Before You Construct a Water Well

Facts a homeowner should know

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Preface

The cost of a well is usually small in comparison to a house itself, but a home is worth little without a good water supply. This booklet has been prepared for prospective homeowners and others who may have to have a well constructed. The more familiar you are with the information in this booklet, the more likely you are to be satisfied with your well and with your home.

Nova Scotia Department of Environment and Labour administers the Well Construction Regulations. A list of regional offices is provided for your convenience at the end of this booklet. Staff will be happy to provide general information or to answer specific questions regarding wells, water supply potential, and the Regulations.

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A Water Supply in your Home

Water is the basis of life. You cannot survive without it. In the past, there was little difficulty in finding sufficient water for the limited household needs. However, indoor plumbing and automatic appliances place much greater demands on water supply today. As a conservative estimate, a home will need in the order of 340 litres (75 imperial gallons) per person per day to meet all these needs.

A household needs not only enough water, but also water that has good bacterial and chemical quality.

About half of Nova Scotians rely on groundwater for water supply. The most common water supply for the home that is not served by a public system is a drilled well. In rural areas, three quarters of new home water supplies are derived from drilled wells, the remainder primarily from dug wells. Springs, cisterns and surface water serve a very small number of homes.

What is Groundwater?

Groundwater is water that is found in pore spaces in the soil or in cracks or pores in the rock. Groundwater begins as rain or snowmelt (precipitation). This water can follow three main paths:

- Some evaporates from the ground and open water surfaces, or is 'breathed' out (transpired) by vegetation and returns to the atmosphere where it can again form clouds, rain and snow and replenish the earth.
- Some runs off into streams or lakes or the ocean, called surface water runoff.
- Some infiltrates into the ground. There, it follows various routes (flowpaths) and can discharge to the ground surface as springs, discharge into surface water, or recharge groundwater deeper in the earth. As groundwater moves through the ground, it dissolves some of the minerals that it contacts. These dissolved minerals give water its chemical character or quality.

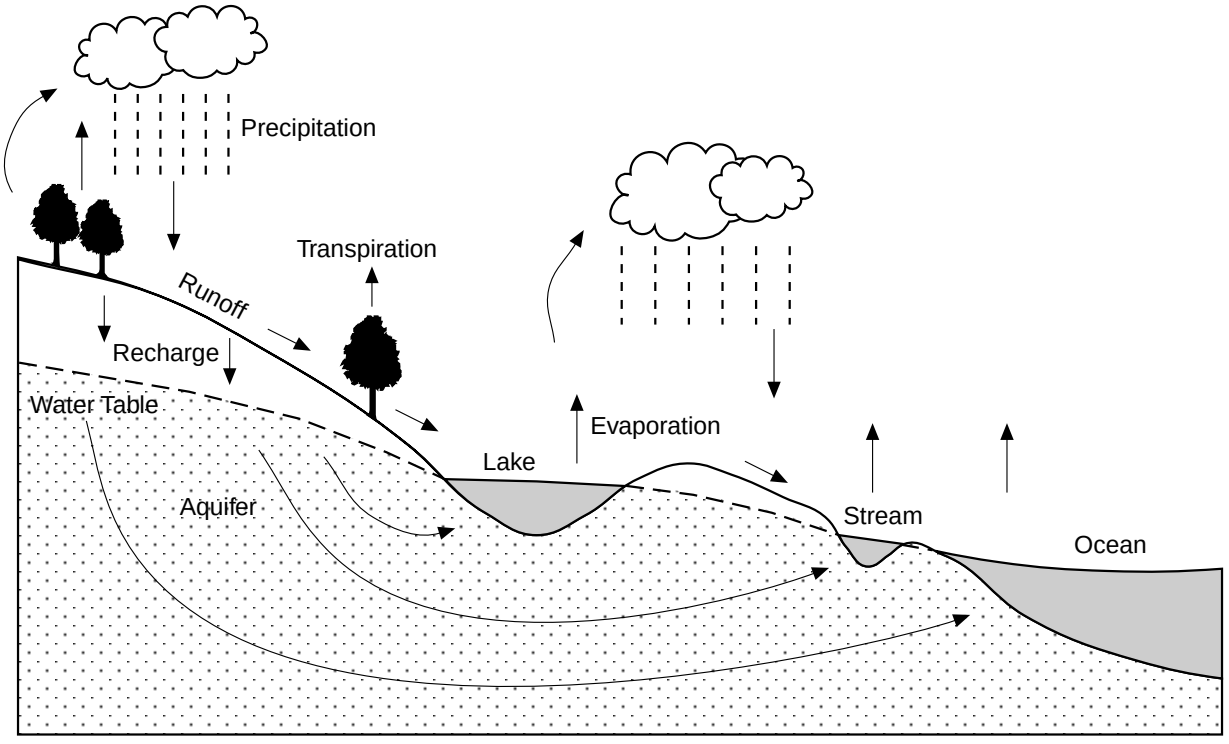


Figure 1 **The hydrologic cycle, or water cycle. This cycle involves the circulation of water between land, atmosphere, and ocean.**

How Does Groundwater Occur in Nova Scotia?

Groundwater is found in aquifers in the bedrock or in the material above the bedrock. An aquifer is a water-bearing permeable formation that will yield water in a usable quantity to a well.

How much water a drilled well yields depends on the type of bedrock, type of overburden or surficial material (the geologic material above the bedrock), well depth, and number of fractures (cracks) or permeable layers encountered during drilling. The bedrock aquifer generally consists of three main rock types:

- igneous and metamorphic rocks such as slate, quartzite and granite, which yield water mainly from fractures
- sedimentary rocks such as sandstone, shale and conglomerate, which yield water from spaces between the grains and from fractures
- carbonate and evaporite rocks such as limestone and gypsum, which yield water mainly from fractures and cavities.

Figure 2 shows how these rock types are distributed in Nova Scotia.

In most places in Nova Scotia, the overburden above the bedrock is made up of glacial till, sandy to clayey in composition, depending on the nature of the local bedrock. Its thickness varies widely with location, but generally ranges from 0 to 10 metres (0 to 33 feet) and averages 6 m (20 ft). Dug wells obtain water from this material or from the contact zone between the surficial material and upper weathered bedrock. Because till is generally low in water yield, dug wells are usually constructed of 90 cm (3 foot) diameter crocks that can store large amounts of water.

In some places, the overburden consists of permeable sand and gravel deposits that are saturated with water. Here, dug wells or screened drilled wells may produce relatively good yields. Such deposits occur along some of the major river systems, the most extensive on the mainland being in the Annapolis and Musquodoboit Valleys.

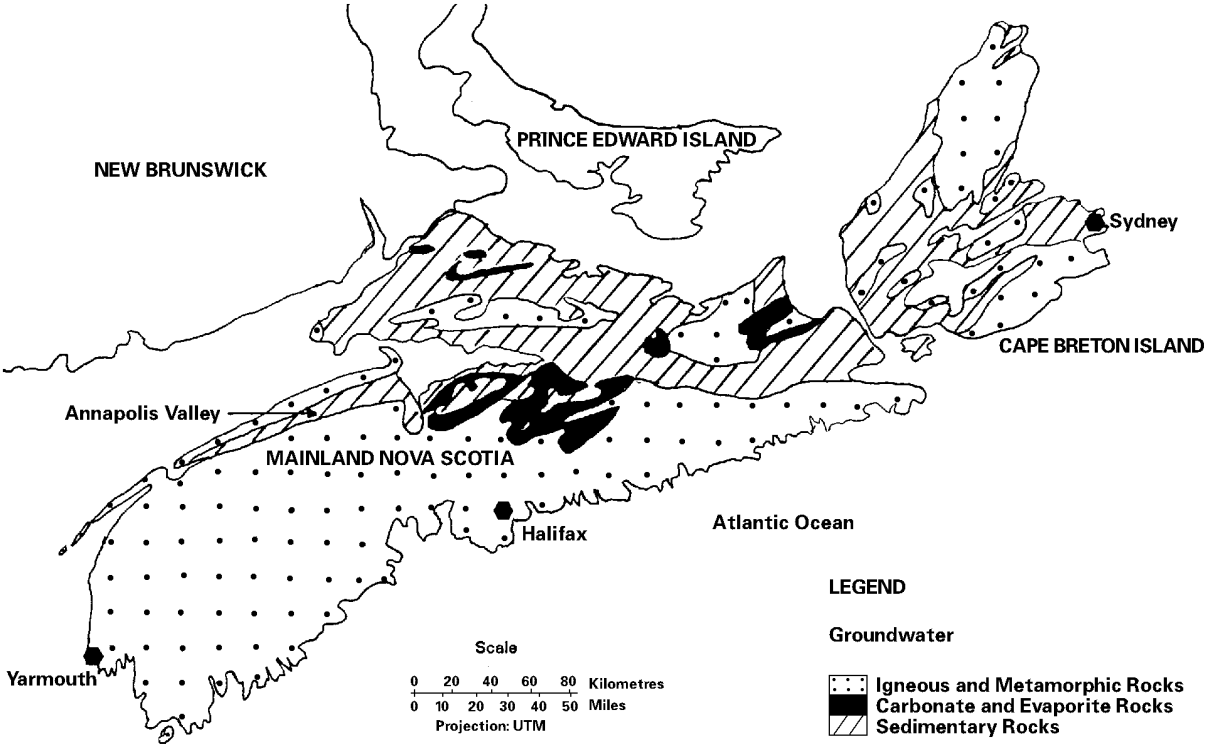


Figure 2 **Groundwater Regions of Nova Scotia (Simplified from Water Resources Map, NSDOE, 1985)**

Planning a Water Supply

Before you build your house or drill or dig your well, plan your water supply: a house is worth little without an adequate supply of good-quality water, which may be found where you had hoped to place the front steps!

To plan your water supply, find out what type of material lies under the ground, how much water you will need, and where the well should be constructed to provide the best water supply and meet regulations.

Have the well constructed before you build!

Why Should I Have a Water Well Constructed Before I Build?

When you drill a well, you are actually exploring to determine the quantity and quality of water available. Totally 'dry' holes are uncommon, but low-yielding wells are more common than you may realize. Some causes of low yield include low natural or seasonal water table, interference with other wells (for example in subdivisions), and geologic conditions, as shown in Figure 3. In addition, good quality water may be difficult to obtain in some areas due to natural causes such as salt deposits and closeness to the ocean. Occasionally problems may arise with well construction, as shown in Figure 4.

If problems arise, the cost to repair them is less if you construct the well first, because only the cost of the well is involved. Also, if a second well must be dug or drilled, there is more likely to be sufficient space on the property if the house is not already there. Too many homes have inadequate water supplies because the property owner did not have a well constructed before the home was built.

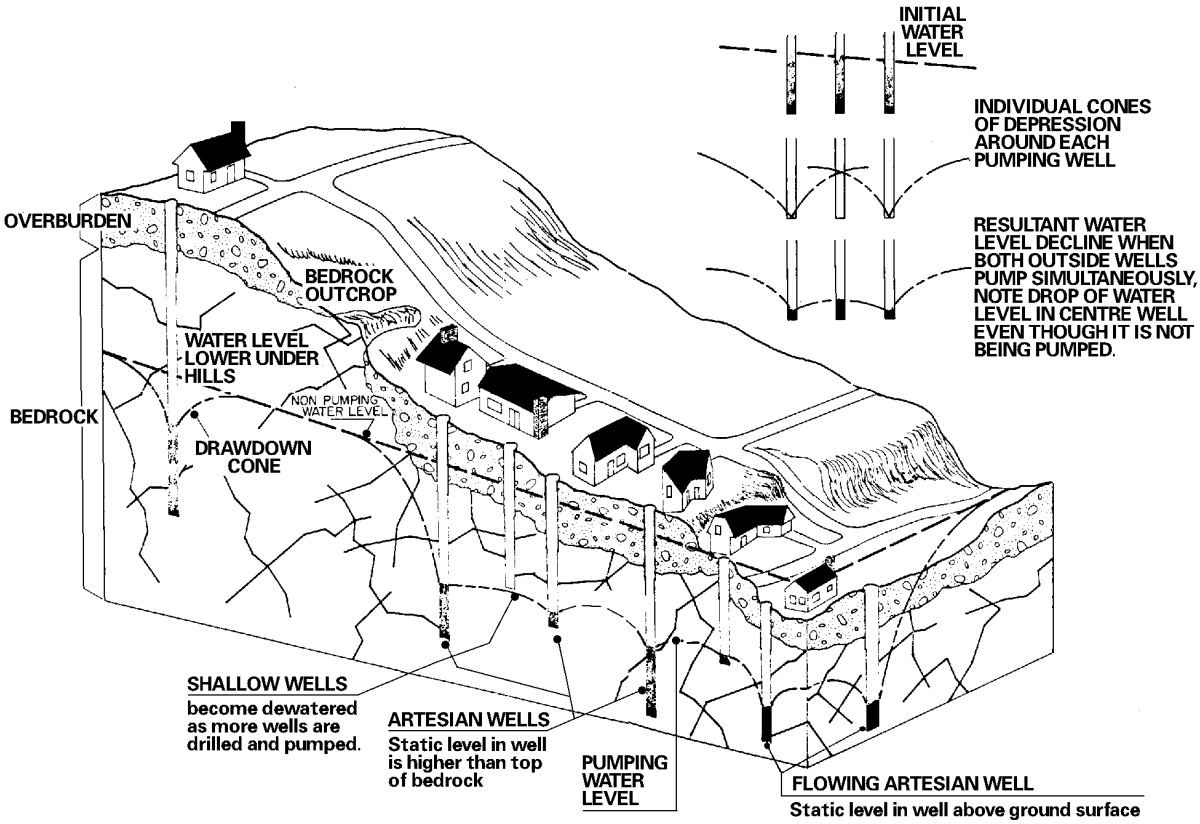


Figure 3 **Dry Shallow Wells in Subdivisions**

An expensive house with a poor well is a poor investment; resale value will be lower. It may be very costly to ensure an adequate supply of good-quality water. It is better to have a well constructed and assess the quantity and quality of the water supply before you build a house. Also, in areas where a usable water supply from drilled wells is questionable, it is better to obtain an option on the property with permission to have a well constructed first. Following such a procedure may save you from a bad investment.

Where Do I Obtain Background Information for My Area?

