3

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE
BOREHOLE LOG
CTW-95 (BH-11)

JOB
APPLE HILL WATER PROJECT

DATE	1997
SCALE	NOT TO SCALE
DRAWN	JBH
JOB No.	94519

DATUM: ELEVATION AT TOP OF STEEL CASING = 92.53 m
GROUND SURFACE ELEVATION = 92.00 m

DRILLING DATE: March 9, 1995

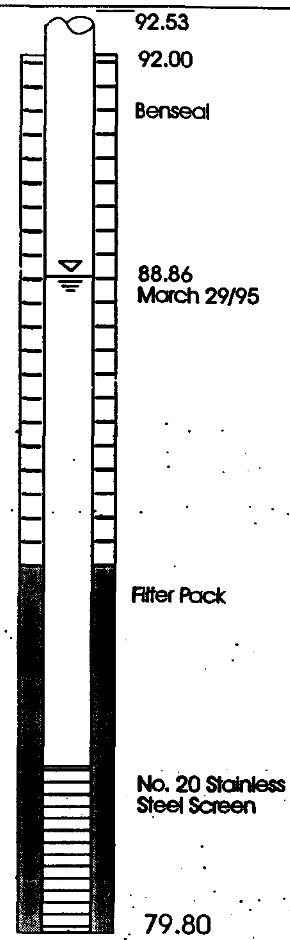
HOLE #: **TW228**

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 92.00					0.0	92.00
Brown compact clay silt and sand with cobbles-TILL.					2.0	90.00
88.00					4.0	88.00
Grey compact silty sand with cobbles and clay with more gravel and becoming moist at depth.						
85.90					6.0	86.00
Wet grey sand and gravel with minor silt. Yield estimated to be 45 L/min.					8.0	84.00
					10.0	82.00
79.80					12.0	80.00
Borehole Terminated						

WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE	BOREHOLE LOG LOT 228	DATE	JUNE 1995
		SCALE	NOT TO SCALE
JOB	APPLE HILL WATER PROJECT	DRAWN	JASB
		JOB No.	94519

DATUM: ELEVATION AT TOP OF STEEL CASING = 91.54 m
GROUND SURFACE ELEVATION = 90.80 m

DRILLING DATE: March 10, 1995

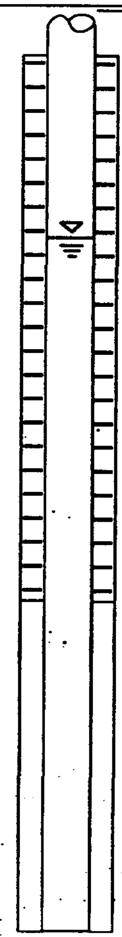
HOLE #: **TW404**

REMARKS:

BORING BY: Air Rotary

SOIL DESCRIPTION	STRAT.	SAMPLE TYPE	SAMPLE No.	N -Value	DEPTH (m)	ELEV. (m)
Ground Surface 90.80					0.0	90.80
Brown, compact clay silt and sand with cobbles-Till.					2.0	88.80
86.80 Grey compact silty sand with cobbles and clay-TILL.					4.0	86.80
					6.0	84.80
82.90 Dense grey limestone, fractured at 81.6 to 81.7 m yielding water at 10 - 13 L/min.					8.0	82.80
					10.0	80.80
78.60 Borehole Terminated					12.0	78.80

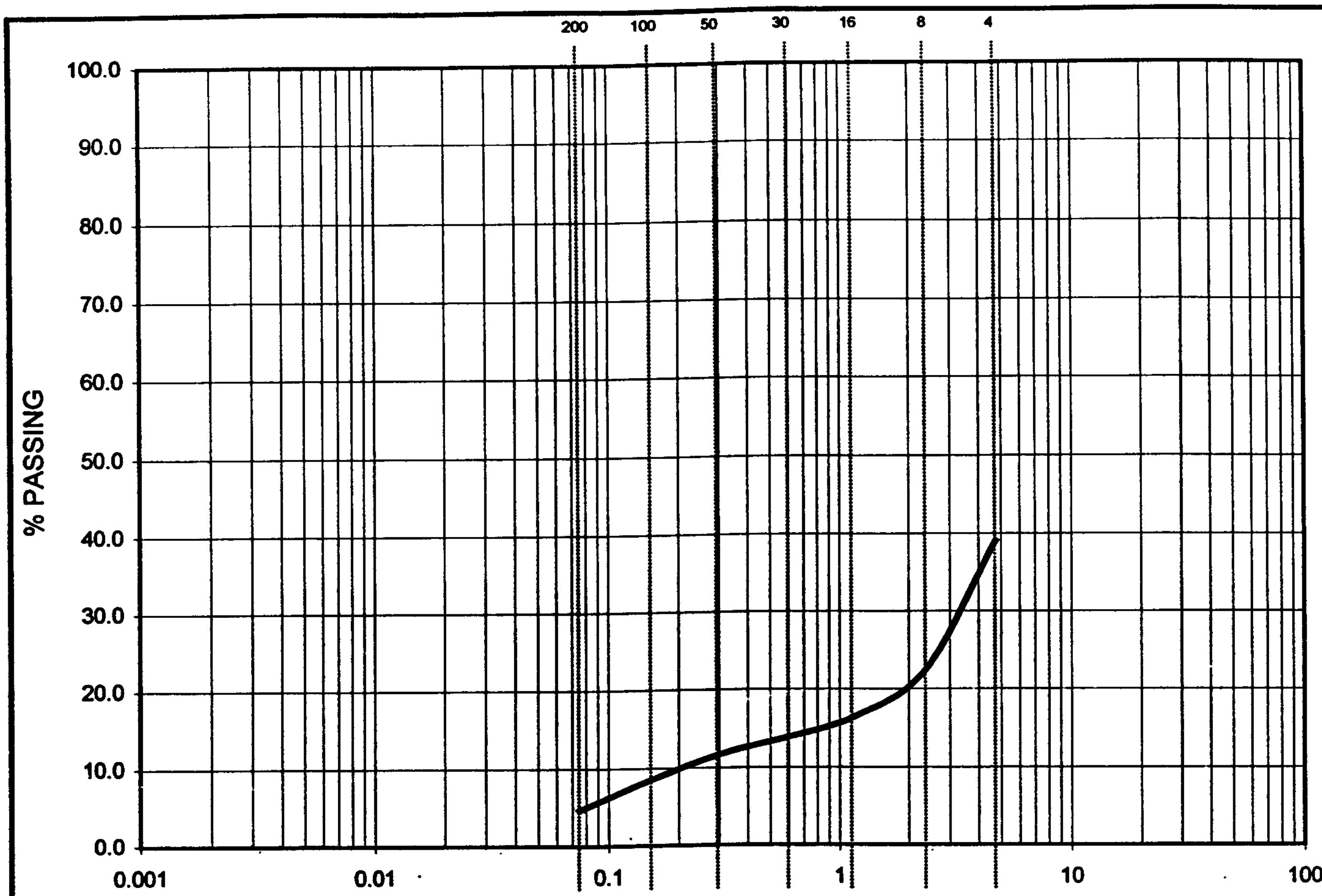
WELL DETAILS



M.S. THOMPSON & ASSOCIATES LTD.
CONSULTING ENGINEERS

FIGURE TITLE	BOREHOLE LOG LOT 404
JOB	APPLE HILL PRIVATE WATER CORRECTION
DATE	JUNE 1995
SCALE	NOT TO SCALE
DRAWN	JASB
JOB No.	94519

Appendix B – Grainsize Distribution Charts



SILT OR CLAY	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

SIEVE No.	OPENING (mm)	% PASSING
4	4.75	39.0
8	2.36	22.4
16	1.18	16.6
30	0.60	13.9
50	0.30	11.7
100	0.15	8.4
200	0.075	4.7

IN SITU CONDITIONS:____________________________

SHAKE TEST RESULTS:____________________________

SOIL DESCRIPTION:____________________________

ESTIMATED PERCOLATION RATE:____________________________

M.S. THOMPSON & ASSOCIATES LTD. consulting engineers CORNWALL KINGSTON	APPLE HILL PHASE III HYDROGEOLOGICAL STUDY	scale NTS
		date MARCH 1999
		drawn JBH
		job no. 94519
The THOMPSON ROSEMOUNT Group	GRAIN SIZE ANALYSIS FOR 98-16	drawing no. APPENDIX B

Appendix C – Potentiometric Data

Potentiometric Elevations
Apple Hill Water Project

Monitor I.D.	Surface Elev. (m)	Screen Elev. (m)	Top of Piez. (m)	Top of Casing (m)	Static Water Level Jun 1/98	Jul 6/98	Jul 21/98	Aug 6/98	Aug 10/98	Aug 11/98	Dec 2/98
TW228	92.00	82.00	—	92.53	87.81	—	—	87.74	87.60	87.59	88.54
95-12	91.63	83.10	91.72	92.05	89.25	91.06	—	89.26	90.42	88.76	90.29
95-13	89.36	77.00	89.86	90.06	88.13	89.35	88.52	87.98	88.03	87.45	89.06
95-14	91.35	81.30	91.71	91.94	89.77	91.20	—	89.69	89.55	89.00	90.64
CTW95	90.17	81.40	—	90.93	88.86	90.40	—	88.60	88.47	88.70	89.60
98-15	85.26	73.98	86.16	86.16	—	85.69	86.16	86.16	86.16	86.16	86.73
98-16	84.22	70.81	85.24	85.28	—	85.04	85.24	85.24	85.24	85.24	85.82
98-18	87.42	75.84	88.25	88.3	—	86.51	87.18	86.64	85.37	85.42	87.46
98-19	87.91	73.28	88.61	88.69	—	87.54	87.17	86.67	86.06	86.20	87.59
CTW98-17	86.93	—	—	87.43	—	86.88	87.05	86.61	86.53	86.15	87.43
Cabin Well		—	91.65	—	—	—	—	—	—	—	90.25
Yellow House		—	92.71	—	—	—	—	—	—	—	90.81
TW241				—	Dry	—	—	—	—	—	-0.40
TW204				—	Dry	—	—	—	—	—	-0.60
Beaudette R.	—	—	85.25	—	—	—	—	—	—	—	81.89

Appendix D – Groundwater Chemistry Analysis

Table 1 - Groundwater Chemical Analysis
Apple Hill Water Project

Parameter / ODWO / Location/Date	Hard.	Alk.	Cond. Lab	Cond. Field	pH Lab	pH Field	Colour	Turb. Field	Turb. Lab	Fl	Fe	Mn	T.P.	Ca	Mg	Na	K	Cl	Ba	B	SO_4	H_2S	NH_3	TKN	Org-N	NO_3	NO_2	Phenols	DOC	TDS	HPC	TC	E. coli
ODWO	80-100	30-500			6.5-8.5		5	1		1.5	0.30	0.05				200		250	1	5	500	0.05			0.15	10	1		5	500	200	0	0
TW228																																	
Mar. 29/95-1	594	250	—	1855	—	7.25	3	—	[illegible]	ND	0.02	[illegible]	—	112.0	76.5	189	3.3	[illegible]	—	—	67.3	—	0.13	0.19	0.06	0.6	ND	ND	—	[illegible]	74	0	0
Mar. 29/95-2	579	310	—	2210	—	7.20	2	—	[illegible]	ND	ND	[illegible]	—	132.0	60.6	[illegible]	3.7	[illegible]	—	—	68.6	—	0.07	0.16	0.09	0.9	ND	ND	—	[illegible]	78	0	0
June 1/98	588	311	—	2360	—	7.06	ND	—	[illegible]	ND	[illegible]	[illegible]	—	141.0	57.3	[illegible]	2.7	[illegible]	—	—	166.0	—	0.07	0.18	0.11	0.8	ND	ND	ND	[illegible]	0	2	0
CTW-95																																	
June 1/98-1	373	290	—	765	—	7.22	ND	—	[illegible]	0.4	[illegible]	[illegible]	—	75.7	44.8	28.2	1.3	17.0	—	—	105.0	—	0.08	0.13	0.07	ND	ND	ND	ND	466	150	[illegible]	0
June 1/98-2	352	285	—	738	—	7.23	ND	—	[illegible]	0.4	[illegible]	0.031	—	68.1	44.1	27.2	1.2	16.7	—	—	102.0	—	0.08	0.13	0.05	ND	ND	ND	ND	448	0	92	0
98-17																																	
July 16/98																																	
9:56 AM	161	177	433	496	—	8.16	—	[illegible]	—	0.9	0.24	0.015	—	18.4	27.9	38.8	3.2	23.0	—	—	18.5	—	—	—	—	ND	ND	—	—	237	—	—	—
10:31 AM	187	175	460	520	—	8.32	—	[illegible]	—	0.9	[illegible]	0.031	—	25.2	30.2	33.8	3.4	23.0	—	—	31.6	—	—	—	—	ND	ND	—	—	254	—	—	—
11:01 AM	185	168	454	517	—	8.31	—	[illegible]	—	0.9	[illegible]	0.014	—	26.1	29.1	33.6	3.2	23.0	—	—	34.7	—	—	—	—	ND	ND	—	—	252	—	—	—
11:31 AM	198	178	485	546	—	8.29	—	[illegible]	—	0.8	0.18	0.011	—	28.6	30.7	30.9	4.3	25.0	—	—	39.3	—	—	—	—	ND	ND	—	—	267	—	—	—
12:02 PM	195	183	491	566	—	8.26	—	[illegible]	—	0.8	0.04	0.009	—	28.3	30.3	30.2	4.3	25.0	—	—	39.3	—	—	—	—	ND	ND	—	—	268	—	—	—
1:31 PM	226	185	509	581	—	8.25	—	[illegible]	—	0.8	0.10	0.010	—	34.5	34	28.6	4.2	27.0	—	—	42.6	—	—	—	—	ND	ND	—	—	284	—	—	—
3:01 PM	232	193	524	582	—	8.29	—	[illegible]	—	0.7	0.03	0.008	—	35.4	34.9	29.9	4.7	29.0	—	—	45.6	—	—	—	—	ND	ND	—	—	296	—	—	—
July 21/98																																	
8:31 AM	210	179	530	—	—	7.97	—	[illegible]	—	—	ND	0.027	—	28.9	33.6	34.7	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9:31 AM	215	182	516	—	—	7.94	—	[illegible]	—	—	ND	0.007	—	30.9	33.4	31.0	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10:01 AM	223	188	525	—	—	7.94	—	[illegible]	—	—	ND	0.008	—	32.3	34.5	30.7	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10:31 AM	226	187	530	—	—	7.94	—	[illegible]	—	—	ND	0.007	—	31.6	35.8	31.2	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11:01 AM	225	198	533	—	—	7.94	—	[illegible]	—	—	ND	0.007	—	31.3	35.7	31.3	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11:31 AM	220	188	539	—	—	7.93	—	[illegible]	—	—	ND	0.007	—	30.9	34.7	32.6	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12:01 PM	223	190	542	—	—	7.93	—	[illegible]	—	—	ND	0.007	—	31.4	35.2	31.8	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12:31 PM	228	194	543	—	—	7.97	—	[illegible]	—	—	ND	0.007	—	33.2	35.3	32.3	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1:01 PM	226	192	545	—	—	7.93	—	[illegible]	—	—	ND	0.007	—	33.3	34.7	32.3	2.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1:31 PM	225	192	547	—	—	7.91	—	[illegible]	—	—	ND	0.007	—	33.3	34.6	32.2	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2:01 PM	230	190	548	—	—	8.03	—	[illegible]	—	—	ND	0.007	—	33.8	35.3	32.0	2.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2:31 PM	237	193	549	—	—	7.95	—	[illegible]	—	—	ND	0.007	—	36.2	35.6	32.3	2.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aug 10/98																																	
9:00 AM	—	—	—	656	—	7.54	—	[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11:00 AM	—	—	—	631	—	8.26	—	[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1:05 PM	—	—	—	642	—	[illegible]	—	[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3:15 PM	—	—	—	649	—	8.41	—	[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aug 11/98																																	
8:05 AM	—	—	—	976	—	8.16	—	0.31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8:20 AM	—	—	—	713	—	7.97	—	[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8:40 AM	243	184	580	677	7.36	7.98	ND	[illegible]	[illegible]	0.7	[illegible]	0.019	—	41.0	34.3	34.5	9.4	46.1	—	—	53.9	[illegible]	0.16	0.16	ND	ND	ND	ND	ND	339	260	6	0
2:50 PM	251	196	570	660	7.57	8.47	ND	[illegible]	[illegible]	0.7	0.11	0.008	—	42.6	35.1	34.3	3.5	38.0	—	—	47.5	[illegible]	0.16	0.16	ND	ND	ND	ND	ND	334	210	10	0
8:45 PM	213	190	557	632	7.81	9.14	ND	[illegible]	[illegible]	0.7	[illegible]	0.020	—	35.6	30.2	35.7	2.3	35.5	—	—	46.3	[illegible]	0.17	0.29	0.12	ND	ND	0.001	ND	315	>200,000	3,000	0
Aug 12/98																																	
7:40 AM	—	—	—	613		8.47	—	7.39		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9:45 AM	208	187	540	622	7.80	8.60	ND	[illegible]	[illegible]	0.7	0.11	0.011	—	24.8	29.4	35.3	2.1	32.1	0.16	0.12	42.8	[illegible]	0.17	0.29	0.12	ND	ND	0.001	ND	293	—	—	—

Note that samples for July 21, 1998 were submitted July 23, 1998.
Note that samples for July 16, 1998 were submitted July 21, 1998.
ODWO - Ontario Drinking Water Objective
5.3 - Indicates exceedence of ODWO
ND - Not Detected

x:\1994\94519\Excel\Chem.xls

REPORT OF ANALYSIS

ARECO CA[illegible] A INC., 40 CAMELOT DR., NEPEAN, ON[illegible] [illegible]IO, K2G 5X8
TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	120898-5	CLIENT:	M. S. T. A
SAMPLE MATRIX:	Water	JOB/PROJECT NO.:	94519
REPORT NUMBER:	32472508	DATE SUBMITTED:	12-Aug-98
REPORT TO:	Dale Phippen	DATE REPORTED:	25-Aug-98

PARAMETERS	UNITS	M.D.L.	ODWO	CDWQG	RESULTS		
					SA 0840	SA 1450	
Date Collected	dd-mmm				11-Aug	11-Aug	
Hardness(as $CaCO_3$)	mg/L	1	80-100		243	251	
Alkalinity(as $CaCO_3$)	mg/L	1	30-500		184	196	
Conductivity	µS/cm	1			580	570	
pH		0.00-14.00	6.5-8.5	6.5-8.5	7.36	7.57	
Colour	T.C.U.	1	5	15	ND	ND	
Turbidity	N.T.U.	0.1	1, 5	1, 5	21.8	5.4	
Fluoride	mg/L	0.1	1.5, 2.4	1.5	0.7	0.7	
Chloride	mg/L	1.0	250	250	46.1	38.0	
Nitrite(N)	mg/L	0.1	1.0	1.0	ND	ND	
Nitrate(N)	mg/L	0.1	10.0	10.0	ND	ND	
Sulphate	mg/L	1.0	500	500	53.9	47.5	
Calcium	mg/L	1.0			41.0	42.6	
Magnesium	mg/L	1.0			34.3	35.1	
Sodium	mg/L	1.0	20, 200	200	34.5	34.3	
Potassium	mg/L	1.0			3.4	3.5	
Ammonia(N)	mg/L	0.01			0.16	0.16	
TKN	mg/L	0.05			0.16	0.16	
Organic Nitrogen	mg/L	0.05	0.15		ND	ND	
Iron	mg/L	0.01	0.30	0.30	0.60	0.11	
Manganese	mg/L	0.005	0.05	0.05	0.019	0.008	
Phenols	mg/L	0.001	0.002		ND	ND	
Hydrogen Sulphide	mg/L	0.01	0.05	0.05	0.85	2.70	
Tannins	mg/L	0.1			0.2	0.1	
Silica (SiO_2)	mg/L	0.1			13.4	13.9	
DOC	mg/L	1	5		ND	ND	
Total Coliform	cts/100mL		5	10	6	10	
E.Coli	cts/100mL		0	0	0	0	
Background	cts/100ml		200	200	280	210	
Anion Sum	meq/L				6.14	6.01	
Cation Sum	meq/L				6.50	6.61	
% Difference	%				2.88	4.74	
Ion Ratio	AS/CS				0.94	0.91	
SAR					0.96	0.94	
Conductivity (calc.)	µS/cm				608	601	
TDS (ion sum calc.)	mg/L		500	500	339	334	
EC(calc.)/EC(actual)					1.05	1.05	
TDS(calc.)/EC(actual)					0.58	0.59	
Langelier Index	S.I.				-0.31	-0.06	

ODWO = Ontario Drinking Water Objectives, Rev. 1994
CDWQG = Canadian Drinking Water Quality Guidelines
- = Not Requested/Analyzed
ND = Not Detected
M.D.L. = Method Detection Limit

THOMPSON / ROSEMOUNT
S.W
W.K.
R.T
G.K.
REC SEP 14 1998

CHARTERED CHEMIST
Gregory J. G. Clarkin
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
Certified by

Greg Clarkin, B.Sc., C.Chem.
Laboratory Director

Address all Inquiries to the Laboratory Director/Manager.

