

New Zealand Standard

Environmental Standard for Drilling of Soil and Rock

Amendment No 1
Appended

**NZS
4411:2001**

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This Standard was prepared by Technical Committee P 4411 for the Standards Council established under the Standards Act 1988.

Committee P 4411 consisted of representatives of the following:

- Auckland Regional Council (Maori Liaison)
- Local Government New Zealand
- Ministry for the Environment
- New Zealand Drillers Federation
- New Zealand Fruitgrowers Federation
- New Zealand Water and Wastes Association

ACKNOWLEDGEMENT

Standards New Zealand acknowledges the assistance provided by Ministry for the Environment, Auckland Regional Council and New Zealand Drillers Federation in the preparation of this Standard.

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Published by Standards New Zealand, the trading arm of the Standards Council, Private Bag 2439, Wellington 6020.

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Website: www.standards.co.nz

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No	Date of issue	Description	Entered by, and date

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RELATED DOCUMENTS

Reference is made in this Standard to the following:

NEW ZEALAND STANDARDS

- NZS/BS 21:1985 Pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions)
- NZS/BS 1387:1985 Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads
- NZS 2403:1991 Code of practice for deep geothermal wells
- NZS 3107:1978 Specification for precast concrete drainage and pressure pipes
- NZS 3122:1995 Specification for Portland and blended cements (General and special purpose)
- NZS/BS 3601:1987 Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes
- NZS 3879:1995 Solvent cements and priming fluids for use with unplasticized PVC (uPVC) pipes and fittings

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

- AS/NZS 1477:1999 PVC pipes and fittings for pressure applications
- AS/NZS 1554:- - - - Structural steel welding
Part 1:2000 Welding of steel structures
- AS/NZS 4765 (Int): 2000 Modified PVC (PVC-M) pipes for pressure applications

AMERICAN STANDARDS

- ASTM A106-99^{E1} Standard specification for seamless carbon steel pipe for high-temperature service
- API 5CT:1988 Specification for casing and tubing

AUSTRALIAN STANDARDS

- AS 1396:2000 Steel water bore casing
- *AS 3518:- - - - Acrylonitrile butadiene styrene (ABS) pipes and fittings for pressure applications
Part 1:1888 Pipes

*currently under revision

NEW ZEALAND LEGISLATION

Resource Management Act 1991

OTHER DOCUMENTS

Brown, L.J. 1990. New Zealand Water Well Driller's Guide to Logging Water Wells. New Zealand Geological Survey Report 145.

Mining Inspection Group, Ministry of Commerce: 1996, Health and Safety Guidelines for Shallow Geothermal Wells.

New Zealand Geomechanics Society: 1988, Guidelines for the Field Description of Soils and Rocks in Engineering Use.

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FOREWORD

The Environmental standard for drilling of soil and rock sets out the minimum national environmental requirements for:

- (a) The drilling of rock and soil;
- (b) The construction, testing and maintenance of bores; and
- (c) The decommissioning of drilled holes and bores.

The Standard aims to protect New Zealand's groundwater resources through the use of appropriate performance standards for drilling, bore construction, testing and maintenance, and the decommissioning of bores and holes. While the Standard addresses matters associated with the drilling and construction of bores in some detail, it also covers general drilling activities.

The Standard is relevant to bore owners, drillers and local authorities. It also applies to other contractors such as pump suppliers or drilling or irrigation engineers that may be involved in the construction, testing or maintenance of bores.

It is expected that the Standard will be used by local authorities as rules in regional or district plans, or as conditions to resource consents. The Standard can also be used by drillers and bore owners as a part of a contract to undertake the drilling activities described above.

The Standard sets out the minimum requirements that will apply nationally. However, from place to place local authorities may have additional requirements. These requirements may include rules, consents or permits for:

- (a) Drilling and/or bore construction;
- (b) Taking groundwater or geothermal water from a bore;
- (c) Earthworks associated with drilling;
- (d) Disposal of wastes down holes or bores;
- (e) Taking water for drilling;
- (f) Disposal of drilling fluid wastes and/or cuttings.

The Standard requires drillers and bore owners to be familiar not only with this document but also with the requirements of the relevant local authorities.

