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1 Introduction

1.1 Purpose

- (1) This Directive defines the minimum requirements for;
 - (a) water wells,
 - (b) open-loop ground source heat exchange wells, and
 - (c) vertical closed-loop ground source heat exchange wells completed at depths above the base of groundwater protection.
- (2) This Directive does not apply to horizontal closed-loop or submerged closed-loop ground source heat exchange systems.

1.2 Definitions

- (1) All definitions in the Water (Ministerial) Regulation and in section 1 of the *Water Act* apply except where expressly defined in this Directive.
- (2) In this Directive:
 - (a) “Act”, means the *Water Act*, as amended or replaced from time to time;
 - (b) “annulus”, means the space between the outside of the casing of a water well and the wall of the borehole;
 - (c) “base of groundwater protection”, means the best estimate of the elevation of the base of the formation in which non-saline groundwater occurs at that location;
 - (d) “certified journeyman driller”, means the holder of a valid trade certificate as a water well driller issued under the *Apprenticeship and Industry Training Act* or a valid trade certificate equivalent issued by another province or territory of Canada;

- (e) “closed-loop ground source heat exchange system” means a ground source heat exchange system that consists of a continuous, sealed, underground earth loop through which a heat-transfer fluid is recirculated to and returns from a heat pump;
- (f) “completion, with respect to a water well”, means except in sections 3.2.10(1)(a) and 3.2.11(3) in this Directive, that the drilling, construction, development, disinfection and yield testing of the water well have been completed as required under this Directive;
- (g) “completion, with respect to a vertical closed-loop ground source heat exchange well”, means the drilling and construction of the vertical closed-loop ground source heat exchange well, including placement and grouting of the earth loop, have been completed as required under this Directive;
- (h) “CSA C4480-Series 16”, means ANSI/CSA C448 Series-16, *Design and installation of ground source heat pump systems for commercial and residential buildings, January 2016*, as amended or replaced from time to time;
- (i) “Directive”, means *Water Wells and Ground Source Heat Exchange Systems Directive*, as amended or replaced from time to time;
- (j) “drilling machine, with respect to a vertical closed-loop loop ground source heat exchange well”, means a machine that is designed to be used or is used to drill a vertical closed-loop ground source heat exchange well;
- (k) “drilling report”, means the drilling report referred to in sections 3.10.2 and 4.4.2 in this Directive;
- (l) “earth loop”, means a continuous, sealed, underground or underwater pipe through which a heat-transfer fluid is circulated to and returns from a heat pump and thermal energy transfer takes place;
- (m) “earth loop technician”, means the holder of a valid trade certificate as a journeyman earth loop technician issued under the *Apprenticeship and Industry Training Act* or a valid trade certificate equivalent issued by another province or territory of Canada;
- (n) “ground source heat exchange system”, means a mechanical system for space heating or cooling that consists of a heat pump, a heat exchanger and a heating/cooling distribution system that relies upon a transfer of thermal energy from the earth through the circulation of a heat-transfer fluid in the earth loop of a closed-loop ground source heat exchange system or groundwater in an open-loop ground source heat exchange system;
- (o) “header”, also called a manifold, means the piping that connects a series of earth loops in a ground source heat exchange system;
- (p) “heat-transfer fluid”, means a fluid that may contain an anti-freeze element, agent, additive or inhibitor to lower its freezing temperature, that is used for the purpose of transferring thermal energy to and from the ground in a closed-loop ground source heat exchange system;
- (q) “open-loop ground source heat exchange system” means a ground source heat exchange system that uses ground water or surface water for the purpose of extracting or rejecting heat by use of a heat pump;
- (r) “open-loop ground source heat exchange well”, means a water well, as defined by the Act, that is used or intended to be used for the purpose of heat exchange in an open-loop ground source heat exchange system in which there is a transfer of water between the well and an aquifer;
- (s) “potable water” with respect to drilling operations, mixing of grout materials and heat-transfer fluid in a closed-loop ground source heat exchange system means, water that is obtained from a water works system as defined in s.1(zzz) of the *Environmental Protection and Enhancement Act* that meets the requirements specified in a current approval or registration;

- (t) “reclamation report”, means the reclamation report referred to in section 4.4.3 in this Directive;
- (u) “qualified driller”, means a person who
 - (i) is not a certified journeyman driller,
 - (ii) is the owner and operator of a drilling machine, and
 - (iii) holds a valid and subsisting approval to drill water wells that was issued under the *Water (Ministerial) Regulation* (AR 205/1998);
- (v) “Regulation”, means the Water (Ministerial) Regulation, as amended or replaced from time to time;
- (w) “vertical closed-loop ground source heat exchange well”, means a borehole, whether cased or uncased, that is equipped with an earth loop and is used or intended to be used for the purpose of heat exchange in a closed-loop ground source heat exchange system where there is no transfer of water between the well and an aquifer;

1.3 Application

- (1) If there is any conflict between this Directive and the Act or Regulation, the Act or the Regulation prevails over the Directive.
- (2) This Directive applies to all water wells, as that term is defined by the Act, including open-loop ground source heat exchange wells.

2 Approval Requirements

2.1 Classes of Approval

2.1.1 Class of Approval for Wells

- (1) The class of approval that is required in respect of an activity described in Column 2 of Table 1 is the class of approval shown in Column 1 of Table 1 opposite that activity.
- (2) The requirement to hold a Class F approval for the drilling and reclamation of vertical closed-loop ground source heat exchange wells will not come into effect until January 1, 2020.

