

This specification outlines the requirements for drilling, development and pump testing of drilled wells to a depth authorized by the Owner in accordance with the Well Drilling Regulations, 2003, under the Water Resources Act (O.C. 2003-221).

## PART 1 REFERENCES

This specification refers to the following standards, specifications, or publications:

American Water Works Association (AWWA)

A100 Water Wells

C654 Disinfection of Wells

ASTM International

B124/B124M Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes

CSA Group

A3000 Cementitious Materials Compendium

Other

Government of Newfoundland and Labrador, Department of Environment and Climate Change, Water Resources Management Division, Aquifer Testing Guidelines

Government of Newfoundland and Labrador, Department of Environment and Climate Change, Water Resources Management Division, Guidelines for Sealing Groundwater Wells

Government of Newfoundland and Labrador Regulation 63/03, Well Drilling Regulations, 2003 Under the Water Resources Act (O.C. 2003-221)

## PART 2 GENERAL

### 2.1 SUBMITTALS

- .1 Submit in accordance with Section 01340 – Shop Drawings, Samples and Submissions.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for piping and well pump and include product characteristics, performance criteria, physical size, finish and limitations.

## 2.12.2 CLOSEOUT SUBMITTALS REPORTS

- .1 Submit in accordance with Section 01720 – Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for piping and well pump for incorporation into manual.
- .4.3 On completion of work, submit to the Owner a report containing documents in accordance with the Well Drilling Regulations, 2003 under the Water Resources Act (O.C. 2003-221). These will generally include, but not be limited to:
  - .1 Well maintenance instructions
  - .2 Log of well drilling
  - .2.3 Geophysical logs
  - .3.4 As-built drawing of well including:
    - .1 Elevations
    - .2 Size and length of each casing section installed
    - .3 Grouting details
    - .4 Description of screen
    - .5 Gravel packing details
  - .5 Records of static water level measurements, times at which they were taken and any observable changes in static water level with well depth.
  - .4.6 Results of final and any interimFinal pumping test results.
  - .7 Well development data.
  - .5.8 Results of chemical and bacteriological tests on water samples.
  - .6.9 Recommendations on water treatment or tests required to determine treatment necessary.
  - .10 Type and size of permanent well pump recommended.

## 2.3 QUALITY ASSURANCE

- .1 Qualifications:
  - .1 The Well Driller must be a Well Drilling Licence Holder with the Department of Environment and Climate Change, Groundwater Section of the Water Resources Management Division.

## 2.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01600 – Materials and Equipment and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

- .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect piping and well pump from nicks, scratches, and blemishes.
- .7.3 Replace defective or damaged materials with new.

PART 3 PRODUCTS

3.1 PERMANENT WELL CASING

- .1 Use new material only.
- .2 Casing in accordance with AWWA A100, 150 mm diameter casing unless otherwise specified in the MERX Schedule of Quantities and Prices, internal diameter 150 mm and wall thickness 9 mm.
- .3 Use pipe fittings of same standard as pipe casing.
- .4 Joints shall be welded or threaded couplings as shown on drawings.
- .5 A Drive Shoe shall be welded to the bottom of the well casing.

3.2 SCREEN

- .1 To the Owner's approval after analysis of the aquifer.
- .2 Pipe size well screen to following requirements:
  - .1 Material: Stainless steel in accordance with ASTM B124/B124M, Alloy 7.
  - .2 Type: as indicated on drawings or as directed by the Owner.
  - .3 Openings: as indicated or directed by the Owner and free of jagged edges or other irregularity.
- .3 The screen shall be provided with such fittings as are necessary to seal tightly the top to the casing and to close the bottom.
  - .1 If the screen is installed inside the casing, figure K-Packer seal shall be used at the top which shall be located so that there is a 300 mm overlap of the well casing and screen.
  - .2 If the screen is attached to the casing, a suitable coupling shall be provided, or the screen shall be welded to the casing.
  - .3 All fittings, except plugs and seals, but including couplings, where required for joining sections of the screen, shall be constructed of the same material as the screen sections of casing over 1.5 m. in length used to connect sections of screen shall not be considered as fittings.

.4 The screen shall have adequate strength to resist external forces applied to it after installation and to minimize the likelihood of damage during installation. The screen must have no change of alignment at any joint after installation. If required by the Owner, the contractor shall submit for approval drawings and other information showing the design and method of construction of the screen.