CLIENT:	M. S. T. A	CLIENT JOB NUMBER:	94519
ADDRESS:	1345 Rosemount Ave. Cornwall, ON. K6J 3E5		
ATTENTION:	Dale Phippen	REPORT DATE:	25-Aug-98

ANALYTICAL REPORT

ARECO LABORATORY I.D.:	120898-5	REPORT NUMBER:	32472508
DATE RECEIVED:	12-Aug-98	TIME RECEIVED:	10:40 AM
SAMPLE MATRIX:	Water		
# OF SAMPLES RECEIVED:	2		

ANALYSES	ANALYST	QTY	DATE EXTRACTED	DATE ANALYZED	TIME ANALYZED	ANALYTICAL METHOD	METHOD REFERENCE
Hardness (as $CaCO_3$)	M.M.	2	NA	17-Aug-98	1:00 PM	ICP-AES	EPA 200.7
Alkalinity (as $CaCO_3$)	S.L.	2	NA	13-Aug-98	10:51 AM	Colorimetric/Electrode	EPA 310.2
Conductivity	D.M.	2	NA	13-Aug-98	1:00 PM	Conductivity Meter	EPA 120.1
pH	D.M.	2	NA	13-Aug-98	12:45 PM	pH Meter	EPA 150.1
Colour	D.M.	2	NA	14-Aug-98	4:00 PM	Colorimetric, Manual	EPA 110.2
Turbidity	D.M.	2	NA	14-Aug-98	4:30 PM	Turbidimeter	EPA 180.1
Anions	D.M.	2	NA	13-Aug-98	11:00 PM	Ion Chromatography	EPA 300.0
Metals - Cations	M.M.	2	NA	17-Aug-98	1:00 PM	ICP-AES	EPA 200.7
Nitrogen - Ammonia (N)	J.D.	2	NA	19-Aug-98	12:45 PM	Colour-Automated	EPA 350.2
Nitrogen - Kjeldahl (N)	J.D.	2	13-Aug-98	14-Aug-98	3:00 PM	Colour-Automated	EPA 351.2
Metals - Heavy	M.M.	2	NA	18-Aug-98	4:10 PM	ICP-AES	EPA 200.7
Phenols	J.D	2	NA	21-Aug-98	1:05 PM	Colour-Automated	EPA 420.2
Hydrogen Sulphide	D.M.	2	NA	14-Aug-98	9:00 AM	Colorimetric	HACH 8131
Tannin & Lignin	S.L.	2	NA	18-Aug-98	2:49 PM	Colorimetric	SM 5500-B
Silica (as SiO_2)	S.L.	2	NA	18-Aug-98	10:40 AM	Colorimetric	SM 4500-Si E
DOC	M.M.	2	NA	13-Aug-98	5:00 PM	Combusion-IR	EPA 415.1
Total Coliform	D.M.	2	12-Aug-98	13-Aug-98	4:15 PM	Membrane Filtration	SM 9222
E. coli.	D.M.	2	12-Aug-98	13-Aug-98	4:15 PM	Membrane Filtration	SM 9225A
Background	D.M.	2	12-Aug-98	13-Aug-98	4:15 PM	Membrane Filtration	SM 9222

- = Not Requested/Analyzed
NA = Not Applicable

Greg Clarkin, B.Sc., C.Chem.
Laboratory Director
ARECO CANADA INC

QUALITY CONTROL REPORT

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	120898-5	CLIENT:	M. S. T. A
SAMPLE MATRIX:	Water	JOB/PROJECT NO:	94519
REPORT NUMBER:	32472508	DATE SUBMITTED:	12-Aug-98
REPORT TO:	Dale Phippen	DATE REPORTED:	25-Aug-98

PARAMETERS	QC DATA					
	Matrix Spike		Duplicate	Lab	QC Sample	
	Found (% Rec)	Limits (% Rec)	R.P.D.	Blank	Found (% Rec.)	Limits (% Rec.)
Hardness (as $CaCO_3$)	115	65-135	0.8	ND	100	82-118
Alkalinity (as $CaCO_3$)	92	25-175	ND	ND	95	86-114
Conductivity	NA	-	ND	1.8	99	98-102
pH	NA	-	ND	NA	101	99-101
Colour	NA	-	25.0	ND	107	96-104
Turbidity	NA	-	3.6	0.07	102	93-107
Fluoride	90	83-117	0.8	ND	99	93-107
Chloride	83	76-124	0.9	ND	100	96-104
Nitrite (N)	97	77-123	ND	ND	102	85-115
Nitrate (N)	102	79-121	ND	ND	100	93-107
Sulphate	98	21-179	1.6	ND	100	95-105
Calcium	109	73-130	0.3	ND	100	79-120
Magnesium	124	65-135	0.7	ND	101	82-118
Sodium	98	73-127	1.2	ND	99	87-113
Potassium	110	65-135	6.0	ND	100	77-123
Nitrogen - Ammonia (N)	98	47-153	ND	ND	102	72-128
Nitrogen - Kjeldahl (N)	98	44-156	0.3	ND	94	84-116
Iron	115	77-125	1.1	ND	98	92-110
Manganese	118	80-120	1.2	ND	101	92-108
Phenols	102	64-136	3.1	ND	103	92-108
Hydrogen Sulphide	NA	-	1.9	ND	NA	-
Tannin & Lignin	86	53-147	ND	ND	94	88-112
Silica (as SiO_2)	70	65-134	ND	ND	104	94-107
DOC	85	75-125	17.4	ND	106	90-110

- = Not Requested/Analyzed
ND = Not Detected
NA = Not Applicable

Greg Clarkin, B.Sc., C.Chem.,
Laboratory Director

REPORT OF ANALYSIS

ARECO CAN A INC., 40 CAMELOT DR., NEPEAN, ONT IO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	M.S.T.A.
SAMPLE MATRIX:	Water	JOB/PROJECT NO.:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	31-Aug-98

PARAMETERS	UNITS	M.D.L.	ODWO	CDWQG	RESULTS		
					SA - 2045		
Date Collected	dd-mmm				11-Aug		
Hardness(as $CaCO_3$)	mg/L	1	80-100		213		
Alkalinity(as $CaCO_3$)	mg/L	1	30-500		190		
Conductivity	µS/cm	1			557		
pH		0.00-14.00	6.5-8.5	6.5-8.5	7.81		
Colour	T.C.U.	1	5	15	ND		
Turbidity	N.T.U.	0.1	1, 5	1, 5	41.2		
Fluoride	mg/L	0.1	1.5	1.5	0.7		
Chloride	mg/L	1.0	250	250	35.5		
Nitrite(N)	mg/L	0.1	1.0		ND		
Nitrate(N)	mg/L	0.1	10.0	10.0	ND		
Sulphate	mg/L	1.0	500	500	46.3		
Calcium	mg/L	1.0			35.6		
Magnesium	mg/L	1.0			30.2		
Sodium	mg/L	1.0	20, 200	200	35.7		
Potassium	mg/L	1.0			2.3		
Ammonia(N)	mg/L	0.01			0.17		
TKN	mg/L	0.05			0.29		
Organic Nitrogen	mg/L	0.05	0.15		0.12		
Iron	mg/L	0.01	0.30	0.30	0.42		
Manganese	mg/L	0.005	0.05	0.05	0.020		
Phenols	mg/L	0.001	0.002		0.001		
Hydrogen Sulphide	mg/L	0.01	0.05	0.05	1.08		
Tannins	mg/L	0.1			0.1		
Silica (SiO_2)	mg/L	0.1			13.7		
DOC	mg/L	1	5		ND		
Total Coliform	cts/100mL		5	10	3000		
E.Coli	cts/100mL		0	0	0		
Background	cts/100ml		200	200	>200000		
Anion Sum	meq/L				5.80		
Cation Sum	meq/L				5.91		
% Difference	%				0.93		
Ion Ratio	AS/CS				0.98		
SAR					1.06		
Conductivity (calc.)	µS/cm				558		
TDS (ion sum calc.)	mg/L		500	500	315		
EC(calc.)/EC(actual)					1.00		
TDS(calc.)/EC(actual)					0.56		
Langelier Index	S.I.				0.09		

THOMPSON / ROSEMOUNT

REC SEP 14 1998

ODWO = Ontario Drinking Water Objectives, Rev. 1994

CDWQG = Canadian Drinking Water Quality Guidelines, 6th Ed., Rev. 1996

- = Not Requested/Analyzed

ND = Not Detected

M.D.L. = Method Detection Limit

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO CHARTERED Gregory G. Clarkin CHEMIST

Certified by

Greg Clarkin, B.Sc., C.Chem.

Laboratory Director

Address all Inquiries to the Laboratory Director/Manager.

REPORT OF ANALYSIS

ARECO CAN A INC., 40 CAMELOT DR., NEPEAN, ONT O, K2G 5X8
TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	MSTA
SAMPLE MATRIX:	Water	JOB/PROJECT NO.:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	10-Sep-98

PARAMETERS	UNITS	M.D.L.	RESULTS			ODWO	
			SA-0945			Objective	Type of Objective
Physical:							
Colour	T.C.U.	1	ND			5	AO
Conductivity	µS/cm	1	540				
Hardness(as $CaCO_3$)	mg/L	1	208			80-100	OG
pH		0.00-14.00	7.80			6.5-8.5	OG
Total Dissolved Solids	mg/L	1	293			500	AO
Turbidity	N.T.U.	0.1	5.9			1,5	MAC,AO
Inorganics - Non-Metals:							
Alkalinity(as $CaCO_3$)	mg/L	1	187			30-500	OG
Chloride	mg/L	1.0	32.1			250	AO
Cyanide	mg/L	0.02	ND			0.2	MAC
Fluoride	mg/L	0.1	0.7			1.5	
Nitrate(N)	mg/L	0.1	ND			10.0	MAC
Nitrite(N)	mg/L	0.1	ND			1.0	MAC
Nitrogen-Ammonia(N)	mg/L	0.01	0.17				
Nitrogen-Kjeldahl(N)	mg/L	0.05	0.29				
Nitrogen-Organic	mg/L	0.05	0.12			0.15	OG
Sulphate	mg/L	1.0	42.8			500	AO
Sulphide	mg/L	0.01	2.70			0.05	AO
Inorganics - Metals:							
Aluminum	mg/L	0.05	ND			0.10	OG
Arsenic	mg/L	0.002	ND			0.025	IMAC
Barium	mg/L	0.01	0.16			1.0	MAC
Boron	mg/L	0.01	0.12			5.0	IMAC
Cadmium	mg/L	0.005	ND			0.005	MAC
Calcium	mg/L	1.0	24.8				
Chromium	mg/L	0.01	ND			0.05	MAC
Copper	mg/L	0.01	ND			1.0	AO
Iron	mg/L	0.01	0.11			0.30	AO
Lead	mg/L	0.001	ND			0.01	MAC
Magnesium	mg/L	1.0	29.4				
Manganese	mg/L	0.005	0.011			0.05	AO
Mercury[A]	mg/L	0.0002	ND			0.001	MAC
Potassium[B]	mg/L	1.0	2.1				
Selenium	mg/L	0.005	ND			0.01	MAC
Sodium	mg/L	1.0	35.3			200	AO
Uranium[A]	mg/L	0.001	ND			0.10	MAC
Zinc	mg/L	0.02	ND			5.0	AO

M.D.L. = Method Detection Limit
- = Not Requested/Analyzed
ND = Not Detected
[A] = Subcontracted to external laboratory
[B] = Potassium included for Ion Balance calculations

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
Gregory J. G. Clarkin
CHEMIST

Certified by,
Greg Clarkin, B.Sc., C.Chem.
Laboratory Director

Address all Inquiries to the Laboratory Director/Manager.

REPORT OF ANALYSIS

ARECO CA[illegible] A INC., 40 CAMELOT DR., NEPEAN, ON[illegible] IO, K2G 5X8
TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	MSTA
SAMPLE MATRIX:	Water	94519
REPORT NUMBER:	32873108	13-Aug-98
REPORT TO:	John St. Marseille	10-Sep-98

PARAMETERS	UNITS	M.D.L.	RESULTS				
						ODWO	
			SA-0945			Objective	Type of Objective
Organics:							
DOC	mg/L	1	ND			5.0	AO
Methane	L/m^3	0.1	ND				
Phenols	mg/L	0.001	0.001				
Ion Balance QC Summary:							
Anion Sum	meq/L		5.57				
Cation Sum	meq/L		5.76				
%Difference	%		1.70				
Ion Ratio	AS/CS		0.97				
Conductivity (calc.)	µS/cm		540				
TDS (ion sum calc.)	mg/L		290				
SAR			1.07				
EC(calc.)/EC(actual)			1.00				
TDS(calc.)/EC(actual)			0.54				
Langelier Index	S.I.		0.07				
Volatile Organics:							
Benzene	µg/L	0.5	ND			5	MAC
Carbon Tetrachloride	µg/L	0.2	ND			5	MAC
Chlorobenzene	µg/L	0.2	ND			80	MAC
Dichlorobenzene, 1,2-	µg/L	0.1	ND			200,3	MAC,AO
Dichlorobenzene, 1,4-	µg/L	0.2	ND			5,1	MAC,AO
Dichloroethane, 1,2-	µg/L	0.1	ND			5	IMAC
Ethylbenzene	µg/L	0.5	ND			2.4	AO
Methylene Chloride	µg/L	3.0	ND			50	MAC
Toluene	µg/L	0.5	ND			24	AO
Trichloroethylene	µg/L	0.1	ND			50	MAC
Vinyl Chloride	µg/L	0.3	ND			2	MAC
Xylenes, o,m,p-	µg/L	2.0	ND			300	AO
Bromodichloromethane	µg/L	0.1	ND				
Bromoform	µg/L	0.1	ND				
Chloroform	µg/L	0.3	ND				
Dibromochloromethane	µg/L	0.1	ND				
Trihalomethanes - Total	µg/L	1.0	ND			350	MAC
Surrogate % Recovery							
1,2-Dichloroethane-d4			107				
Toluene-d8			102				
4-Bromofluorobenzene			102				

ND = Not Detected
tr = Trace amounts detected
M.D.L. = Method Detection Limit
ODWO = Ontario Drinking Water Objectives, Revised 1994
AO = Aesthetic Objective
OG = Operational Guideline
MAC = Maximum Acceptable Concentration
IMAC = Interim Maximum Acceptable Concentration

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO CHARTERED Gregory J. G. Clarkin CHEMIST

Certified by,
Greg Clarkin, B.Sc., C.Chem.
Laboratory Director

Address all Inquiries to the Laboratory Director/Manager.

REPORT OF ANALYSIS

ARECO CAN A INC., 40 CAMELOT DR., NEPEAN, ON IO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	MSTA
SAMPLE MATRIX:	Water	JOB/PROJECT NO.:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	10-Sep-98

PARAMETERS	UNITS	Reporting Limit	RESULTS				
						ODWO	
			SA-0945			Objective	Type of Objective
Aldrin	mg/L	0.0005	ND			0.0007	MAC
Chlordane	mg/L	0.001	ND			0.007	MAC
DDT	mg/L	0.0005	ND			0.03	MAC
Dieldrin	mg/L	0.0005	ND			0.0007	MAC
Endrin	mg/L	0.0005	ND				
Heptachlor	mg/L	0.0005	ND			0.003	MAC
Heptachlor epoxide	mg/L	0.0005	ND			0.003	MAC
Lindane	mg/L	0.0005	ND			0.004	MAC
Methoxychlor	mg/L	0.001	ND			0.9	MAC
PCB's	mg/L	0.002	ND			0.003	IMAC
Surrogate % Recovery							
Decachlorobiphenyl			81.0				

PARAMETERS	UNITS	Reporting Limit	RESULTS				
			SA-0945				
Gross Alpha (Am-241 Equiv.)[A]	Bq/L	0.1	ND				
Gross Beta (Sr-90 Equiv.)[A]	Bq/L	0.2	ND				

- = Not Requested/Analyzed
ND = Not Detected
ODWO = Ontario Drinking Water Objectives, Revised 1994
AO = Aesthetic Objective
OG = Operational Guideline
MAC = Maximum Acceptable Concentration
IMAC = Interim Maximum Acceptable Concentration
[A] = Subcontracted to external laboratory

Certified by,
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Laboratory Director

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REPORT OF ANALYSIS

AREKO CAN A INC., 40 CAMELOT DR., NEPEAN, ONT IO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	MSTA
SAMPLE MATRIX:	Water	JOB/PROJECT NO.:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	10-Sep-98

PARAMETERS	UNITS	Reporting Limit	RESULTS				
						ODWO	
			SA-0945			Objective	Type of Objective
Alachlor	mg/L	0.005	ND			0.005	IMAC
Aldicarb	mg/L	0.005	ND			0.009	MAC
Atrazine + N-dealkylated met.	mg/L	0.001	ND			0.005	IMAC
Azinphos-methyl	mg/L	0.02	ND			0.02	MAC
Bendiocarb	mg/L	0.002	ND			0.04	MAC
Benzo(a)pyrene	mg/L	0.00001	ND			0.00001	MAC
Bromoxynil	mg/L	0.005	ND			0.005	IMAC
Carbaryl	mg/L	0.005	ND			0.09	MAC
Carbofuran	mg/L	0.005	ND			0.09	MAC
Chlorpyrifos	mg/L	0.009	ND			0.09	MAC
Cyanazine	mg/L	0.005	ND			0.01	IMAC
Diazinon	mg/L	0.002	ND			0.02	MAC
Dicamba	mg/L	0.02	ND			0.12	MAC
Dichlorophenol, 2,4-	mg/L	0.001	ND			0.9	MAC
2,4-D	mg/L	0.02	ND			0.1	IMAC
Diclofop-methyl	mg/L	0.009	ND			0.009	MAC
Dimethoate	mg/L	0.005	ND			0.02	IMAC
Dinoseb	mg/L	0.01	ND			0.01	MAC
Diquat[A]	mg/L	0.02	ND			0.07	MAC
Diuron	mg/L	0.1	ND			0.15	MAC
Glyphosate[A]	mg/L	0.01	ND			0.28	IMAC
Malathion	mg/L	0.005	ND			0.19	MAC
Metalochlor	mg/L	0.005	ND			0.05	IMAC
Metribuzin	mg/L	0.005	ND			0.08	MAC
Paraquat[A]	mg/L	0.008	ND			0.01	IMAC
Parathion	mg/L	0.002	ND			0.05	MAC
Pentachlorophenol	mg/L	0.01	ND			0.06,0.03	MAC,AO
Phorate	mg/L	0.002	ND			0.002	IMAC
Picloram	mg/L	0.02	ND			0.19	IMAC
Prometryne	mg/L	0.001	ND			0.001	IMAC
Simazine	mg/L	0.001	ND			0.01	IMAC
Temephos	mg/L	0.2	ND			0.28	IMAC
Terbufos	mg/L	0.001	ND			0.001	IMAC
Tetrachlorophenol, 2,3,4,6-	mg/L	0.001	ND			0.10,0.001	MAC,AO
Triallate	mg/L	0.01	ND			0.23	MAC
Trichlorophenol, 2,4,6-	mg/L	0.001	ND			0.005,0.002	MAC,AO
2,4,5-T	mg/L	0.01	ND			0.28,0.02	MAC,AO
2,4,5-TP	mg/L	0.01	ND				
Trifluralin	mg/L	0.01	ND			0.045	IMAC

- = Not Requested/Analyzed

ND = Not Detected

[A] = Subcontracted to external laboratory

ASSOCIATION OF THE CHEMICAL PROFESSION ONTARIO — CHARTERED CHEMIST — Gregory J. Clarkin

Certified by,

Greg Clarkin, B.Sc., C.Chem.

Laboratory Director

Address all Inquiries to the Laboratory Director/Manager.