The type of material beneath the ground surface in your area (geology) can tell you how successful you may be in obtaining a suitable water supply from a well. In many areas of the province, groundwater conditions have been examined and information can be obtained from local well contractors, the nearest Department of Environment and Labour Regional Office (listed on page 33 of this booklet), and neighbours.

- **Local well contractors.** Drawing on their experience in the area, contractors can supply information on the probable depth of the well, and possible quantity and quality of water that can be expected.
- **Department of Environment and Labour.** Information on geology, general information on the water supply potential for the area, and well records for other drilled and dug wells in the immediate vicinity are available. Well contractors are required to file a standardized well report for each well constructed (Figures 5 and 6). The report includes information on well location, depth, type and thickness of bedrock and surface materials, quantity of water, and quality (e.g., sulfurous, salty, clear). An average of 3000 reports per year are entered into a computer database.
- **Nearby homeowners.** Ask them about their water quantity and quality.

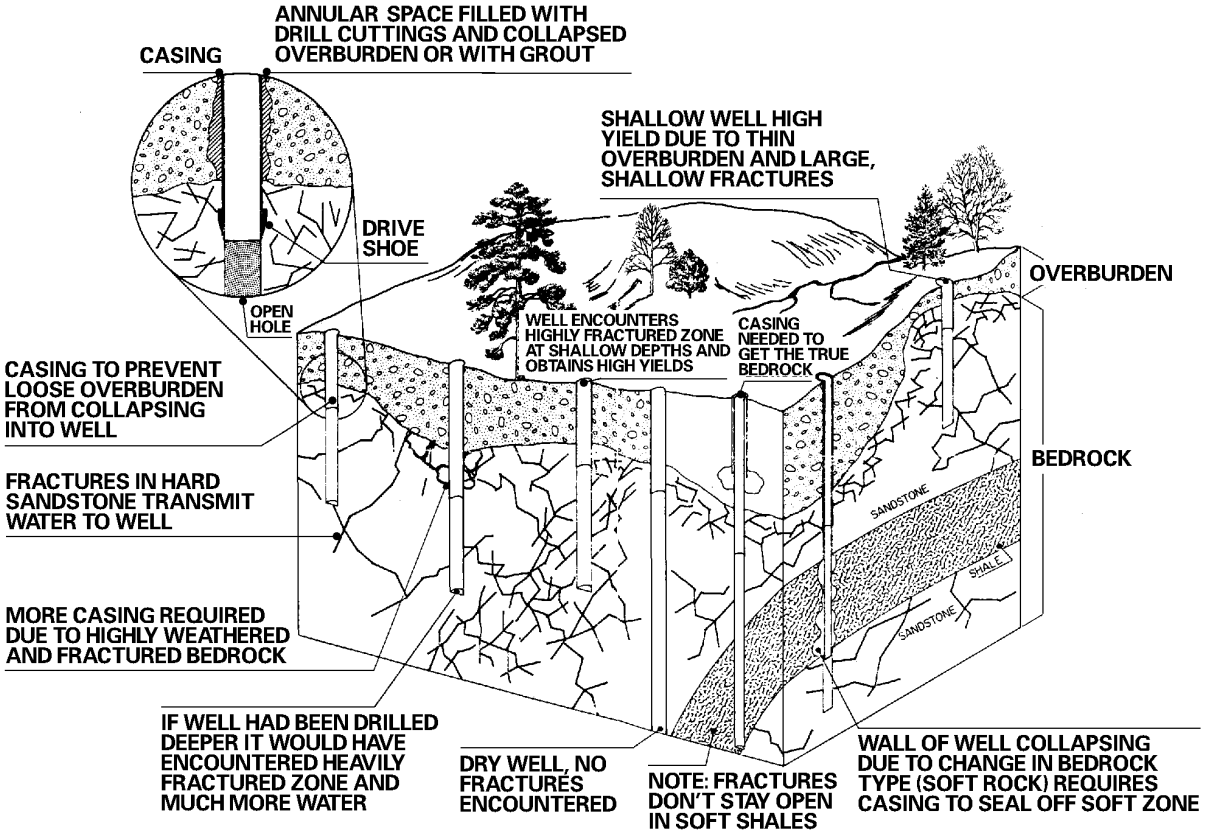
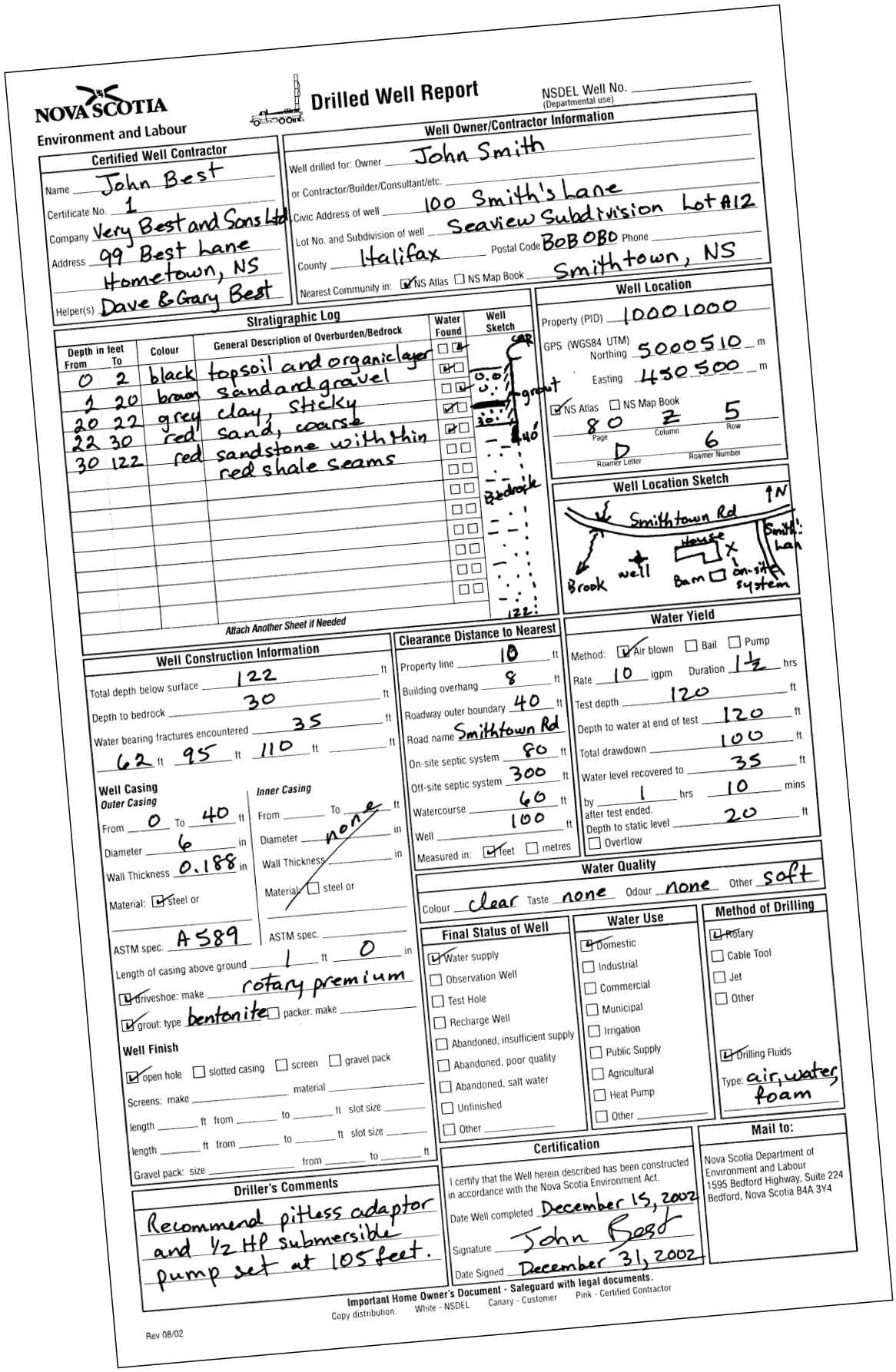


Figure 4 **Problems Encountered in Drilled Well Construction**



NOVA SCOTIA
Environment and Labour

Drilled Well Report

NSDEL Well No. _____ (Departmental use)

Certified Well Contractor
Name: John Best
Certificate No.: 1
Company: Very Best and Sons Ltd
Address: 99 Best Lane, Hometown, NS
Helper(s): Dave & Gary Best

Well Owner/Contractor Information
Well drilled for: Owner: John Smith
or Contractor/Builder/Consultant/etc.:
Civic Address of well: 100 Smith's Lane
Lot No. and Subdivision of well: Seaview Subdivision Lot A12
County: Halifax Postal Code: B0B 0B0 Phone:
Nearest Community in: ☑ NS Atlas ☐ NS Map Book: Smithtown, NS

Stratigraphic Log

Depth in feet From	To	Colour	General Description of Overburden/Bedrock	Water Found
0	2	black	topsoil and organic layer	☐
2	20	brown	sand and gravel	☑
20	22	grey	clay, sticky	☐
22	30	red	sand, coarse	☑
30	122	red	sandstone with thin red shale seams	☐

Attach Another Sheet if Needed

Well Sketch: CSA; 0.0; grout; 30; 40; bedrock; 122

Well Location
Property (PID): 10001000
GPS (WGS84 UTM) Northing: 5000510 m
Easting: 430500 m
☑ NS Atlas ☐ NS Map Book
Page: 80 Column: Z Row: 5
Roamer Letter: D Roamer Number: 6

Well Location Sketch
Smithtown Rd; N; Smith's Lane; House; X; Brook; well; Barn; on-site system

Well Construction Information
Total depth below surface: 122 ft
Depth to bedrock: 30 ft
Water bearing fractures encountered: 35 ft
62 ft 95 ft 110 ft ft

Well Casing
Outer Casing
From 0 To 40 ft
Diameter 6 in
Wall Thickness 0.188 in
Material: ☑ steel or
ASTM spec. A589
Inner Casing
From To ft
Diameter none in
Wall Thickness in
Material: ☐ steel or
ASTM spec.
Length of casing above ground 1 ft 0 in
☑ driveshoe: make rotary premium
☑ grout: type bentonite ☐ packer: make

Well Finish
☑ open hole ☐ slotted casing ☐ screen ☐ gravel pack
Screens: make material
length ft from to ft slot size
length ft from to ft slot size
Gravel pack: size from to ft

Clearance Distance to Nearest
Property line 10 ft
Building overhang 8 ft
Roadway outer boundary 40 ft
Road name Smithtown Rd
On-site septic system 80 ft
Off-site septic system 300 ft
Watercourse 60 ft
Well 100 ft
Measured in: ☑ feet ☐ metres

Water Yield
Method: ☑ Air blown ☐ Bail ☐ Pump
Rate 10 igpm Duration 1½ hrs
Test depth 120 ft
Depth to water at end of test 120 ft
Total drawdown 100 ft
Water level recovered to 35 ft
by 1 hrs 10 mins after test ended.
Depth to static level 20 ft
☐ Overflow

Water Quality
Colour clear Taste none Odour none Other soft

Final Status of Well
☑ Water supply
☐ Observation Well
☐ Test Hole
☐ Recharge Well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Abandoned, salt water
☐ Unfinished
☐ Other

Water Use
☑ Domestic
☐ Industrial
☐ Commercial
☐ Municipal
☐ Irrigation
☐ Public Supply
☐ Agricultural
☐ Heat Pump
☐ Other

Method of Drilling
☑ Rotary
☐ Cable Tool
☐ Jet
☐ Other
☑ Drilling Fluids
Type: air, water, foam

Driller's Comments
Recommend pitless adaptor and ½ HP submersible pump set at 105 feet.

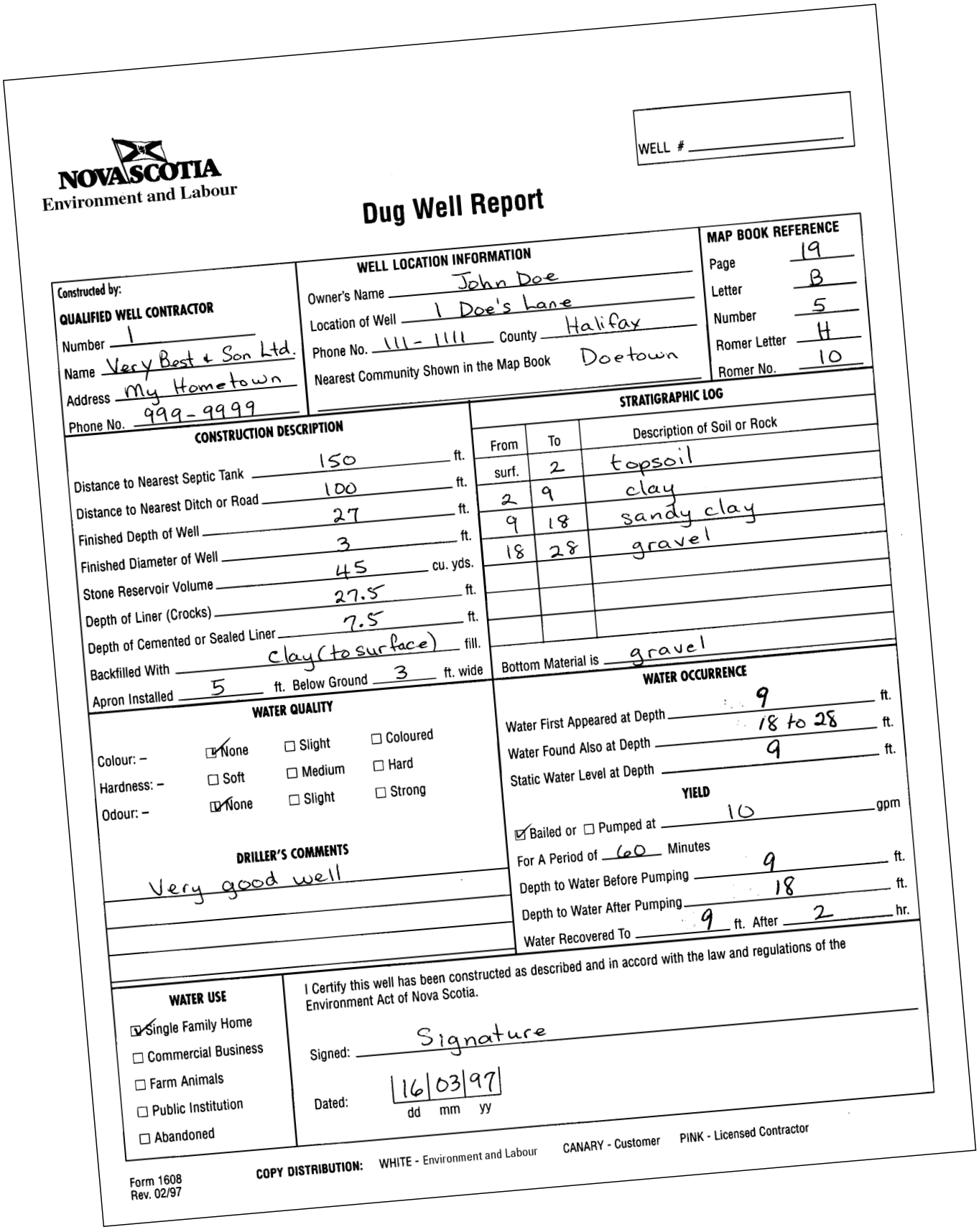
Certification
I certify that the Well herein described has been constructed in accordance with the Nova Scotia Environment Act.
Date Well completed: December 15, 2002
Signature: John Best
Date Signed: December 31, 2002