3.3 WELL SEAL

.1 The well shall be sealed with a vermin proof sanitary seal sized to fit the well casing with a 32 mm hole or a well cap sized to fit the casing as directed by the Owner.

PART 4 EXECUTION

4.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for water supply well installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of the Owner.

.2 Inform the Owner of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Owner.

4.14.2 DRILLING

.1 Notify the Owner 48 hours before commencement of drilling.

.2 Use drilling equipment and methods approved by the Owner.

.3 Drill in locations and to depths indicated or directed.

.4 Drill holes round, plumb and true to line.

.5 Dispose of drill cuttings as directed.

.6 Ensure drilling methods do not impair production for aquifers encountered.

.7 Prevent foreign matter from entering borehole and prevent contaminated water or other objectionable fluids from reaching aquifer through borehole.

.8 Cover top of bore hole ~~Take measures as necessary~~ to prevent tampering ~~with borehole~~ and to eliminate dangerous conditions for persons or animals in area.

.6.9 Maintain log of all boreholes including following information:

- .1 Depth of changes in formation.
- .2 Description of formations encountered.
- .3 Elevations at which aquifers are encountered, sudden changes in water level, loss of drilling mud or other indications of permeable strata.

.10 In unconsolidated formations, obtain duplicate soil samples from each 3 m maximum of depth drilled and at least one set of duplicate samples from each formation encountered.

.7.1 Submit samples to the Owner with identification data on drill hole and depth.

.11 Obtain continuous samples for 7 m minimum through aquifer.

.1 Screen samples using split spoon sampling or other method approved in writing by the Owner.

.8.12 In consolidated formation, obtain one (1) rock sample from each 6 m of depth drilled.

.13 Conduct well development and pumping tests and obtain clear water samples as directed.

.14 Be prepared to shut off and seal a-hole if should flowing artesian water or gas be encountered.

.15 Equip arterial wells with variable flow control device to control rate of flow after completion.

.1 Stop flow of water for period of 48 hours minimum by closing control device, and determine if well is effectively sealed to prevent escape of water from annular space of well and immediate vicinity.

.9.2 Seal off water by grouting as necessary.

.10.16 Seal abandoned holes in accordance with Sealing Wells subsection 4.10 of this Section.

.11.17 At no cost to the Owner, redrill holes lost due to caving or abandoned due to loss of drilling equipment.

#### 4.24.3 SCREEN INSTALLATION

- .1 When aquifer material has been sampled and analyzed, the Owner will advise on type and size of screen required.
- .2 Install screen by approved methods and to manufacturer's recommendations.

#### 4.34.4 PERMANENT CASING INSTALLATION

- .1 Clean casing pipe and fittings prior to installation.
- .2 Install permanent well casing to sizes and depths as indicated or directed by the Owner.
- .3 Centre casing by use of centring brackets spaced not more than 15 m apart and install so that variance from vertical does not exceed two thirds internal diameter of casing per 30 m of depth.
- .4 Prove alignment by lowering into casing a straight section of pipe 12 m long with outside diameter not more than 12 mm smaller than internal diameter of casing being tested.
  - .4.1 If plumb fails to move freely through casing to lowest anticipated pumping level, correct alignment to satisfaction of and at no cost to the Owner.
- .5 Seal annular space between casing and borehole wall by grouting, to prevent entrance of surface water or other deleterious matter into aquifer, and to prevent intermixing of water.
- .6 After grouting is completed, cut off casing squarely and neatly 450 mm above ground level.
  - .5.1 and Cover casing with screwed or flanged cap satisfactory to the Owner.
- .6.7 Maintain accurate records of casing lengths and sizes installed.

#### 4.44.5 GRAVEL PACKING

- .1 Gravel used for gravel packing shall be clean, rounded, water washed quartz or granite gravel free of silt, clay, and other deleterious materials. Gradation will be decided by the Owner after analysis of aquifer samples.
- .2 Place gravel packing by approved methods to details indicated or as directed.
- .2.3 Store gravel packing in manner which avoids contamination.

#### 4.54.6 GROUTING AND SEALING

- .1 Seal casing of well extending into consolidated formation into upper 1.5 m of formation by grouting with neat cement grout.
- .1 Neat cement grout shall be a mixture of Type 10 Portland cement in accordance with CSA A3000 with 3 % by volume bentonite clay added and not more than 880 L of water per cubic metre of cement.