CLIENT:	M.S.T.A.	CLIENT JOB NUMBER:	94519
ADDRESS:	1345 Rosemount Ave. Cornwall, ON K6J 3E5		
ATTENTION:	John St. Marseille	REPORT DATE:	31-Aug-98

ANALYTICAL REPORT

ARECO LABORATORY I.D.:	130898-3	REPORT NUMBER:	32873108
DATE RECEIVED:	13-Aug-98	TIME RECEIVED:	10:40 AM
SAMPLE MATRIX:	Water		
# OF SAMPLES RECEIVED:	1		

ANALYSES	ANALYST	QTY	DATE EXTRACTED	DATE ANALYZED	TIME ANALYZED	ANALYTICAL METHOD	METHOD REFERENCE
Hardness (as $CaCO_3$)	M.M.	1	NA	17-Aug-98	1:05 PM	ICP-AES	EPA 200.7
Alkalinity (as $CaCO_3$)	S.L.	1	NA	21-Aug-98	10:05 AM	Colour-Automated	EPA 310.2
Conductivity	D.M.	1	NA	17-Aug-98	3:15 PM	Conductivity Meter	EPA 120.1
pH	D.M.	1	NA	13-Aug-98	12:45 PM	pH Meter	EPA 150.1
Colour	D.M.	1	NA	14-Aug-98	4:00 PM	Colorimetric, Manual	EPA 110.2
Turbidity	D.M.	1	NA	14-Aug-98	4:30 PM	Turbidimeter	EPA 180.1
Anions	D.M.	1	NA	14-Aug-98	5:00 AM	Ion Chromatography	EPA 300.0
Metals - Cations	M.M.	1	NA	17-Aug-98	1:05 PM	ICP-AES	EPA 200.7
Nitrogen - Ammonia (N)	J.D.	1	NA	19-Aug-98	12:50 PM	Colour-Automated	EPA 350.2
Nitrogen - Kjeldahl (N)	J.D.	1	19-Aug-98	20-Aug-98	12:00 PM	Colour-Automated	EPA 351.2
Metals - Heavy	M.M.	1	NA	18-Aug-98	4:13 PM	ICP-AES	EPA 200.7
Phenols	J.D	1	NA	21-Aug-98	1:15 PM	Colour-Automated	EPA 420.2
Hydrogen Sulphide	D.M.	1	NA	14-Aug-98	9:00 AM	Colorimetric	HACH 8131
Tannin & Lignin	S.L.	1	NA	18-Aug-98	2:49 PM	Colour-Automated	SM 5500-B
Silica (as SiO_2)	S.L.	1	NA	18-Aug-98	10:40 AM	Colour-Automated	SM 4500-Si E
DOC	M.M.	1	NA	20-Aug-98	5:00 PM	Combusion-IR	EPA 415.1
Total Coliform	D.M.	1	13-Aug-98	14-Aug-98	3:30 PM	Membrane Filtration	SM 9222
E. coli.	D.M.	1	13-Aug-98	14-Aug-98	3:30 PM	Membrane Filtration	SM 9225A
Background	D.M.	1	13-Aug-98	14-Aug-98	3:30 PM	Membrane Filtration	SM 9222

- = Not Requested/Analyzed
NA = Not Applicable

Greg Clarkin, B.Sc., C.Chem.
Laboratory Director
ARECO CANADA INC

QUALITY CONTROL REPORT

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	M.S.T.A.
SAMPLE MATRIX:	Water	JOB/PROJECT NO:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	31-Aug-98

PARAMETERS	QC DATA					
	Matrix Spike		Duplicate	Lab	QC Sample	
	Found (% Rec)	Limits (% Rec)	R.P.D.	Blank	Found (% Rec.)	Limits (% Rec.)
Hardness (as $CaCO_3$)	115	65-135	0.8	ND	100	87-113
Alkalinity (as $CaCO_3$)	92	17-183	0.5	ND	98	91-109
Conductivity	NA	-	ND	1.4	98	98-102
pH	NA	-	ND	NA	101	98-102
Colour	NA	-	25.0	ND	107	71-129
Turbidity	NA	-	3.6	0.07	102	92-108
Fluoride	90	64-136	0.8	ND	99	94-106
Chloride	83	45-155	0.9	ND	100	91-109
Nitrite (N)	97	66-134	ND	ND	102	90-110
Nitrate (N)	102	51-149	ND	ND	100	94-106
Sulphate	98	38-162	1.6	ND	100	92-108
Calcium	109	65-135	0.3	ND	100	84-117
Magnesium	125	63-137	0.7	ND	101	88-113
Sodium	98	73-127	1.2	ND	99	90-110
Potassium	110	64-137	6.0	ND	100	85-115
Nitrogen - Ammonia (N)	98	87-113	ND	ND	102	92-108
Nitrogen - Kjeldahl (N)	93	79-121	6.8	ND	103	86-114
Iron	115	82-118	1.1	ND	98	90-110
Manganese	118	84-116	1.2	ND	101	91-109
Phenols	105	85-115	ND	ND	103	96-104
Hydrogen Sulphide	NA	-	1.9	ND	NA	-
Tannin & Lignin	86	53-147	ND	ND	94	88-112
Silica (as SiO_2)	70	65-134	ND	ND	104	92-108
DOC	100	74-126	ND	ND	90	82-119

- = Not Requested/Analyzed
ND = Not Detected
NA = Not Applicable

Greg Clarkin, B.Sc., C.Chem.,
Laboratory Director

REPORT OF ANALYSIS

ARECO CAN A INC., 40 CAMELOT DR., NEPEAN, ONT IO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	MSTA
SAMPLE MATRIX:	Water	JOB/PROJECT NO.:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	10-Sep-98

DIBENZODIOXINS/FURANS IN LIQUID[A]

Dioxins	SA-0945		Toxic Equivalency		C13 Surrogate Recoveries	
	Conc.	MDL	I-TEF	TEQ	pg Spiked	% Recovery
2,3,7,8-Tetra CDD[B]	0.0000	0.0015	1.00000	0.00150	100	66
1,2,3,7,8-Penta CDD	0.0000	0.0015	0.50000	0.00075	100	56
1,2,3,4,7,8-Hexa CDD	0.0000	0.0015	0.10000	0.00015	100	83
1,2,3,6,7,8-Hexa CDD	0.0000	0.0025	0.10000	0.00025	100	80
1,2,3,7,8,9-Hexa CDD	0.0000	0.0025	0.10000	0.00025		
1,2,3,4,6,7,8-Hepta CDD	0.0000	0.0100	0.01000	0.00010	100	78
Octa CDD	0.0000	0.0300	0.00100	0.00003	100	61
Total Tetra CDD	0.0000	0.0015				
Total Penta CDD	0.0000	0.0015				
Total Hexa CDD	0.0000	0.0025				
Total Hepta CDD	0.0000	0.01				

2,3,7,8-Tetra CDF[C]	0.0000	0.0015	0.10000	0.00015	100	80
1,2,3,7,8-Penta CDF	0.0000	0.0015	0.05000	0.00008	100	54
2,3,4,7,8-Penta CDF	0.0000	0.0015	0.50000	0.00075	100	57
1,2,3,4,7,8-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	86
1,2,3,6,7,8-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	84
2,3,4,6,7,8-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	83
1,2,3,7,8,9-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	77
1,2,3,4,6,7,8-Hepta CDF	0.0000	0.0100	0.01000	0.00010	100	84
1,2,3,4,7,8,9-Hepta CDF	0.0000	0.0025	0.01000	0.00003	100	73
Octa CDF	0.0000	0.0300	0.00100	0.00003		
Total Tetra CDF	0.0000	0.0015				
Total Penta CDF	0.0000	0.0015				
Total Hexa CDF	0.0000	0.0015				
Total Hepta CDF	0.0000	0.0100				

Total Toxic Equivalency	0.00476

Units = ppt unless otherwise indicated
[B]:CDD = Chloro Dibenzo-p-Dioxin
[C]: CDF = Chloro Dibenzofuran
MDL = Method Detection Limit
0.000 = ND = Not Detected

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
Gregory J. G. Clarkin
CHEMIST

Certified by,
Greg Clarkin, B.Sc., C.Chem.
Laboratory Director

Address all Inquiries to the Laboratory Director/Manager.

CLIENT: MSTA
ADDRESS: 1345 Rosemount Ave.
Cornwall, ON.
K6J 3E5

CLIENT JOB NUMBER: 94519

ATTENTION: John St. Marseille

REPORT DATE: 10-Sep-98

ANALYTICAL REPORT

ARECO LABORATORY I.D.: 130898-3

REPORT NUMBER: 32873108

DATE RECEIVED: 13-Aug-98

TIME RECEIVED: 10:40 AM

SAMPLE MATRIX: Water
OF SAMPLES RECEIVED: 1

ANALYSES	ANALYST	QTY	DATE EXTRACTED	DATE ANALYZED	TIME ANALYZED	ANALYTICAL METHOD	METHOD REFERENCE
Colour	D.M.	1	NA	14-Aug-98	4:00 PM	Colorimetric, Manual	EPA 110.2
Conductivity	D.M.	1	NA	17-Aug-98	3:15 PM	Conductivity Meter	EPA 120.1
Hardness (as $CaCO_3$)	M.M.	1	NA	17-Aug-98	1:05 PM	ICP-AES	EPA 200.7
pH	D.M.	1	NA	13-Aug-98	12:45 PM	pH Meter	EPA 150.1
Total Dissolved Solids	S.L.	1	20-Aug-98	21-Aug-98	-	Gravimetric	EPA 160.1
Turbidity	D.M.	1	NA	14-Aug-98	4:30 PM	Turbidimeter	EPA 180.1
Alkalinity	S.L.	1	NA	21-Aug-98	10:05 AM	Colorimetric	EPA 310.2
Anions	D.M.	1	NA	14-Aug-98	5:00 AM	Ion Chromatography	EPA 300.0
Cyanide	S.L.	1	NA	20-Aug-98	10:54 AM	Colour-Automated	SM 4500E
Nitrogen - Ammonia (N)	J.D.	1	NA	19-Aug-98	12:55 PM	Colour-Automated	EPA 350.2
Nitrogen - Kjeldahl (N)	J.D.	1		20-Aug-98	12:05 PM	Colour-Automated	EPA 351.2
Sulphide	D.M.	1	NA	14-Aug-98	9:00 AM	Colour-Manual	SM 4510
DOC	M.M.	1	NA	20-Aug-98	5:00 PM	Combustion-IR	EPA 415.1
Phenols	J.D.	1	NA	21-Aug-98	1:30 PM	Colour-Automated	EPA 420.2
Metals - Cations	M.M.	1	NA	17-Aug-98	1:05 PM	ICP-AES	EPA 200.7
Metals - Heavy	M.M.	1	NA	20-Aug-98	12:00 PM	ICP-AES	EPA 200.7
Metals - Arsenic	M.G.	1	NA	17-Sep-98	1:30 PM	GFAAS	EPA 206.2
Metals - Lead	M.G.	1	NA	03-Sep-98	2:45 PM	GFAAS	EPA 239.2
Metals - Selenium	M.G.	1	NA	20-Aug-98	8:40 AM	GFAAS	EPA 270.2
OC Pesticides/PCB's	D.M.	1	25-Aug-98	27-Aug-98	9:17 PM	GC/ECD	EPA 8081
ODWO-ABN	G.M.	1	21-Aug-98	22-Aug-98	6:16 PM	GC/MS	EPA 8270
Volatile Organic Cmpds	G.M.	1	13-Aug-98	14-Aug-98	12:43 AM	P & T GC/MS	EPA 8260

- = Not Requested/Analyzed
NA = Not Applicable

Greg Clarkin, B.Sc., C.Chem.
Laboratory Director
ARECO CANADA INC

QUALITY CONTROL REPORT

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	MSTA
SAMPLE MATRIX:	Water	JOB/PROJECT NO:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	10-Sep-98

PARAMETERS	QC DATA					
	Matrix Spike		Duplicate	Lab	QC Sample	
	Found (% Rec.)	Limits (% Rec.)	R.P.D.	Blank	Found (% Rec.)	Limits (% Rec.)
Colour	NA	-	25.0	ND	107	71-129
Conductivity	NA	-	ND	1.4	98	98-102
Hardness (as $CaCO_3$)	115	65-135	0.8	ND	100	87-113
pH	NA	-	ND	NA	101	98-102
Turbidity	NA	-	3.6	ND	102	92-108
Alkalinity (as CaCO3)	92	17-1783	0.5	ND	98	91-109
Chloride	83	45-155	0.9	ND	100	91-109
Fluoride	90	64-136	0.8	ND	99	94-106
Nitrate (N)	102	51-149	ND	ND	100	94-106
Nitrite (N)	97	66-134	ND	ND	102	90-110
Sulphate	98	38-162	1.6	ND	100	92-108
Nitrogen - Ammonia (N)	98	87-113	ND	ND	102	92-108
Nitrogen - Kjeldahl (N)	93	79-121	6.8	ND	103	86-114
DOC	100	74-126	ND	ND	90	82-119
Phenols	105	85-115	ND	ND	103	96-104
Aluminum	106	67-133	3.2	ND	95	85-116
Arsenic	90	51-165	ND	ND	85	60-140
Barium	94	81-118	2.7	ND	103	93-106
Boron	94	79-120	1.7	ND	105	74-126
Cadmium	106	79-122	ND	ND	97	91-109
Calcium	109	65-135	0.3	ND	100	84-117
Chromium	110	83-117	ND	ND	100	91-109
Copper	94	76-125	ND	ND	101	91-108
Cyanide	76	14-214	ND	ND	104	10-191
Iron	120	82-118	2.3	ND	99	90-110
Lead	88	50-146	ND	ND	84	47-153
Magnesium	125	63-137	0.7	ND	100	88-113
Manganese	104	84-116	1.6	ND	100	91-109
Potassium	110	64-137	6.0	ND	99	85-115
Selenium	68	38-162	ND	ND	117	74-125
Sodium	98	73-127	1.2	ND	99	90-110
Zinc	969	80-120	1.0	ND	102	89-112
Sulphide	NA	-	ND	ND	NA	-
Total Dissolved Solids	NA	-	ND	ND	NA	-

- = Not Requested/Analyzed
ND = Not Detected
NA = Not Applicable

Greg Clarkin, B.Sc., C.Chem.,
Laboratory Director

QUALITY CONTROL REPORT

ARECO CANADA INC., 40 CAMELOT DR., NEPEAN, ONTARIO, K2G 5X8

TELEPHONE: (613) 228-1145 FACSIMILE: (613) 228-1148

LABORATORY I.D.:	130898-3	CLIENT:	MSTA
SAMPLE MATRIX:	Water	JOB/PROJECT NO:	94519
REPORT NUMBER:	32873108	DATE SUBMITTED:	13-Aug-98
REPORT TO:	John St. Marseille	DATE REPORTED:	10-Sep-98

DIBENZODIOXINS/FURANS IN LIQUID[A]
QC REPORT

Dioxins	Method Blank		Toxic Equivalency		C13 Surrogate Recoveries	
	Conc.	MDL	I-TEF	TEQ	pg Spiked	% Recovery
2,3,7,8-Tetra CDD[B]	0.0000	0.0015	1.00000	0.00150	100	
1,2,3,7,8-Penta CDD	0.0000	0.0015	0.50000	0.00075	100	
1,2,3,4,7,8-Hexa CDD	0.0000	0.0015	0.10000	0.00015	100	
1,2,3,6,7,8-Hexa CDD	0.0000	0.0025	0.10000	0.00025	100	
1,2,3,7,8,9-Hexa CDD	0.0000	0.0025	0.10000	0.00025		
1,2,3,4,6,7,8-Hepta CDD	0.0000	0.0100	0.01000	0.00010	100	
Octa CDD	0.0000	0.0300	0.00100	0.00003	100	
Total Tetra CDD	0.0000	0.0015				
Total Penta CDD	0.0000	0.0015				
Total Hexa CDD	0.0000	0.0025				
Total Hepta CDD	0.0000	0.0100				

2,3,7,8-Tetra CDF[C]	0.0000	0.0015	0.10000	0.00015	100	
1,2,3,7,8-Penta CDF	0.0000	0.0015	0.05000	0.00008	100	
2,3,4,7,8-Penta CDF	0.0000	0.0015	0.50000	0.00075	100	
1,2,3,4,7,8-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	
1,2,3,6,7,8-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	
2,3,4,6,7,8-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	
1,2,3,7,8,9-Hexa CDF	0.0000	0.0015	0.10000	0.00015	100	
1,2,3,4,6,7,8-Hepta CDF	0.0000	0.0100	0.01000	0.00010	100	
1,2,3,4,7,8,9-Hepta CDF	0.0000	0.0025	0.01000	0.00003	100	
Octa CDF	0.0000	0.0300	0.00100	0.00003		
Total Tetra CDF	0.0000	0.0015				
Total Penta CDF	0.0000	0.0015				
Total Hexa CDF	0.0000	0.0015				
Total Hepta CDF	0.0000	0.0100				

Total Toxic Equivalency	0.00476

Units = ppt unless otherwise indicated
[B]:CDD = Chloro Dibenzo-p-Dioxin
[C]: CDF = Chloro Dibenzofuran
MDL = Method Detection Limit
0.0000 = ND = Not Detected
tr = Trace Amount Detected
[A] = Subcontracted to external laboratory

Greg Clarkin, B.Sc., C.Chem.,
Laboratory Director

QUALITY CONTROL REPORT

Lab Control Sample (LCS): V81308CS.1
Lab Method Blank: V81308MB.1
Lab Control Duplicate: V81308CD.1
Lab Matrix Spike: V81308MS.1

Instrument I.D.: Saturn I, 000109
Calibration File ID.: V82502CF.1

PARAMETERS	Matrix Spike (% Rec.)		Duplicate		Lab	LCS Sample (% Rec.)	
	Found	Limits	R.P.D.	Limits (%)	Blank	Found	Limits
Vinyl Chloride	91	55-145	ND	20	ND	88	55-145
Methylene Chloride	102	65-135	ND	20	ND	117	54-146
Chloroform	89	32-168	ND	20	ND	99	79-121
Benzene	96	77-123	ND	20	ND	114	74-126
Carbon Tetrachloride	113	80-120	ND	20	ND	116	78-122
Trichloroethene	89	66-134	ND	20	ND	100	76-124
1,2-Dichloroethane	105	72-128	ND	20	ND	89	80-120
Bromodichloromethane	80	66-134	1	20	ND	93	77-123
Toluene	104	83-117	ND	20	ND	110	81-119
Dibromochloromethane	100	70-130	1	20	ND	97	83-117
Chlorobenzene	98	82-118	ND	20	ND	100	66-134
Ethylbenzene	107	75-125	ND	20	ND	112	71-129
m,p-Xylene	101	81-119	ND	20	ND	107	69-131
o-Xylene	100	77-113	ND	20	ND	107	76-124
Bromoform	105	68-132	ND	20	ND	102	78-122
1,4-Dichlorobenzene	96	82-118	ND	20	ND	95	70-130
1,2-Dichlorobenzene	97	77-123	ND	20	ND	100	64-136
Surrogate % Recovery							
1,2-Dichloroethane-d4	105	82-118			111	111	78-122
Toluene-d8	105	81-119			103	104	85-115
4-Bromofluorobenzene	105	79-121			102	105	89-111

- = Not Requested/Analyzed
ND = Not Detected
NA = Not Applicable

PARAMETERS	QC DATA						
	DCS Sample (% Rec.)		Duplicate		Lab	LCS Sample (% Rec.)	
	Found	Limits	R.P.D.	Limits (%)	Blank	Found	Limits
PCB - Total	103	69-126	ND	20	ND	83.1	25-142
Aroclor Type	1254				-	1254	
Surrogate % Recovery							
Decachlorobiphenyl	105	70-110			57.8	73.7	30-114

- = Not Requested/Analyzed
ND = Not Detected
NA = Not Applicable

DCS = Daily Calibration Standard
LCS = Laboratory Control Standard (Spiked Blank Water)

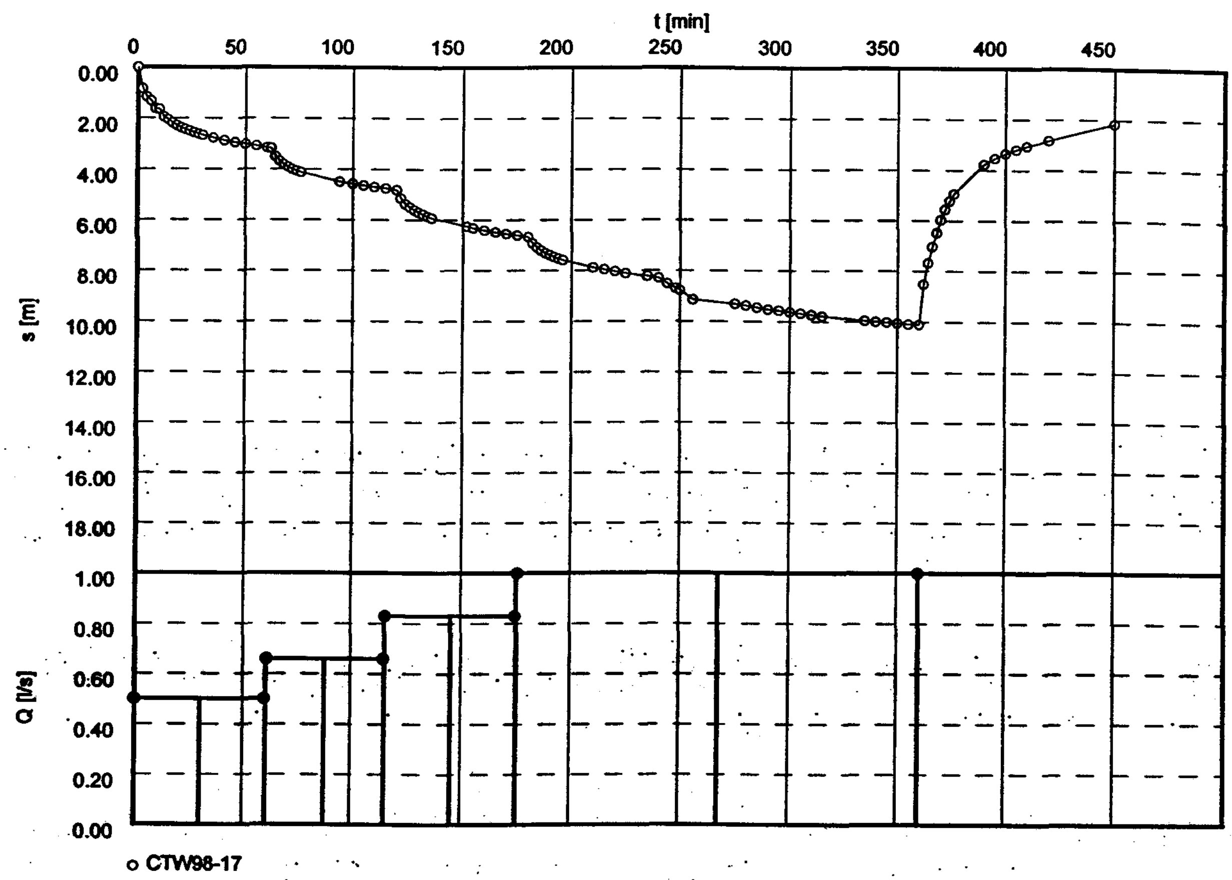
Gordon Murphy
Supervisor, Organic Chemistry