The Standard is written as a narrative, performance-based standard. It sets out what is to be achieved to meet this Standard, but allows the driller and the bore owner flexibility as to how the requirements of the Standard will be achieved.

This standard's development project has arisen as a result of a request from Auckland Regional Council who initiated a 3-year national project in July 1998 to set up and create a common standard for drilling activities in New Zealand. Support has been provided by regional councils, New Zealand Drillers Federation, environmental consultants, the Ministry for the Environment and other organizations involved with drilling activities.

The Standard addresses environmental matters associated with drilling. It does not address matters that are covered by other legislation or regulations (e.g. occupational health and safety). Also it is not a guideline, nor does it provide information of a training or advisory nature. Relevant supporting documents not referenced specifically in this Standard are:

Standards

NZS 4402:Part 6, Section 5.1:1988 Determination of the penetration resistance of a soil. Test 6.5.1 Standard penetration test (SPT).
AS 2368:1990 Test pumping of water wells.
American Society for Testing and Materials 1996. ASTM Standards on Ground Water and Vadose Zone Investigations: Drilling, Sampling, Well Installation and Abandonment Procedures.
American Water Works Association (ANSI/AWWA A100-97) 1998: AWWA Standard for Water Wells.

Training

Australian Drilling Industry Training Committee Limited 1996. Drilling: The Manual of Methods, Applications and Management.

Drilling, Bore Construction & Maintenance

Agriculture and Resource Management Council of Australia and New Zealand 1997. Minimum Construction Requirements for Water Bores in Australia.

Driscoll, F.G. 1995 (6th ed). Groundwater and Wells. Johnson Screens, St Paul, Minnesota 55112.

Heinz, W.F. 1994. Diamond Drilling Handbook. Sigma Press South Africa.

National Water and Soil Conservation Authority 1983: Commissioning and Maintaining a Water Well in New Zealand. A Guide to Good Practice. Water and Soil Miscellaneous Publication No 61.

Bore Testing

Brooks, T. 1998. Aquifer Test Guidelines. Canterbury Regional Council Report No R98 (10).

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REVIEW OF STANDARDS

Suggestions for improvement of this Standard will be welcomed. They should be sent to the Chief Executive, Standards New Zealand, Private Bag 2439, Wellington.

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Approved by the Standards Council on 11 July 2001 to be a New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 11 July 2001

The following SNZ references relate to this Standard:

Project No. P 4411

Draft for comment No. DZ 4411

Typeset by: Standards New Zealand

Printed by: Standards New Zealand

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NEW ZEALAND STANDARD

ENVIRONMENTAL STANDARD FOR DRILLING OF SOIL AND ROCK

1 PRELIMINARY AND GENERAL

1.1 Scope and Introduction

1.1.1

This Standard sets out the minimum national environmental performance requirements for drilling of soil and rock, the design, construction, testing and maintenance of bores, the decommissioning of holes and bores, and record keeping.

C1.1.1

This Standard is intended for application by being referenced in contracts and in resource consents and plans developed pursuant to the Resource Management Act 1991.

1.1.2

The drilling of blast holes, seismic shot holes or similar, where the hole will be destroyed upon construction, and where adverse effects on groundwater resources as a result of this activity are avoided are outside the scope of this Standard.

1.1.3

Drilling, construction, testing and maintenance of geothermal bores with a groundwater temperature in excess of 70 °C is outside the scope of this Standard.

C1.1.3

Such geothermal bores are covered by "Health and Safety Guidelines for Shallow Geothermal Wells" and by NZS 2403.

1.1.4

This Standard does not address contractual or health and safety matters.

1.1.5

Training and advisory information is not included in this Standard.

1.2 Interpretation

1.2.1

The word "shall" identifies a mandatory requirement for compliance with this Standard. The word "should" refers to practices which are advised or recommended.

1.2.2

Clauses prefixed by "C" and printed in italic type are intended as comments on the corresponding mandatory clauses. They are not to be taken as the only or complete interpretation of the corresponding clause, nor should they be used for determining in any way the mandatory requirements of compliance within this Standard. The Standard can be complied with if the comment is ignored.

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1.3 Definitions

For the purpose of this Standard, the following definitions shall apply:

ANNULUS. The space between the casing and the wall of the hole, or outer casing.