Table 1, Class of Approval for Wells

Column 1 Class of Approval	Column 2 Description of Activity
Class A	Drilling of water wells for the diversion and use of groundwater, includes all work described under Classes B, C, D, and E.
Class B	Drilling, by means of digging, of water wells for the diversion and use of groundwater.
Class C	Drilling of water wells for the purpose of obtaining groundwater data for special groundwater investigations not related to Class A or B.
Class D	Reconditioning of water wells.

Class E	Drilling of water wells to a depth of not less than 450 metres to obtain saline groundwater.
Class F	Drilling and reclamation of vertical closed-loop ground source heat exchange wells.

2.1.2 Duration of Approval

- (1) When the Director issues an approval with respect to the drilling of a water well or a vertical closed-loop ground source heat exchange well, the approval must have an expiry date of one year.

2.1.3 Exemptions from Approval Requirements

- (1) The following activities are exempt from the requirement for an approval:
- (a) drilling a water well if
 - (i) the person drilling the water well is the owner of
 - A. the land on which the water well is to be located, and
 - B. the drilling machine, and
 - (ii) the water from the well is to be used solely for household purposes under section 21 of the Act.
 - (b) reclamation of a water well.

2.1.4 Requirements for a Class A Approval

- (1) The Director may issue a Class A approval to an applicant who,
- (a) is a certified journeyman driller,
 - (b) employs a certified journeyman driller, or
 - (c) is a qualified driller.
- (2) An applicant for an approval who employs a certified journeyman driller must disclose the name of that certified journeyman driller in the application.
- (3) A Class A approval holder shall not allow any person to operate a drilling machine unless,
- (a) in the case of an approval issued to a person under subsection (1)(a) or (b), that person is,
 - (i) a certified journeyman driller,
 - (ii) enrolled in an apprenticeship program for the designated trade of water well driller under the *Apprenticeship and Industry Training Act* and is directly supervised by a certified journeyman driller at least once a day, or
 - (iii) under the direct and continuous supervision of a certified journeyman driller at the drilling site,
 - or
 - (b) in the case of an approval issued to a person under subsection (1)(c), that person is the qualified driller to whom the approval was issued or a certified journeyman driller who is employed by that person.

2.1.5 Requirements for a Class F Approval

- (1) The Director may issue a Class F approval to an applicant who,

- (a) is an earth loop technician, or
 - (b) employs an earth loop technician.
- (2) An applicant for an approval who employs an earth loop technician must disclose the name of that earth loop technician in the application.
- (3) A Class F approval holder shall not allow any person to operate a drilling machine, with respect to a vertical closed-loop ground source heat exchange well, unless that person is,
- (a) an earth loop technician,
 - (b) enrolled in an apprenticeship program for the designated trade of earth loop technician under the *Apprenticeship and Industry Training Act* and is directly supervised by a certified journeyman earth loop technician at least once a day, or
 - (c) under the direct and continuous supervision of an earth loop technician at the drilling site.

2.1.6 Notification of Change in Information

- (1) An approval holder must notify the Director
- (a) within 10 days after any change to any information provided in an application for an approval if the information relates to the eligibility of the approval holder, and
 - (b) within 60 days after any other change in any information provided in an application for an approval.

2.2 Rig Plates

- (1) The Director must provide an approval holder with one plate for each drilling machine owned and operated by the approval holder.
- (2) No person shall use or permit the use of a drilling machine unless the plate is prominently displayed on the drilling machine.
- (3) No approval holder shall transfer a plate to any other person.
- (4) If an approval holder sells, transfers or otherwise disposes of a drilling machine or retires the machine from use, the approval holder must immediately return the plate to the Director.

3 Water Wells

3.1 Siting a Water Well

3.1.1 Accessibility

- (1) The approval holder and the owner of a water well must locate a water well site so that
- (a) the water well is accessible for cleaning, treatment, repair, testing, maintenance and inspection,
 - (b) the area immediately surrounding the water well may be kept in a sanitary condition,
 - (c) surface water does not collect or pond in the vicinity of the water well, and
 - (d) the water well is at least 3.25 metres away from the nearest building.
- (e) Section 3.1.1(1)(b) and (d) do not apply to a water well drilled by the holder of a Class C approval.

3.1.2 Well Pits

- (1) No person shall locate a water well in a pit unless it is a water well drilled by the holder of a Class C approval.

3.1.3 Pumphouse

- (1) No person shall locate a water well in a building other than a pumphouse that houses only the water well and the pump unless it is a water well drilled by the holder of a Class C approval.
- (2) The owner of a water well must construct and maintain a pumphouse so that water does not collect on the pumphouse floor.

3.1.4 Distance from Sources of Contamination

- (1) No person shall locate or drill a water well for the diversion of groundwater, other than saline groundwater, closer to a source of substance described in Column 1 of Table 2 than the distance specified in Column 2 of Table 2.
- (2) If the diversion of water from a water well is licensed for municipal purposes, no person shall locate or drill a water well closer than 100 metres from a source of substance listed in Column 1 of Table 2.

Table 2, Distance from Sources of Substance

Column 1 Sources of Substance	Column 2 Minimum Distance Required
Watertight septic tank or sewage holding tanks	10 metres
Sub-surface weeping tile effluent disposal field or an evaporation mound	15 metres
Above ground storage tanks containing petroleum substances	50 metres
Sewage effluent discharge to the ground surface	50 metres
Sewage lagoon	100 metres

- (3) No person shall locate a source of substance described in Column 1 of Table 2 closer to a water well than the distance specified in Column 2 of Table 2.