Greg Clarkin, B.Sc., C.Chem.,
Lab Director

Appendix E – Pumping Test Analysis Data

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall, Ontario	Pumping test analysis Time-Drawdown plot with discharge	Date: 15.07.1999	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 6, 1998
CTW98-17	
Discharge 0.84 l/s	



THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown plot with discharge	Date: 15.07.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 6, 1998
CTW98-17	CTW98-17

Static water level: 0.820 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
1	0.00	0.820	0.000	
2	2.00	1.650	0.830	
3	4.00	1.980	1.160	
4	6.00	2.140	1.320	
5	8.00	2.440	1.620	
6	10.00	2.460	1.640	
7	12.00	2.770	1.950	
8	14.00	2.880	2.060	
9	16.00	3.000	2.180	
10	18.00	3.110	2.290	
11	20.00	3.190	2.370	
12	22.00	3.260	2.440	
13	24.00	3.320	2.500	
14	26.00	3.380	2.560	
15	28.00	3.440	2.620	
16	30.00	3.490	2.670	
17	35.00	3.590	2.770	
18	40.00	3.690	2.870	
19	45.00	3.770	2.950	
20	50.00	3.840	3.020	
21	55.00	3.900	3.080	
22	60.00	3.980	3.160	
23	62.00	3.990	3.170	
24	64.00	4.320	3.500	
25	66.00	4.500	3.680	
26	68.00	4.640	3.820	
27	70.00	4.740	3.920	
28	72.00	4.820	4.000	
29	74.00	4.890	4.070	
30	76.00	4.950	4.130	
31	94.00	5.320	4.500	
32	100.00	5.390	4.570	
33	105.00	5.460	4.640	
34	110.00	5.520	4.700	
35	115.00	5.570	4.750	
36	120.00	5.630	4.810	
37	122.00	5.960	5.140	
38	124.00	6.190	5.370	
39	126.00	6.310	5.490	
40	128.00	6.430	5.610	
41	130.00	6.520	5.700	
42	132.00	6.600	5.780	
43	134.00	6.680	5.860	
44	136.00	6.740	5.920	
45	152.00	7.080	6.260	
46	155.00	7.140	6.320	
47	160.00	7.230	6.410	
48	165.00	7.300	6.480	
49	170.00	7.370	6.550	
50	175.00	7.430	6.610	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown plot with discharge	Date: 15.07.1999	Page 3
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

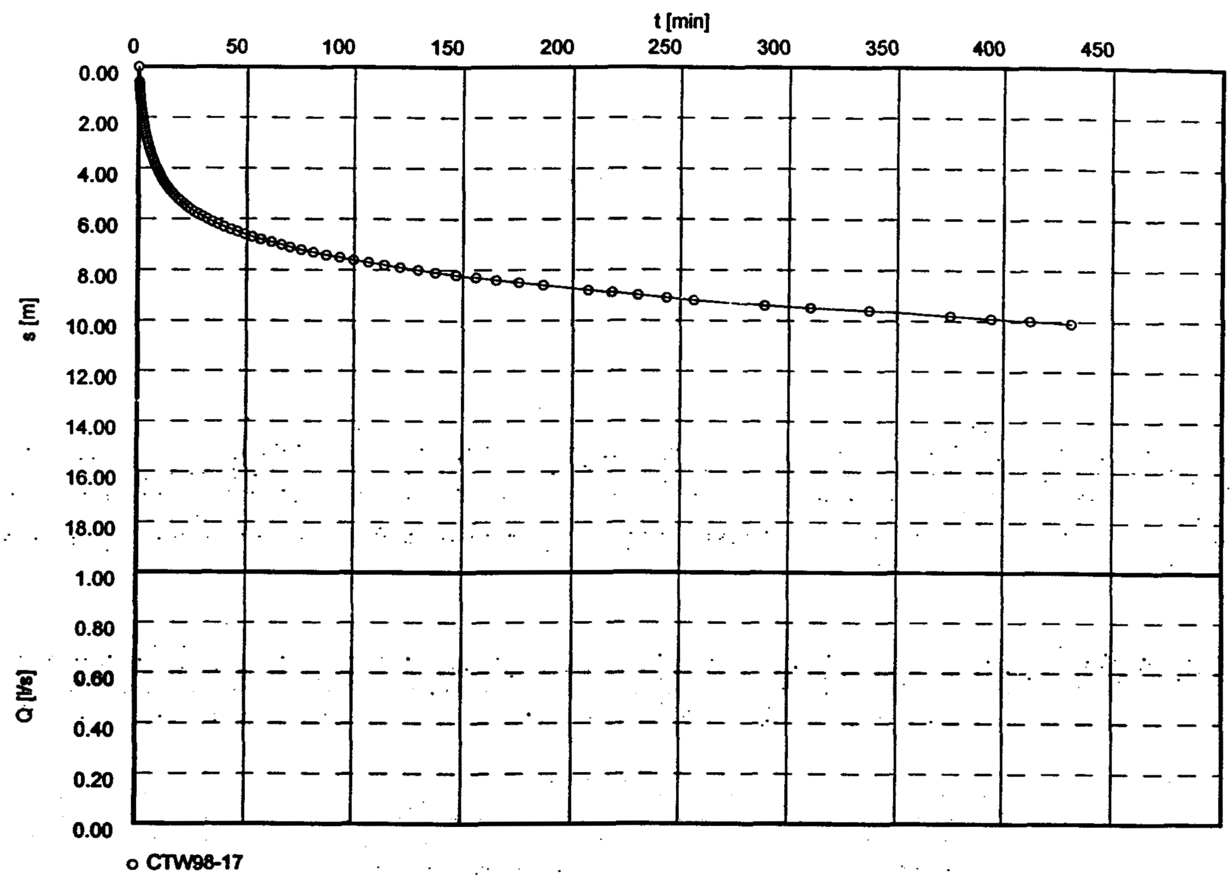
Pumping Test No. 1	Test conducted on: August 6, 1998
CTW98-17	CTW98-17

Static water level: 0.820 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
51	180.00	7.490	6.670	
52	182.00	7.740	6.920	
53	184.00	7.910	7.090	
54	186.00	8.030	7.210	
55	188.00	8.140	7.320	
56	190.00	8.210	7.390	
57	192.00	8.290	7.470	
58	194.00	8.350	7.530	
59	196.00	8.410	7.590	
60	210.00	8.700	7.880	
61	215.00	8.780	7.960	
62	220.00	8.860	8.040	
63	225.00	8.930	8.110	
64	235.00	9.060	8.240	
65	240.00	9.120	8.300	
66	244.00	9.330	8.510	
67	248.00	9.530	8.710	
68	250.00	9.600	8.780	
69	256.00	9.970	9.150	
70	275.00	10.130	9.310	
71	280.00	10.200	9.380	
72	285.00	10.270	9.450	
73	290.00	10.340	9.520	
74	295.00	10.390	9.570	
75	300.00	10.450	9.630	
76	305.00	10.500	9.680	
77	310.00	10.550	9.730	
78	315.00	10.600	9.780	
79	335.00	10.770	9.950	
80	340.00	10.810	9.990	
81	345.00	10.840	10.020	
82	350.00	10.880	10.060	
83	355.00	10.910	10.090	
84	360.00	10.930	10.110	
85	362.00	9.330	8.510	
86	364.00	8.490	7.670	
87	366.00	7.850	7.030	
88	368.00	7.300	6.480	
89	370.00	6.780	5.960	
90	372.00	6.370	5.550	
91	374.00	6.040	5.220	
92	376.00	5.750	4.930	
93	390.00	4.580	3.760	
94	395.00	4.350	3.530	
95	400.00	4.160	3.340	
96	405.00	4.000	3.180	
97	410.00	3.860	3.040	
98	420.00	3.640	2.820	
99	450.00	2.970	2.150	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown plot with discharge	Date: 15.07.1999	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: jbh	

Pumping Test No. 1	Test conducted on: August 10/98
98-17	



THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown plot with discharge	Date: 15.07.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: jbh	

Pumping Test No. 1	Test conducted on: August 10/98
98-17	CTW98-17

Static water level: 0.900 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
1	0.00	0.900	0.000	
2	0.25	1.500	0.600	
3	0.42	1.600	0.700	
4	0.45	1.700	0.800	
5	0.50	1.800	0.900	
6	0.58	1.900	1.000	
7	0.67	2.000	1.100	
8	0.83	2.100	1.200	
9	0.92	2.200	1.300	
10	1.07	2.300	1.400	
11	1.20	2.400	1.500	
12	1.33	2.500	1.600	
13	1.47	2.600	1.700	
14	1.63	2.700	1.800	
15	1.83	2.800	1.900	
16	2.03	2.900	2.000	
17	2.17	3.000	2.100	
18	2.37	3.100	2.200	
19	2.58	3.200	2.300	
20	2.80	3.300	2.400	
21	2.98	3.400	2.500	
22	3.28	3.500	2.600	
23	3.53	3.600	2.700	
24	3.82	3.700	2.800	
25	4.08	3.800	2.900	
26	4.42	3.900	3.000	
27	4.72	4.000	3.100	
28	4.97	4.100	3.200	
29	5.42	4.200	3.300	
30	5.75	4.300	3.400	
31	6.17	4.400	3.500	
32	6.58	4.500	3.600	
33	7.00	4.600	3.700	
34	7.47	4.700	3.800	
35	7.93	4.800	3.900	
36	8.45	4.900	4.000	
37	9.00	5.000	4.100	
38	9.58	5.100	4.200	
39	10.20	5.200	4.300	
40	10.87	5.300	4.400	
41	11.57	5.400	4.500	
42	12.33	5.500	4.600	
43	13.13	5.600	4.700	
44	14.00	5.700	4.800	
45	14.92	5.800	4.900	
46	15.92	5.900	5.000	
47	17.00	6.000	5.100	
48	18.13	6.100	5.200	
49	19.33	6.200	5.300	
50	20.72	6.300	5.400	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown plot with discharge	Date: 15.07.1999	Page 3
		Project: Apple Hill Water Project	
		Evaluated by: jbh	

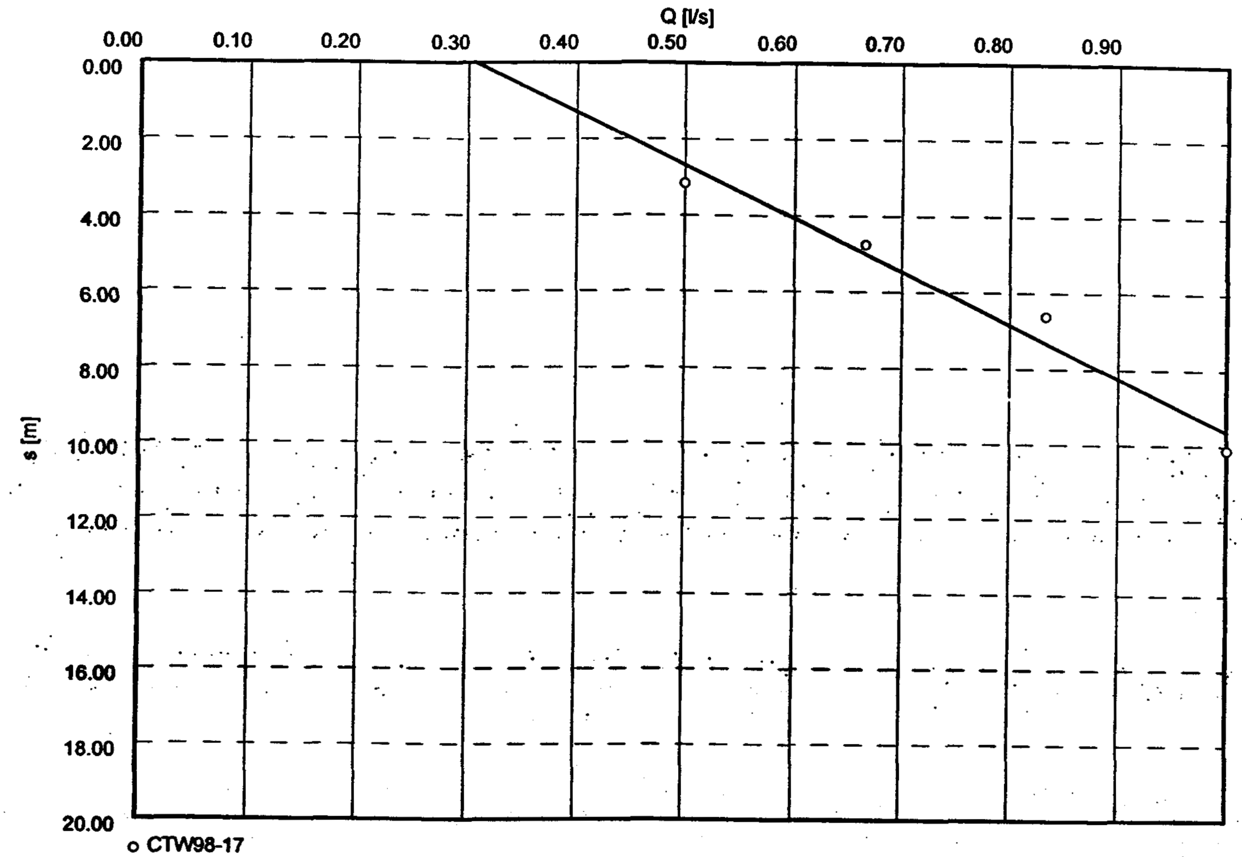
Pumping Test No. 1	Test conducted on: August 10/98
98-17	CTW98-17

Static water level: 0.900 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
51	22.13	6.400	5.500	
52	23.72	6.500	5.600	
53	25.50	6.600	5.700	
54	27.37	6.700	5.800	
55	29.38	6.800	5.900	
56	31.60	6.900	6.000	
57	33.98	7.000	6.100	
58	36.53	7.100	6.200	
59	39.35	7.200	6.300	
60	42.35	7.300	6.400	
61	45.50	7.400	6.500	
62	48.87	7.500	6.600	
63	52.62	7.600	6.700	
64	56.67	7.700	6.800	
65	62.03	7.800	6.900	
66	66.60	7.900	7.000	
67	70.58	8.000	7.100	
68	75.73	8.100	7.200	
69	81.33	8.200	7.300	
70	87.22	8.300	7.400	
71	93.40	8.400	7.500	
72	99.92	8.500	7.600	
73	106.62	8.600	7.700	
74	113.83	8.700	7.800	
75	121.27	8.800	7.900	
76	129.32	8.900	8.000	
77	137.50	9.000	8.100	
78	146.88	9.100	8.200	
79	155.95	9.200	8.300	
80	165.15	9.300	8.400	
81	175.52	9.400	8.500	
82	186.75	9.500	8.600	
83	207.25	9.700	8.800	
84	218.68	9.800	8.900	
85	230.80	9.900	9.000	
86	243.88	10.000	9.100	
87	256.42	10.100	9.200	
88	289.00	10.300	9.400	
89	310.12	10.400	9.500	
90	337.42	10.500	9.600	
91	375.00	10.700	9.800	
92	394.42	10.800	9.900	
93	412.38	10.900	10.000	
94	431.17	11.000	10.100	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Well performance test Determination of specific capacity	Date: 01.09.1998	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 6, 1998
CTW98-17	



specific capacity C [m³/min]: 4.31 x 10^{-3}

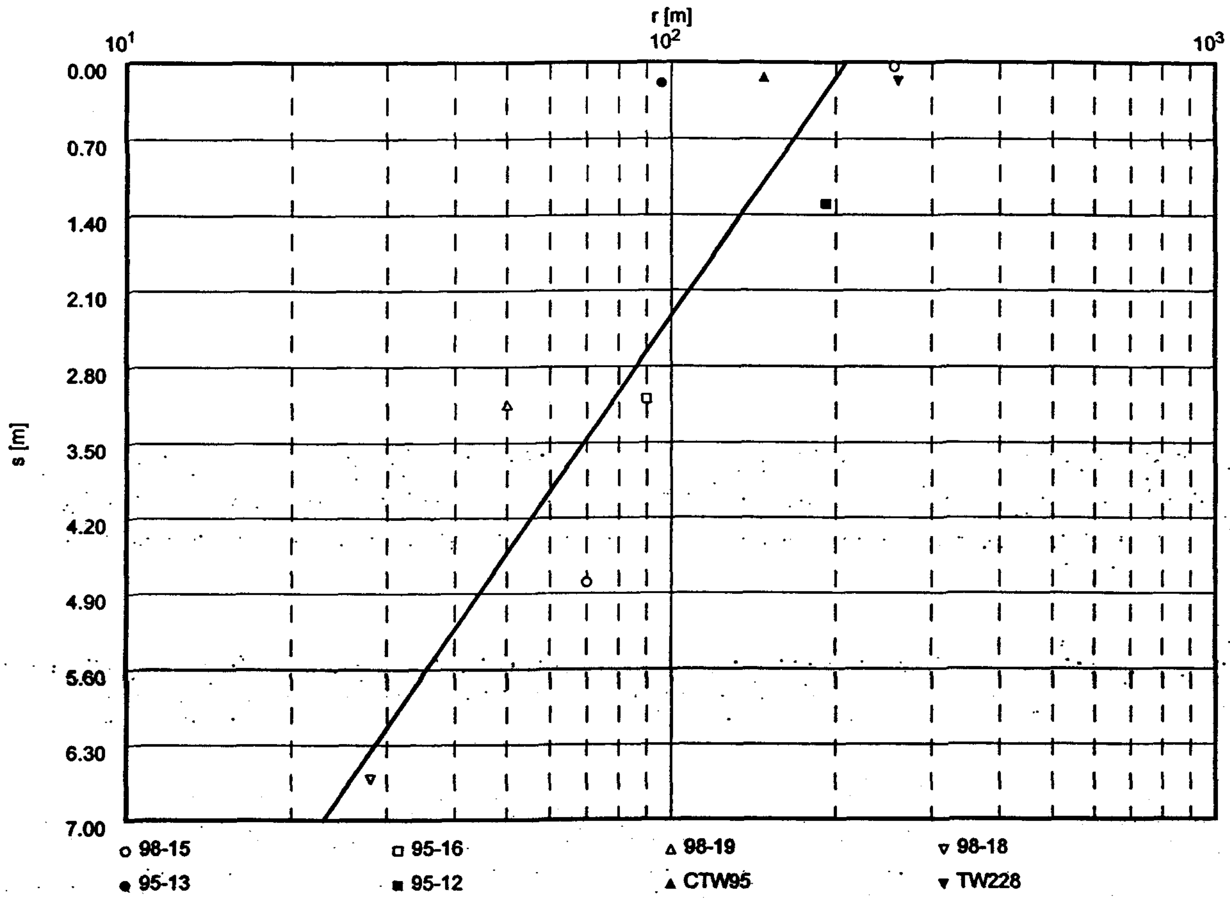
THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Well performance test Determination of specific capacity	Date: 01.09.1998	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 6, 1998
CTW98-17	CTW98-17

	Discharge [l/s]	Water level below datum [m]	Drawdown [m]	
1	0.50	3.978	3.158	
2	0.67	5.572	4.752	
3	0.83	7.431	6.611	
4	1.00	10.930	10.110	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Distance-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 31.08.1998 — Page 1 Project: Apple Hill Water Project Evaluated by: JBH

Pumping Test No. 1	Test conducted on: August 10, 1998
CTW98-17	
Discharge 1.00 l/s	Analysis at time (t) 0.00 min