Mail to:
Nova Scotia Department of Environment and Labour
1595 Bedford Highway, Suite 224
Bedford, Nova Scotia B4A 3Y4

Important Home Owner's Document - Safeguard with legal documents.
Copy distribution: White - NSDEL Canary - Customer Pink - Certified Contractor

Rev 08/02

Figure 5 **Drilled Well Report**



NOVA SCOTIA
Environment and Labour

WELL # _____

Dug Well Report

Constructed by:
QUALIFIED WELL CONTRACTOR
Number 1
Name Very Best & Son Ltd.
Address My Hometown
Phone No. 999-9999

WELL LOCATION INFORMATION
Owner's Name John Doe
Location of Well 1 Doe's Lane
Phone No. 111-1111 County Halifax
Nearest Community Shown in the Map Book Doetown

MAP BOOK REFERENCE
Page 19
Letter B
Number 5
Romer Letter H
Romer No. 10

CONSTRUCTION DESCRIPTION
Distance to Nearest Septic Tank 150 ft.
Distance to Nearest Ditch or Road 100 ft.
Finished Depth of Well 27 ft.
Finished Diameter of Well 3 ft.
Stone Reservoir Volume 45 cu. yds.
Depth of Liner (Crocks) 27.5 ft.
Depth of Cemented or Sealed Liner 7.5 ft.
Backfilled With clay (to surface) fill.
Apron Installed 5 ft. Below Ground 3 ft. wide

STRATIGRAPHIC LOG

From	To	Description of Soil or Rock
surf.	2	topsoil
2	9	clay
9	18	sandy clay
18	28	gravel

Bottom Material is gravel

WATER QUALITY
Colour: – ☑ None ☐ Slight ☐ Coloured
Hardness: – ☐ Soft ☐ Medium ☐ Hard
Odour: – ☑ None ☐ Slight ☐ Strong

DRILLER'S COMMENTS
Very good well

WATER OCCURRENCE
Water First Appeared at Depth 9 ft.
Water Found Also at Depth 18 to 28 ft.
Static Water Level at Depth 9 ft.

YIELD
☑ Bailed or ☐ Pumped at 10 gpm
For A Period of 60 Minutes
Depth to Water Before Pumping 9 ft.
Depth to Water After Pumping 18 ft.
Water Recovered To 9 ft. After 2 hr.

WATER USE
☑ Single Family Home
☐ Commercial Business
☐ Farm Animals
☐ Public Institution
☐ Abandoned

I Certify this well has been constructed as described and in accord with the law and regulations of the Environment Act of Nova Scotia.

Signed: Signature

Dated: 16 | 03 | 97
dd mm yy

Form 1608
Rev. 02/97

COPY DISTRIBUTION: WHITE - Environment and Labour CANARY - Customer PINK - Licensed Contractor

Figure 6 **Dug Well Report**

How Much Water is Enough?

'Enough' water means sufficient quantity to meet the following needs:

- **Everyday use:** drinking, cooking, and all the luxuries of inside plumbing. 'Plumbing' includes toilets, bathtubs, showers, automatic washers, dishwashers, and many other water-using automatic appliances.
- **Seasonal use:** lawn and garden watering, car washing, and swimming pool.
- **Other special uses:** animal watering, crop irrigation, water treatment devices which require backwashing.
- **Fire protection:** this is a special need for which a home seldom depends on a well. The local fire department usually has access to large quantities of water from ponds or surface water.

A conservative estimate is that a home will need about 680 to 1360 litres (150 to 300 gallons) per day for two to four people to meet average needs.

A day's water use may be concentrated into a period of one to two hours, often in different areas of the house at the same time (laundry, bathroom, lawn). The water supply system must be able to meet this type of peak demand. Canada Mortgage and Housing Corporation require 18 litres per minute (4 gallons per minute) for one hour, and the ability to reproduce this yield 24 hours later, before they will approve a mortgage loan. Where individual wells produce less than this amount, at least 900 litres (200 gallons) of cold water storage must be provided.

Three factors must be considered when determining how much is 'enough':

- **Flow Rate:** continuous rate of yield for well.
- **Size of Well:** diameter and depth of well.
- **Static Level:** level at which water stands in a well when no water is being pumped from the well.

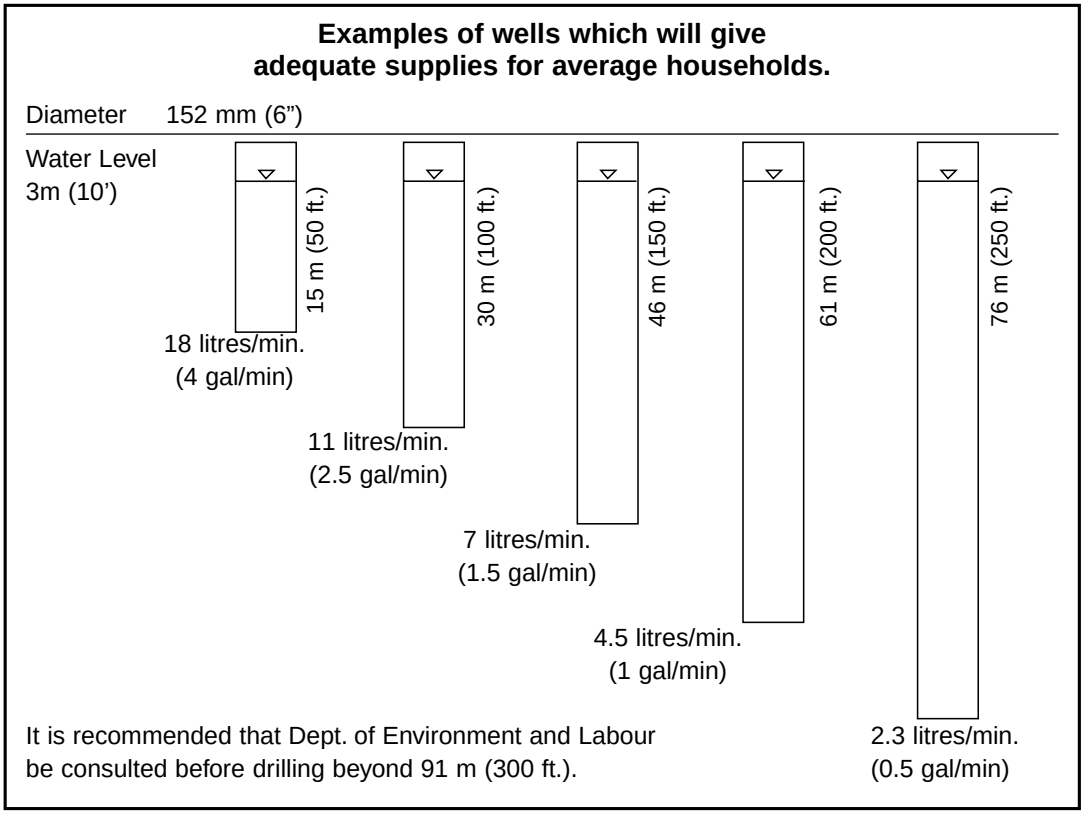


Figure 7 **The question "How much is enough?" depends on a combination of factors such as well yield, well diameter and depth, and static water level (natural water level with no pumping). Whatever the quantity available, water conservation is good practice, cutting energy cost and load on the sewer system and making the best use of low-yield wells. Appendix 2 shows how to calculate the volume of water stored in your well.**

In addition to providing for regular household use, wells sometimes supply water for heating and cooling purposes. Some energy-conscious homeowners install groundwater heat pumps, which extract and concentrate heat energy from water and make it available for heating or cooling purposes. Groundwater is a good source for heating or cooling because below a depth of 6.1 m (20 ft) its temperature is approximately constant at between 7 and 10°C.

When the household supply well is also being used to provide water for a groundwater source heat pump, the well should be able to deliver between 27 and 55 litres (6 and 12 gallons) per minute. This discharge rate must be added to the peak demand allowance required for the home. Some homes use a more complicated two-well system for heat pump purposes.

Be careful not to overlook items that you may take for granted in a city with a good water supply. A home with its own water system and pump can offer the same conveniences, provided the quantity and quality of the water are adequate.

Where Should My Well Be Located?

The actual location of the well on your property will often be determined by factors other than the geology. Land surface features such as steep slopes and poorly drained areas are considerations in the location of the well and building. Whenever possible, wells should be located at higher elevations than the surrounding areas, to decrease the potential for contamination.

The well must be accessible.

- Where surface water runoff will pass over or near the opening of the well, the area immediately surrounding the well shall be filled with clay or clean earth for a distance of at least 4.5 m (15 ft) in all directions from the well and graded to an elevation of at least 610 mm (2 ft) above the highest known surface water level.

The well should be located and maintained so that it is accessible for cleaning, treatment, repair, testing, inspection and other activities which may be necessary over time.

- The top of a well must not be located within the basement or under a building having no basement unless special provisions are made for servicing and repairing the well.

The following minimal distances must be maintained, unless other local codes or regulations (such as On-site Sewage Disposal Systems Regulations) are more stringent:

Boundary or Source of Pollution	Distance
Cesspool (receiving raw sewage)	61 m (200 ft)
Seepage (leaching pit), filter bed, soil absorption field, earth pit, privy or similar disposal unit	
• From a drilled well	15.2 m (50 ft)
• From a dug well	30.5 m (100 ft)
Septic tank, concrete vault privy, sewer of tightly joined tile or equivalent material or sewer-connected foundation drain	
• From a drilled well	15.2 m (50 ft)
• From a dug well	30.5 m (100 ft)
Sewer of cast iron with leaded or approved mechanical joints, independent clear water drain, or cistern	3 m (10 ft)
Pumphouse floor drain, cast iron with leaded joints, draining to ground surface	610 mm (2 ft)
Vertical extension of the centre line of the well from any projection of a building	1.6 m (5.2 ft)
Property boundary	1.5 m (5 ft)
Outer boundary of any road or public highway as defined in the Public Highways Act	6.1 m (20 ft)
Landfill, garbage dump or other source of contamination (if written approval is granted for well construction)	61 m (200 ft)

Contracting the Job

How Do I Select A Water Well Contractor?

Under the Well Construction Regulations, all persons constructing or repairing water wells must have a certificate of qualification from the Department of Environment and Labour. The certificate is renewable annually.

Nova Scotia has approximately 50 certified drilled well and 250 certified dug well contractors. Most operate within a one- to three-county radius. Experienced contractors who have worked in the area will be familiar with local conditions.

Prior to selecting a water well contractor for the job, it is a good idea to obtain information from and about several contractors. Check for the following:

- ✓ Does he have a valid certificate of qualification from Department of Environment and Labour?
- ✓ Does he regularly submit well logs as required?
- ✓ Does he have adequate equipment in good condition to do the job?
- ✓ Does he have adequate liability and worker's compensation insurance to protect you?
- ✓ Is he familiar with applicable health and safety codes?
- ✓ What is the contractor's reputation with previous customers?
- ✓ Will he furnish a written contract, specifying the terms and conditions for the job?

All persons constructing or repairing water wells must have a certificate of qualification.

The contractor must work with geologic conditions as they exist and cannot guarantee quantity or quality of water. Low yield and poor water quality may be due to natural conditions in the area.

Once the contractor is selected, keep in mind the following principles:

- Trust the contractor's judgement in solving unforeseen difficulties that may come up and discuss unforeseen costs.
- If original construction plans must be changed, discuss the options with the contractor and/or Department of Environment and Labour.
- Don't expect the contractor to work for nothing if the well does not fulfill expectations.

What Items Should Be Covered In The Contract?

Unless you know what each contractor will do for his specified price, you cannot compare offers and decide which one to hire. A low lump sum may result in an unsatisfactory job if the workmanship and materials are poor. To ensure that you are satisfied and to protect yourself in case of court action, you should have a written contract. The contract is protection for both you and the contractor.