AQUIFER. Saturated rock or soil material capable of transmitting and yielding water in quantities sufficient for abstraction.

ARTESIAN. Groundwater confined under pressure in an aquifer so that the water in a bore intersecting the aquifer will rise above the top of the aquifer.

BORE. Any hole regardless of the method of formation that has been constructed to provide permanent access to the ground (for example for the monitoring of ground or groundwater conditions, extraction of groundwater or disposal of wastes).

BORE OWNER. Owner or operator of a bore or purchaser of drilling service(s). Includes an agent or technical representative of the bore owner.

DECOMMISSION. To permanently abandon a hole or bore or take a bore out of service.

DEVELOPMENT. The removal of rock and soil materials from the aquifer immediately surrounding a bore, to increase bore yield.

DRILLER. Company or person engaged by the bore owner to undertake a service(s) related to this Standard. Includes the bore testing technician, engineer or pump supplier.

DRILLING. Method of boring a hole into the ground predominantly by rotating, percussive or washing action. Excludes excavation of pits by digging, blasting or other forms of excavation, driven posts or driven solid piles.

DRILLING FLUID. Water or air-based fluid (liquid or gas) including additives.

DRILLING PROJECT. Overall scope of drilling required by the bore owner (for example, geotechnical investigation, water bore work-over).

GEOTECHNICAL. Investigation of soil/rock for engineering purposes.

GEOHERMAL WATER. Water heated by the earth to temperatures in excess of 30 °C. Geothermal water includes water, steam and water vapour and geothermal energy.

GRAVEL PACK. Material designed to provide zone of high permeability in the annulus around a bore screen.

GROUNDWATER. Water found in soil and rock. It includes geothermal water and groundwater that is contaminated.

GROUT. A fluid mixture of cement and/or bentonite and water used to provide a watertight seal in a bore annulus or hole. Grout can also be used to avoid corrosion of the bore casing or to provide structural support for casing materials.

HEADWORKS. All materials used at the ground surface to complete the bore. Includes pipework, valves, gauges and access points, concrete pads and/or cellars.

HOLE. Any hole that is created by drilling.

INVESTIGATION. Drilling of a temporary nature to investigate subsurface conditions.

LOCAL AUTHORITY. Statutory resource management agency. Includes regional councils, unitary authorities, district councils and city councils.

RISING MAIN. Pipe used to carry water from the bore to the ground surface.

SCREEN. Slotted or perforated material used to stabilize the aquifer or gravel pack while allowing groundwater to flow into the bore.

SPECIFIC DISCHARGE TEST. A test to determine the rate of bore discharge per unit of drawdown (commonly expressed as m³/day/m). A specific discharge test provides a broad measure of the performance of a bore.

TOXIC. Capable of causing ill-health in, or injury to, human beings and/or ill-health, injury, or death to any living organism.

WELL. Refer bore.

WELLHEAD. Refer headworks.

1.4 Regulatory requirements

1.4.1

The bore owner shall determine the relevant local authority requirements for the proposed works, including obtaining the necessary consents, and shall inform the driller of these requirements before drilling commences.

1.4.2

The bore owner and driller shall comply with the relevant local authority requirements to carry out the proposed works.

1.5 Experience and training

The driller shall be competent on the basis of relevant experience, training and skills to achieve the bore owner's specifications in accordance with this Standard.

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2 DRILLING, BORE DESIGN AND CONSTRUCTION

2.1 Scope

This section describes the minimum requirements for the drilling of soil and rock, the construction and maintenance of bores, and the decommissioning of holes and bores.

2.2 Completion

All holes shall, as soon as practicable, either be completed as bores in accordance with 2.5 and 2.6 or shall be decommissioned in accordance with 2.7.

2.3 Planning and design

2.3.1

All bore sites shall have sufficient open surroundings to avoid the accumulation of hazardous gases in the vicinity of the bore site, and allow access for maintenance, testing or decommissioning of the bore.

2.3.2

All water supply bores shall be positioned and/or constructed to avoid contamination from potential sources such as septic tanks, underground storage tanks, refuse dumps, effluent discharges (e.g. sewage or industrial waste discharges), or herbicide/pesticide use or preparation areas.