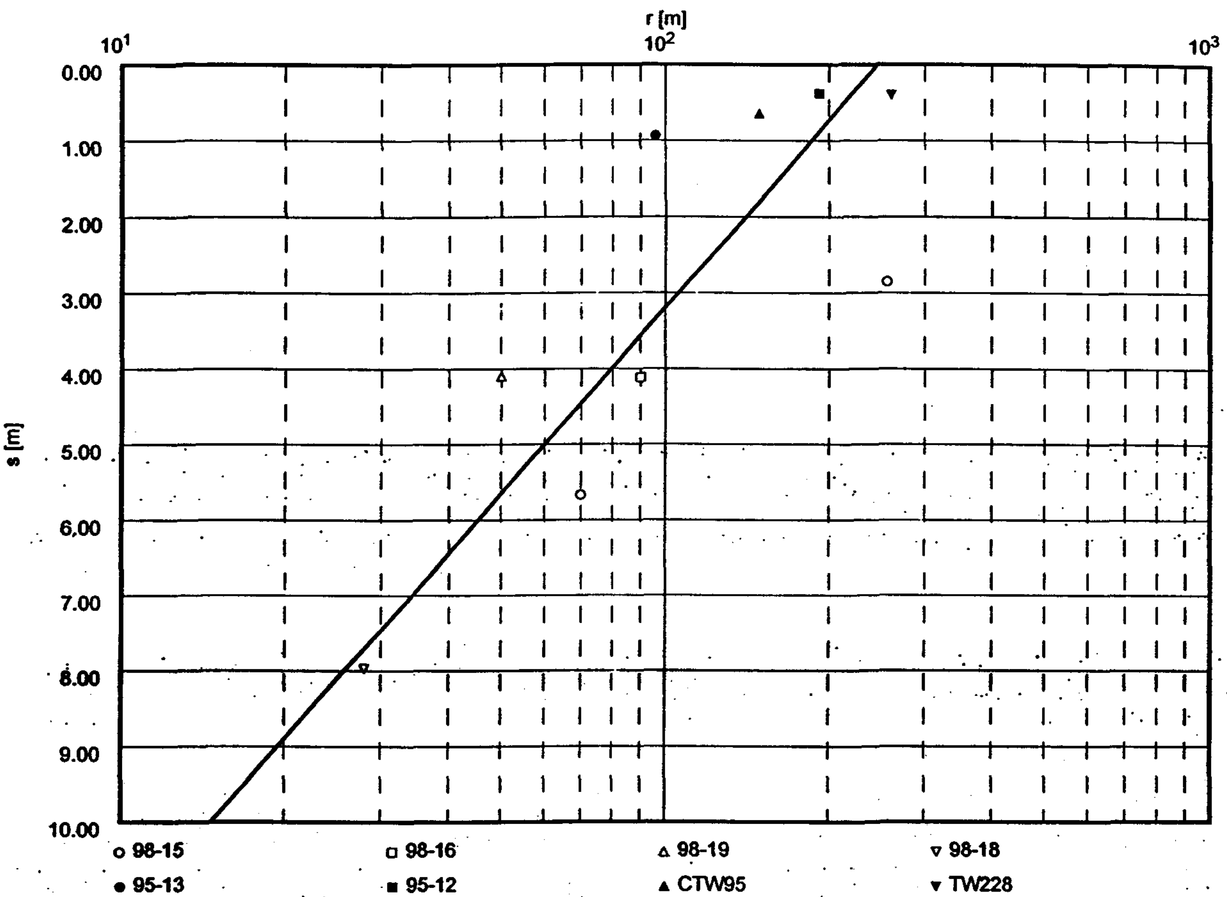


Transmissivity [m²/min]: 3.01×10^{-3}

Storativity: 0.00×10^{0}

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Distance-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 31.08.1998	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 12, 1998
CTW98-17	
Discharge 0.83 l/s	Analysis at time (t) 0.00 min

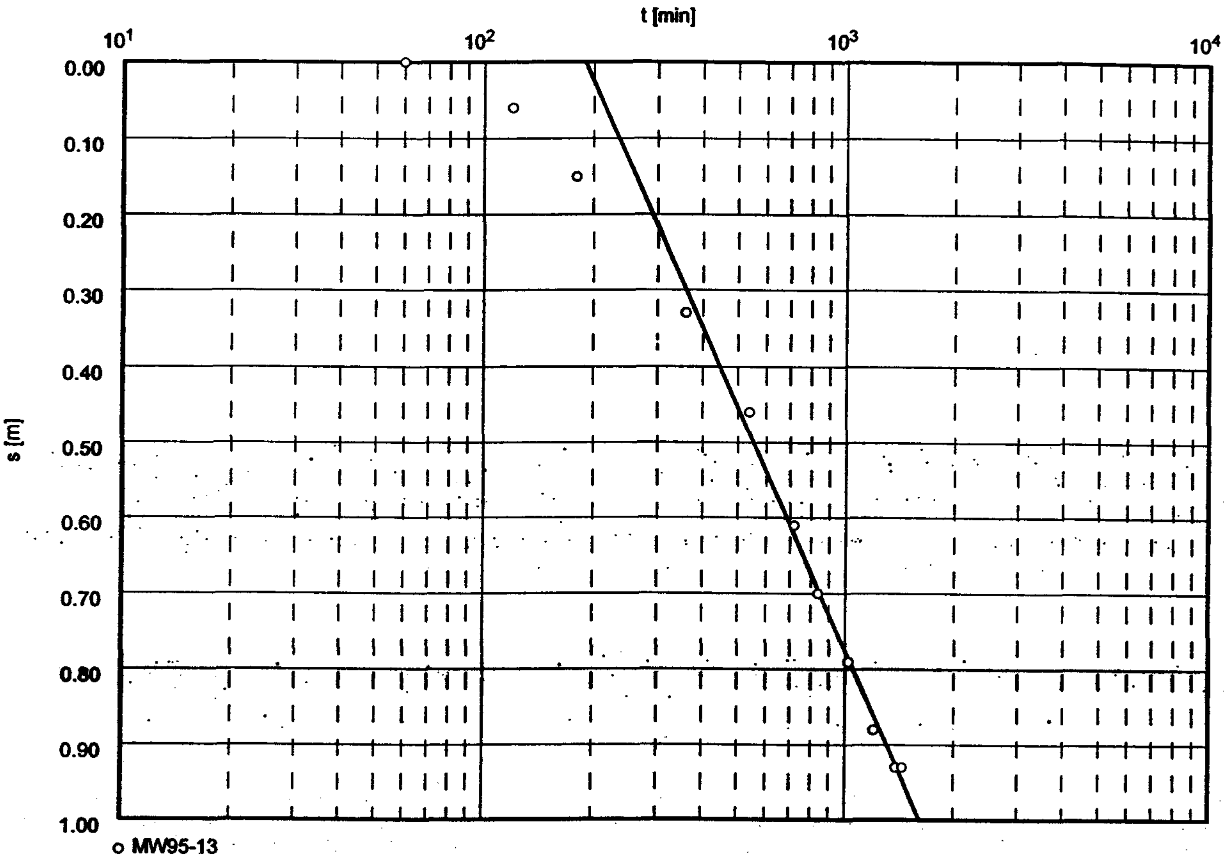


Transmissivity [m²/min]: 2.23×10^{-3}

Storativity: 0.00×10^{0}

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999 — Page 1 Project: Apple Hill Water Project Evaluated by: JBH

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	
Discharge 0.83 l/s	



Transmissivity [m²/min]: 8.47×10^{-3}

Storativity: 3.89×10^{-4}

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

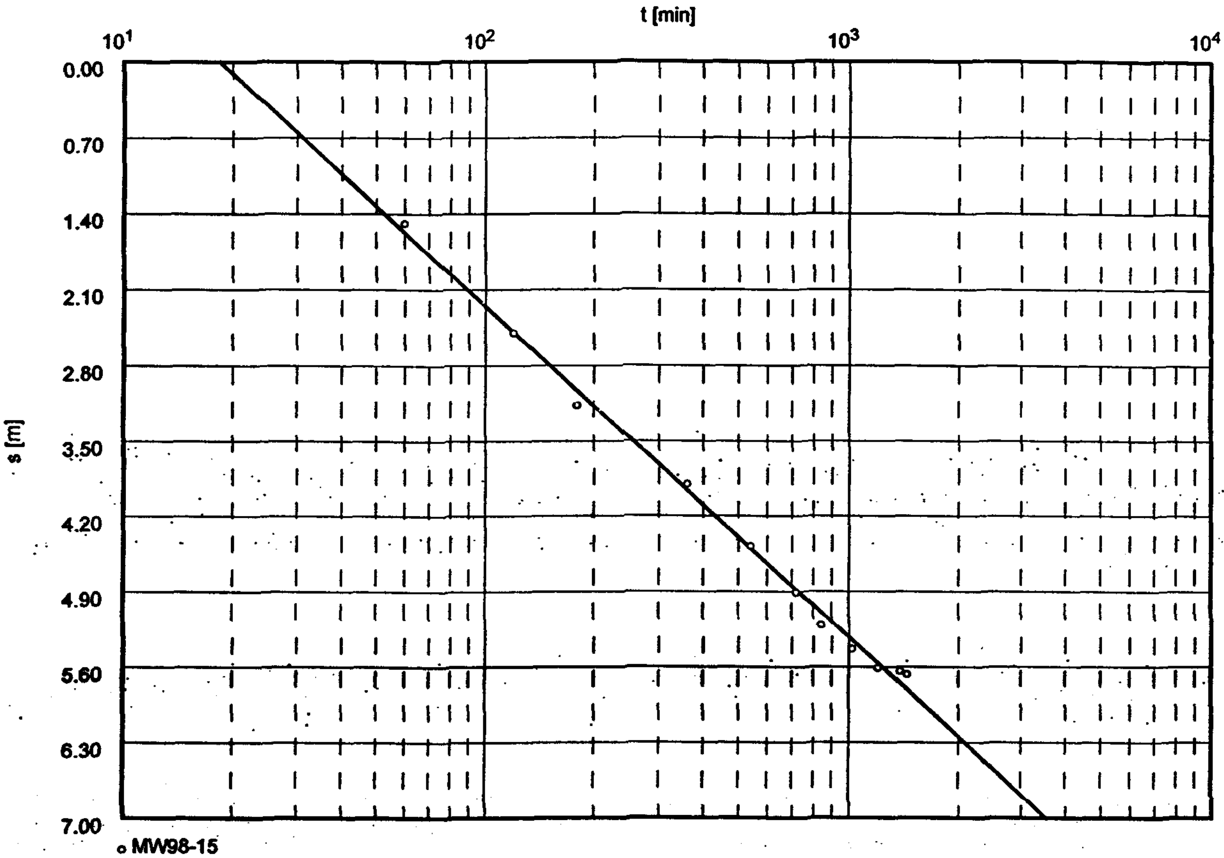
Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	MW95-13
Discharge 0.83 l/s	Distance from the pumping well 96.300 m

Static water level: 2.410 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
2	60.00	2.410	0.000	
3	120.00	2.470	0.060	
4	180.00	2.560	0.150	
5	360.00	2.740	0.330	
6	540.00	2.870	0.460	
7	720.00	3.020	0.610	
8	840.00	3.110	0.700	
9	1020.00	3.200	0.790	
10	1200.00	3.290	0.880	
11	1380.00	3.340	0.930	
12	1440.00	3.340	0.930	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall, Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	
Discharge 0.83 l/s	



Transmissivity [m²/min]: 2.97×10^{-3}

Storativity: 2.60×10^{-5}

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

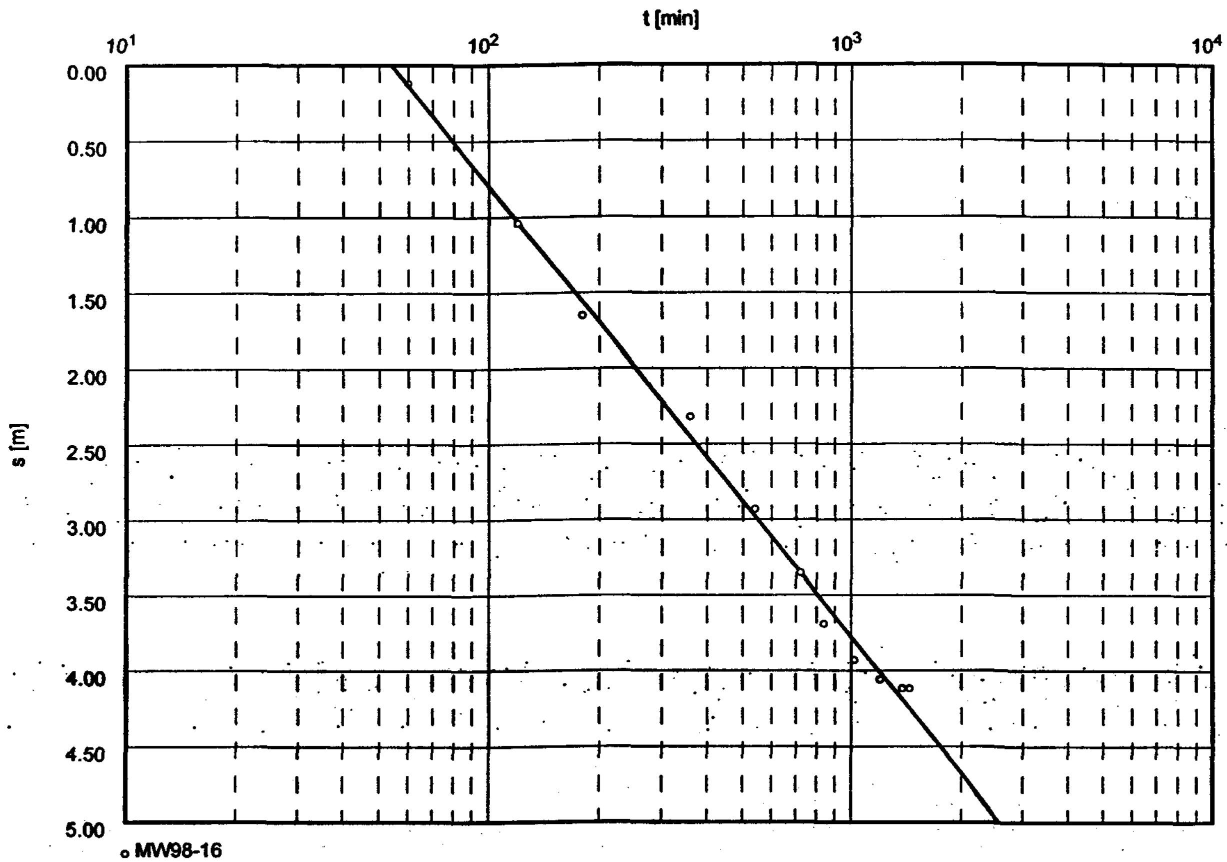
Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	MW98-15
Discharge 0.83 l/s	Distance from the pumping well 68.800 m

Static water level: 0.000 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
2	60.00	1.490	1.490	
3	120.00	2.500	2.500	
4	180.00	3.170	3.170	
5	360.00	3.900	3.900	
6	540.00	4.480	4.480	
7	720.00	4.910	4.910	
8	840.00	5.210	5.210	
9	1020.00	5.430	5.430	
10	1200.00	5.610	5.610	
11	1380.00	5.640	5.640	
12	1440.00	5.670	5.670	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	
Discharge 0.83 l/s	



Transmissivity [m²/min]: 3.05×10^{-3}

Storativity: 4.61×10^{-5}

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

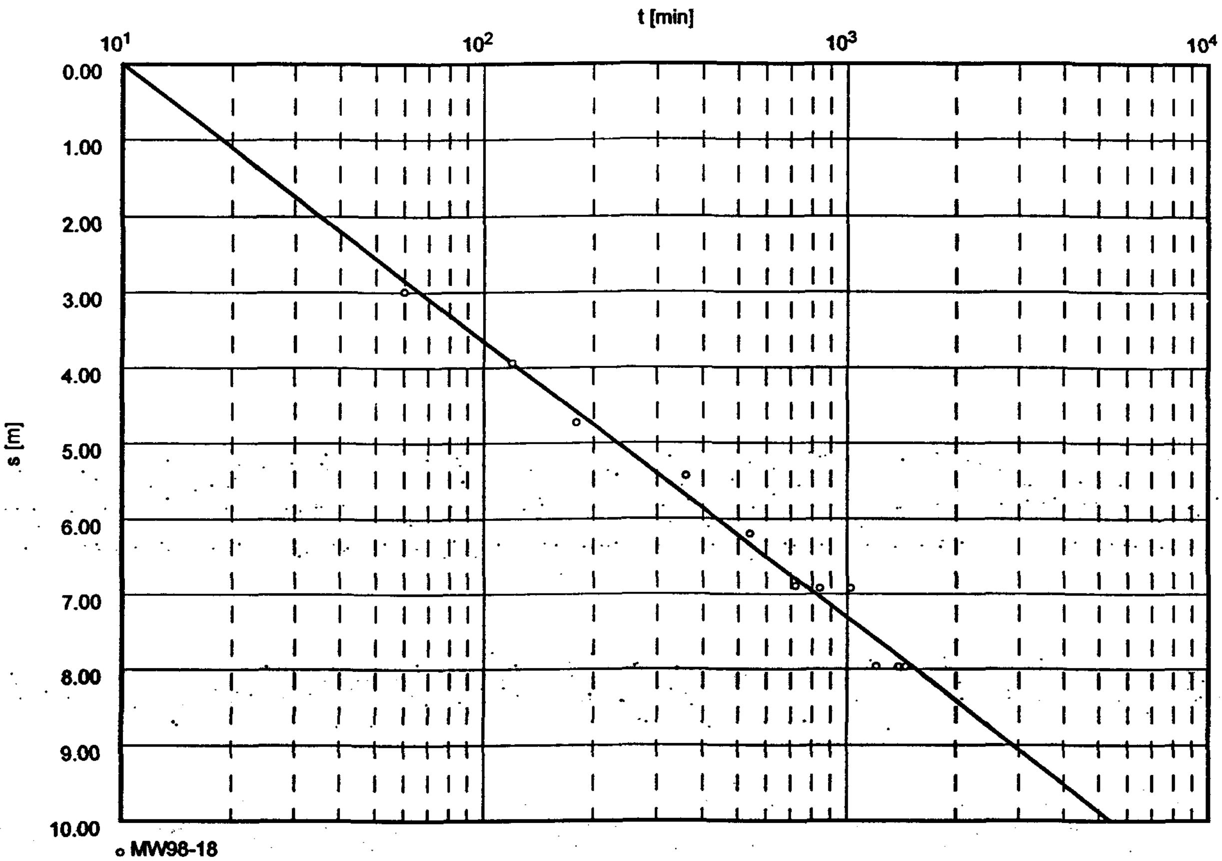
Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	MW98-16
Discharge 0.83 l/s	Distance from the pumping well 89.700 m

Static water level: 0.000 m below datum

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
2	60.00	0.120	0.120	
3	120.00	1.040	1.040	
4	180.00	1.650	1.650	
5	360.00	2.320	2.320	
6	540.00	2.930	2.930	
7	720.00	3.350	3.350	
8	840.00	3.690	3.690	
9	1020.00	3.930	3.930	
10	1200.00	4.060	4.060	
11	1380.00	4.120	4.120	
12	1440.00	4.120	4.120	

THOMPSON ROSEMOUNT GROUP 1345 Rosemount Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	
Discharge 0.83 l/s	