Some contractors rely on verbal or handwritten agreements, others have a standard contract form, specifying in detail the work to be done, prices, and terms. A sample contract is shown at the back of this booklet. For a drilled well, the contract may include items such as:

- liability insurance coverage held by both the owner and the contractor
- a statement that all work is to comply with local and provincial regulations and codes

- the diameter and wall thickness of the casing to be used
- the type of well development and yield evaluation procedures to be used
- the type of screen to be installed, where needed
- the type of well cap or seal to be provided
- the disinfection procedure
- the cleanup after drilling which includes all material abandoned without authorization at a drill site except drill cuttings and wastewater
- an anticipated date for start of drilling
- a guarantee of materials and workmanship. The contract should specify that the contractor will return to do or to correct the initial work if necessary
- costs: An itemized list of charges is better than a lump sum. The list could include:
  - cost of drilling per metre (foot)
  - cost of casing per metre (foot)
  - cost of other materials, such as drive shoe, grout, well cap
  - cost of other operations, such as grouting, developing (if longer than an hour, such as in screened wells), test pumping, disinfection
  - cost of drilling deeper and/or a second well, if required to ensure an adequate water supply
  - cost of abandonment should it prove necessary (for example if salt water is encountered and another site must be selected)
  - what costs are not included in the specifications

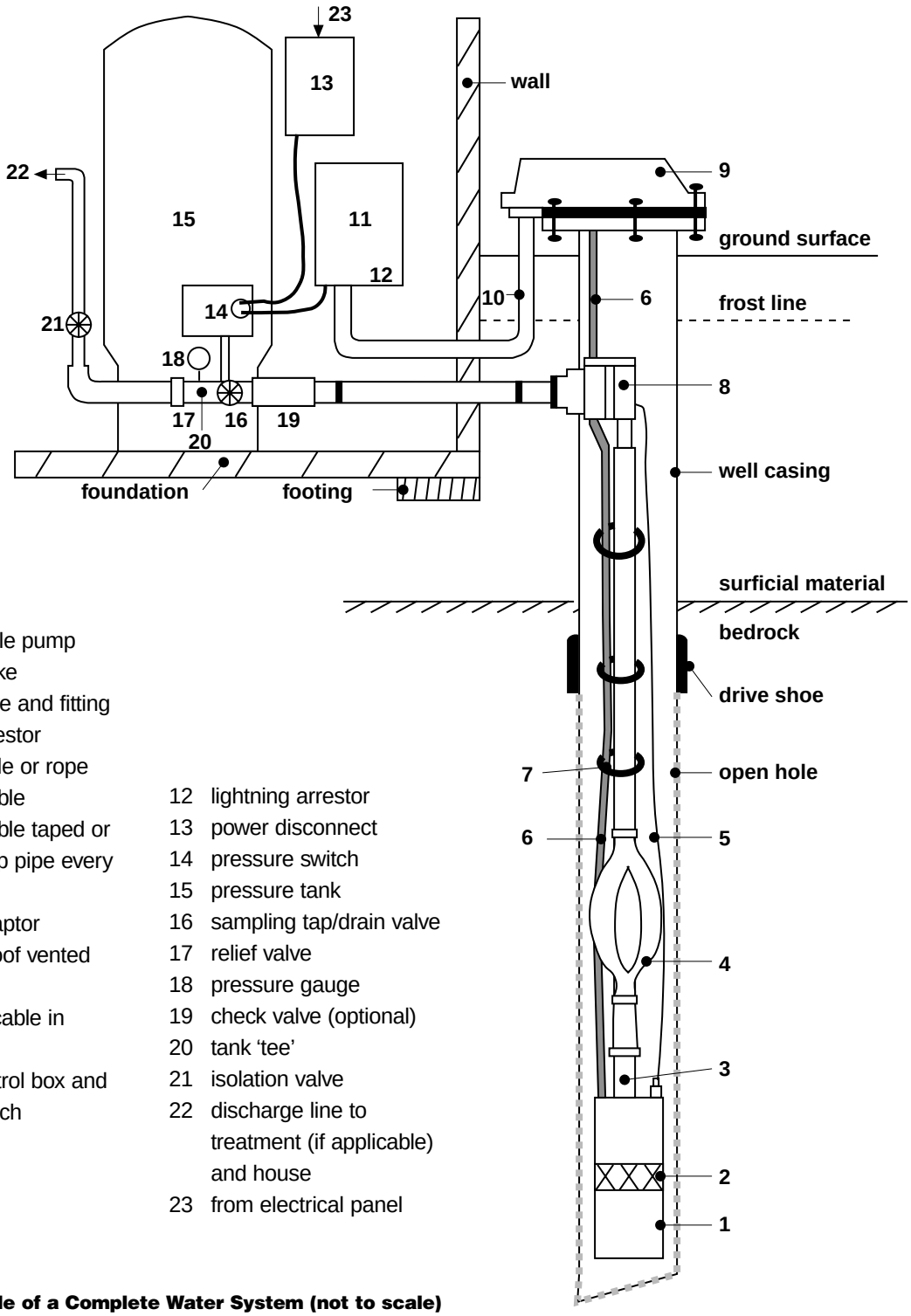
Final Well Inspection

After the well has been constructed and before the contractor removes his equipment from the site, you should inspect the well. Here is a list of items to check:

- **Well depth.** This is easily done by tying a weight on a tape. Verify the measurement against the well construction report made out by the contractor.
- **Well yield.** Ask the contractor at how many litres (gallons) per minute the well was tested, what distance the water level dropped during the test, and how quickly the water level recovered after the test.
- **Well cap.** Ensure that the well is capped and secure and that the cap is at least 152 mm (6 in) above ground level.
- **Disinfection.** Ask the contractor if the well was disinfected.
- **Well construction record.** Make certain that you will receive your copy of the well record. The contractor is required to deliver copies of the record to the owner and to Department of Environment and Labour within a month of drilling, and to keep a record for himself for two years. It would be advisable for you to keep your well record with your house deed so that the information is passed on to future owners.

Components of a Water Supply System

Once a water source is established, and a pump contractor is selected, the water supply system can be installed. The system as referred to in this report consists of the components between the source and you, the end user: well, pump, water storage (pressure) tank, distribution system, and treatment system if necessary. Figure 8 shows a typical complete drilled well system installed with a submersible pump.



Legend

1 submersible pump
2 pump intake
3 check valve and fitting
4 torque arrestor
5 safety cable or rope
6 electric cable
7 electric cable taped or tied to drop pipe every 3 m (10 ft)
8 pitless adaptor
9 vermin-proof vented well cap
10 electrical cable in conduit
11 pump control box and safety switch
12 lightning arrestor
13 power disconnect
14 pressure switch
15 pressure tank
16 sampling tap/drain valve
17 relief valve
18 pressure gauge
19 check valve (optional)
20 tank 'tee'
21 isolation valve
22 discharge line to treatment (if applicable) and house
23 from electrical panel

Figure 8 **Example of a Complete Water System (not to scale)**

The Well

The well must be constructed according to specific regulatory requirements of the Well Construction Regulations established under Section 110 of the Environment Act.

What is a Drilled Well?

A drilled well consists of a hole bored into the aquifer, with the upper part lined with casing, usually steel. The casing prevents the collapse of the borehole walls and, along with a drive shoe or grout seal, helps prevent surface or subsurface contaminants from entering the water supply. The casing also provides a housing for the pumping mechanism and for the pipe, usually plastic, that moves water from the pump to the surface.

A minimum of 152 mm (6 in) casing diameter is required to ensure ease of servicing (e.g., deepening or installing liner casing or packer) and installing proper pumping equipment. The casing must meet certain specifications, since substandard pipe does not have sufficient strength to withstand driving without potential damage to the joints. Such damage may allow contaminated shallow or surface water to enter the well.

The casing must also have a drive shoe attached to the bottom to prevent damage during driving and to make a good seal with the formation. In some applications, a grout seal of cement or bentonite may also be recommended to prevent contamination.

Below the casing, the lower portion of the borehole is the intake through which water enters the well from the aquifer. The intake may be an open hole in solid bedrock, or it may be screened and gravel-packed, depending upon the geologic conditions.

Once the well is completed, it is bailed or pumped to 'develop' the aquifer and determine the yield. Many aquifers need further work after drilling to remove fine material remaining from the drilling process so that water can more readily enter the well. Possible development methods include compressed air ('blowing'), bailing, jetting, surging, or pumping. The quantity of water (yield test) is usually measured during development. The minimum test time required is one hour.

Construct the well according to the Well Construction Regulations.

After proper disinfection, the well is capped to provide sanitary protection until it is hooked into the user's system. The cap requires an air vent. The purpose of the vent is to equalize the air pressure between the inside of the casing and the atmosphere, and to release unpleasant or explosive lighter-than-air gases. If such gases are present and the well is enclosed in a building or confined space, the air vent should always be extended to the outside atmosphere. The vent pipe must be shielded and screened to prevent the entry of foreign material such as insects into the well. Earwigs, for example, can cause a high bacterial count.

If drilling produces poor-quality water, the water can be sealed off. One method is to install additional casing or liner inside the original casing and grout it in place. Figure 9 shows some common defects in well construction and illustrates how grouting or sealing the annular space can be a solution.

If the water quality remains unsatisfactory, or if construction defects cannot be remedied, the well must be abandoned and completely sealed to prevent cross-contamination between aquifers. Abandonment of, or changes to, a well must be recorded on the well contractor's report filed with Department of Environment and Labour.

Regulatory requirements for drilled wells include the following specifications, although variances may be granted under some conditions.

- The casing must be of new material, with a nominal inside diameter of at least 152 mm (6 in), minimum length 6.1 m (20 ft), and must extend at least 152 mm (6 in) above the ground surface upon completion. It must be of standard weight and wall thickness according to ASTM (American Society for Testing of Materials) Standard A589 (type IV, grade B) or A53 (type E, grade B) for carbon steel casing and F480 for thermoplastic well casing. Steel casing in Nova Scotia is normally welded, and has a minimum wall thickness of 4.7 mm (0.185 in).
- The casing must have a drive shoe attached to the bottom. Grouting is not required, but if there is a potential for contamination, the casing should have a cement or bentonite grout seal at least 25 mm (1 in) thick.
- Upon completion of the well, all debris should be removed and the well should be disinfected.
- The well must be sealed or capped until a pump is installed. The minimum requirement is a vermin-proof, vented, pitless well cap. Such a cap is fitted with a rubber gasket for sealing and attaching to the top of the casing. A screened vent at least 12 mm (0.5 in) diameter is present in the cap so only atmospheric air can enter the well. A sealing device in the cap allows water-tight passage of power cables to the well.

If there are any drilled wells on your property which are not being used or maintained for present or future use, the Well Construction Regulations require that they must be properly abandoned, in a manner approved by a Department of Environment and Labour Inspector. Such wells may be an avenue for groundwater contamination and/or a safety hazard. For further information, contact your local Department Office (see list on page 33).

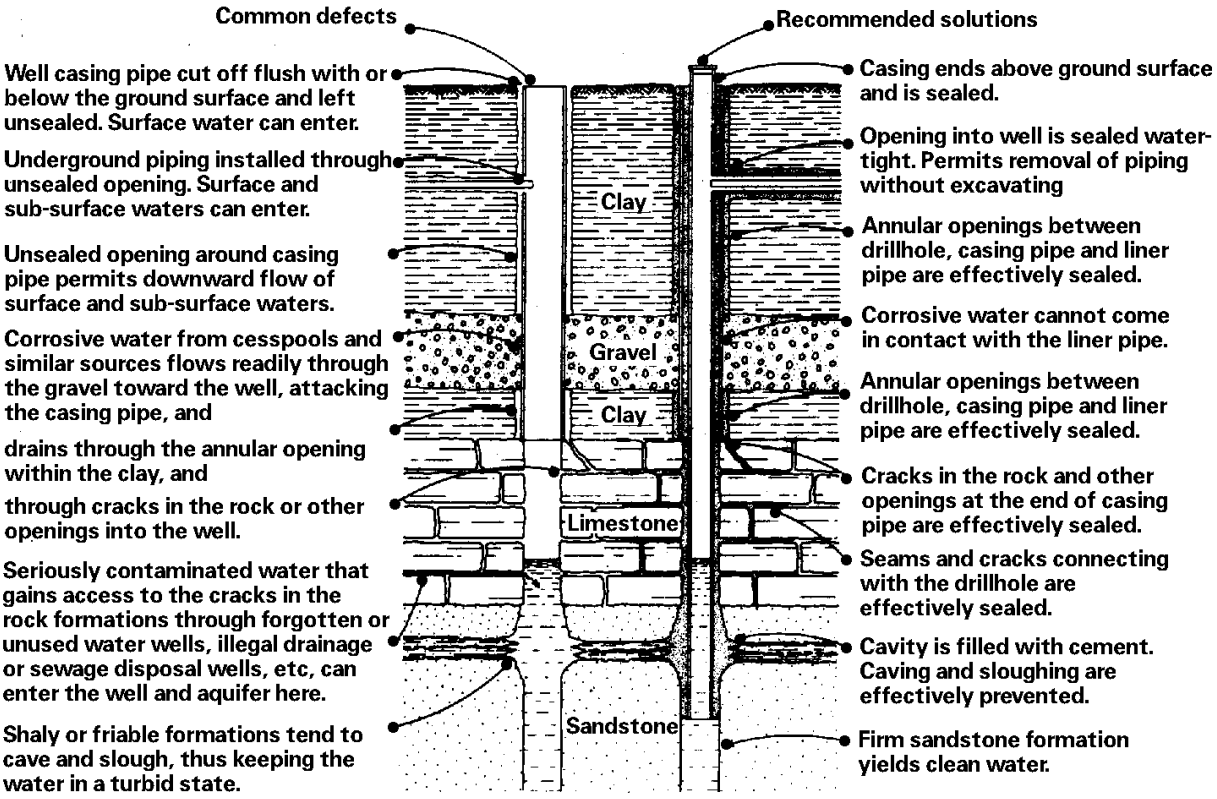


Figure 9 **Common Defects of Well Construction and Remedies** Note that grouting can solve many problems.

What is a Dug Well?

A dug well consists of an excavation (usually with a backhoe or excavator) into the aquifer, and is lined with concrete crocks. The crocks prevent the collapse of the excavated walls and, along with an apron and seal, exclude surface contaminants from entering the water supply.

In a dug well, the hole is either lined with crocks to the bottom, or crocks at the top and rocks at the bottom, and the crocks are backfilled as described below.

Once the well is completed, it is bailed with the backhoe or excavator bucket or pumped to develop the aquifer and determine the yield. After proper disinfection, the well is capped or sealed to provide sanitary protection until it is hooked into the user's system.

Figure 10 illustrates a typical dug well construction. Regulatory requirements for dug wells include the following specifications, although variances may be granted under some conditions.