2.3.3

All bores shall be designed to consider the likely subsurface conditions during drilling, bore construction, testing, operation and maintenance to comply with the requirements of 2.4.

2.4 Materials

2.4.1 *Drilling fluid*

2.4.1.1 *Water*

Water used for drilling fluid shall be sufficiently clean to avoid the contamination of ground water. Where practical, water shall be obtained from a potable supply.

2.4.1.2 *Additives*

2.4.1.2.1

Chemicals or other drilling fluid additives that could leave a residual toxicity in groundwater shall not be used.

2.4.1.2.2

The use of additives shall be in accordance with the manufacturer's recommendations.

2.4.1.2.3

The driller shall have available the manufacturers' guidelines and safety data sheets for all additives used. This shall include instructions for handling, preparation, use, potential hazards, and disposal requirements for the additive and its container.

2.4.1.2.4

Adequate quantities of additives shall be available to the driller to control drilling conditions at all times.

2.4.2 Casing

2.4.2.1

All casing materials used (including temporary casing) shall be suitable in terms of its composition, cleanliness, strength and corrosion resistance for site and installation conditions, and the intended use of the bore.

2.4.2.2

The use of the casing shall comply with the manufacturer's recommendations.

C2.4.2.2

Acceptable casing materials include those shown in table 2.1.

Table 2.1 – Bore casing manufacturing Standards

Casing material	Standard number
Steel	NZS/BS 1387
	NZS/BS 3601
	AS 1396
	API 5CT
	ASTM A106
ABS	AS 3518
uPVC	NZS 1477
mPVC	AS/NZS 4765(Int)
Concrete	NZS 3107

2.4.2.3

Casing that is to be slotted or perforated shall be selected with appropriate allowances made for the weakening of the casing material due to slotting or perforation.

2.4.2.4

The casing diameter selected shall be sufficient to allow for unimpeded specified downhole operations.

2.4.2.5

For groundwater supply bores, the casing diameter shall be selected with regard to expected pumping requirements and pump efficiency.

2.4.3 Grout

All grout materials used shall be suitable in terms of its composition, density, strength and corrosion resistance for the site and installation conditions.

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2.4.3.1 *Cement*

2.4.3.1.1

Cement used for grout shall be to NZS 3122.

2.4.3.1.2

Cement shall be fresh and free from lumps.

2.4.3.1.3

Sulphate-resisting cement shall be used where sulphate concentrations exceed 1400 milligrams per litre (mg/l) in groundwater or 2300 mg/l in soil in a 2:1 water/soil extract.

2.4.3.1.4

Cement additives shall be functional under all expected service conditions.

2.4.3.2 *Bentonite*

Bentonite shall be a natural clay product free of substances that may either adversely affect the strength of the grout or grout setting time or adversely affect groundwater quality.

2.4.3.3 *Water*

Water used for grout shall be free of substances that may either adversely affect the strength of the grout or grout setting time, or adversely affect groundwater quality.

C2.4.3.3

Water can be expected to comply with 2.4.3.3 if it is:

(a) Potable;

(b) From a municipal water supply; or

(c) Clean and free from oils, acids, alkalis, salts, organic materials, and other substances that may be deleterious to grout or steel.

2.4.3.4 *Additives*

2.4.3.4.1

The driller shall have available manufacturers' guidelines and material safety data sheets for all grout additives. This shall include instructions for handling, preparation, use, potential hazards, and disposal requirements for the additive and its container.

2.4.3.4.2

Grout additives that could leave a residual toxicity in groundwater shall not be used.

2.4.4 *Screens*

2.4.4.1

All screen material used (including temporary screen) shall be suitable, in terms of its composition, cleanliness, strength and corrosion resistance for site and installation conditions and the intended use of the bore.

2.4.4.2

Appropriate screen slot size shall be selected with reference to aquifer and/or gravel pack grain size and grading.

2.4.5 Gravel pack

2.4.5.1

The gravel pack shall consist of non toxic, washed, rounded gravel, free of material that may decay or disintegrate during installation, development and bore use.

2.4.5.2

The gravel pack shall consist of rounded material of selected grain size and gradation. Thin, flat or elongated material, the maximum dimensions of which exceed three times the minimum, shall not be in excess of 2 % by weight.