Transmissivity [m²/min]: 2.49×10^{-3}

Storativity: 7.46×10^{-5}

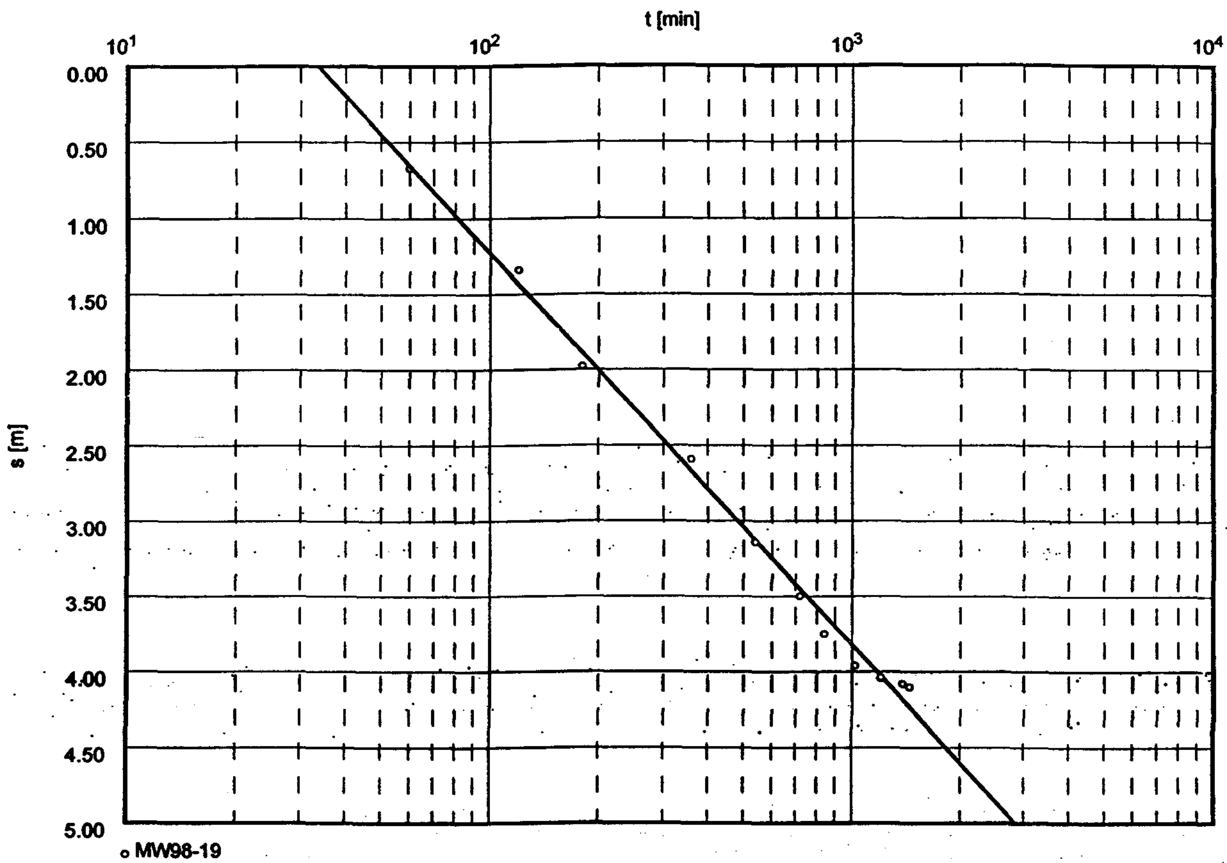
THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	MW98-18
Discharge 0.83 l/s	Distance from the pumping well 27.400 m
Static water level: 2.830 m below datum	

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
2	60.00	5.820	2.990	
3	120.00	6.770	3.940	
4	180.00	7.560	4.730	
5	360.00	8.260	5.430	
6	540.00	9.020	6.190	
7	720.00	9.720	6.890	
8	840.00	9.750	6.920	
9	1020.00	9.750	6.920	
10	1200.00	10.790	7.960	
11	1380.00	10.800	7.970	
12	1440.00	10.800	7.970	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall, Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 1
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	
Discharge 0.83 l/s	



Transmissivity [m²/min]: 3.51×10^{-3}

Storativity: 1.11×10^{-4}

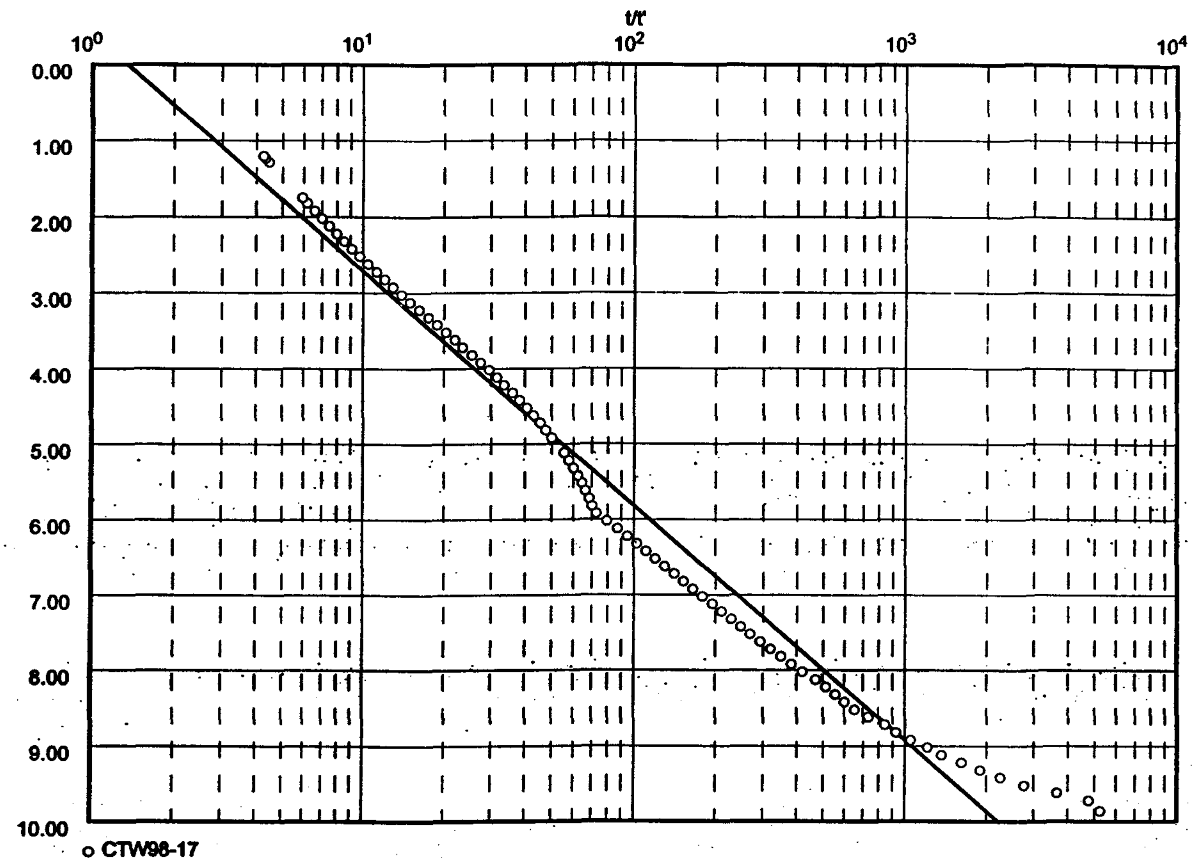
THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Confined aquifer	Date: 17.03.1999	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: Aug 12/98
CTW98-17	MW98-19
Discharge 0.83 l/s	Distance from the pumping well 48.900 m
Static water level: 2.410 m below datum	

	Pumping test duration [min]	Water level [m]	Drawdown [m]	
2	60.00	3.080	0.670	
3	120.00	3.750	1.340	
4	180.00	4.390	1.980	
5	360.00	5.000	2.590	
6	540.00	5.550	3.140	
7	720.00	5.910	3.500	
8	840.00	6.160	3.750	
9	1020.00	6.370	3.960	
10	1200.00	6.450	4.040	
11	1380.00	6.490	4.080	
12	1440.00	6.510	4.100	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 31.08.1998 — Page 1 Project: Apple Hill Water Project Evaluated by: JBH

Pumping Test No. 1	Test conducted on: August 12, 1998
CTW98-17	
Discharge 0.83 l/s	
	Pumping test duration: 1576.00 min



Transmissivity [m²/min]: 2.94 x 10^{-3}

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 31.08.1998	Page 2
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 12, 1998
CTW98-17	CTW98-17
Discharge 0.83 l/s	Distance from the pumping well 10.000 m
Static water level: 1.280 m below datum	Pumping test duration: 1576.00 min

	Time from end of pumping [min]	Water level [m]	Residual drawdown [m]	
1	0.30	11.140	9.860	
2	0.33	11.000	9.720	
3	0.43	10.900	9.620	
4	0.57	10.800	9.520	
5	0.70	10.700	9.420	
6	0.83	10.600	9.320	
7	0.97	10.500	9.220	
8	1.15	10.400	9.120	
9	1.30	10.300	9.020	
10	1.50	10.200	8.920	
11	1.70	10.100	8.820	
12	1.87	10.000	8.720	
13	2.15	9.900	8.620	
14	2.40	9.800	8.520	
15	2.62	9.700	8.420	
16	2.83	9.600	8.320	
17	3.07	9.500	8.220	
18	3.35	9.400	8.120	
19	3.75	9.300	8.020	
20	4.12	9.200	7.920	
21	4.50	9.100	7.820	
22	4.92	9.000	7.720	
23	5.38	8.900	7.620	
24	5.87	8.800	7.520	
25	6.37	8.700	7.420	
26	6.90	8.600	7.320	
27	7.50	8.500	7.220	
28	8.13	8.400	7.120	
29	8.83	8.300	7.020	
30	9.57	8.200	6.920	
31	10.38	8.100	6.820	
32	11.25	8.000	6.720	
33	12.15	7.900	6.620	
34	13.18	7.800	6.520	
35	14.28	7.700	6.420	
36	15.47	7.600	6.320	
37	16.75	7.500	6.220	
38	18.22	7.400	6.120	
39	20.00	7.300	6.020	
40	21.88	7.200	5.920	
41	22.70	7.100	5.820	
42	23.28	7.000	5.720	
43	24.02	6.900	5.620	
44	24.78	6.800	5.520	
45	25.65	6.700	5.420	
46	26.63	6.600	5.320	
47	27.67	6.500	5.220	
48	28.88	6.400	5.120	
49	32.08	6.200	4.920	
50	33.73	6.100	4.820	

THOMPSON ROSEMOUNT GROUP 1345 Rosemont Avenue Cornwall,Ontario	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 31.08.1998	Page 3
		Project: Apple Hill Water Project	
		Evaluated by: JBH	

Pumping Test No. 1	Test conducted on: August 12, 1998
CTW98-17	CTW98-17
Discharge 0.83 l/s	Distance from the pumping well 10.000 m
Static water level: 1.280 m below datum	Pumping test duration: 1576.00 min

	Time from end of pumping [min]	Water level [m]	Residual drawdown [m]	
51	35.40	6.000	4.720	
52	37.30	5.900	4.620	
53	39.53	5.800	4.520	
54	42.15	5.700	4.420	
55	44.78	5.600	4.320	
56	48.15	5.500	4.220	
57	51.42	5.400	4.120	
58	55.15	5.300	4.020	
59	59.35	5.200	3.920	
60	64.17	5.100	3.820	
61	69.98	5.000	3.720	
62	75.07	4.900	3.620	
63	81.30	4.800	3.520	
64	88.03	4.700	3.420	
65	95.57	4.600	3.320	
66	104.10	4.500	3.220	
67	113.00	4.400	3.120	
68	122.18	4.300	3.020	
69	132.17	4.200	2.920	
70	142.75	4.100	2.820	
71	154.15	4.000	2.720	
72	166.50	3.900	2.620	
73	179.75	3.800	2.520	
74	193.87	3.700	2.420	
75	209.42	3.600	2.320	
76	225.38	3.500	2.220	
77	242.75	3.400	2.120	
78	261.37	3.300	2.020	
79	281.67	3.200	1.920	
80	303.63	3.100	1.820	
81	319.00	3.030	1.750	
82	454.00	2.560	1.280	
83	473.00	2.510	1.230	
84	484.00	2.480	1.200	

Appendix F –
Detailed Calculations of Drawdown in Production Wells

Detailed Calculation of Drawdown of Proposed Production Wells - Apple Hill

Q	T	t	r	S
m3/day	m2/day	days	metres	
72	4	1	100	0.00011

Radius from Pump (m)		Well 1		Well 2		Well 3
	Q (Flow in m3/day)	29		29		29
	T (transmissivity in m3/day)	4		4		4
	s (storativity)	0.00011		0.00011		0.00011
Radius from Pump (m)						
	Drawdown in casing	9.5		9.5		9.5
0.075						
100	r 100 (w2)			1.2		
100	r 100 (w1)	1.2		1.2		1.2
200	r 200	0.4				0.4
	Total Drawdown incl. Induced (m)	11.1	Total s	11.9	Total s	11.1

x:\1994\94519\Excel\storativity calc3.xls

Detailed Calculation of Drawdown of Proposed Production Wells - Apple Hill

Q m3/day	T m2/day	t days	r metres	S
72	4	1	100	0.00011

		Well 1		Well 2		Well 3
	Q (Flow in m3/day)	30		27		30
	T (transmissivity in m3/day)	4		4		4
	s (storativity)	0.00011		0.00011		0.00011
Radius from Pump (m)						
0.075	Drawdown in casing	9.8		8.8		9.8
100	r 100 (w2)			1.3		
100	r 100 (w1)	1.1		1.3		1.1
200	r 200	0.4				0.4
	Total Drawdown incl. Induced (m)	11.4	Total s	11.4	Total s	11.4

x:\1994\94519\Excel\storativity calc3.xls

Detailed Calculation of Drawdown of Proposed Production Wells - Apple Hill

Q m3/day	T m2/day	t days	r metres	S
72	4	1	100	0.00011

		Well 1		Well 2		Well 3
	Q (Flow in m3/day)	35		17		35
	T (transmissivity in m3/day)	4		4		4
	s (storativity)	0.00011		0.00011		0.00011
Radius from Pump (m)						
	Drawdown in casing	11.5		5.6		11.5
0.075						
100	r 100 (w2)			1.5		
100	r 100 (w1)	0.7		1.5		0.7
200	r 200	0.5				0.5
	Total Drawdown incl. Induced (m)	12.7	Total s	8.5	Total s	12.7

x:\1994\94519\Excel\storativity calc3.xls

Appendix G –
Origin of Groundwater Recharge for the Town of Apple Hill, WHI, 1999

Origin of Groundwater Recharge For the Town of Apple Hill

Report to

The Thompson Rosemount Group

February 1999

waterloo hydrogeologic
SOFTWARE · CONSULTING · TRAINING

The THOMPSON ROSEMOUNT Group

TABLE OF CONTENTS

1. Introduction

As part of groundwater management initiatives in the town of Apple Hill, Ontario, the Thompson Rosemount Group (TRG) has been investigating the groundwater flow system. TRG is interested in delineating the recharge areas that provide water to communal well 98 in the community. Inherent uncertainties in the geology/hydrogeology often lead to several plausible conceptual models for a groundwater flow system. The validity of each of these conceptual models can be tested using a numerical model. This was the approach adopted in this study.

Waterloo Hydrogeologic, Inc. (WHI) was retained to analyze the groundwater flow system. The purpose of this study was to determine the groundwater origin for municipal supply wells through numerical modelling of the groundwater flow.

A key focus of this document was to determine whether the groundwater supply for the town of Apple Hill is derived from local or regional recharge. Information of this nature is extremely valuable for water resource management and protection.

The study objective was addressed through the simulation of steady state groundwater flow using the three-dimensional finite difference model MODFLOW (McDonald and Harbaugh, 1996). Particle trace analysis using MODPATH (Pollock, 1994) was also conducted to help assess groundwater origin for the municipal supply wells.

The simulation of groundwater flow requires the development of a conceptual model of the flow domain. This conceptual model represents the stratigraphy, lithology, hydraulic and chemical characteristics throughout the study area. The development of a conceptual model for a groundwater system is evolutionary. It is anticipated that additional site data will result in refinements to the conceptual model. Site characterization developed by TRG was used as the basis for this work.

The modelling approach employed in this study is described in Section 2. The conceptual models for the Apple Hill groundwater flow regime are developed in Section 3. The modelling results and discussions are presented in Section 4. The study conclusions and recommendations are presented in Section 5.

2. Modelling Approach

To address the issues of model development and the origin of water in the Apple Hill groundwater system the following modelling approach was used:

- development of a suite of potential conceptual models based on TRG's site characterization;
- development of numerical models for each conceptual model;
- calibration of each numerical model;
- analysis and review of the feasibility of each calibrated numerical model;
- elimination of conceptual models which require unrealistic or nonphysical numerical model inputs to attain satisfactory calibration; and,
- utilization of the most plausible model to provide insight into the origin of Apple Hill's groundwater supply.

This approach assures that the primary components likely to control the groundwater flow system are investigated and identifies the most likely conceptual model. Further analysis with the best model can determine the probable source of Apple Hill's groundwater more definitively.

3. Conceptual Model Development

This section describes the conceptual models developed to describe the groundwater flow system at Apple Hill.

Within the town, the general direction of groundwater flow is to the southeast, towards the Beaudette River. The generalized subsurface geology existing beneath the study area and approximate thickness of the units are:

- Upper clay/till unit — 8 meter thickness
- Gravel unit — 5 meter thickness
- Limestone bedrock unit — 80+ meter thickness

Using information provided by TRG, the following conceptual models were developed to investigate the source of Apple Hill water:

1. Water is provided through local recharge and is distributed throughout the domain with a high rate in the marsh area west of well 95-8.
2. Water is provided through local recharge, with the majority of the recharge entering the groundwater system in the marsh area west of well 95-8.
3. Water is provided both regionally from the limestone bedrock and locally from distributed recharge.

3.1 Spatial Domain

Groundwater flow for the Apple Hill system was investigated by subdividing the spatial domain into 53 grid blocks in the northwest to southeast direction and 41 grid blocks in the northeast to southwest direction as shown in Figure 1. Conceptual models 1 and 2 were represented by 2 vertical layers (1 layer for the upper clay/till unit and 1 layer for the gravel unit) and 4346 grid blocks. Conceptual model 3 was represented by 5 vertical layers (1 layer for the upper clay/till unit, 1 layer for the gravel unit and 3 layers for the limestone bedrock unit) and 10865 grid blocks.

The thickness and elevation of the finite difference grid blocks for the upper clay/till and gravel units were individually adjusted in order to match the geological layering at the site observed by TRG. The bottom of the limestone bedrock unit was chosen to be at an elevation of 50 m. Flow at this depth is expected to be horizontal and regional in nature. A cross section of the 5 layer model is shown in Figure 2.

3.2 Boundary Conditions

An important component of a groundwater flow model is the boundary conditions. To simulate groundwater flow the following boundary conditions were used:

- no flow boundary conditions along interpreted flow lines or divides were used at the top and sides of the upper clay/till unit as shown in Figure 3;
- river boundary conditions were applied along the Beaudette river with a river stage elevation of 81.89 m, a depth of 1 m and a conductance of 23000 m^2/year as shown in Figure 4;
- prescribed head boundary conditions were used to describe the northwestern end of the model in the gravel and limestone bedrock units as shown in Figure 5;
- prescribed head boundary conditions were used to describe the southeastern end of the model at the base of the limestone bedrock unit as shown in Figure 6;
- no flow boundary conditions along flow lines were used at the southeastern end of the model in the gravel and upper portion of the limestone unit; and
- recharge to the upper clay/till unit was adjusted to improve model calibration and was varied between the different conceptual models.

The boundary conditions in the limestone bedrock were prescribed to allow a component of the regional flow to discharge to the river. Water approaching the outflow boundary at the bottom of the model will exit through the constant head boundary at the base of the limestone bedrock unit or discharge to the Beaudette River.

3.3 Geologic Properties

The calibration of the conceptual model involved the perturbation of the hydraulic conductivities for the various layers within realistic ranges until a reasonable match was obtained observed and calculated hydraulic head values. To simulate groundwater flow, hydraulic conductivities must be assigned to each grid block in the model domain. Suggested values of the hydraulic conductivities for the various zones are presented in

Table 1. These values are used as a guideline in calibrating the model parameters. To conduct particle trace analysis porosity values are required. These values are also presented in Table 1.

Table 1: Geologic Properties

Geological Unit	Porosity (-)	Hydraulic Conductivity (m/s)	Source
Surface clay/till	0.30	1×10^{-7} to 1×10^{-9}	Freeze and Cherry, 1979
Gravel	0.25	1×10^{-3} to 1×10^{-4}	Freeze and Cherry, 1979
Limestone bedrock	0.20	1×10^{-5} to 1×10^{-6}	Freeze and Cherry, 1979

4. Modelling Results and Discussion

This section presents the modelling results and discusses the validity of the three conceptual models presented in Section 3.

Following the manual calibration procedure, the hydraulic conductivity and recharge values were adjusted until a reasonable comparison was obtained between the observed water levels and the model calculated heads for each of the models.

4.1 Conceptual Model 1

Description

Water is provided through local recharge and is distributed throughout the domain with a high in the marsh area west of well 95-8

Analysis

The recharge distribution required to calibrate this model is shown in Figure 7. The observed/calculated heads for conceptual model 1 are shown in Figure 8. It is evident in Figure 7 that a very large quantity of recharge is required to achieve a reasonable calibration. It is expected that the average rate of recharge through the upper till/clay unit is approximately 100 mm/yr, which is much smaller than the recharge rates that were required to achieve calibration.

The recharge rate that was required by the model to achieve a reasonable calibration is much larger than was initially expected, and suggests that this conceptual model is not physically realistic.

Although the calibration appears adequate, artificially large recharge rates were required to generate calculated heads that matched observed values. This indicates that the water supply to the Apple Hill groundwater system is not derived entirely from local recharge.

4.2 Conceptual Model 2

Description

Water is provided through local recharge, with the majority of the recharge entering the groundwater system in the marsh area west of well 95-8

Analysis

In this scenario, a large quantity of recharge was applied to the marsh area west of well 95-8, which is shown in Figure 9. Throughout the rest of the domain, a recharge rate of 100 mm/yr was used. To calibrate the model to the observed heads, 67502 m^3/year of recharge was applied to the marsh over area of 3750 m^2. This resulted in a recharge to the marsh of 18 m/year. Although Figure 10 shows that the calibration plot of observed and calculated heads appears reasonable the simulated recharge through the marsh is unrealistic.