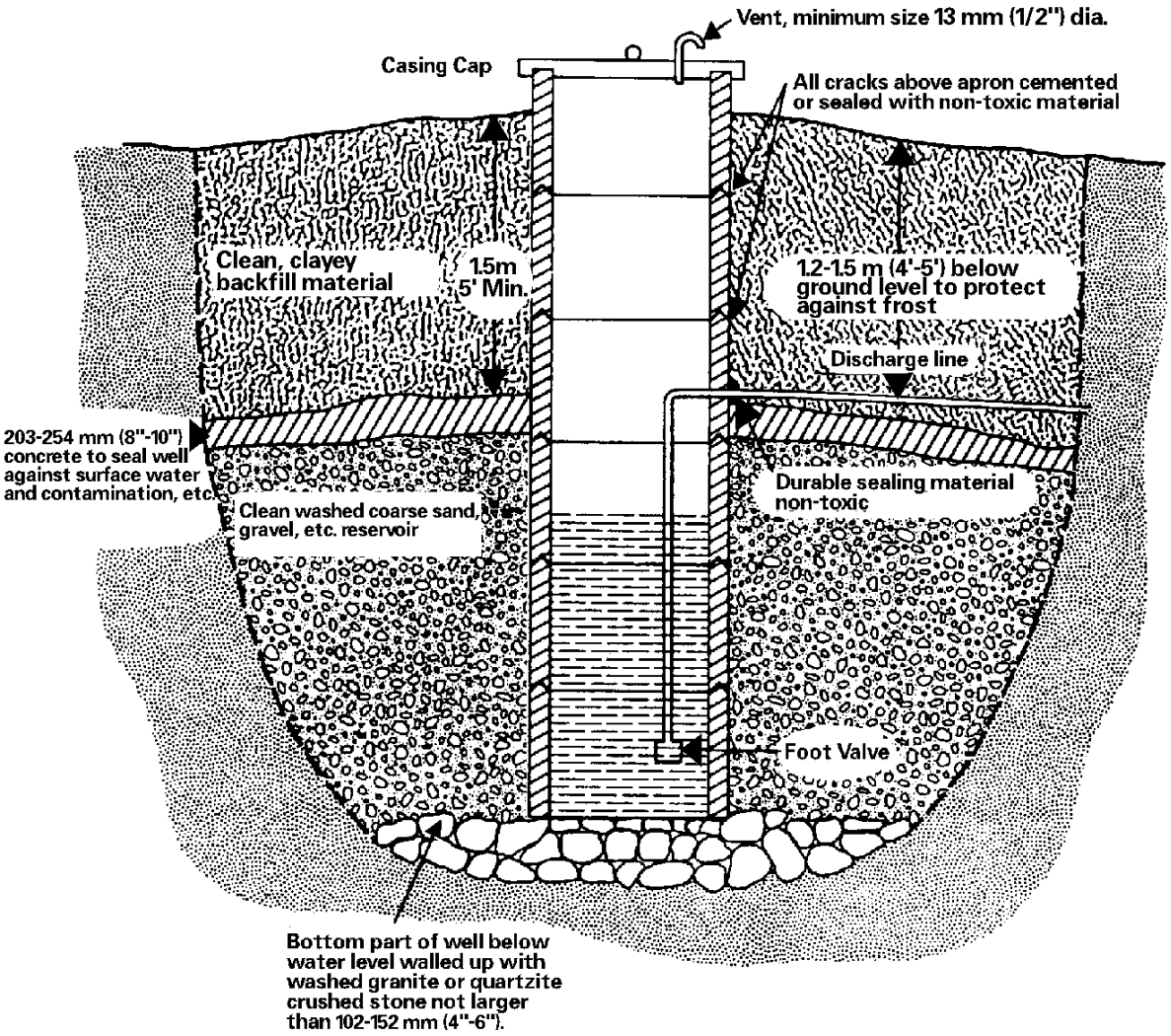


Figure 10 **Cross Section of a Typical Dug Well**

- The well casing consists of groove joint, precast concrete rings. It extends at least 152 mm (6 in) above the land surface, and drainage is away from the well. At least the top 1.8 m (6 ft) of casing consists of concrete rings, or poured reinforced concrete or brick lining.
- A concrete apron at least 152 mm (6 in) thick is constructed around the well below the frost line, extending a minimum distance of 914 mm (3 ft) from the perimeter of the well. Minimum slope of the apron is 21 mm/m (0.25 in/ft). Above this apron, all joints in the casing are made watertight, either with sand and cement mortar mix, or with a certified non-toxic flexible sealing compound.
- The annular space (space between the well casing and the geologic material around it) from the bottom of the well to the apron is filled with clean washed gravel, sand, crushed rock, or small boulders. From above the apron to the land surface is backfilled with cement or bentonite grout or equivalent commercial slurry, clay slurry, or puddled clay to prevent the direct entry of surface water into the well.
- Where a pump connection is made below ground, the connection must be made watertight with durable non-toxic sealing material. The pump connection excavation is filled with cement or bentonite grout or equivalent commercial slurry, clay slurry, puddled clay, or native material (if clayey), extending from the casing at least 305 mm (1 ft) outwards, and extending from the bottom of the excavation to within 610 mm (2 ft) of the land surface to prevent surface water entry.
- After the well is completed, any debris within and around the well should be removed and the well disinfected.

If there are any dug wells on your property which are not being used or maintained for present or future use, they must be properly abandoned, as noted under drilled wells (page 13).

How Long Should Well Yield Tests Be?

Following construction of a well, the driller or digger estimates the yield of the well. For water use for other than a single residence, longer tests are necessary to determine if the estimated yield is sustainable when pumping for long periods of time. Specific requirements include the following.

- Where a well is intended to supply water for domestic purposes to a single residence with use less than 23,000 litres (5000 gallons) per day, the well contractor performs either a bail or air lift test of not less than one hour's duration or a pump test of not less than six hours' duration. Water level recovery is observed and recorded as part of the test.
- Where a well is intended to supply water for domestic purposes to a single residence with use greater than 23,000 litres (5000 gallons) per day, a pump test of not less than 24 hours' duration must be carried out by a certified individual at the well owner's expense.
- Where a well is intended to supply water for any other purposes, a pump test of 72 hours' duration must be carried out by a certified individual at the well owner's expense. For a public water supply, additional wells for observation purposes may also be required.
- Water level measurements must be made by a certified individual before, during, and after any pump test. Sufficient measurements of water level recovery must be made after pumping stops to establish the recovery curve.

The results of the tests, including analyses and interpretations, must be reported to the Department of Environment and Labour within 30 days of completion of the test. The well contractor reports the results of the preliminary yield test required for all new wells. The well owner reports the information in the case of wells where any additional testing is required.

The Pump

How do I Select a Pump?

Once the well has been completed and developed to produce clear water, a pump is necessary to move the water from the well to the point of use. Pumps that lift water by suction from depths of 7.6 m (25 ft) or less are called shallow well pumps. Pumps that lift water from greater depths are called deep well pumps. The most common types of deep well pumps are submersible pumps, although deep well jet pumps are still used.

The pump should have adequate capacity for present and future uses. Generally, pump capacity is equal to or slightly less than the safe yield of the well so it will make use of the well's potential but not overpump it. A pump with a capacity greater than the safe yield will draw the water level down in the well too far, causing the system to pump air or lose its prime. Continued lowering of the water level by pumping may cause other difficulties in the well itself (decrease in yield, cloudy water, sand in water). The pump should also provide adequate pressure for the present and future use, considering the possibility of a lower water level in the well.

Generally, you will rely on a competent, certified pump installer to select and install the pump (see checklist below). Here are some considerations for pump selection.

- Costs involved, including the pump itself, labour to install it, materials (fittings, piping, accessories, pitless adaptor, etc), operation (power plus replacement parts).
- Power supply available, i.e., 125 versus 250 volt service.
- Is sufficient space available to install the pump?
- Ease and cost of servicing the pump. Can it be repaired in the field or in the dealer's repair shop, or does it have to go back to the factory?
- Will the pump dealer agree to install and service the pump?

How do I Select a Pump Installer?

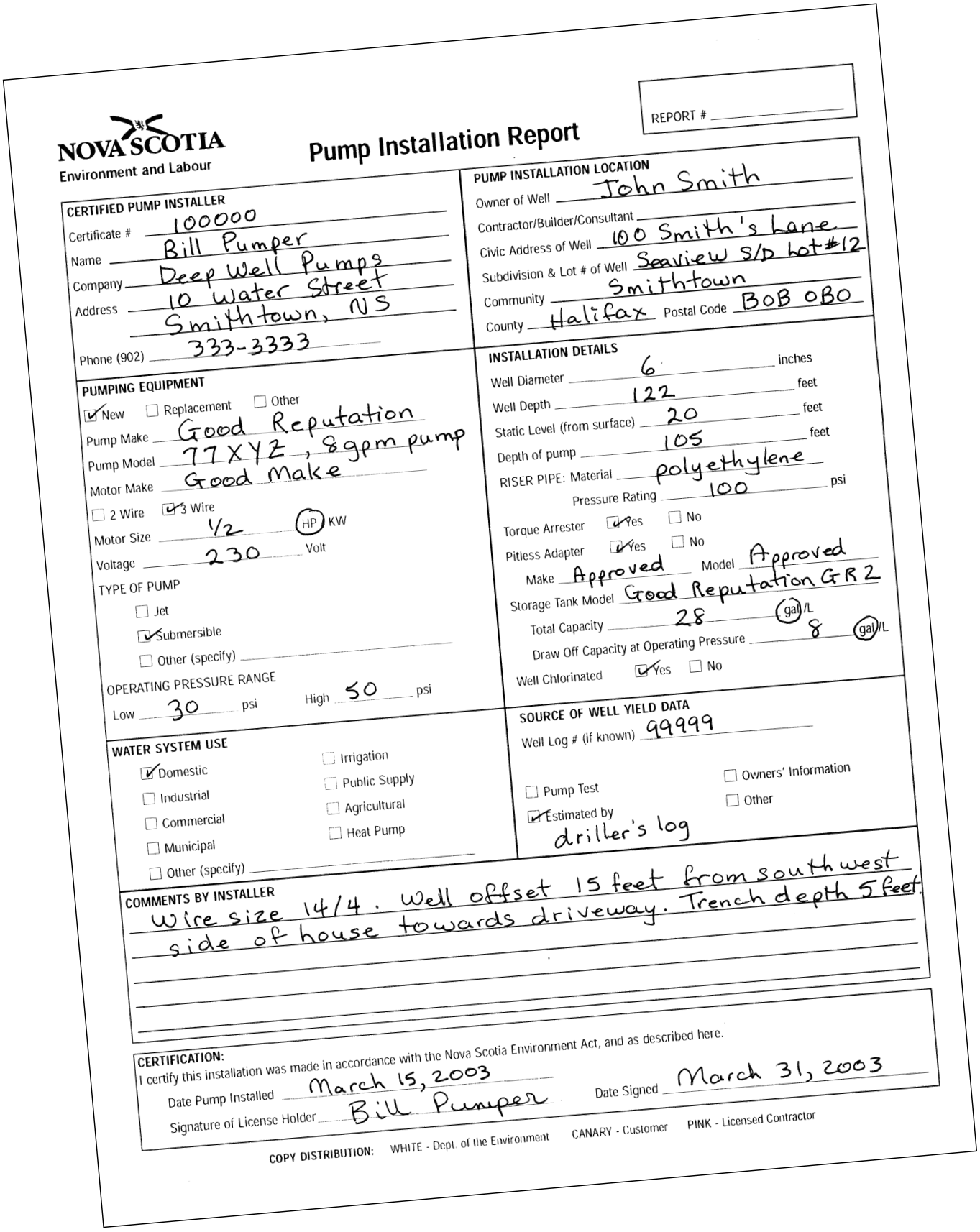
Under the Well Construction Regulations, all persons installing, repairing, or modifying pumping equipment in a well must have a certificate of qualification from the Department of Environment and Labour. The certificate is renewable annually.

There are about 600 certified pump installers in Nova Scotia. The guidelines for hiring a pump installer are similar to those for hiring a well contractor. They are detailed on page 9, but, briefly, you should check for the following:

- ✓ a valid certificate of qualification
- ✓ adequate equipment to do the job
- ✓ adequate liability and worker's compensation insurance
- ✓ history of submitting logs to the Department of Environment and Labour
- ✓ familiarity with relevant health and safety codes
- ✓ references from previous jobs

The installer must assess the well and determine depth and static water level. He must submit a record for each pump installed or repaired (Figure 11).

All persons installing, repairing, or modifying pumping equipment in a well must have a certificate of qualification.



NOVA SCOTIA
Environment and Labour

Pump Installation Report

REPORT # _____

CERTIFIED PUMP INSTALLER
Certificate # 100000
Name Bill Pumper
Company Deep Well Pumps
Address 10 Water Street
Smithtown, NS
Phone (902) 333-3333

PUMP INSTALLATION LOCATION
Owner of Well John Smith
Contractor/Builder/Consultant
Civic Address of Well 100 Smith's Lane
Subdivision & Lot # of Well Seaview S/D Lot #12
Community Smithtown
County Halifax Postal Code B0B 0B0

PUMPING EQUIPMENT
☑ New ☐ Replacement ☐ Other
Pump Make Good Reputation
Pump Model 77XYZ, 8gpm pump
Motor Make Good Make
☐ 2 Wire ☑ 3 Wire
Motor Size 1/2 (HP) KW
Voltage 230 Volt
TYPE OF PUMP
☐ Jet
☑ Submersible
☐ Other (specify)
OPERATING PRESSURE RANGE
Low 30 psi High 50 psi

INSTALLATION DETAILS
Well Diameter 6 inches
Well Depth 122 feet
Static Level (from surface) 20 feet
Depth of pump 105 feet
RISER PIPE: Material polyethylene
Pressure Rating 100 psi
Torque Arrester ☑ Yes ☐ No
Pitless Adapter ☑ Yes ☐ No
Make Approved Model Approved
Storage Tank Model Good Reputation GR2
Total Capacity 28 (gal)/L
Draw Off Capacity at Operating Pressure 8 gal/L
Well Chlorinated ☑ Yes ☐ No

WATER SYSTEM USE
☑ Domestic ☐ Irrigation
☐ Industrial ☐ Public Supply
☐ Commercial ☐ Agricultural
☐ Municipal ☐ Heat Pump
☐ Other (specify)

SOURCE OF WELL YIELD DATA
Well Log # (if known) 99999
☐ Pump Test ☐ Owners' Information
☑ Estimated by driller's log ☐ Other

COMMENTS BY INSTALLER
Wire size 14/4. Well offset 15 feet from south west side of house towards driveway. Trench depth 5 feet.

CERTIFICATION:
I certify this installation was made in accordance with the Nova Scotia Environment Act, and as described here.
Date Pump Installed March 15, 2003
Signature of License Holder Bill Pumper
Date Signed March 31, 2003

COPY DISTRIBUTION: WHITE - Dept. of the Environment CANARY - Customer PINK - Licensed Contractor

Figure 11 **Pump Installation Report**

The Well Construction Regulations provide specifications for pump installations. They are listed here.