- .2 Grout annular space around casing to details indicated or as directed by the Owner.
- .3 Place grout from bottom up by approved methods.
  - .3.1 Place grout in one continuous operation with entire amount placed before initial set occurs.
- .4 Use retainer, packer or plug at bottom as necessary to ensure grout does not leak into wall.
- .5 When further drilling is required after grouting, do not drill until 72 hr minimum after complete placement of grout.

#### 4.64.7 DISINFECTION

- .1 After well has been completely constructed, thoroughly clean the well to remove of foreign substances, including tools, timbers, rope, cement, oil, grease, joint dope and scum.
  - .1 Thoroughly swab casing pipe using alkalis if necessary to remove oil, grease or joint dope.
  - .2 Disinfect well in accordance with AWWA C654.
- .3 During final test pumping, obtain two samples of water for bacteriological analysis and a sample for chemical analysis one half hour after start of test pumping and again during last 15 min of test pumping. Total of six (6) samples. Submit samples to the designated laboratory, as approved by the Owner.

#### 4.74.8 TEST PUMPING

- .1 Test pumping equipment requirements:
  - .1 Pump with variable pumping rate up to capacity as indicated or directed and capable of operating a minimum of 54 hours or more without interruption. Equip with tachometer to measure pump motor speed.
  - .2 Discharge piping of sufficient size and length to conduct water being pumped during test to an approved point of discharge where it will not recharge aquifer, damage property or create nuisance
    - .2.1 Insure and equipped with valve is close to pump.
  - .3 Apparatus to measure rate of pump discharge shall be an orifice plate with transparent tube to measure water head upstream of plate, or a suitable water meter.
  - .4 Apparatus to measure pumping level shall be an electric sounder (or calibrated air line).

- .2 Conduct interim test pumping during construction as directed by the Owner.
- .3 Final test pumping shall be as follows:
  - .1 Pumping rate as directed.
  - .2 Testing time of 72 hours or as directed.
  - .3 After pumping commences record water level in well at following intervals: every minute for first 10 min, every 2 min for next 10 min, every 5 min for next 40 min, every 10 min for next 1 hour, every 30 min for next 3 hours, every hour for next 5 hours and every 2 hr to end of test.
  - .4 After test pumping has ceased, record water level at same time intervals as in subsection 4.7.3.3 of this specification until static water level is reached.
  - .5 Take temperature of water discharged from well during test pumping at intervals of 1 hour.
- .4 When test pumping is to be conducted after disinfection, swab with strong chlorine solution all parts of test pump coming into contact with well water prior to start of test pumping.
- .5 Should test pump fail during pump test, allow water to reach static level prior to recommencing test. No payment will be made for pump time prior to such failure.
- .6 Do not allow pumping level to fall below an elevation 2 m above top of well screen.

#### 4.9 WATER SAMPLING

- .1 Obtain 4 minimum water samples from well during test pumping for analysis by the Owner for suspended solids.
- .2 Supply field turbidity metre.
  - .1 Measure and record water turbidity every 30 minutes during pumping.
  - .3 During final test pumping, obtain two samples of water for bacteriological analysis and a sample for chemical analysis one-half hour after start of test pumping and again during last 15 min of test pumping. Total of six (6) samples.
- .4 Submit samples to the designated laboratory, as approved by the Owner.

4.84.10 WELL DEVELOPMENT

- .1 The contractor shall furnish all necessary pumps, compressors, plungers, bailing or other needed equipment that shall be necessary to effectively extract from the water bearing formation, the maximum practical quantity of sand, drilling mud and other fine materials in order to bring the well to maximum yield per foot of drawdown and to a sand-free condition. Compressed air, surge plungers, high velocity jetting equipment and pumps may be used for the development work. This work must be done in a manner that does not cause undue settlement and disturbance of the strata above the water-bearing formation nor disturb the natural seal affected around the well casing and thereby reduce the sanitary protection otherwise affected by such seal.
- .2 Development of the well shall be continued until water pumped from the well at the maximum test pumping rate is clear and free of sand. The water shall be considered sand-free when no samples, taken during test pumping, contain more than 5 parts per million of sand by weight.
- .3 Pumping or Bailing Method
  - .1 Development process shall be carried out by surging and bailing the well. The surging shall be done by a single or double solid (or valved) surge block. Surging shall start at the bottom of the lowest screen in the well and proceed upwards.
- .4 Hydraulic Jetting Method
  - .1 Development shall be accomplished by simultaneous high-velocity, horizontal-jetting and pumping. The outside diameter of the jetting tool shall be one inch less in diameter than the screen inside diameter. The minimum exit velocity of the jetting fluid at the jet nozzle shall be 46 m/s. The tool shall be rotated at a speed less than 1 rpm. It shall be positioned at one level for not less than two minutes and then shall be moved to the next level which shall be no more than 6 inches vertically from the preceding jetting level. The jetting shall proceed from the bottom of the screen to the top. Pumping from the well shall be at a rate of 5 to 15 percent more than the rate at which water is introduced through the jetting tool. Water to be used for jetting must contain less than 1 ppm suspended solids.
  - .2
- .5 Air Development Method
  - .1 Development shall be done by the utilization of single pipe air pumping system using the casing or the borehole itself as the eductor line. The compressors, air lines, hoses, fittings, etc., shall be of adequate size to pump the well by the air lift principle at 1½ to