3.2 Drilling and Construction

3.2.1 General

- (1) The driller must meet the following requirements:
 - (a) the water well must be constructed so that surface water or substances cannot enter any aquifer,
 - (b) the water well must be designed and developed so as to allow production consistent with the water well owner's water requirements, taking into account the production potential of the aquifer being used,

- (c) the water well must be sufficiently straight and free of obstructions to admit the pumping equipment without damage,
 - (d) in the case of a water well intended to be equipped with a submersible or independent jet pump, the water well must be constructed so that the casing has an inside diameter of at least 10.16 centimetres from the top of the water well to below the optimum pump intake depth, and
 - (e) when non-metallic pipe is used as casing, the water well must be protected at the ground surface by steel casing that is firmly anchored in the ground.
- (2) Sections 3.2.1(1)(b), (d) and €do not apply in respect of a water well drilled by the holder of a Class C approval.

3.2.2 Records during Drilling

- (1) During the drilling of a water well, the driller must,
- (a) maintain a current record of the construction and testing of the water well, including a lithologic log, and
 - (b) have the record available for inspection at the drilling site.

3.2.3 Fluids and Substances

- (1) No driller shall use a fluid or substance in a drilling operation that may cause an adverse effect on the environment, human health, property or public safety.

3.2.4 Materials

- (1) No person shall use or permit the use of materials in the drilling, construction, maintenance, servicing or monitoring of a water well unless the materials
- (a) are new and uncontaminated, and
 - (b) meet or exceed the specifications set out for that material and purpose by the Canadian Standards Association or the American Society for Testing and Materials.

3.2.5 Casing Specifications

- (1) The driller must use casing in a water well that has at least the following wall thicknesses:
- (a) 4.78 millimetres for metal well casing;
 - (b) 3.96 millimetres for metal liner casing;
 - (c) for cement-like casing, 6.35 centimetres if the inside casing diameter is 60.96 centimetres or less, with an additional 2.54 centimetres for each additional 30.48 centimetres of diameter
 - (d) 6-gauge for corrugated and galvanized steel casing used in bored or dug water wells, or
 - (e) for plastic casing, the casing must
 - (i) be ABS or PVC pipe that is manufactured from virgin resin and approved for potable water use by the Canadian Standards Association or the American Society for Testing and Materials, and
 - (ii) comply with the specifications for wall thickness set out in Table 3.
- (2) Section 3.2.5(1)(e) does not apply in respect of a water well drilled by the holder of a Class C approval.

Table 3, Pipe Sizes

Nominal Pipe Size (Millimetres)	Standard Dimension Ratio or Schedule Number	Minimum Wall Thickness (Millimetres)
50.8	SDR 21	2.67
	SCH 40	3.91
	SCH 80	5.54
76.2	SDR 21	4.24
	SCH 40	5.49
	SCH 80	7.62
101.6	SDR 21	5.44
	SCH 40	6.02
	SCH 80	8.58
127.0	SDR 21	6.73
	SCH 40	6.55
	SCH 80	9.53
152.4	SDR 21	8.03
	SCH 40	7.11
	SCH 80	10.97
203.2	SDR 21	10.41
	SCH 40	8.18
	SCH 80	12.70
254.0	SDR 21	12.98
	SCH 40	9.27
	SCH 80	15.08

3.2.6 Casing Joints

- (1) The driller must make all joints in the casing of a water well in a manner that effectively prevents entry into the water well of any substance that may cause an adverse effect on the environment, human health, property or public safety.

3.2.7 Casing Height

- (1) The driller must construct a water well, except a water well drilled by the holder of a Class C approval, so that the casing extends
 - (a) not less than 20 centimetres above the pumphouse floor or the established ground surface, and
 - (b) at least 60 centimetres above the highest flood record in the area, if the water well is not to be equipped with a watertight cap.

3.2.8 Well Cover during Drilling

- (1) The driller must, where a water well is being drilled and left unattended, securely cover the water well to prevent the entry of surface water and foreign materials into the water well and to prevent persons or animals from falling into the water well.

3.2.9 Well Cap or Well Seal

- (1) The driller must cover the water well that is bored or dug with a cover that has a 5-centimetre overlap and does not allow water to enter through the top of the water well.
- (2) The person who installs pumping equipment in a water well that was drilled by a method other than boring or digging must seal the top of the casing with a commercially manufactured water well cap.

3.2.10 Production Interval

- (1) The driller must meet the following requirements in relation to a water well that is required to be licensed for a diversion of groundwater:
 - (a) construct the water well in a manner that does not result in multiple aquifer completions,
 - (b) construct the water well with an open hole, or a slotted or screened section that does not exceed 7.62 metres if distinct water-producing units are not present, and
 - (c) seal the full length of the annulus from the ground surface to the top of the aquifer using suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or using clay slurry, impervious water well cuttings or impervious overburden materials.

3.2.11 Annulus

- (1) The driller, in relation to a water well that is bored or dug to a depth of more than 4.5 metres must fill the annulus,
 - (a) adjacent to the perforated section of the casing, and not closer to the land surface than 4.5 metres, with clean material free of clay and silt, and
 - (b) between the ground surface and the area described in clause (a) with suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or with clay slurry, impervious water well cuttings or impervious overburden materials.
- (2) The driller, in relation to a water well that is bored or dug to a depth of 4.5 metres or less must fill the annulus
 - (a) from the bottom of the water well to a depth not closer to the ground surface than one metre with clean material free of clay and silt, and
 - (b) between the ground surface and the area described in clause (a) with suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or with clay slurry, impervious water well cuttings or impervious overburden materials.