Similar to results from scenario 1, the conceptual model for scenario 2 is physically unrealistic and indicates that the Apple Hill flow system is not completely supplied with local recharge.

4.3 Conceptual Model 3

Description

Water is provided both regionally from the limestone bedrock and locally from recharge

Analysis

In this scenario, three model layers were added to simulate flow in the limestone bedrock unit. The five-layer model with the addition of the limestone bedrock unit provides a way to assess the importance of regional flow on the Apple Hill groundwater flow system.

For scenario 3, a recharge rate of 100 mm/yr is used throughout the domain. As indicated by the calibration plot in Figure 11, a reasonable calibration is obtained. This conceptual model, that includes the influence of regional flow on the local Apple Hill flow system, provides a realistic scenario in which a calibration was attained while maintaining physically realistic recharge rates. Further analysis to provide insight regarding the source of Apple Hill's water can be conducted with the scenario 3 conceptual model, but will involve significant investigation outside of the current study area.

4.4 Apple Hill Water Source Identification

Utilizing the numerical model developed for conceptual model 3, interaction between the regional and local flow systems was investigated. Reverse particle trace simulations were used to determine whether water pumped by communal test well 98 originates from a local or a regional recharge area.

Figures 12 and 13 show the results of a simulation in which 12 particles in a cylindrical formation around communal test well 98 were released and tracked backwards. As shown in Figure 13, particles were released at the bottom, middle and top of the grid-block in which the well is screened. The 8 particles that were released from the bottom and middle of the grid block are shown to exit the model at the top boundary. The 4 particles that were released from the top of the grid-block exit the model at the ground surface. The particles that exited the model at the ground surface indicate that some of the water pumped by the well is obtained from local recharge. The other particles that exited at the northwest end of the model indicate that water is obtained regionally, from water that likely enters the flow system to the northwest of Apple Hill.

Using the reverse particle trace information, an estimate of the water source for the communal test well 98 can be made. The quantity of water that enters the groundwater flow system above the 4 particles that terminate at the ground surface is the maximum quantity that can be attributed to local recharge. This region, as shown in Figure 14, has an area of 46250 m^2. With a recharge rate of 100 mm/yr, the quantity of water pumped from local recharge is 4625 m^3/yr. This represents 18% of the water that is pumped at communal test well 98. Therefore, 82% of the water that is pumped at communal test well 98 is derived from region sources. The local scale model that was developed is not capable of predicting travel times for the regional groundwater component that supplies communal test well 95.

4.5 Remaining Uncertainty

Many particles exit at the northwest boundary of the model, rather that at the ground, due to the confining clay/till unit that overlies the gravel aquifer. The till unit reduces the quantity of recharge that enters the local groundwater system; therefore, water must travel from farther afield to supply pumping at communal test well 98. Provided the till unit in the area of Apple Hill is continuous and is not heavily fractured, the gravel aquifer will be well protected from potential ground surface contaminant sources within the community. However, as noted above, with the local scale model it is impossible to comment on the susceptibility to contamination of water that enters the flow system outside the local boundaries of the groundwater flow model. Based on the simulations conducted in this study, it takes 5 years for particles to travel through the gravel and limestone bedrock to exit the northwest model boundary. Particles travelling through the till/clay confining layer, however, must travel for longer than 1000 years before reaching the ground surface, provided the till/clay layer is continuous and not heavily fractured.

5. Conclusions and Recommendations

This study has developed and analyzed using modelling techniques, a suite of possible conceptual models of groundwater flow in the town of Apple Hill. The following conclusions are based on this work:

1. It is unlikely that all of the water pumped from communal well 98 is derived from local recharge.
2. An estimate of the proportion of water that originates locally versus regionally that is pumped at communal well 98 is 18% locally and 82% regionally.
3. The regional flow component that supplies communal test well 98 has travel times in excess of 5 years.
4. The local flow component that supplies communal test well 98 has travel times in excess of 1000 years, provided the till/clay layer is continuous and not heavily fractured.
5. Further study is necessary to assess the regional contribution to the Apple Hill groundwater flow system and its susceptibility to contamination.

References

Freeze, R.A., and J.A. Cherry, 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, NJ.

McDonald, M.G., and A.W. Harbaugh, 1996. User's Documentation for MODFLOW-96, An Update to the U.S. Geological Survey Modular Three-Dimensional Finite-Difference Groundwater Flow Model. U.S. Geological Survey Open-File Report 96-485.

Pollock, D.W., 1994. User's Guide for MODPATH/MODPATH-PLOT, Version 3: A Particle Tracking Post-Processing Package for MODFLOW, the U.S. Geological Survey Finite-Difference Groundwater Flow Model. U.S. Geological Survey Open-File Report 94-464.