2 times the design capacity of the well. The Contractor shall initially pump the well with air until the well is developed to the point that it yields clear, sand-free water. They shall then shut off the air and allow water in the well to return to a static condition. They shall then re-open the valve and re-introduce air into the well until water is again brought to the surface by the air lift, at which time they will close the air valve and allow the water to drop back down the well and return to a static condition. They shall repeat this lifting and dropping of the column of water until the water in the well becomes turbid at which time they will continuously pump the well with air until it again yields clear sand-free water. The Contractor shall repeat the above operations until the well no longer produces fine material when it is surged and backwashed as described above.

.2 The bottom of the air line shall be placed at different levels in order to facilitate development of all intake areas and multiple water-producing zones, and the process repeated until all zones yield water free of turbidity when surged and backwashed.

#### .6 Sand Content Testing

.1 The sand content shall be determined by averaging the results of five (5) samples collected at the following times during the intermediate pumping test:

- .1 15 minutes after start of the test,
- .2 after one quarter (1/4) of the total planned test time has elapsed,
- .3 after one half (1/2) of the total planned test time has elapsed,
- .4 after three quarters (3/4) of the total planned test time has elapsed,
- .5 near the end of the pumping test.

.2 The minimum volume of water sample collected for testing for sand content shall be the test rate of flow in gallons per minute (GPMpm) multiplied by 0.05.

.3 Sand content shall be determined in the following manner. When the circular orifice meter is used to measure flow rate, the sample shall be withdrawn from a measuring flow rate. On wells of a lower production rate, a sample may be collected directly from the full and open discharge. The sample shall be allowed to settle not less than 10 minutes before the liquid is decanted. The sand content as determined above shall not be greater than 5 ppm.

.4 Record of Measurement

.1 A record shall be made showing time, type of operation, pumping rate, and the sand content measured and recorded.

These records shall be submitted to the Owner or their representative.

4.94.11 AQUIFER TEST

- .1 Aquifer Test shall be as recommended in the Department of Environment and Climate Change, Water Resources Management Division, Aquifer Testing Guidelines.
- .2 Perform bacteriological and chemical water quality testing as required in the Department of Environment and Climate Change, Water Resources Management Division, Aquifer Testing Guidelines.

4.104.12 SEALING WELLS

- .1 Seal abandoned wells in accordance with the Department of Environment and Climate Change, Water Resources Management Division, Guidelines for Sealing Groundwater Wells.

**PART 5 PAYMENT**

**5.1 MEASUREMENT FOR PAYMENT**

- .1 Drilling in unconsolidated and consolidated formations will be measured in metres of each size hole drilled.
- .2 Supply and installation of casing will be measured in metres of each type and size of casing permanently installed.
- .3 Supply and install of drive shoes will be measured by the number of each size installed.
- .4 Supply and installation of screen will be lump sum if size listed in MERX Schedule of Quantities or to be negotiated after screen selection if size not specified.
- .5 Gravel packing will be measured in kilograms of gravel installed in well.
- .6 Grouting will be measured as number of 40 kg bags of Portland cement used in grouting.
- .7 Well development will be measured in hours during which Contractor is actually engaged in well development.
- .8 Disinfection of well will be lump sum.
- .9 Test pumping will be measured in hours during which pump is in operation to successfully complete a test.
- .10 Well seals and caps by the number of each size supplied and installed.

.11 Water quality testing will be lump sum.

5.2 BASIS OF PAYMENT

.1 All costs associated with the work outlined in this specification shall be deemed to be included in the appropriate unit and lump sum prices quoted as outlined in the Measurement for Payment subsection of this section and as included in the MERX Schedule of Quantities and Prices.

Not For Construction