2.4.5.3

No more than 5 % of the gravel pack shall be acid soluble (e.g. limestone).

2.5 Bore construction and maintenance

2.5.1 Casing

2.5.1.1

Bore casing shall be leakproof throughout its length.

2.5.1.2

Casing joints shall comply with the manufacturer's recommendations.

C2.5.1.2

Acceptable casing joints may be made using the references in table 2.2.

Table 2.2 – Standards for bore casing joints

Casing material	Type of joint	Title
Steel	Welded	AS/NZS 1554.1 (Category GP)
	Threaded	NZS/BS 21
uPVC	Solvent welded push sockets	NZS 3879

2.5.1.3

Casing joints shall be secure, leakproof, and suitable for the stresses placed on the joints during installation, bore testing and bore use.

2.5.2 Grouting / sealing

2.5.2.1

The annular space between the bore casing and the hole shall be sealed from the surface to whatever depth is necessary to prevent the contamination or pollution of groundwater by surface or shallow subsurface sources, to control subsurface pressures, and to prevent movement of the casing.

2.5.2.2

All aquifers and permeable zones of differing pressure, water quality, or temperature shall be sealed to prevent the interconnection and/or wastage of groundwater between aquifers and permeable zones.

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2.5.2.3

Where more than one aquifer or production zone is to be penetrated, the driller shall ensure that any specific local authority requirements for aquifer separation are met.

C2.5.2.3

The purpose of 2.5.2.2 and 2.5.2.3 is to prevent interconnection of aquifers of different water quality, temperature or pressure.

2.5.2.4

The minimum specific gravity of cement grout shall be of sufficient density to comply with 2.5.2.1 and 2.5.2.2.

2.5.3 Screening

The screen shall be securely sealed to the casing to prevent entry of rock or soil or gravel pack material into the bore.

2.5.4 Gravel pack

The gravel pack material shall fill the annulus extending from below the screen up to a level to prevent the top of the gravel pack settling to below the top of the screen during bore development, testing and use.

2.5.5 Headworks

2.5.5.1

All bore headworks materials shall be appropriate in terms of composition, corrosion resistance, and strength for the site and installation conditions, and the intended use of the bore.

2.5.5.2

All joints, valves and gauges used in headworks shall withstand the pressure and temperature of the bore under all conditions.

2.5.5.3

Bore headworks shall be constructed and maintained to prevent leakage of groundwater to waste, prevent movement of the casing, and prevent foreign material, surface water, spillage or other leakage entering the bore or annulus.

2.5.5.4

All holes or openings in the headworks shall be covered to prevent leakage or the entry of foreign material into the bore.

2.5.5.5

Bore headworks shall be protected at the surface to prevent damage and ensure continued compliance with 2.5.5.3 and 2.5.5.4.

2.5.5.6

If a bore is temporarily open, a cap shall be fitted to prevent leakage or the entry of foreign material into the bore.

2.5.5.7

To enable the measurement of bore water levels or pressures, access shall be provided which can be sealed when not in use.

C2.5.5.7

For example, access can be achieved by an airline, minimum 12 mm diameter hole and plug attachment, or pressure coupling to the side of the casing.

2.5.5.8

All rising mains or pumps shall be fitted with a device to prevent backflow.

2.6 Cleaning/disinfection**2.6.1**

All equipment used for drilling and bore construction and maintenance shall be sufficiently clean to avoid adverse effects on groundwater quality.

C2.6.1

The level of cleanliness required for drilling equipment shall be sufficient to avoid contamination of soil or water.

2.6.2

Disinfection of bores shall result in groundwater having no residual toxicity as a result of the disinfection process.

2.7 Decommissioning (abandonment)**2.7.1**

The bore owner shall ensure that all holes and bores not complying with 2.5 shall either be decommissioned or brought into compliance as soon as practicable.

2.7.2

Decommissioned holes and bores shall be backfilled and sealed at the surface to prevent adverse effects on groundwater quality.

2.7.3

Decommissioned holes and bores intersecting groundwater shall be sealed to prevent the vertical movement of groundwater, and to permanently confine the groundwater to the specific zone (or zones) in which it originally occurred.