- (3) The driller, in relation to a water well that is drilled by a method other than boring or digging, must fill the annulus with suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or with clay slurry, impervious water well cuttings or impervious overburden materials,
 - (a) when a casing-liner completion method is used, from the bottom of the casing to the ground surface, and
 - (b) when a single string casing completion method is used, from immediately above the perforated section to the ground surface.

3.3 Well Development

3.3.1 Protection from Sediment

- (1) The driller must complete a water well so that the pumping system, plumbing and fixtures are not damaged by sediment in the water.

3.4 Yield Test

3.4.1 Testing of Water Well Yield, Pumping

- (1) After drilling and developing a new water well the driller must test the yield of the water well in accordance with this section or section 3.4.2.
- (2) The driller must conduct a yield test by pumping the water well for at least 2 continuous hours immediately followed by 2 hours of recovery.
- (3) The driller must ensure that the pumping rate during the yield testing is at least equal to the expected pumping rate of the water well and the rate must be held constant.
- (4) When conducting a yield test the driller must, by means of a tape, air line or electrical device, measure,
 - (a) the static water level in the water well immediately before commencement of the pumping,
 - (b) the water level during pumping at time intervals specified in the production test in the drilling report,
 - (c) the water level in the water well immediately after the end of the pumping and at time intervals specified in the yield test section in the drilling report, for
 - (i) 2 continuous hours, or
 - (ii) until 90 % recovery of the static water level measured immediately before commencement of the pumping is achieved,whichever occurs first.
- (5) The driller must record, in the drilling report, the rate of pumping and the water level measurements taken during the yield test.
- (6) If water cannot be pumped from the water well during the yield test as stated in section 3.4.1(2) the driller must record the following information in the drilling report:
 - (a) the reason the pumping was discontinued,
 - (b) the rate of pumping, the length of time of the pumping and the recovery methods, and
 - (c) the water level measurements taken during the pumping and recovery periods.

3.4.2 Testing of Water Well Yield, Water Removal

- (1) When the yield of water from a water well is tested by a bailer or other equipment that does not permit accurate drawdown measurements in the well, the driller must,
 - (a) measure the static water level in the water well immediately before removal of the water from the water well,
 - (b) remove water from the well for at least 2 continuous hours,
 - (c) measure the water level in the water well immediately after termination of water removal, and at the time intervals specified in the yield test section in the drilling report, for
 - (i) 2 continuous hours, or
 - (ii) until 90 % recovery of the static water level measured immediately before removal of the water from the water well is achieved,whichever occurs first,
 - (d) measure the water levels in the water well by means of a tape, air-line or electrical device, and
 - (e) record the rate of water removal during the test and the water level measurements taken during the recovery in the drilling report.
- (2) If water cannot be removed from the water well for 2 continuous hours, the driller must,
 - (a) measure the water level in the water well immediately after termination of water removal and at time intervals specified in the production test in the drilling report for
 - (i) 2 continuous hours, or
 - (ii) until 90 % recovery of the static water level measured immediately before removal of the water from the water well is achieved,whichever occurs first, and
 - (b) record the following information in the drilling report:
 - (i) the reason water removal was discontinued,
 - (ii) the rate of water removal, the length of time of the water removal and the recover periods, and
 - (iii) the water level measurements taken during the recovery period.

3.4.3 Exemptions to Section 3.4.1 and 3.4.2 Requirements

- (1) Sections 3.4.1 and 3.4.2 in this Directive do not apply in respect of a water well that
 - (a) has been yield tested in accordance with the requirements of an approval for the exploration of groundwater if that approval requires longer periods of water removal and recovery than those required by sections 3.4.1 and 3.4.2, or
 - (b) was drilled by the holder of a Class C approval.

3.5 Pumping Equipment

3.5.1 Installation of Pumping Equipment

- (1) A person who installs pumping equipment in a water well must install the pumping equipment so that
 - (a) the pump, water well and its surroundings can be kept in a sanitary condition,
 - (b) the flow rate does not exceed the recommended pumping rate of the water well as set out in the drilling report,

- (c) the pump is not placed in an unsupported open hole,
 - (d) if the connection of the pumping equipment through the casing of the water well is made below the ground surface,
 - (i) a pitless adapter is used and the connection is watertight, and
 - (ii) the outside excavation
 - A. extends a minimum distance outward of 0.5 metre from the casing,
 - B. extends from the bottom of the excavation to within 0.5 metre of the ground surface, and
 - C. is filled with suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or with clay slurry, impervious water well cuttings or impervious overburden materials.
- (2) This section does not apply in respect of a water well drilled by the holder of a Class C approval.

3.5.2 Venting

- (1) The person installing the pumping equipment in a water well must equip the well with an air vent that complies with this section if
 - (a) pumping equipment is installed in the water well,
 - (b) the water well casing is not used to transmit the water in the water well, and
 - (c) the water well cap is not designed to vent the inside of the water well to the atmosphere.
- (2) The air vent must,
 - (a) have a minimum inside diameter of
 - (i) 0.3 centimetre, if the inside diameter of the water well casing is less than 10.16 centimetres, or
 - (ii) 1.2 centimetres, if the inside diameter of the casing is 10.16 centimetres or more, and
 - (b) extend above the ground surface
 - (i) for 30 centimetres, or
 - (ii) to a height equal to the highest flood on record in the area,
 whichever is greater,
 - (c) have the open end of the air vent shielded and screened to prevent the entry of any material into the water well, and
 - (d) extend to the outside atmosphere so that all gases are safely dispersed.

3.6 Disinfection

3.6.1 Disinfection of Water Well

- (1) When a water well, other than a flowing water well, has been drilled, developed and yield tested, the driller must,
 - (a) disinfect the water well so that a concentration of 200 milligrams of chlorine per litre of water is present throughout the water in the water well, and
 - (b) maintain the concentration prescribed in clause (a) in the water well for a period of at least 12 hours.