- An air vent must be present, with nominal inside diameter at least 12 mm (0.5 in), that extends at least 152 mm (6 in) above ground surface into the open air. The open end must be shielded and screened to prevent entry into the vent of any solid or liquid substance into the well. A regulation cap will provide such a vent. The purpose of the vent was discussed earlier.
- Maintain a clearance of at least 12 mm (0.5 in) between the pumping equipment and the sidewall of the well.
- A new well and pumping or water distribution equipment must be properly connected with a pitless adaptor. The installation should take into account possible corrosion of different metal components.
- Any hand pump mounted on well casing or pump mounting sleeve must be sealed to prevent the entry of any solid or liquid substance into the well.
- A sampling port or tap must be available between the well and any water treatment device for drawing raw water.
- The installation must meet the building code of the municipality where the pump is to be installed. The minimum requirement is compliance with the National Plumbing Code of Canada.
- After completion of the work, debris must be removed from within and around the well and the well disinfected.

New household systems must use a pitless adaptor. Pitless adaptors are devices designed for attachment to the well casing below the frostline and provide a watertight seal where the water line passes through the wall casing (Figure 8). They have three main functions:

- to prevent entrance of contamination into a well
- to conduct the water from the well to the home
- to provide access to the pumping equipment within the well and within extensions of the well casing above the ground surface.

Use of a pitless adaptor allows the well to be completed above ground surface. The well is then easily accessible for maintenance or repairs, if necessary, without excavating or disrupting the earth. The adaptor is easily disconnected, and the well pump and pump column can be removed from the well. In Nova Scotia, such adaptors must meet the standards of NSF (National Sanitation Foundation).

The Water Storage (Pressure) Tank

In a domestic system for a single home where the water supply meets the owner's needs, a pressure tank is usually the only point of artificial storage for cold water. Newer tanks are commonly of the bladder or diaphragm type. The pressure tank serves the following functions:

- The tank allows you to draw some water from the system when the pump is not running. Pressure drops as water is used in the home. When the pressure drops to a pre-set limit, the pump starts and refills the pressure tank.
- The tank keeps the pump from running every time water is used. The larger the tank, the more water can be drawn without cycling (turning on and off the pump). The more the pump cycles, the faster it wears out.
- The storage tank provides water under pressure to the distribution system. The most pressure it can deliver is equal to the maximum pressure of the pump.

When the yield of the well is limited, it may not be possible to meet peak demands and some type of additional storage must then be provided. The well itself can provide some storage: 5.5 litres (1.2 gallons) per foot of water in a 152 mm (6 inch) well. Appendix 2 gives storage volumes available in wells of various diameters.

For larger water users (schools, hospitals, campgrounds, municipalities, etc.), other storage options may include an intermediate storage tank with a second pressure pump, or an above-ground storage tank with gravity feed.

The Distribution System

This system consists of the pipe, valves, and fittings that conduct the water from the well to the various points of use. The choice of pipe will depend on underground soil corrosion, corrosion inside the pipe, safe working pressure, effect of freezing, local plumbing codes, ease of installation, and cost. Plastic pipe is the most common material used in household systems for submersible pumps and distribution lines, and is available in various sizes and strengths. Potable (drinking) water pipe must meet the standards designated by AWWA (American Water Works Association) or NSF (National Sanitation Foundation).

Fittings are usually available in the same sizes and materials as piping, but valves are generally cast in brass or other alloys. Where dissimilar metals are present, corrosion may occur. Dissimilar metals should not be in contact with one another. The use of nonconductive plastic inserts between metal pipe and fittings and/or the installation of sacrificial anodes helps to minimize corrosion. The National Plumbing Code of Canada now does not allow use of galvanized steel fittings and pipe in water distribution systems except under special circumstances.

The Treatment System

Once a water supply system has been hooked up and is in normal use, a sample for water quality should be taken for both bacterial and chemical analysis. If the water does not meet established guidelines or the owner's aesthetic needs, a treatment system or device can be installed. A port or tap for sampling raw untreated water should always be installed between the well and any treatment device on any water system.

Water Quality

Why Should I Test?

Water for drinking, cooking, and other domestic uses should be of good quality, that is, free from organisms that may cause disease and from chemical substances and radioactive matter that may pose a health risk. The water should be aesthetically appealing, which means that it should be free from objectionable colour, odour, and taste. Other considerations such as corrosiveness, encrustation or excessive soap consumption due to hardness are also important in terms of public acceptance.

You, the homeowner, should have your water tested to determine its quality. Harmful bacteria or chemicals can be present in drinking water that tastes, looks, and smells acceptable. Some of the potential threats to groundwater quality in Nova Scotia include petroleum products, sea water intrusion, deicing salt, sewage disposal systems, animal wastes, landfills, and pesticides.

A complete bacterial and chemical water quality analysis allows the following:

- ✓ an assessment of any possible contaminants, such as bacteria and ammonia from sewage, chlorides from sea water intrusion, and arsenic and uranium from natural minerals
- ✓ an assessment of potential aesthetic problems, such as hardness or staining
- ✓ a comparison of all parameters tested to the Guidelines for Canadian Drinking Water Quality
- ✓ validation of the accuracy of the analysis

What is Bacterial Quality?

Bacterial quality is usually assessed by a coliform test. Coliform are a group of bacteria found in soil and in large numbers in the intestines of warm-blooded animals, including humans. Experience has established the significance of coliform group density as a measure of the degree of pollution and of sanitary quality.

Before you use your well water, you should collect a sample for bacterial analysis. Make sure the results are acceptable before drinking it. If necessary, use bottled water until you receive the results. After two to four weeks of regular household use, recheck the bacterial quality. Remember, disinfecting an improperly located or constructed well will not ensure its safety!

> The only way you can be sure your water supply is safe is to have it tested.

How Do I Test for Bacteria?

✓ **Container**

- Use a sterilized sample bottle with added sodium thiosulfate preservative (a chlorine neutralizer). Bottles are available from your local Department of Environment and Labour office, water quality laboratories, and from some hospitals. A list of *approved* laboratories is available on the web at: http://www.gov.ns.ca/enla/water/labs.htm
- Keep sample containers clean and free from contamination before and after collecting the sample. Do **NOT** open them prior to collecting the sample.
- Examine the sample bottle for cracks, a missing seal, or other signs that its sterility may be compromised. If any of these indications are found, discard the bottle and use a suitable one.
- Label the bottle with your name, location of your water source, date, and time.

✓ **Flush the System**

- Do NOT take samples from a flexible hose or garden hose or outside hose bib. Sample from the cold water faucets only.
- For locations at which the sample must be

collected from a tap, inspect the outside of the faucet. If water leaks around the outside of the faucet, select a different sampling site.
- Remove any aerators, strainers, hose attachments, mixing type faucets, purification devices, or any other attachments, from the tap.
- If necessary, remove debris and sterilize the faucet outlet, for example by swabbing with a disinfecting wipe.
- If the sample is to be taken from a tap or a pump, allow the water to run at least 5 minutes before collection. This will help to remove stagnant water from the distribution system.

✓ **Collect the Sample**
- If you have a chlorine disinfection treatment unit, measure and record chlorine residual. Normally free chlorine residual is measured, however total chlorine residuals may be required on occasion. In either case, mark "F" or "T" on the lab requisition form, indicating free or total chlorine residual. The majority of wells for private homes do not have chlorine treatment units.
- Before taking the sample, reduce the tap flow rate to approximately the width of a pencil. The flow rate should be low enough to ensure that no splashing occurs as the container is filled. Do not adjust the flow rate while taking the sample. At sampling points where the water runs continuously, do not adjust the flow rate. Collect the sample directly into the sterile bottle; do not use a dipper or pail.
- While holding the sample container at the base, remove the seal around the cap before attempting to open the bottle.
- Remove the cap with the free hand. Be careful **NOT TO TOUCH** the edge or bottom or inside of the cap, or the neck or top or lip of the bottle. Continue to hold the cap in one hand with the inside facing down while the bottle is being filled. Do **NOT** touch the interior of the cap or lay it down. **DO NOT** breathe on the bottle or cap.
- Do **NOT** rinse the bottle.
- Fill the bottle to the fill line (usually about 3/4 full). Do **NOT** allow the bottle to overflow. Space is needed for the lab to add and mix test chemicals. Carefully replace the cap.
- If the sample is to be taken from a well or spring without a pump, tie a wire or string around the neck of the bottle and lower it beneath the surface if you cannot reach the water level. It is very difficult to obtain a sample this way without contaminating it during collection. If you can reach the water, use a sterile glove on the hand holding the bottle and collect the sample with the bottle neck facing away from you into the flow. Inexperienced samplers are likely to contaminate the sample during collection.
- Complete all required parts of the laboratory requisition form.

✓ **Storage and Transport**
- Refrigerate the sample immediately or place it in a cooler with ice packs to maintain a water temperature of about 4°C until delivered to the lab. Samples should not be frozen.
- Transport the sample to an approved water quality laboratory as soon as possible, and definitely within 24 hours of collection. Check ahead with the lab about days/time deadlines for sample acceptance to ensure meeting the 24-hour criterion.

What Do The Results Mean?

For potable waters submitted by private individuals, the lab reports presence or absence of total coliform bacteria and E. coli. Total coliform occur naturally in soil and in the intestines of humans and animals. E. coli are found only in the intestines of humans and animals.

The maximum acceptable concentration (MAC) for the bacteriological quality of private drinking water systems for human consumption is NO (zero) coliforms and NO (zero) E. coli detectable per 100 mL.
- NO sample should contain E. coli. The presence of E. coli indicates that the source or the system has been impacted by recent faecal contamination and therefore the water is unsafe to drink. *If E. coli is detected, the water should be retested immediately to confirm the result. While waiting for the results, you should boil the drinking water or use an alternative safe source.*
- NO sample should contain other coliform bacteria. The presence of other coliform bacteria in non-disinfected well water in the absence of E. coli means either that:
  - the well is prone to surface water infiltration and therefore at risk of faecal contamination, or
  - a biofilm has developed within the well or plumbing system.

In water systems that include disinfection, the presence of total coliform bacteria indicates a failure in the disinfection process or the presence of a biofilm.
If a sample contains other coliform bacteria, the drinking water should be retested immediately for total coliform and E. coli.

The resampling described above is to confirm the results (in case the sample was contaminated during collection). While waiting for the results of the second sample, either boil the water (rolling boil for at least 1 minute) or use another alternative such as bottled water, for any activity involving human consumption. Examples of such activities include drinking, cooking, washing foods such as fruits and vegetables, dental hygiene such as brushing/rinsing teeth, and preparation of infant formulas, juices and ice cubes.

There are two possible results of the second test:

1. The second test result does not contain coliform bacteria and E. coli (both are absent)
If the second test result indicates that coliform bacteria and E. coli are absent, collect a third sample for verification during the next 2 to 4 weeks.

- If the third sample result is 'absent' for both, the water should be safe to drink. However, the water should be resampled again after about 3 to 4 months to ensure that the contamination has not recurred. Continue to monitor regularly, about twice a year.
- If the third sample contains E. coli or other coliform bacteria (either are 'present'), follow the directions in number 2 below.

2. The second test result contains coliform bacteria and/or E. coli (one or both are present)
If the second test result still has coliform bacteria and/or E. coli present, boil the drinking water or use an alternative safe source and take the following corrective actions:

- Conduct a sanitary survey to verify the safe condition of the well, wellhead, pump, plumbing, and surrounding area. Correct any identified faults before proceeding to the next step. You may want to obtain the services of a certified professional.

If all the physical conditions are acceptable, then:

- Shock chlorinate the well and plumbing system (see Appendix 1 for procedure).
- After disinfection, flush the system thoroughly and take another sample (third sample) to confirm that the water is safe to drink. This sample can be taken after 48 hours IF testing indicates absence of a chlorine residual. In the absence of chlorine testing, wait about 5 days after disinfection before sampling for bacteria. In the meantime, continue to either boil the water (rolling boil for at least 1 minute), or use an alternative safe source such as bottled or municipal water, for any water for drinking or other human consumption.

If the third test result does not contain coliform bacteria and/or E. coli (both are absent), an additional (fourth) test should be taken after about 3 to 4 months to confirm that disinfection has been effective and contamination has not recurred. If the test has 'absent' results, continue to monitor bacterial quality at least twice a year.

If the third test result still has either coliform bacteria and/or E. coli present, an investigation should be carried out by a certified professional to determine the cause. Depending on the cause, some options may be well reconstruction, well replacement, or water treatment. In the meantime, continue to use boiled water or an alternative source for human consumption activities.

Note that a single sample with no bacteria does not necessarily mean a safe water supply. To check the safety of your water over the long term, continue to monitor bacterial quality at least twice a year, or more often if you suspect any changes in your water quality. Sampling should be carried out when the risk of contamination is greatest, such as during spring thaw, during extended periods of heavy rain or drought, or after lengthy periods of non-use.

What is Chemical Quality?

Chemical quality refers to all the dissolved mineral matter in the water. It reflects the type of material in the ground and how long the water has been in contact with the material.

The following parameters are recommended for a complete chemical analysis:

- **Basic Chemical Parameters:** sodium, potassium, calcium, magnesium, hardness, alkalinity, sulfate, chloride, silica, ortho-phosphate, nitrate plus nitrite-nitrogen, ammonia-nitrogen, iron, manganese, copper, zinc, color, turbidity, specific conductance, pH, dissolved organic carbon.
- **Additional Recommended Parameters:** arsenic, uranium, lead, fluoride.
- **Specialized Parameters:** many additional tests are available. Such tests may require special containers and sampling procedures. If you have a specific concern, you should discuss it first with Department of Environment and Labour, the laboratory, or a trained professional.

Most mortgage and lending institutions will require analysis for arsenic, uranium and bacteria.

Most laboratories offer various package prices that include most of the basic parameters and/or metals; the packages may be cheaper than individual tests and will usually provide more information.

How Do I Test for Chemical Quality?

✓ **Container**

- For most basic parameters, use a clean polyethylene bottle available from your local hospital or water quality laboratory or Department of Environment and Labour office. For additional or specialized parameters, discuss the requirements with the laboratory or a trained professional before sampling.
- Label the bottle with your name, address, location of your water source, date, and time.
- Make sure all information on the requisition is filled out completely.

✓ **Flush the System**

- If the sample is to be taken from a tap or pump, run the cold water tap 10 minutes, if possible. This will help to flush stagnant water that may have artificially elevated metal concentrations from the distribution system.