2.7.4

Sealing materials shall comply with 2.4.3 and 2.5.2 and shall be placed from the bottom upward, by methods that will avoid segregation or dilution of material and the contamination of groundwater.

2.7.5

Backfill materials where used shall consist of grout, clean sand, coarse stone, clay or drill cuttings. The material shall be non-toxic.

2.8 Records

Records to be kept shall be in accordance with section 4 of this Standard.

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3 GROUNDWATER BORE PRODUCTION TESTING

3.1 Scope

This section applies to groundwater bore production testing by pumping, airlift or free flow (artesian) methods. It does not apply to specialist packer testing or “instantaneous” (slug/bail) tests.

3.2 Test planning

3.2.1 Advice

The driller shall seek advice from the relevant local authority on any particular bore testing requirements that may affect the type or duration of the test to be undertaken.

3.2.2 Selection of test method

3.2.2.1

Where there is no potential for adverse effects from the proposed bore use, and determination of approximate bore yield is the bore owner's only test requirement, a specific discharge test is acceptable.

3.2.2.2

Where accurate bore performance or aquifer information is required by the bore owner (for example to support a consent application), a pumping test shall be carried out.

3.2.2.3

Where distance drawdown information is sought, observation bore(s) shall be included in the test programme.

3.2.2.4

Tests specifically for pump selection shall be carried out in the completed bore.

3.2.3 Test duration and rate

3.2.3.1

Pumping test duration shall be sufficient to determine the effects likely to arise from the proposed bore use. The test duration shall be sufficient to define a stable trend in drawdown or discharge.

C3.2.3.1

For pumping tests, the abstraction rate should be approximately equal to or higher than the proposed bore abstraction rate.

3.2.3.2

The rate of abstraction in a pumping test shall remain constant throughout the test or test step (unless a constant drawdown procedure is employed).

3.2.4 General preparation

The driller and bore owner shall identify a groundwater disposal point to:

- (a) Comply with local authority requirements;
- (b) Avoid recharge influence; and
- (c) Avoid erosion, the discharge of sediment to surface water, or other potential adverse effects.

3.2.5

The driller shall assess whether nearby bores have the potential to affect the results of the bore test. If such effects are possible, pumping at any such bore shall be prevented or held constant during the test.

3.3 Test execution**3.3.1**

Discharge rate, time and groundwater level shall be measured simultaneously during a pumping test.

3.3.2

Groundwater levels shall be measured in the test bore and any observation bores before testing commences, over a minimum period of two hours, and preferably 12 to 24 hours, to assess background groundwater level fluctuations.

3.3.3

Groundwater levels shall be measured at a frequency sufficient to define trends clearly.

3.3.4

Groundwater level recovery shall be measured until groundwater levels reach approximately pre-test levels.

3.3.5

For pumping tests, groundwater level shall be measured to within $\pm 0.1\%$ (i.e. ± 10 mm at 10 m).

3.3.6

Groundwater level measurements shall be with reference to a defined datum (e.g. metres below ground level or Reduced Level).

3.3.7

Discharge rate shall be measured to within $\pm 5\%$.

C3.3.7

This accuracy is only practically achievable using an orifice weir or calibrated flowmeter.

3.3.8

All data shall be recorded on site, during or immediately after the test.

3.3.9

The bore shall be covered and secured following test completion.

3.4 Records

Test records shall include, as a minimum:

- (a) Test date(s);
- (b) Test method used (e.g. step drawdown);
- (c) Reference datum(s) for groundwater level measurements;
- (d) Test data (time, drawdown, flow rates) including measurement units;
- (e) Scaled site plan showing the location of the pumped bore and all observation bores; and
- (f) Bore logs and construction details for the pumped bore and observation bores.

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4 RECORD KEEPING

4.1 Scope

4.1.1

This section describes the information that shall be recorded for drilling which is covered by this Standard.

4.1.2

The record that shall be kept as a minimum is a drilling log.

4.2 Drilling log

4.2.1

The driller shall complete a drilling log for all drilling covered by this Standard.

4.2.2

The information recorded in a drilling log shall include that specified in 4.3, where applicable.