3.6.2 Disinfection of Pumping Equipment

- (1) A person who installs pumping equipment in a water well must, after installation,
 - (a) disinfect the pumping equipment by using chlorinated water in the concentration prescribed in section 3.6.1(1)(a), and
 - (b) maintain the concentration prescribed in clause (a) in the pumping system for at least 12 hours.
- (2) At the end of the disinfection period, the person who installed the pumping equipment must operate the pumping equipment until no odour of chlorine remains in the water.
- (3) This section does not apply in respect of a water well drilled by the holder of a Class C approval.

3.7 Reclamation

3.7.1 Responsibility for Reclamation

- (1) If a water well is not completed due to a construction problem or inadequate water yield to meet the water well owner's water requirements,
 - (a) the driller must immediately reclaim the water well in accordance with this Directive, and
 - (b) the driller, or in the case of a water well that does not require an approval, the person who drilled the well must complete the drilling report and provide it as if the water well were completed as required by section 3.10.2 of this Directive.

3.7.2 Procedure for Reclamation

- (1) A person who reclaims a water well must only use equipment that is free of any substance that may cause an adverse effect on the environment, human health, property or public safety.
- (2) A person who reclaims a water well must,
 - (a) thoroughly flush and clean the water well of all foreign materials,
 - (b) disinfect the water well with a concentration of at least 200 milligrams of chlorine per litre of water in the water well,
 - (c) with respect to all equipment and materials, including casing, liner and riser pipe,
 - (i) remove the equipment and materials, or
 - (ii) if removal of the equipment or materials is impracticable, cut off all equipment and materials at least 0.5 metre below ground level,and
 - (d) fill the full length of the water well, with only materials specified in section 3.7.3, so that vertical movement of water within the water well bore is effectively and permanently prevented.
- (3) A person who reclaims a water well must backfill the uppermost 0.5 metre of the borehole of the water well to the ground surface with material appropriate for the intended use of the land.

3.7.3 Materials Used in Reclamation

- (1) A person who reclaims a water well must fill the water well under section 3.7.2(2)(d) with material that is,
 - (a) free of any substance that may cause an adverse effect on the environment, human health, property or public safety,
 - (b) suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or clay slurry, impervious water well cuttings or impervious overburden materials,

- (c) introduced at the bottom of the water well and placed progressively upwards, unless it is designed and manufactured for the purpose of being introduced into the water well from the ground surface, and
- (d) put in place by the use of drill pipe, grout pipe or tremie pipe, cement bucket or dump bailer in such a way as to avoid segregation or dilution of the sealing materials.

3.8 Flowing Artesian Wells

3.8.1 Potential Flowing Water Wells

- (1) If a water well being drilled has the potential of flowing, the driller must drill the water well in a manner that prevents the water from flowing out of control.

3.8.2 Completed Flowing Water Well

- (1) On completion of a flowing water well, the driller must equip the well with a variable flow control device to control the flow of water from the water well.
- (2) After the installation of the variable flow control device, the driller must,
 - (a) stop the flow of water for a period of at least 48 hours by closing the control device, and
 - (b) effectively seal the water well to prevent the escape of water from the annulus of the water well or its immediate vicinity.

3.8.3 Maximum Allowable Flow

- (1) No person shall allow a flowing water well to flow at a rate in excess of the lesser of
 - (a) the water requirements of the owner of the water well, and
 - (b) 100 cubic metres per week.
- (2) Subsection (1) does not apply to a water well that is licensed and the licence authorizes a yield in excess of 100 cubic metres per week.

3.9 Deepening, Reconditioning of Water Wells

3.9.1 Deepening Water Well

- (1) Subject to subsection (2), if an existing water well is deepened, this Directive applies to the deepening of the water well, including the portion of the existing water well that is used as part of the deepened water well.
- (2) If an existing water well that was bored or dug is deepened by a method other than boring or digging through the bottom of the water well, the driller must
 - (a) install casing that extends upward through the dug or bored water well in accordance with section 3.2.7(1), and
 - (b) fill the annulus between the casing referred to in clause (a) and the casing of the existing bored or dug water well from the bottom to the ground surface with suitable cement, grout, concrete, bentonite or equivalent commercial slurry, or with clay slurry, impervious water well cuttings or impervious overburden materials.

3.9.2 Reconditioning

- (1) A driller who reconditions a water well must use materials and equipment in the reconditioning that is free of any substance that may cause an adverse effect on the environment, human health, property or public safety.

3.10 Reporting Requirements

3.10.1 Reporting Saline Groundwater or Gas

- (1) If saline groundwater is encountered in drilling a water well, the driller must,
 - (a) notify the owner of the water well that saline groundwater has been encountered, and
 - (b) seal off the saline groundwater to prevent it from mixing with any other water that is not saline groundwater.
- (2) If gas is encountered in drilling a water well, the driller must notify the owner of the water well that the gas has been encountered.
- (3) If gas is encountered in a quantity that would prevent the safe drilling or operation of the water well, the driller must,
 - (a) notify the Director within 24 hours after encountering the gas by reporting to the 24-hour Environmental Hotline at 1-800-222-6514, and
 - (b) immediately seal off the gas to prevent an adverse effect on the environment, human health, property and public safety.
- (4) If saline groundwater or gas is encountered in the drilling of a water well, the driller must, in the drilling report, report to the Director the remedial steps taken.