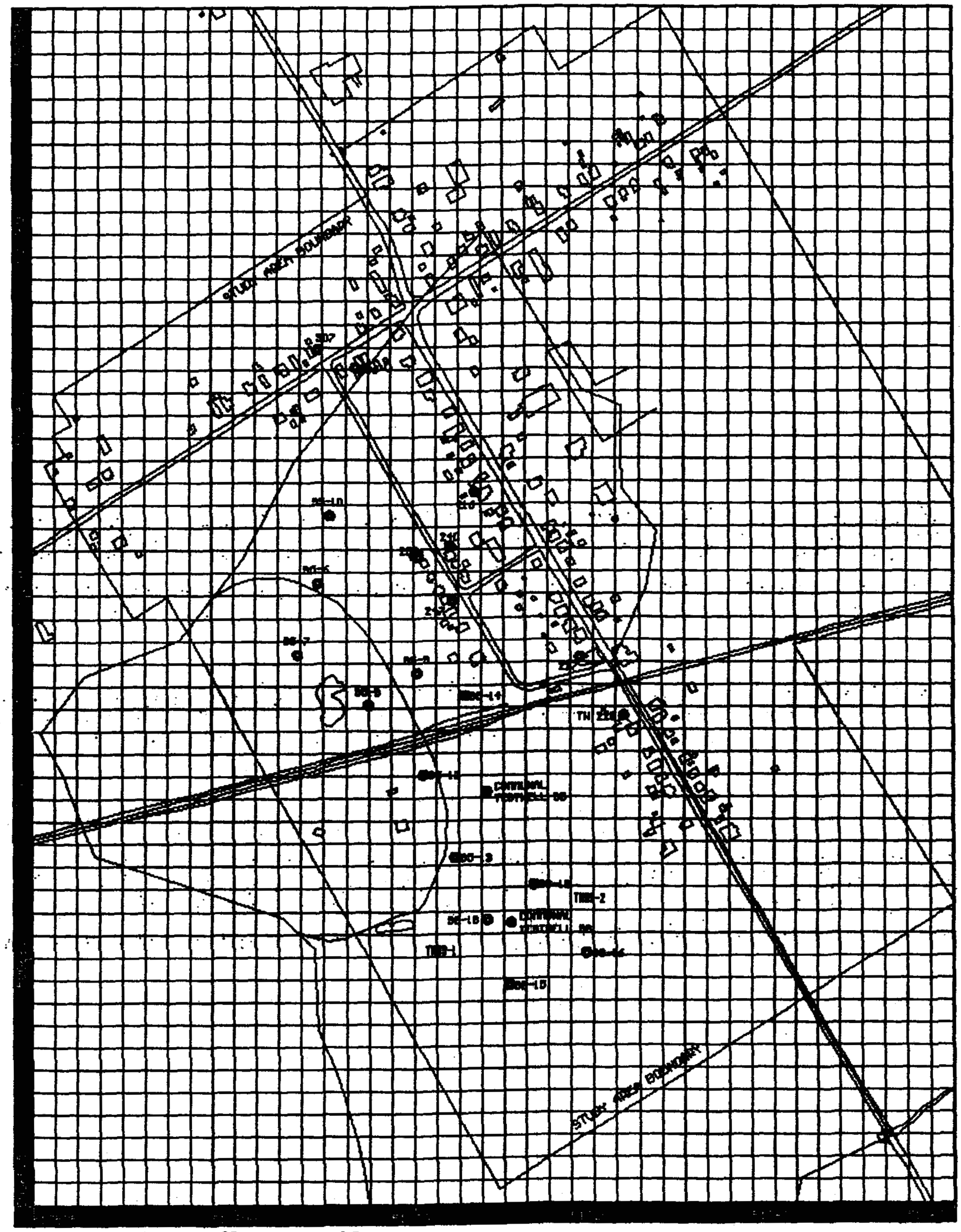


Figure 1: Finite difference grid

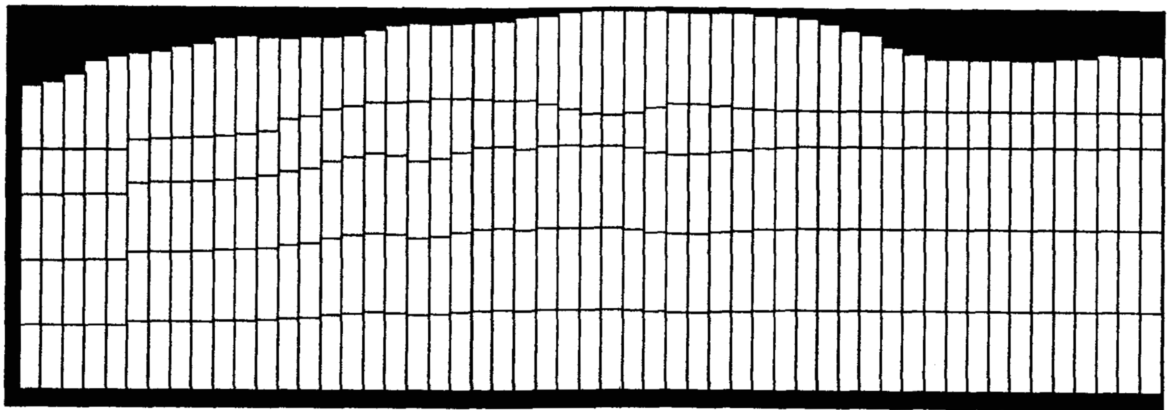


Figure 2: Model 3, vertical layering

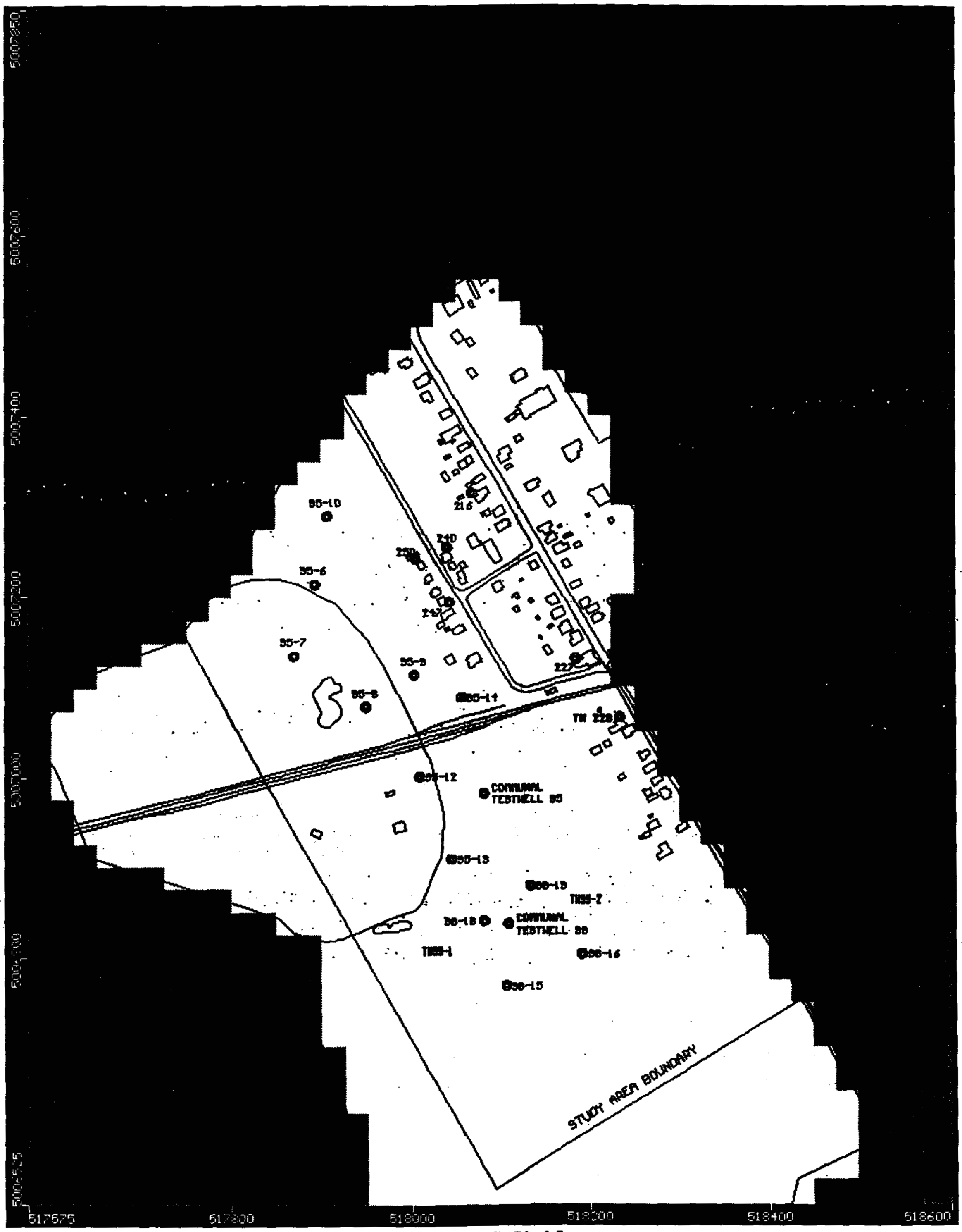


Figure 3: Upper till/clay unit, flow lines and divides

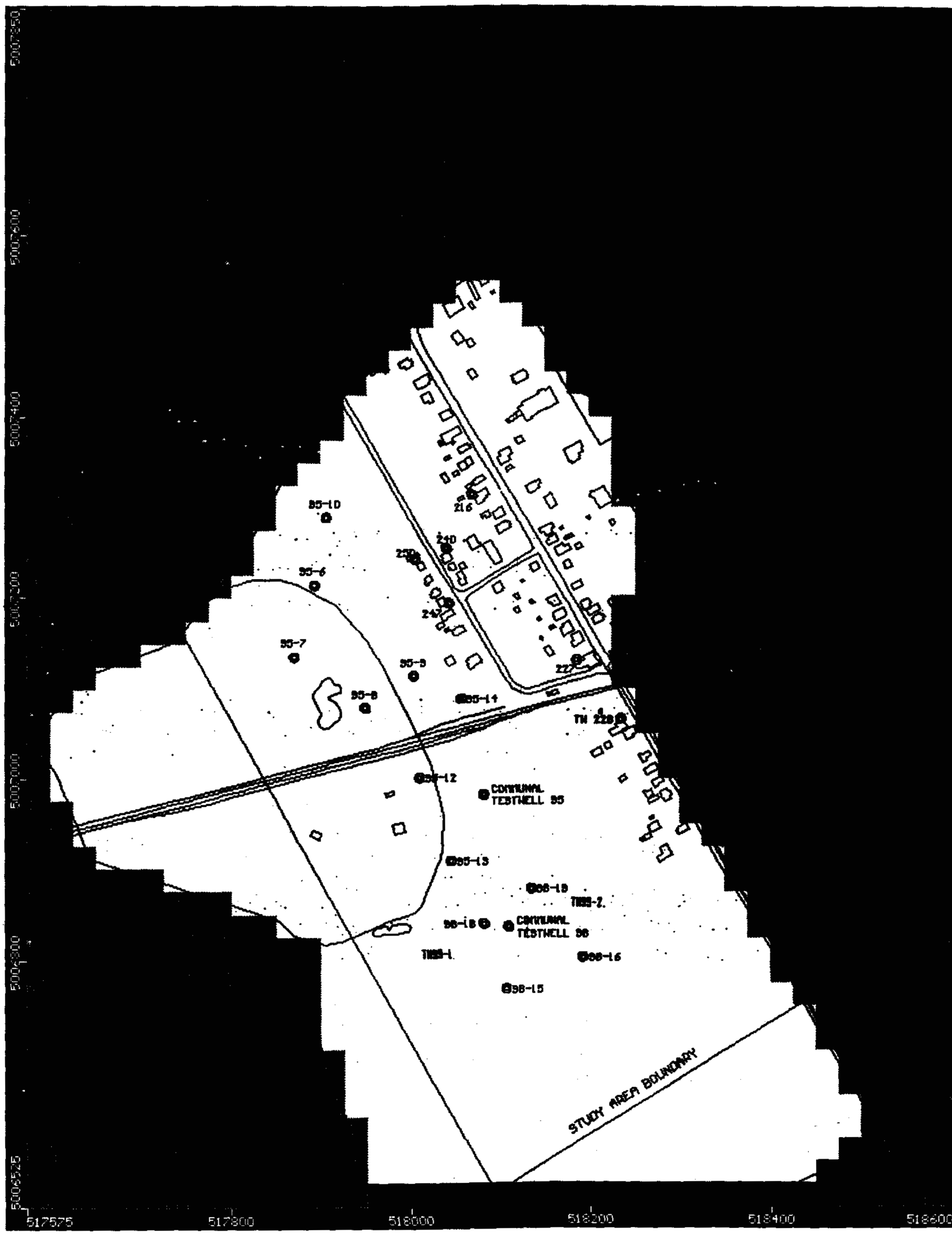


Figure 4: River boundary condition

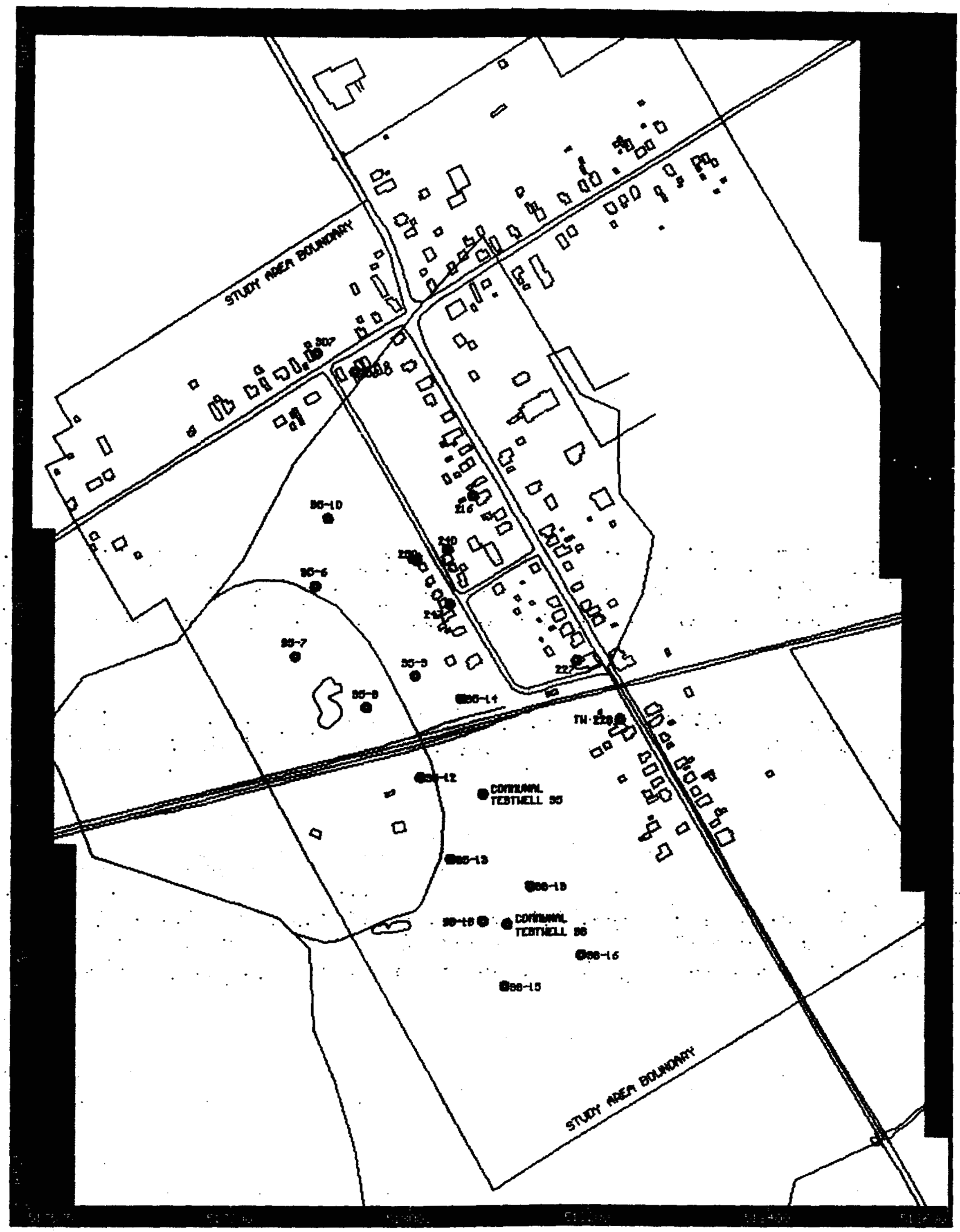


Figure 5: Top of model, constant head boundary

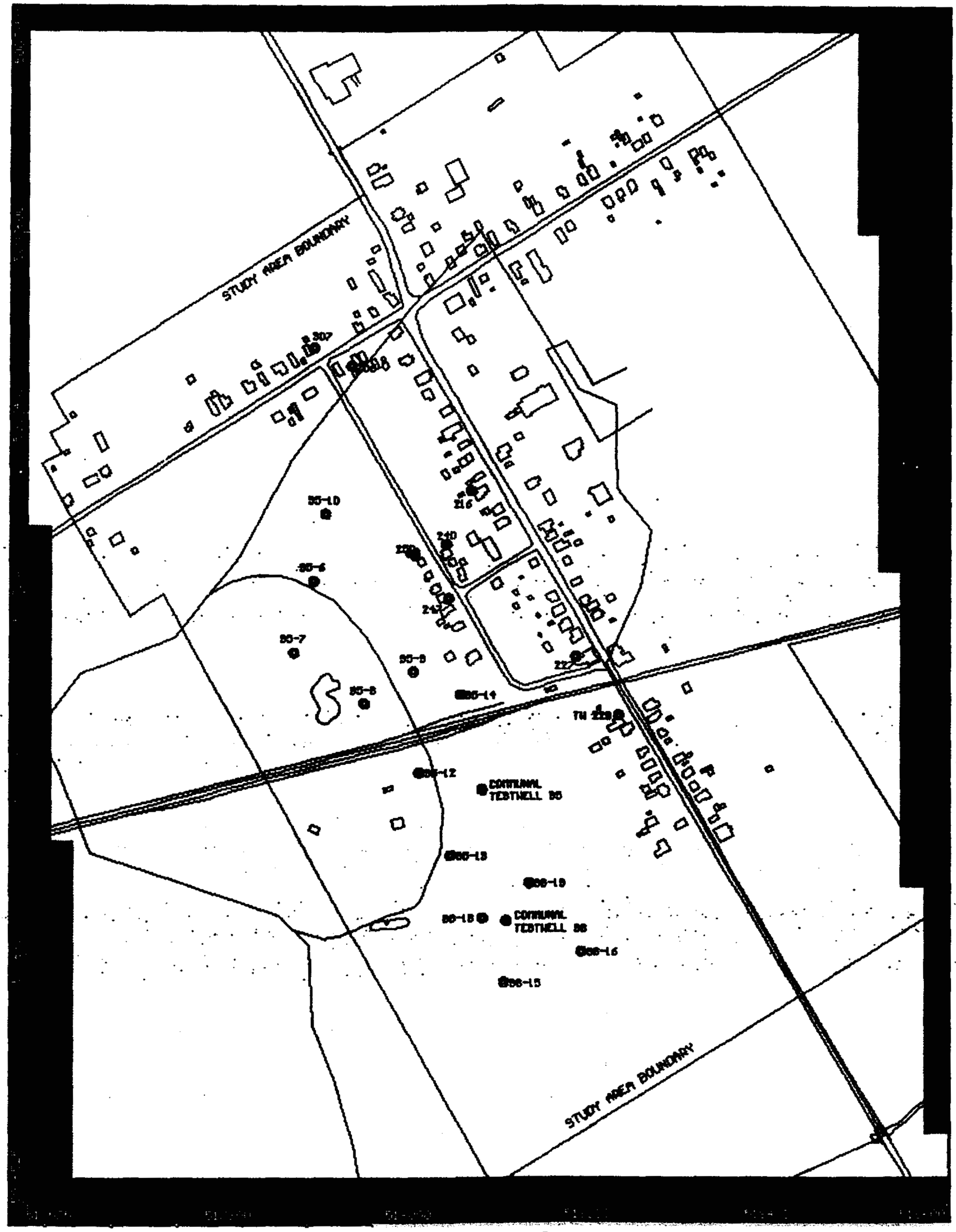


Figure 6: Bottom of model, constant head boundary

blue = 100 mm/yr, green = 300 mm/yr, purple = 450 mm/yr, red = 500 mm/yr
Figure 7: Model 1, recharge distribution

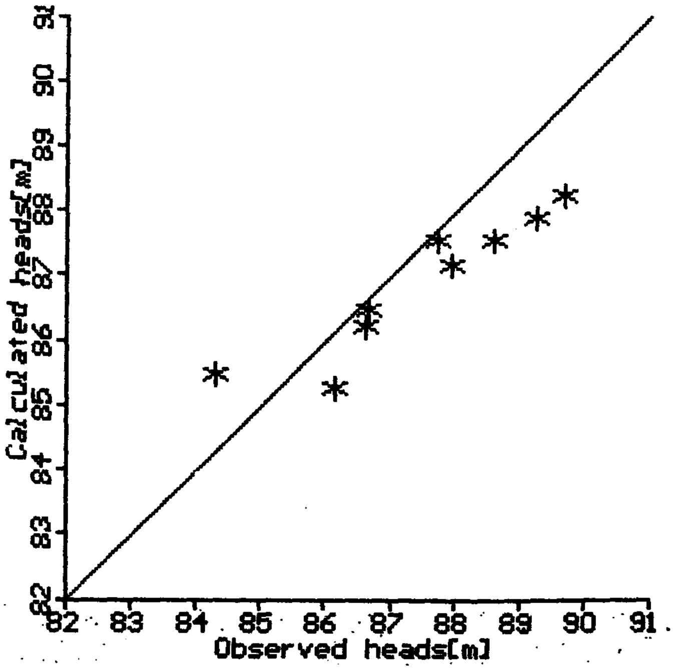


Figure 8: Model 1, observed/calculated heads

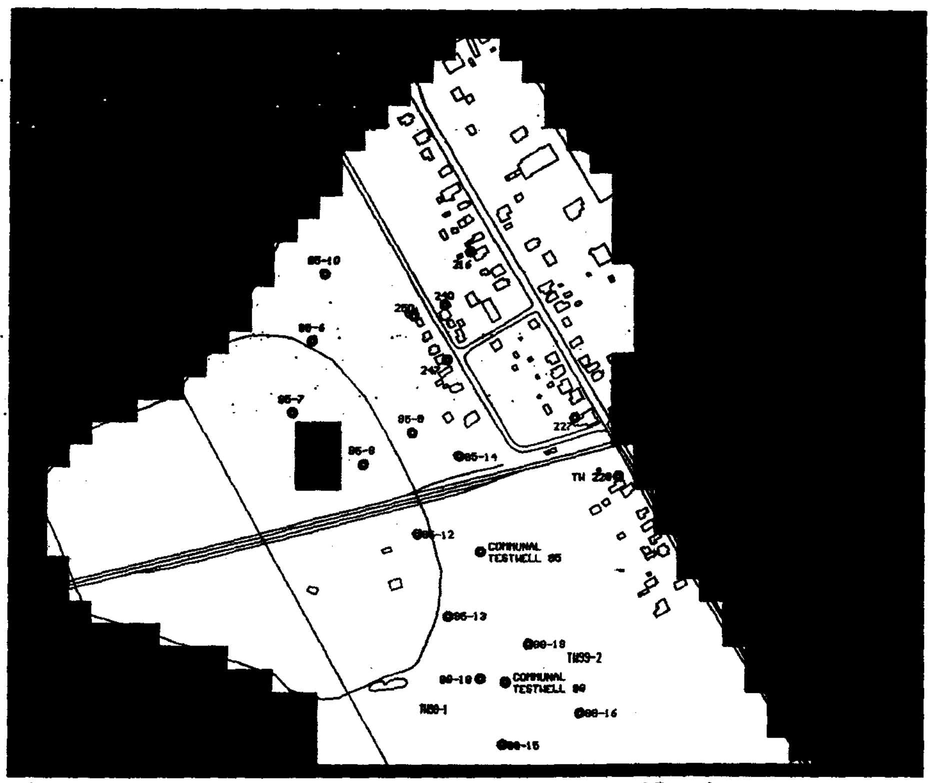


Figure 9: Model 2, marsh location recharge = 18 m/yr

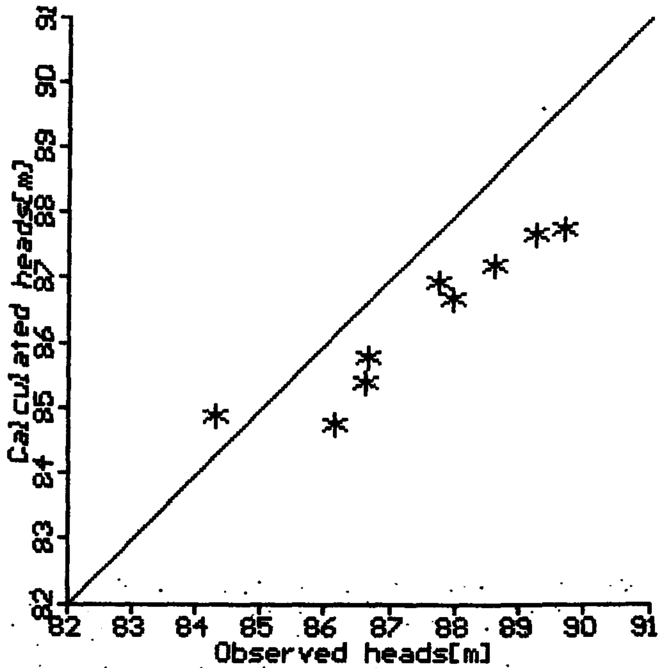


Figure 10: Model 2, observed/calculated heads

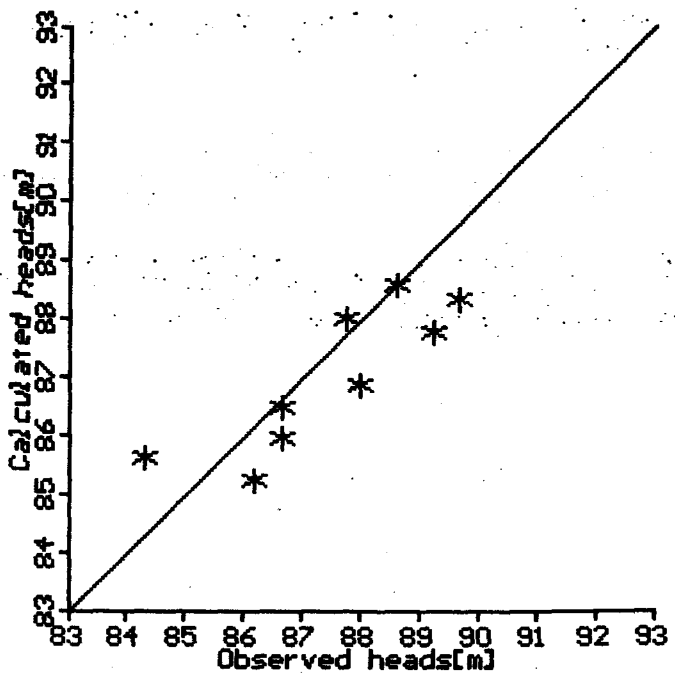


Figure 11: Model 3, observed/calculated heads

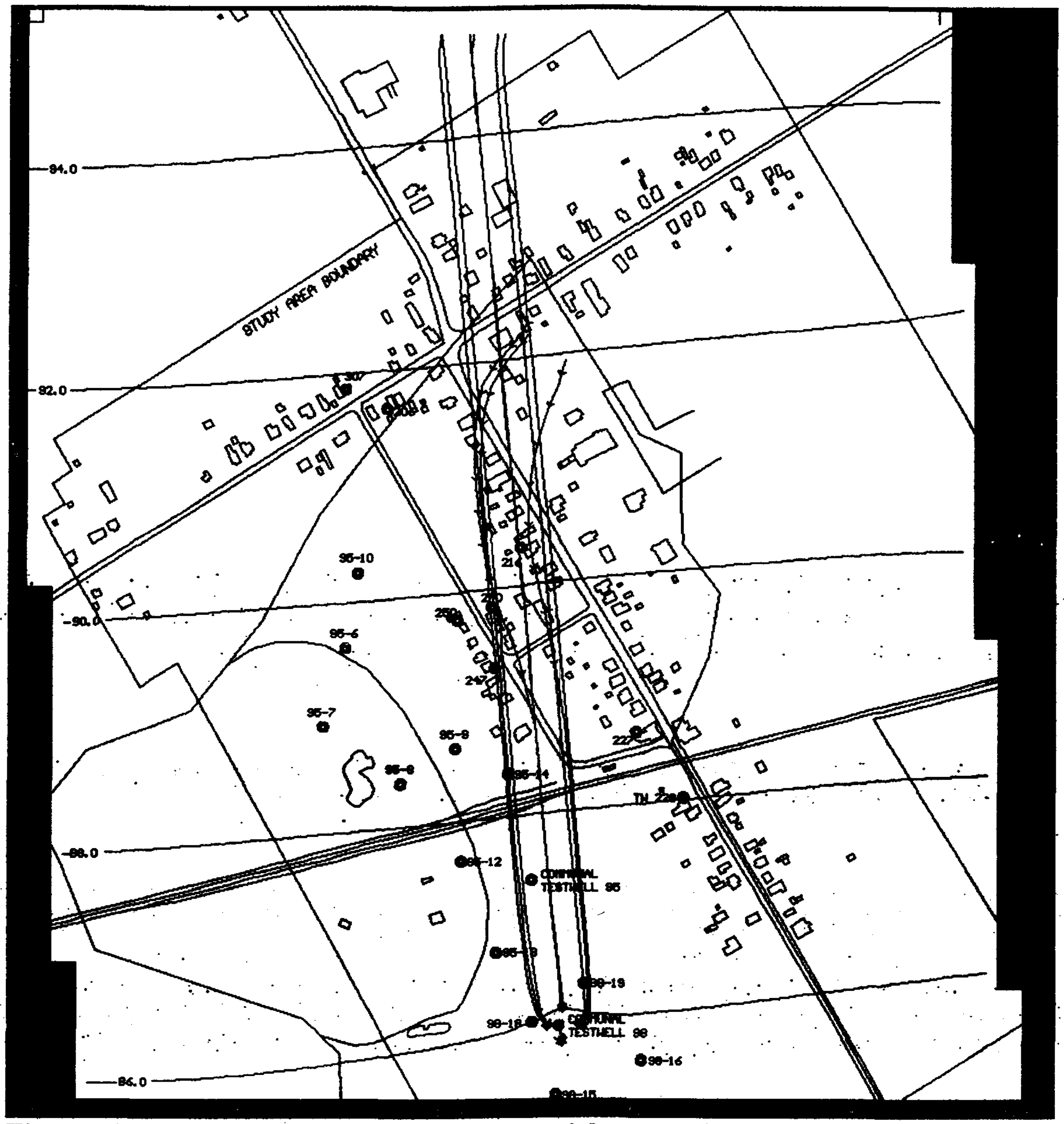


Figure 12: Model 3, plan view of reverse particle traces from communal well 98

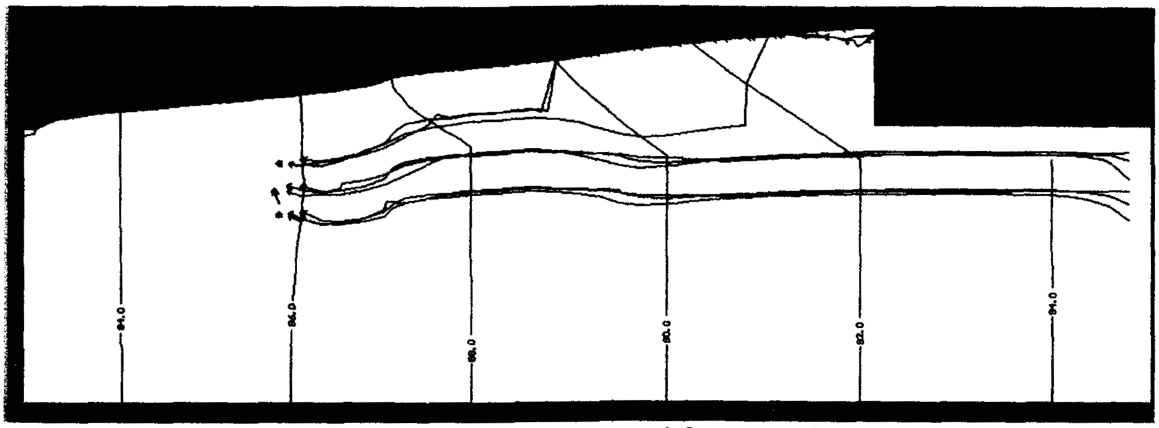


Figure 13: Model 3, cross-section of reverse particle traces from communal well 98

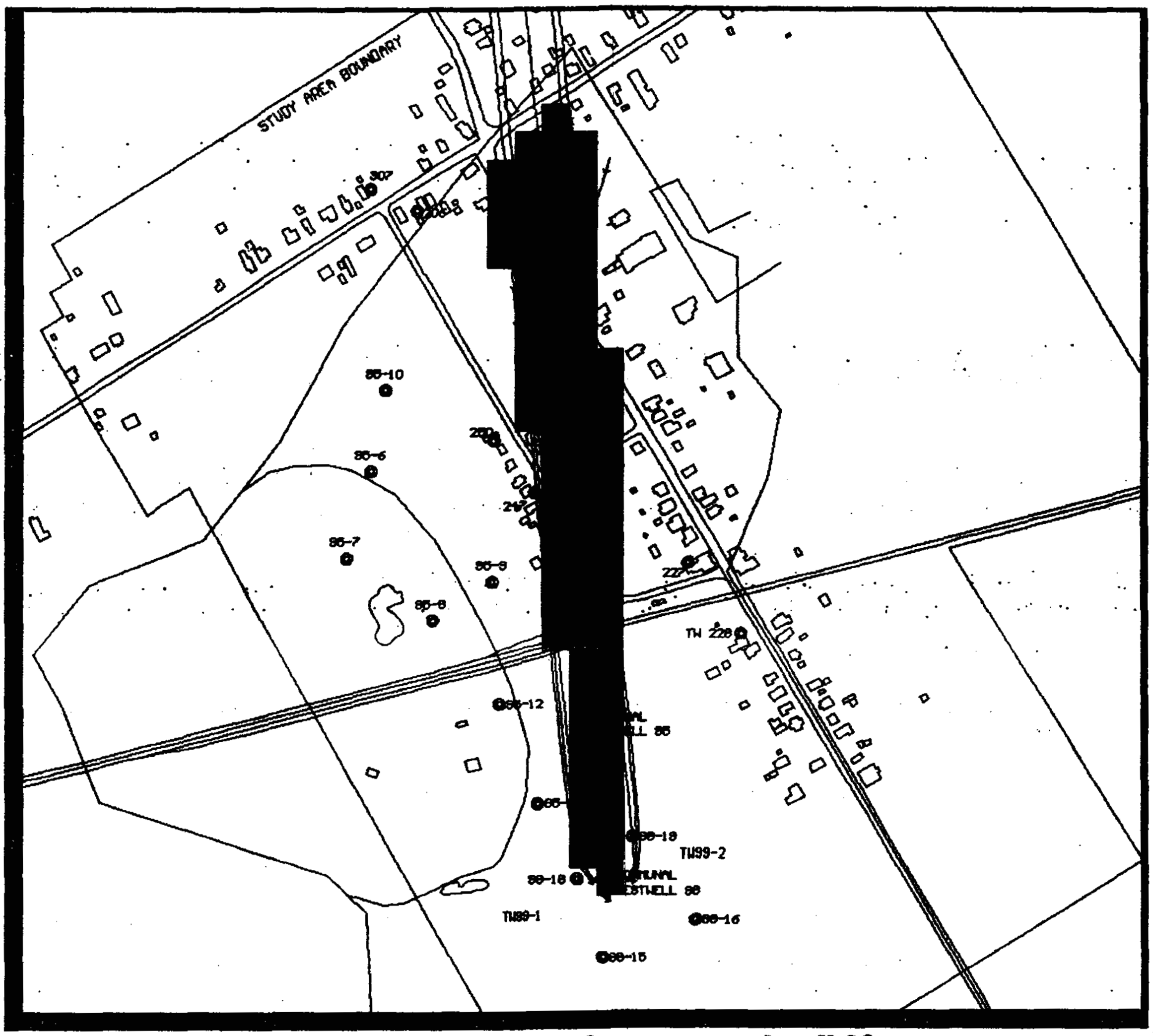


Figure 14: Model 3, area of local recharge for communal well 98