4.2.3

The drilling log shall be prepared as soon as practicable following the completion of drilling, bore construction, maintenance or testing, or decommissioning of holes and bores, or where appropriate, at the completion of each day or shift.

4.3 Information to be recorded on drilling log

The drilling log shall include the following written information.

4.3.1 *Drilling project information*

Drilling project information shall include the following:

- (a) Name of bore owner;
- (b) Location of the drilling project;
- (c) Description of drilling project;
- (d) Project number or job reference, and resource consent or permit number if applicable;
- (e) Name and address of driller;
- (f) Name of personnel on site including the driller, drilling crew, and supervisor;
- (g) Name of person preparing the drilling log;
- (h) A map, sketch or drawing of the drilling project area, showing the location of all holes and bores, and their location in relation to nearby pertinent features.

4.3.2 *Drilling and bore information*

Drilling information shall include:

- (a) Hole or bore number, location and grid reference;
- (b) Date and time of start and finish of drilling, or drilling shift where applicable;

- (c) Method of drilling;
- (d) Size of hole (diameter and finished depth);
- (e) Orientation of hole if not vertical (azimuth or bearing and angle);
- (f) Size (diameter, length) and type of casing and depth(s) of cased portion(s) of the bore;
- (g) Size (diameter, length) and type (materials, slot size, slot type) of screen(s), or liner(s), and depth of screened or lined intervals;
- (h) Description of types and quantities of annulus backfill or seal materials used including installation methods, and depths used.

4.3.3 Subsurface information

Subsurface information to be recorded shall include:

- (a) Depth of changes and discontinuities in rock and soil material;
- (b) An accurate description of rock and soil material drilled including colour, texture and composition of the material;
- (c) A description of the nature of the boundary between different soil and rock types (e.g. gradual or abrupt, as appropriate) and other relevant features such as fractures, or discolouration of the rock or soil.

C4.3.3

The description of soil and rock should be in accordance with: "Guidelines for the Field Description of Soils and Rocks in Engineering Use". However, for groundwater bore drilling, the description of soil and rock in accordance with: "Brown, L.J. New Zealand Water Well Drillers' Guide to Logging Water Wells" is acceptable.

4.3.4 Groundwater records

Groundwater records shall include the following:

- (a) Depths, dates and times at which groundwater is encountered;
- (b) Losses or gains in drilling fluid;
- (c) Depth to groundwater level at drilling breaks or at the completion of drilling, (note condition of hole, for example, cased or uncased) and date and time measured;
- (d) Depth to groundwater level at a reported time period following completion of drilling;
- (e) Where specified by the bore owner, the depth of groundwater samples collected including the quantity of the sample collected and the method of sample collection;
- (f) Where specified by the bore owner, a description of any field tests conducted on groundwater samples and the results;
- (g) Where specified by the bore owner, a description and results of bore testing carried out.

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4.3.5 *Equipment installation*

Records regarding installation of instrumentation or equipment shall include the following:

- (a) A full description of the type of equipment installed, (e.g. pump, inclinometer), including physical dimensions and construction materials;
- (b) Depth installed;
- (c) Methods used to protect equipment (casing cap or locks);
- (d) Construction log.

4.3.6

All subsurface measurements recorded in the drilling log shall be referenced to a datum (e.g. metres below ground level, metres RL) and shall include measurement units.

4.4 Lithological log

4.4.1

An interpretive lithological log shall be prepared by the driller where specified by the bore owner.

4.4.2

A lithological log shall summarize for each hole or bore, the information collected in 4.3.

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ENVIRONMENTAL STANDARD FOR DRILLING OF SOIL AND ROCK

AMENDMENT No. 1

REVISED TEXT

EXPLANATORY NOTE

This amendment extends the range of acceptable casing materials in Commentary Clause C2.4.2.2.

APPROVAL

Amendment No. 1 was approved on 24 July 2003 by the Standards Council to be an amendment to NZS 4411:2001.

Commentary Clause C2.4.2.2 (page 11)

Delete the first sentence and **substitute**:

Acceptable casing materials include but are not restricted to those shown in table 2.1. Alternatives may be used provided that they meet or exceed the minimum standards of the indicated materials.

(Amendment No.1, August 2003)

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