3.10.2 Drilling Report

- (1) Within 60 days after the completion of a water well, the approval holder must ensure,
 - (a) a drilling report is completed in a form acceptable to and containing the information required by the Director, and
 - (b) a copy of the drilling report is provided to the Director and the owner of the water well.
- (2) A person who drills a water well for which an approval is not required under this Directive must, within 60 days after completion of the water well,
 - (a) complete a drilling report in a form acceptable to and containing the information required by the Director, and
 - (b) provide a copy of the drilling report is provided to the Director.
- (3) A person required to complete a drilling report under this section must retain a copy of the drilling report for at least 5 years after it is completed.

4 Ground Source Heat Exchange Systems

4.1 General

- (1) For the purpose of Part 4, all references to an earth loop technician include persons who undertake the drilling and construction of a vertical closed-loop ground source heat exchange well without holding a Class F approval prior to January 1, 2020.

4.2 Drilling and Construction of Vertical Closed-Loop Ground Source Heat Exchange Wells

4.2.1 Drilling

- (1) The earth loop technician must locate a vertical closed-loop ground source heat exchange well so that surface water does not collect or pond in the vicinity of the well.
- (2) During the drilling of a vertical closed-loop ground source heat exchange well, the earth loop technician must take measures to prevent,
 - (a) surface water or substances from entering into any aquifer,
 - (b) movement of groundwater from one aquifer to another, and
 - (c) discharge of groundwater from flowing artesian aquifers to the ground surface.
- (3) The earth loop technician must, in the case of a vertical closed-loop ground source heat exchange well that is being drilled and is left unattended, securely cover the well to prevent the entry of surface water and foreign materials into the well.

4.2.2 Fluids and Substances

- (1) No earth loop technician shall use a fluid or substance in a drilling operation that may cause an adverse effect on the environment, human health, property or public safety.
- (2) The earth loop technician must use only potable water in drilling operations.

4.2.3 Materials

- (1) No person shall use or permit the use of materials in the drilling, construction, maintenance, servicing, monitoring or reclamation of a vertical closed-loop ground source heat exchange well unless the materials are,
 - (a) new and uncontaminated, and
 - (b) meet, at a minimum, the specifications set out for that material and purpose in *CSA C448 Series-16*.

4.2.4 Records during Drilling

- (1) During the drilling of a vertical closed-loop ground source heat exchange well, the earth loop technician must,
 - (a) maintain a current record of the construction and testing of the vertical closed-loop ground source heat exchange well, including a lithologic log and the well location recorded in decimal degrees to 6 decimal places using a differential correction GPS device, and
 - (b) have the record available for inspection at the drilling site.

4.2.5 Setbacks

- (1) No person shall locate or drill a vertical closed-loop ground source heat exchange well closer to a thing described in Column 1 of Table 4 than the distance specified in Column 2 of Table 4.

Table 4 Setback Requirements

Column 1 Source	Column 2 Minimum Distance Required
Buried utilities (electrical, gas)	1 metre
Existing or planned building or above-ground structure	1 metre
Property line	3 metres
Buried utilities (water)	3 metres
Unpressurized (gravity flow) sewer lateral into a building	3 metres
Pressurized (pumped) sewer lateral into a building	6 metres
Water well	15 metres
Septic tank	15 metres
Subsurface sewage leaching field	30 metres
Spring	30 metres

4.2.6 Earth Loops

- (1) During the installation of an earth loop into a vertical closed-loop ground source heat exchange well, the earth loop technician must,
 - (a) use pipe and fitting materials for the earth loop that meet, at a minimum, the specifications prescribed in *CSA C448 Series-16*, and
 - (b) use heat fusion joining methods that meet, at a minimum, the specifications prescribed in *CSA C448 Series-16* when pipe and fitting form a homogeneous assembly that will be installed below ground surface.
- (2) Prior to installing an earth loop into a vertical closed-loop ground source heat exchange well, the earth loop technician must,
 - (a) verify earth loop lengths by inspecting the manufacturer's distance marking stamp on the pipe wall,
 - (b) conduct an air pressure test that meets the specifications prescribed in *CSA C448 Series-16*, to ensure no leaks in the earth loop, and
 - (c) flush all earth loop piping and fusion joints with potable water to remove debris and air.

- (3) The earth loop technician must not use any earth loop piping that fails the air pressure test referred to in subsection (2)(b) unless,
 - (a) any identified leaks in the earth loop can be located and repaired, and
 - (b) the earth loop passes a subsequent air pressure test prior to being installed in the vertical closed-loop ground source heat exchange well.
- (4) After installation of an earth loop into a vertical closed-loop ground source heat exchange well and before grouting occurs, the earth loop technician must,
 - (a) conduct a pressure test on the earth loop using air or potable water, at a minimum pressure rating of 100 psi, for
 - (i) the time period dictated by the local jurisdiction or
 - (ii) for a minimum of 1 hourwhichever time period is longer,
 - (b) confirm there are no leaks in the earth loop, and
 - (c) fuse a temporary cap onto the earth loop to prevent any debris from entering the loop prior to connection to the header piping.