✓ **Collect the Sample**

- Rinse bottle and cap 2 to 3 times unless specialized sampling uses containers with preservatives and/or requires non-rinse procedures.
- Turn flow volume down so that water runs gently. The flow rate should be low enough to ensure that splashing is minimized as the container is filled.
- Sample for sensitive parameters (organics, metals) first. Filtration and preservation may be necessary for metals, depending on the purpose of sampling.
- Fill bottle to top (overflow), unless specialized sampling uses containers with preservatives added. Cap tightly with no air gap.
- Measure temperature of the flowing water if you have a thermometer available.

✓ **Storage and Transport**

- Refrigerate the sample immediately or place it in a cooler with ice packs to maintain a water temperature of about 4°C until delivered to the lab. Samples should not be frozen. Samples should be kept in the dark.
- Transport the sample to an approved water quality laboratory as soon as possible, preferably within 24 hours of collection. If samples cannot be delivered within that time, check with the lab for sample holding times.

What Do The Results Mean?

The chemical quality of the water should be compared to the latest Guidelines for Canadian Drinking Water Quality. Guidelines for selected common parameters are shown in Table 1. If any parameter poses a health problem, or is present at levels exceeding those expected for normal uncontaminated groundwater, then an investigation is necessary to determine the source of the problem. Your local Department of Environment and Labour office can help with this.

TABLE 1 Guidelines for Selected Chemical Parameters

Parameter (1)	Maximum Acceptable Concentration, mg/L (2)	Interim Maximum Acceptable Concentration, mg/L (3)	Aesthetic Objective, mg/L (4)
Arsenic (12)		0.025 (under review)	
Chloride			≤250
Colour			≤15 TCU
Copper (5)			≤1.0
Fluoride (6)	1.5		
Hardness (as CaCO3)			(7)
Iron			≤0.3
Lead (5)	0.010		
Manganese			≤0.05
Nitrate-nitrogen (8)	10.0		
pH (no unit)			6.5-8.5
Sodium (9)			≤200
Sulphate (10)			≤500
Sulphide (as H2S)			≤0.05
Temperature			≤15°C
Total dissolved solids			≤500
Turbidity (11)	1 NTU (under review)		≤5 NTU
Uranium		0.02	
Zinc (5)			≤5.0

Notes:

The numbers in brackets in Table 1 refer to explanatory notes on page 25.

The information in Table 1 is taken from the Summary Table of Guidelines for Canadian Drinking Water Quality (April 2003) on the Health Canada website http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index_e.html. These guidelines are updated frequently. Please check the Health Canada website for the most current information.

(1) Concentrations in mg/L unless otherwise noted. TCU = true colour unit. NTU = nephelometric turbidity unit.

(2) Maximum acceptable concentrations (MACs) have been established for certain substances that are known or suspected to cause adverse effects on health. They have been derived to safeguard health on the basis of lifelong consumption. The use of drinking water for all domestic purposes, including personal hygiene, has been considered in the derivation of guidelines. However, water of higher quality may be required for special purposes, including renal dialysis.

Drinking water that continually contains substances at levels greater than the MAC will contribute significantly to consumers' exposure to the substance and may, in some cases, induce deleterious effects on health. Short term exposure above the MAC does not necessarily mean that the water constitutes an undue risk to health. The amount, time, as well as the toxicity of the substance must be considered.

(3) Interim maximum acceptable concentrations (IMACs) are recommended for substances with insufficient toxicological data to derive an MAC with reasonable certainty. They consider available health-related data but employ a larger safety factor to account for uncertainties. The IMACs are reviewed periodically as new information becomes available.

(4) Aesthetic objectives (AOs) apply to certain substances or characteristics of drinking water which can affect its acceptance by consumers or interfere with practices for supplying good quality water. Where only AOs are specified, the values are below those considered to constitute a health hazard.

(5) At the point of consumption. Because first-drawn water may contain higher concentrations of metals than are found in running water after flushing, faucets should be thoroughly flushed before water is taken for consumption or analysis.

(6) It is recommended that the concentration of fluoride be adjusted to 0.8 - 1.0 mg/L, which is the optimal range for the control of dental caries.

(7) Public acceptance of hardness varies considerably, thus no MAC has been established. Generally, hardness levels between 80 and 100 mg/L (as calcium carbonate) are considered acceptable. Levels greater than 200 mg/L are considered poor but can be tolerated. Levels in excess of 500 mg/L are usually considered unacceptable for most domestic purposes. Where water is softened by sodium ion exchange, it is recommended that a separate, unsoftened supply be retained for culinary and drinking purposes.

(8) Equivalent to 45 mg/L as nitrate. Where nitrate-nitrogen and nitrite-nitrogen are determined separately, the level of nitrite-nitrogen should not exceed 1.0 mg/L (3.2 mg/L as nitrite).

(9) It is recommended that sodium be included in routine monitoring programs, as levels may be of interest to authorities who wish to prescribe sodium-restricted diets for their patients.

(10) There may be a laxative effect in some people when sulphate levels exceed 500 mg/L.

(11) An average MAC is 1 NTU for water entering a distribution system so disinfection is not compromised. A less stringent value may be permitted if it is demonstrated that the system has a history of acceptable microbiological quality and that a higher turbidity value will not compromise disinfection. Please note that the MAC for turbidity is under review. It will likely be lowered in the near future for surface water and groundwater under the direct influence of surface water. An AO of 5 NTU is set for water at the point of consumption.

(12) The guideline for arsenic is under review. It will likely be lowered in the near future.

Water Treatment

The most common parameters exceeding the aesthetic guidelines in Nova Scotia are hardness, iron, and manganese. If the water is unacceptable to the consumer, a treatment device can be installed. The most common health-related problems are arsenic, nitrate and uranium, depending on the location. Treatment is available for most of these problems. For example, most households with an arsenic problem treat one tap for drinking and cooking purposes. Common problems, causes and solutions are summarized in Table 2.

Appropriate treatment begins with a good chemical analysis and good background data. A smart homeowner will take the results to a reputable treatment dealer.

TABLE 2 Common Water Quality Problems and Possible Solutions

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTIONS
Health problems	Coliform bacteria	Investigate source first Chlorination, Ultraviolet light Ozonation
Hard scaly deposits in kettles and piping, bathtub ring, soap scum, high soap consumption	Hardness	Water softener
Red or orange stains on laundry or fixtures, metallic taste, rust particles after water sits	Iron	Water softener, Greensand filter, Chlorination/filtration (depending on concentration)
Black stains on laundry or fixtures, metallic/bitter taste in coffee and tea	Manganese	Water softener, Greensand filter Chlorination/filtration (depending on concentration)
Red to brown slime in toilet tank, iron staining, unpleasant taste or odour	Iron bacteria	Shock chlorination of water source and entire system Chlorination/filtration
Acid water, causing corrosion of piping (green stains due to copper corrosion)	Low alkalinity, presence of carbonic acid usually, sometimes mineral acids such as sulfuric acid	Soda ash Neutralizing tank
Rotten egg odor and flavor, silverware may turn black, worse in hot water	Hydrogen sulfide and/or sulfate-reducing bacteria	Greensand filter Chlorination/filtration Aeration, Activated carbon
Cloudy, dirty or muddy appearance	Turbidity	Fine filters (sand diatomaceous earth), Coagulation (alum) & filtration
High blood pressure	Sodium	Reverse osmosis, Distillation (single tap)
Salty taste, corrosive	Chloride	Reverse osmosis, Distillation (single tap), Anion exchange
Gas bubbles escaping from water	Gases such as methane	Aeration, Activated carbon
Laxative effects	Sulfate	Reverse osmosis, Distillation (single tap), Anion exchange
Health problems	Arsenic	Reverse osmosis, Distillation, Activated alumina, Ferric hydroxide, Anion exchange
Health problems	Uranium	Reverse osmosis, Distillation (single tap)
Oily smell or film on water	Gasoline and/or oil	Investigate and eliminate source first Activated carbon, Gravity separation
'Blue babies' in formula-fed infants under 6 months	Nitrate	Reverse osmosis, Anion exchange Use nitrate-free water for infant formula preparation

Well Maintenance

How Often Should I Check Water Quality?

You should be responsible for ongoing monitoring of your well water quality. The bacterial quality should be checked every six months. The chemical quality should be checked every one to two years, or earlier if you notice any change, such as increased turbidity, staining, or hardness, or a change in taste or odor. The parameters to be analyzed are the same as those listed previously.

How Can I Protect my Water Supply for the Future?

Protecting your water source and water supply system must be your prime consideration. Protection starts with proper location and construction of the well, followed by disinfection. Chemical disinfection or chlorination is essential to ensure that your well, pump, and pipes are free from bacteria that can be introduced during well construction, pump installation, and well or pump repair. Disinfection is the final step after all defects in location and construction have been corrected and before samples are collected for bacterial examination. Any time that the pump or lines are removed for any reason, or repair work is carried out on the well, it must be disinfected.

Frequent testing checks the integrity of your well, lets you know if corrective measures are required, and warns you if another activity is having an impact on your well.

Disinfection will kill only the bacteria present in the well or system. If there is some external source of contamination, the problem will be solved only temporarily by a single application of chlorine solution. Improperly located and constructed water supplies are never safe, and disinfection cannot be relied on for 100 % destruction of harmful bacteria. The most commonly used methods of disinfection involve chlorine either in liquid or tablet formulations. Appendix 1 contains suggested procedures.

The final protective measures are taken when the pump and other components of the distribution system are installed and the system is made operational. The purpose is to protect against surface water entering directly into the top of the well or the annular space.

You should check at least once a year that:

- the cap is securely in place and undamaged
- the vent screen in the cap is intact and not blocked by vegetation growth
- connections in the well casing are properly sealed
- drilled well casing has no holes or cracks and there are no gaps between the casing and the ground around it
- joints and connections in dug well crocks are not leaking, and vents are shielded and screened
- surface drainage near the well is directed away from the well casing or crocks
- surface water does not pond near the well
- the well pump and distribution system is functioning properly, with no leaks

Changes in the quantity and quality of the water should be investigated immediately.

You can also follow some of these simple rules:

- Do not allow liquids or wastes from contaminant sources such as garbage and manure piles to drain towards the well.
- Grow a grass buffer and do not treat the area around the well with pesticides or fertilizer.
- Do not use bark mulch or wood chips near a dug well.
- Do not bury brush piles, stumps or other such debris on your property, especially near to or upgradient of a dug well.
- Do not flush oils, detergents, paints, solvents or other chemicals down the toilet.
- Do not dispose of waste oil, paints, pesticides, etc. on the ground.
- Do not allow animals to urinate or defecate near the well.

If you follow these guidelines, your well should provide good quality water for a long time.

Summary

Here are some Dos and Don'ts to keep in mind.

DO construct a well before you build.

DO hire a certified water well contractor and inquire about his reputation and qualifications.

DO require a written contract, but don't try to be a superintendent over the contractor. He knows his job and his judgement can be trusted.

DO hire a certified pump installer and ensure that a pitless adaptor is used in new installations.

DO check bacterial and chemical quality regularly.

DON'T take an individual's word that an ample supply of water will be available from a well without obtaining existing information from your local Department of Environment and Labour Office and a reputable well contractor.

DON'T compare contractors' abilities and proposals merely on the per metre (per foot) prices they charge. A cheap well may mean poor materials and workmanship and may prove more costly at a later date.

DON'T locate a well too close to sources of contamination. Check regulatory distances with your local Department of Environment and Labour Office.

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Appendix 1

Disinfection of Water Wells by Chlorination

Chlorination, or "shock chlorination", is the process of flushing your well and water system with a chlorine solution to kill bacteria and other microorganisms. Disinfection by chlorination is usually recommended if a water sample from the well has tested positive for bacteria. It is an effective method to eliminate a "one-time" case of bacterial contamination; however, if there is an on-going problem related to faulty well construction or contaminated groundwater, disinfection is only a temporary fix and the problem should be investigated and corrected at the source.

How do I Disinfect my Well?

It may take up to 24 hours to complete the disinfection process. Before you begin, make sure you store enough water to meet your household needs during this period. If you have a water softener or other treatment units, check with your treatment dealer whether disinfection could adversely affect the unit or not.

Step 1. Mix the amount of liquid bleach shown in Table 1-1 for your well in 10 to 20 litres (2 to 5 gallons) of water. Use common, unscented household bleach that does not contain detergent or other additives such as fabric-guard. Chlorine can be dangerous if not used properly. Always follow the directions on the label for safe storage, handling and use.

Step 2. Remove the well cap and pour the mixed chlorine solution into the well. If the well is buried with the old type of well seal top, either expose the top of the well, remove the well seal and pour the solution directly into the well, or pour the solution through a clean funnel into the air vent or siphon through the vent (flush the air line with clean water after chlorination).

Step 3. Open one faucet in the system and let the water run until the chlorine odour is detected. Turn this faucet off. Repeat at each faucet in the system in turn, one at a time, until all faucets have been completed (include inside and outside faucets, cold and hot water, dishwashers, toilets, baths, showers, sinks, etc.).

Step 4. If possible, connect a garden hose to a nearby tap and place the other end in the well. Turn on the tap and allow the water to circulate for about one hour to ensure that the chlorine is thoroughly mixed in the well. During this process, add additional chlorine solution if the chlorine odour is not strong. Note that although recirculation is desirable if possible, it may not be appropriate in wells with screens, gravel packs, heavy iron buildup, soft or caving zones, and other less common conditions. If you have any concerns, contact your local Department of Environment and Labour Office or a certified contractor for information.

Step 5. Seal the top of the well and let the system sit idle for about 12 hours, preferably overnight. Do not leave chlorine for more than 24 hours as it may affect some pump parts.

Step 6. After this time, flush the system by discharging the chlorinated water through an outside tap until the chlorine odour has completely disappeared. Pump at a low rate, in the order of 10 litres per minute (2 gallons per minute) or less. This procedure may take several hours, or longer. IF you have a low yield well, you may have to allow the well to recover between pumping periods. During the flushing process, do not discharge the chlorinated water to a natural water body (such as streams or lakes, etc.) or to areas where it can harm desired vegetation (e.g., vegetable gardens, landscaped areas, etc.). Do not discharge this water into the on-site sewage disposal system.

TABLE 1-1

Depth of water in well		Amount of unscented household bleach[1]	
		Drilled Well	**Dug Well**
metres	feet	Casing diameter 15 cm (6 inches)[2]	Casing diameter 92 cm (36 inches)[2]
1	3	40 mL	1.5 L
3	10	120 mL	4.5 L
5	15	200 mL	7.5 L
10	30	400 mL	15.0 L
30	100	1.2 L	
50	150	2.0 L	
100	300	4.0 L	

Notes:

1 Assumes liquid bleach with approximately 5.2% hypochlorite. This will produce about 100 mg/L of chlorine solution when mixed with the water in the well.