4.2.7 Grouting

- (1) The earth loop technician must use only grout materials in a vertical closed-loop ground source heat exchange well that meet, at a minimum, the specifications for grout materials prescribed in *CSA C448 Series-16*.
- (2) To mix grout materials, the earth loop technician must use only potable water.
- (3) Within 24 hours after the placement of the earth loop into a vertical closed-loop ground source heat exchange well, the earth loop technician must, at a minimum,
 - (a) remove any drilling fluids from the borehole,
 - (b) grout the entire length of the vertical closed-loop ground source heat exchange well in accordance with section 4.2.7(4) to,
 - (i) ensure continuous contact between the earth loop and the annulus of the vertical closed-loop ground source heat exchange well for efficient heat transfer,
 - (ii) prevent surface water from entering into any aquifers encountered in the drilling of the vertical closed-loop ground source heat exchange well, and
 - (iii) prevent mixing of water from one aquifer to another.
 - (c) monitor the vertical closed-loop ground source heat exchange well for settling of the grout mixture for a period of at least 24 hours, and
 - (d) add additional grout if any settling is observed.
- (4) The earth loop technician must grout the vertical closed-loop ground source heat exchange well in accordance with section 4.2.7(3)(b) by,
 - (a) placing the grout in the vertical closed-loop ground source heat exchange well using a tremie pipe, and
 - (b) pressure pumping the grout through the tremie pipe,
 - (i) in a continuous operation, and
 - (ii) using a positive displacement method,

until the density of the grout mixture flowing out the top of the vertical closed-loop ground source heat exchange well is equal to the density of the grout mixture being pumped in.

4.2.8 Header

- (1) Any person who installs the header of a closed-loop ground source heat exchange system must meet, at minimum, the specifications prescribed in *CSA C448 Series-16* for,
 - (a) pipe and fitting materials used for the supply and return lines of the header,
 - (b) heat fusion joining methods for the connection of all header piping and connection of the earth loops to the header supply and return lines
 - (c) construction of the trench,
 - (d) installation of the header piping into the trench, and
 - (e) backfilling of the trench.
- (2) The person who installs the header of a closed-loop ground source heat exchange system must,
 - (a) maintain a separation distance of at least 0.5 metres between the header supply and return lines,
 - (b) insulate any header piping located closer than 3.0 metres from other fluid-based on-site services, to prevent any current or future thermal interference with those services, and
 - (c) insulate any header piping that passes within 1.5 metres of a wall, structure, drainage pipe or water pipe with a minimum R2 closed cell insulation.
- (3) The person who installs the header of a closed-loop ground source heat exchange system must clearly identify the location of all header piping by affixing conductive tracer wire or metal detectable underground tape to the header piping by,
 - (a) affixing tracer wire, if using,
 - (i) in a location that is accessible at ground surface in a test port or terminates above final grade at the building foundation, and
 - (ii) with a permanent label indicating the nature of the wire,
 - (b) affixing metal detectable underground tape, if using,
 - (i) with a minimum thickness of 6 millimetres and width of 152 millimetres, and
 - (ii) in a continuous loop along the entire length of the header piping.
- (4) Before backfilling the trench, the person who installs the header of a closed-loop ground source heat exchange system must conduct a final pressure test, using equipment and methods that meet the specifications prescribed in *CSA C448 Series-16*, to verify there is no air remaining in any of the earth loops or header piping of the closed-loop ground source heat exchange system.

4.2.9 Flushing and Purging

- (1) After the earth loop in each of the vertical closed-loop ground source heat exchange wells in a closed-loop ground source heat exchange system has been connected to the header piping, and before the system is put into operation, the person installing the header must,
 - (a) flush all of the connected earth loops and header piping, to remove any remaining debris, using equipment and methods that meet, at a minimum, the specifications prescribed in *CSA C448 Series-16*,
 - (b) purge each supply and return circuit with potable water,
 - (i) in both the forward and reverse direction,

- (ii) at a minimum velocity of 0.61 m/s through each piping section using a calibrated flow meter to verify flow velocity, and
- (iii) maintain flow for a minimum of 15 minutes in each direction to remove all air from the system.

4.2.10 Heat-transfer Fluid

- (1) The person installing the heat-transfer fluid used in a closed-loop ground source heat exchange system must, at a minimum,
 - (a) meet the specifications prescribed in *CSA C448 Series-16*.
 - (b) use only potable water, if water is being used as a component of the heat-transfer fluid, and
 - (c) use only anti-freeze that is non-toxic and food grade quality if the system has a vertical closed-loop ground source heat exchange well located within 50 metres of a water well that is licensed for municipal purpose.

4.3 Reclamation

4.3.1 Responsibility for Reclamation

- (1) The earth loop technician must immediately reclaim a vertical closed-loop ground source heat exchange well in accordance with this Directive, if the well is not completed due to a construction problem, including the unsuccessful installation of an earth loop into the well.

4.3.2 Procedures for Reclamation

- (1) When a vertical closed-loop ground source heat exchange well is to be reclaimed before it is connected to the header, the earth loop technician must, at a minimum, complete the following:
 - (a) remove any earth loop piping from the well,
 - (b) fill the full length of the well, with materials specified in section 4.3.3, so that vertical movement of water within the well bore is effectively and permanently prevented,
 - (c) if casing was installed during construction of the well, and grouted the full length of the annulus, and the casing is undamaged at time of reclamation,
 - (i) the casing may be left in place, and
 - (ii) cut off at least 1 metre below ground level
 - (d) if casing was installed during construction of the well, but not grouted the full length of the annulus, the details of the annulus grouting are unknown or if the casing is damaged at time of reclamation,
 - (i) the casing must be removed, or
 - (ii) if removal of the casing is impracticable, it must be
 - A. perforated to allow sealing materials to penetrate the annulus to facilitate proper sealing, and
 - B. cut off at least 1 metre below ground level, and
 - (e) backfill the uppermost 1 metre of borehole to the ground surface with material appropriate for the intended use of the land.
- (2) When a vertical closed-loop ground source heat exchange well is to be reclaimed because it is leaking, or was but is no longer being used as vertical closed-loop ground source heat exchange well in a closed-loop

ground source heat exchange system, the earth loop technician must, at a minimum, complete the following:

- (a) identify and isolate the vertical closed-loop ground source heat exchange well being reclaimed from the remaining vertical closed-loop ground source heat exchange wells in the closed-loop ground source heat exchange system,
- (b) flush any heat-transfer fluid from the earth loop within the vertical closed-loop ground source heat exchange well and dispose of it in accordance with the Waste Control Regulation of the *Environmental Protection and Enhancement Act*, as amended from time to time,
- (c) pressure pump grout material into the earth loop of the vertical closed-loop ground source heat exchange well being reclaimed so that it is filled full length so that movement of any fluid within the loop is effectively and permanently prevented, and
- (d) backfill any excavation that was made to access the earth loop inside the vertical closed-loop ground source heat exchange well with clean earth material appropriate for the current and future intended use of the land.

4.3.3 Materials Used in Reclamation

- (1) The earth loop technician who reclaims a vertical closed-loop ground source heat exchange well under section 4.3.2 must use grout material that,
 - (a) meets, at a minimum, the specifications for grout material prescribed in *CSA C448 Series-16*,
 - (b) is introduced at the bottom of the vertical closed-loop ground source heat exchange well and placed progressively upwards,
 - (c) is placed by the use of drill pipe, grout pipe or tremie pipe in a manner so as to avoid segregation or dilution of the grout material, and
 - (d) is pressure pumped,
 - (i) in a continuous operation, and
 - (ii) using a positive displacement methoduntil the density of the grout mixture flowing out the top of the well is equal to the density of the grout mixture being pumped in.

4.4 Reporting Requirements for Vertical Closed-Loop Ground Source Heat Exchange Wells

4.4.1 Reporting Saline Groundwater, Artesian Groundwater Flow or Gas

- (1) If saline groundwater is encountered in drilling a vertical closed-loop ground source heat exchange well, the earth loop technician must,
 - (a) notify the owner of the well that saline groundwater has been encountered, and
 - (b) seal off the saline groundwater to prevent it from mixing with any other water that is not saline groundwater.
- (2) If artesian groundwater flow is encountered in drilling a vertical closed-loop ground source heat exchange well, the earth loop technician must,
 - (a) notify the owner of the well that artesian groundwater flow has been encountered, and
 - (b) immediately seal off the artesian groundwater flow to prevent it from flowing at ground surface or leaking into another aquifer penetrated by the well.

- (3) If gas is encountered in drilling a vertical closed-loop ground source heat exchange well, the earth loop technician must notify the owner of the well that the gas has been encountered.
- (4) If gas is encountered in drilling a vertical closed-loop ground source heat exchange well, in a quantity that would prevent the safe drilling of the well, the earth loop technician must,
 - (a) notify the Director within 24 hours after encountering the gas by reporting to the 24-hour Environmental Hotline at 1-800-222-6514, and
 - (b) immediately seal off the gas to prevent an adverse effect on the environment, human health, property and public safety.
- (5) If saline groundwater, artesian groundwater flow or gas is encountered in the drilling of a vertical closed-loop ground source heat exchange well, the earth loop technician must, in the drilling report, report to the Director the remedial steps taken.

4.4.2 Drilling Report

- (1) For residential vertical closed-loop ground source heat exchange systems, the approval holder must ensure, within 60 days after the completion of each vertical closed-loop ground source heat exchange well,
 - (a) a drilling report is completed in a form acceptable to and containing the information required by the Director, and
 - (b) a copy of the drilling report is provided to the Director and the owner of the closed-loop ground source heat exchange system.
- (2) For commercial or institutional vertical closed-loop ground source heat exchange systems, the approval holder must complete a drilling report for each of the following vertical closed-loop ground source heat exchange wells:
 - (a) any vertical closed-loop ground source heat exchange well that was used for in-situ thermal conductivity testing,
 - (b) any vertical closed-loop ground source heat exchange well where saline groundwater, artesian groundwater flow or gas was encountered during drilling,
 - (c) each vertical closed-loop ground source heat exchange well in a closed-loop ground source heat exchange system, if a total of less than 20 vertical closed-loop ground source heat exchange wells were completed, and
 - (d) if the closed-loop ground source heat exchange system was completed with a total of 20 or more vertical closed-loop ground source heat exchange wells, an additional representative vertical closed-loop ground source heat exchange well for every 21st well beyond the first 20 on the site, using the formula,
 - (i) number of vertical closed-loop ground source heat exchange wells divided by 20, and
 - (ii) if there is a decimal number, add one more well.
- (3) Within 60 days after the completion of each vertical closed-loop ground source heat exchange well described in section 4.4.2(2)(c) and (d), the approval holder must ensure,
 - (a) a drilling report is completed in a form acceptable to and containing the information required by the Director, and
 - (b) a copy of the drilling report is provided to the Director and the owner of the closed-loop ground source heat exchange system.

- (4) The approval holder must retain a copy of the drilling report referred to in section 4.4.2(1) or (3) for a period of at least 5 years after it is completed.

4.4.3 Reclamation Report

- (1) Within 60 days after the reclamation of a vertical closed-loop ground source heat exchange well, the approval holder must ensure,
- (a) a reclamation report is completed in a form acceptable to and containing the information required by the Director, and
 - (b) a copy of the reclamation report is provided to the Director and the owner of the closed-loop ground source heat exchange system.
- (2) The approval holder must retain a copy of the reclamation report for at least 5 years after it is completed.

Original signed by: _____

Bev Yee
Deputy Minister
Environment and Parks

Date: December 11, 2018