2 For wells with other casing diameters, contact your local Department of Environment and Labour Office

Example Calculation for a Drilled Well:

Measurements:

- Well diameter = 150 mm (6 in)
- Well depth = 60 m (200 ft)
- Depth to water from surface = 10 m (30 ft)

Calculations:

- Depth of water in well = 60 - 10 = 50 m or depth of water in well = 200 - 30 = 170 ft
- From Table 1-1, required volume of bleach to get 100 mg/L solution is about 2 litres

Sampling after Disinfection

After disinfection, sample the water for total coliform and E. coli bacteria to confirm that the water is safe to drink. Wait about 5 days after disinfection before sampling. While waiting for the results, any water for human consumption should be boiled (rolling boil) for at least 1 minute, or use an alternative source.

IF the sample result indicates that both coliform bacteria and E. coli are absent, confirm that disinfection has been effective by 2 additional samples, one in the next 2 to 4 weeks, another after 3 to 4 months. To check the safety of your water over the long term, continue to monitor bacterial quality at least twice a year, or more often if you suspect any changes in your water quality.

IF the sample result indicates either coliform bacteria and/or E. coli are present, it is recommended that the well owner seek advice from Department of Environment and Labour or a certified professional. In the meantime, continue to use boiled water or an alternative source for human consumption activities.

Final Notes

You may experience some temporary inconveniences as a result of the disinfection process such as dirty or discoloured water, staining, or sedimentation problems. However, the water should clear with time. In some cases, a few days may be necessary. Do not use the water for aquariums or pets during this time. Check with your physician about other uses of the water, such as bathing, if you have allergies or other medical concerns.

Please note that under some conditions, such as biofilm buildup in a well, more than one disinfection may be required.

If you have any questions about disinfecting your well, or wish to have a certified person do the work for you, please contact your local Department of the Environment and Labour Office for information, or check the certified contractor list at: www.gov.ns.ca/enla/water

Appendix 2

Volume of Water in Wells

It is often good to know how much water is actually stored in your well. Depending on well depth and pump setting, a low-yield drilled well with a high static water level may have a day's supply of water in storage in the well itself. During dry seasons of the year, many dug well owners check regularly to see how much water is in their well, and increase or decrease their use accordingly. You can calculate your well volume easily by using Tables 2-1 and 2-2.

TABLE 2-1

Well Diameter (Drilled Wells)		Well Volume (amount of Water in Well)	
MM	**Inches**	**Litres/M**	**Gallons/ft**
100	4	8.1	0.54
130	5	12.7	0.85
150	6	18.2	1.22
200	8	32.4	2.17

Example Calculation, Drilled Well:

Measurements:

- Well diameter 150 mm (6 in)
- Well depth 60 m (200 ft)
- Depth to water from surface 15 m (50 ft)
- Pump intake setting 58 m (190 ft) from surface

Calculations:

- Depth of available water in well = 58-15 = 43 m or
- Depth of available water in well = 190-50 = 140 ft
- Volume of water stored in well = 43 (depth of water from line above) x 18.2 (for 150 mm well from Table 2-1) = approx. 780 litres or
- Volume of water stored in well = 140 (depth of water from line above) x 1.22 (for 6 inch well from Table 2-1) = approx. 170 gallons

TABLE 2-2

Well Diameter (Dug Wells)		Well Volume (amount of Water in Well)	
MM	**Inches**	**Litres/M**	**Gallons/ft**
760	30	456	30.6
915	36	657	44.0
1070	42	894	60.0
1220	48	1168	78.3

Example Calculation, Dug Well:

Measurements:

- Well diameter 915 mm (36 in)
- Well depth 6 m (19.7 ft)
- Depth to water from surface 1.0 m (3.3 ft)
- Pump intake setting 5.8 m (19.0 ft) from surface

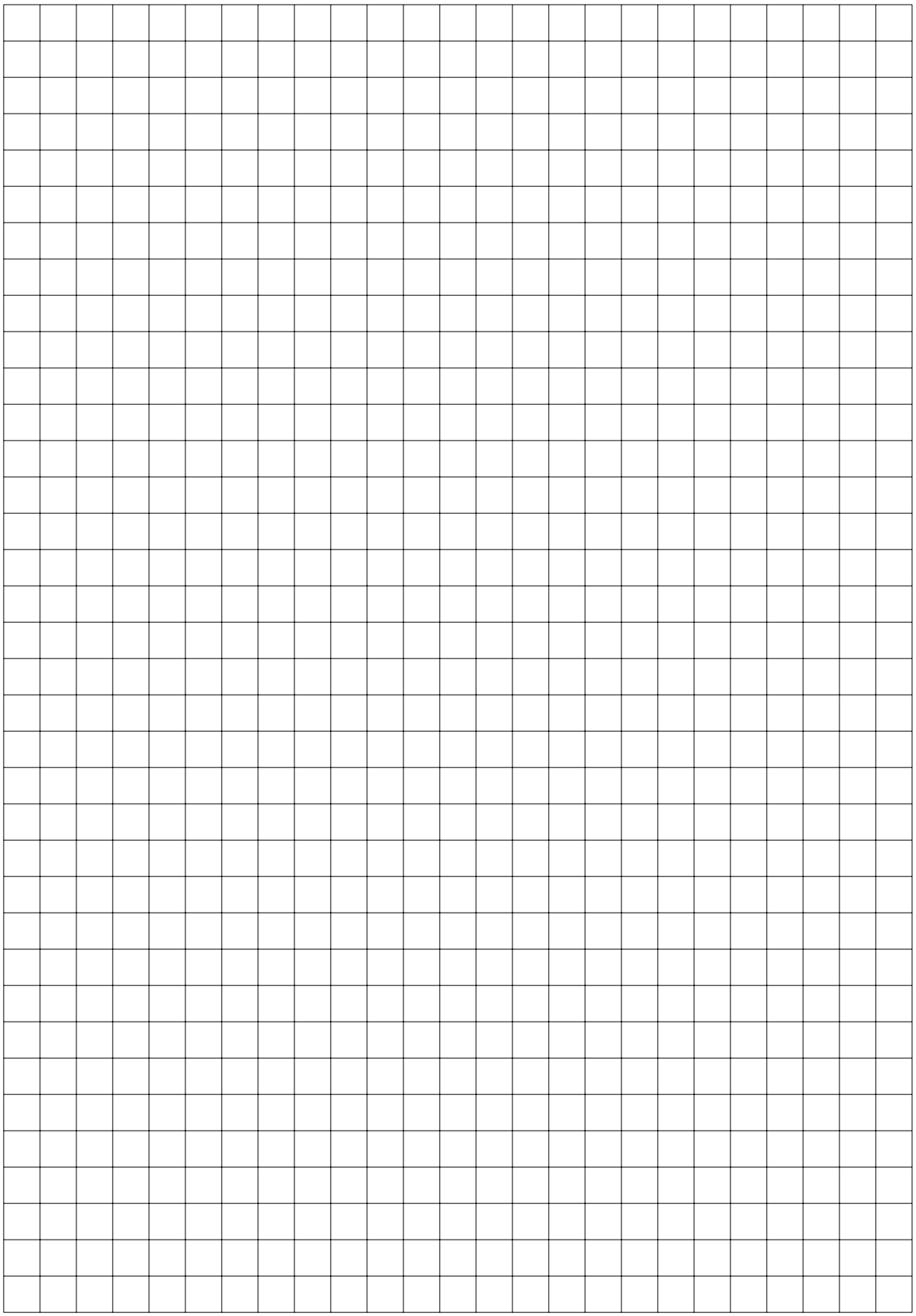
Calculations:

- Depth of available water in well = 5.8-1 = 4.8 m or
- Depth of available water in well = 19-3.3 = 15.7 ft
- Volume of water stored in well = 4.8 (depth of water from line above) x 657 (for 915 mm well from Table 2-2) = approx. 3150 litres or
- Volume of water stored in well = 15.7 (depth of water from line above) x 44 (for 36 inch well from Table 2-2) = approx. 690 gallons

Nova Scotia Environment and Labour Regional Offices

REGION	STREET AND MAILING ADDRESS	TELEPHONE NO.	FAX NO.
Central Region Bedford	1595 Bedford Highway Suite 224, Sunnyside Mall Bedford, NS B4A 3Y4	(902) 424-7773	(902) 424-0597
Sheet Harbour	Fire Hall, 22835 Highway #7 PO Box 35 Sheet Harbour, NS B0J 3B0	(902) 885-2462	(902) 885-2743
Northern Region Truro	44 Inglis Place, 2nd Floor, Suite 3 PO Box 824 Truro, NS B2N 5G6	(902) 893-5880	(902) 893-0282
Pictou	Middle River Pumping Station, Granton Road PO Box 675 New Glasgow, NS B2H 5E7	(902) 396-4194	(902) 396-4765
Amherst	32 Church Street, 2nd Floor Amherst, NS B4H 3A8	(902) 667-6205	(902) 667-6214
Antigonish	Kirk Place, 219 Main Street, Suite 205 Antigonish NS B2G 2C1	(902) 863-7389	(902) 863-7411
Western Region Kentville	136 Exhibition Street Kentville NS B4N 4E5	(902) 679-6088	(902) 679-6186
Middleton	101 Magee Drive PO Box 1000 Middleton, NS B0S 1P0	(902) 825-2123	(902) 825-4471
Bridgewater	60 Logan Road Bridgewater NS B4V 3J8	(902) 543-4685	(902) 527-5480
Yarmouth	13 First Street Yarmouth NS B5A 1S9	(902) 742-8985	(902) 742-7796
Eastern Region Sydney	295 Charlotte Street PO Box 714 Sydney, NS B1P 6H7	(902) 563-2100	(902) 563-2387
Port Hawkesbury	400 Reeves Street Unit 126 Port Hawkesbury, NS B9A 2R5	(902) 625-0791	(902) 625-3722
Head Office Halifax	5151 Terminal Road PO Box 697 Halifax, NS B3J 2T8	(902) 424-5300	(902) 424-0501

Notes or Sketches



Sample Well Drilling Contract

BETWEEN

_____

Name of Drilling Company (hereinafter called the 'Contractor') License Number

_____

Address/Phone/Fax of Drilling Company

AND

_____

Person or Firm Contracting this Order (hereinafter called the 'Customer')

_____

Address/Phone/Fax of Customer

The Customer agrees to retain the services of the Contractor for the purposes of constructing a well or wells at the following location:

_____

The Customer warrants that the premises belong to or are under his/her legal control, and that he/she has full right and authority to enter into this drilling contract.

The Customer shall be responsible for access to the drill site(s). The location(s) of the well(s) shall be agreed upon by the Contractor and the Customer.

The Customer shall permit the Contractor and his/her representatives free and unobstructed access to the site of the water well(s) for the purpose of carrying out this agreement.

The Contractor warrants that he/she has liability insurance of $ _____

The approximate starting date for construction of the well(s) is: _____.
If the Contractor has not started to construct the well(s) after 10 days of the approximate starting date, the Customer has the option to terminate this contract by verbal or written notice, and the Contractor will return the Customer's deposit.

The Contractor shall ensure that the water well(s) is (are) constructed, cased, tested and completed in compliance with the Well Construction Regulations made under Section 110 of the Environment Act of the Province of Nova Scotia.

The well(s) shall be drilled to a sufficient depth to meet expected needs (or minimum requirements if applicable). Should insufficient quantity be obtained by 91 metres (300 feet) depth, the Customer or his/her agent will be notified so that options may be evaluated. Drilling will be discontinued at any time upon direction from the Customer.

The Contractor warrants and guarantees that the work to be performed under this Agreement shall be executed and completed in a proper and workmanlike manner, but does not warrant or guarantee that water will be obtained nor the quantity or quality of any water which may be obtained.

The Customer agrees to pay the Contractor for the work at the following rates:

Drilling	$_____	per metre (per foot) of depth from the surface
Casing	$_____	per metre (per foot) (materials and installation)
One drive shoe	$_____	materials and installation
One well cap	$_____	materials and installation

Extra costs Geological conditions are reasonably well known in most areas, but unexpected conditions may occur. Such conditions may necessitate the use of additional materials or work (such as drilling mud or foam, liner casing, well screens, cement, pumps, tanks, pipes, etc.). These may be employed if deemed necessary by the Contractor and charged to the Customer accordingly. The Contractor will contact the Customer to inform him/her of such conditions and possible extra costs prior to conducting the work.

Additional materials such as the above, if not required by geological conditions but recommended by N.S. Department of Environment and Labour, or requested by the Customer, will be supplied at the Contractor's current retail prices.

Extra labour Any additional pumping or developing required for bacteriological or chemical testing above and beyond regulatory requirements, or use of the Contractor's equipment and personnel for any service not referred to above will be an additional cost.

Taxes All work and materials are subject to applicable taxes in addition to the above, payable by the Customer.

Payments The Customer agrees to pay the Contractor as follows:

(a) $_____ deposit on signing of this contract towards moving and setup costs, which shall be credited towards the total cost.

(b) the balance in a lump sum as described below.

All accounts rendered by the Contractor to the Customer, whether interim, final or otherwise, shall be paid within 30 days of the date set out on the accounts. Accounts not paid within the 30 day period shall accrue interest at the rate of _____% per month calculated from the date set out on the accounts.

The Contractor guarantees workmanship and materials to be free of defect for a period of _____ years from the equipment leaving the well drilling premises. Workmanship and materials on a pump system purchased from and installed by the Contractor are guaranteed to be free of defect for a period of _____ years from the date of installation. These guarantees shall be void if explosives, dry ice, hydro-fracturing, etc. are used by anyone (including the Contractor) in the well(s).

Upon completion of the work, the Contractor shall complete a well construction report(s) as required by N.S. Department of Environment and Labour, and provide copies to the Department, the Customer, and shall keep a copy for a period of at least 2 years from the date of completion of the well(s).

This agreement is subject to other terms and conditions between the Contractor and the Customer as set out immediately below:

_____

_____

_____

_____

_____

I ACCEPT THE ABOVE AGREEMENT, DATED THIS _____ DAY OF _____ 20_____

AT _____ IN _____ COUNTY, PROVINCE OF _____

_____

CUSTOMER CONTRACTOR/AUTHORIZED AGENT