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APPENDICES

Appendix (1)

API Standard Thread Casing

Casing				Coupling			
O.D. (in)	Weight Ib/ft	Nominal thickness	Inside dia. in	Drift dai.	O.D. (in)	Short (in)	Long (in)
6	15.00	0.238	5.524	5.399	6.625	7.00	8.50
6	18.00	0.238	5.424	5.299	6.625	7.00	8.50
6	20.00	0.324	5.352	5.227	6.625	7.00	8.50
6	23.00	0.380	5.240	5.115	6.625	7.00	-
6	26.00	0.434	5.232	5.007	6.625	7.00	-
6-5/8	17.00	0.245	6.135	6.010	7.390	7.250	8.75
6-5/8	2.00	0.255	6.049	5.924	7.390	7.250	8.75
6-5/8	24.00	0.352	5.900	5.769	7.390	7.250	8.75
6-5/8	28.00	0.417	5.791	5.666	7.390	7.250	8.75
6-5/8	32.00	0.475	5.675	5.550	7.390	7.250	8.75
7	17.00	0.231	6.538	6.413	7.656	7.250	-
7	20.00	0.272	6.456	6.331	7.656	7.250	-
7	23.00	0.317	6.366	6.241	7.656	7.250	9.00
7	26.00	0.362	6.276	6.151	7.656	7.250	9.00
7	29.00	0.408	6.184	5.059	7.656	7.250	9.00
7	32.00	0.453	6.094	5.969	7.656	7.250	9.00
7	35.00	0.498	6.004	5.879	7.656	7.250	9.00
7	38.00	0.540	5.650	5.795	7.656	7.250	9.00

7-5/8	20.00	0.250	7.125	7.000	8.500	7.500	-
7-5/8	24.00	0.300	7.025	6.900	8.500	7.500	-
7-5/8	26.40	0.328	7.969	6.844	8.500	7.500	9.250
7-5/8	26.70	0.375	6.875	6.750	8.500	7.500	9.250
7-5/8	33.70	0.430	6.765	6.640	8.500	7.500	9.250
7-5/8	39.00	0.500	6.625	6.500	8.500	7.500	9.250
8-5/8	24.00	0.264	8.097	7.972	9.625	7.750	-
8-5/8	28.00	0.304	8.017	7.892	9.625	7.750	-
8-5/8	32.00	0.352	7.981	7.796	9.625	7.750	10.000
8-5/8	36.00	0.400	7.825	7.700	9.625	7.750	10.000
8-5/8	40.00	0.450	7.725	7.600	9.625	7.750	10.000
8-5/8	44.00	0.500	7.625	7.500	9.625	7.750	10.000
8-5/8	49.00	0.557	7.511	7.386	9.625	7.750	10.000
9-5/8	29.30	0.281	9.063	8.907	10.907	7.750	-
9-5/8	32.30	0.312	9.001	8.845	10.625	7.750	-
9-5/8	36.00	0.352	8.981	8.765	10.625	7.750	10.500
9-5/8	40.00	0.395	8.879	8.679	10.625	7.750	10.500
9-5/8	43.00	0.435	8.755	8.599	10.625	7.750	10.500
9-5/8	47.00	0.472	8.681	8.525	10.625	7.750	10.500
9-5/8	53.00	0.545	8.535	8.379	10.625	7.750	10.500
10-3/4	32.75	0.27	10.198	10.036	11.750	8.000	10.500
10-3/4	40.50	0.35	10.050	9.894	11.750	8.000	10.500
10-3/4	45.50	0.50	9.950	9.794	11.750	8.000	10.500
10-3/4	51.00	0.450	9.450	9.694	11.750	8.000	10.500
10-3/4	55.50	0.495	9.760	9.604	11.750	8.000	10.500
10-3/4	60.70	0.545	9.660	9.505	11.750	8.000	10.500
10-3/4	65.70	0.595	9.560	9.404	11.750	8.000	10.500

11-3/4	38.00	0.300	11.150	10.994	12.750	8.000	-
11-3/4	42.00	0.333	11.084	10.928	12.750	8.000	-
11-3/4	47.00	0.375	11.000	10.844	12.750	8.000	-
11-3/4	54.00	0.435	10.800	10.742	12.750	8.000	10.500
11-3/4	60.00	0.489	10.722	10.616	12.750	8.000	10.500
13-3/8	48.00	0.330	12.715	12.559	14.375	8.000	-
13-3/8	54.50	0.380	12.615	12.459	14.375	8.000	-
13-3/8	61.00	0.430	12.515	12.359	14.375	8.000	10.500
13-3/8	68.00	0.493	12.415	12.259	14.375	8.000	10.500
13-3/8	72.00	0.514	12.347	12.191	14.375	8.000	10.500
16	55.00	0.3125	15.375	15.188	17.000	9.000	-
16	65.00	0.375	15.200	15.062	17.000	9.000	-
16	75.00	0.4375	15.125	14.938	17.000	9.000	-
16	84.00	0.495	13.010	14.822	17.000	9.000	-
20	90.00	0.417	19.166	18.936	21.000	9.000	-
20	94.00	0.438	19.124	18.936	21.000	9.000	10.500

Appendix (1) continued

API Standard Thread Casing
Minimum joint strength of various API (Rolled)
(Tensile) in thousands lbs

O.D. (in)	Weight Ib/ft	Grade F-25	Grade H-4	Grade J-55	Grade N-80	Grade P-110	Grade J-55	Grade N-80	Grade P-110
6	15.00	108	-	-	-	-	-	-	-
6	18.00	-	179	239	278	-	278	232	-
6	20.00	-	-	-	314	-	-	366	-
6	23.00	-	-	-	371	-	-	432	565
6	26.00	-	-	-	-	-	-	-	646
6-5/8	17.00	121	-	-	-	-	-	-	-
6-5/8	2.00	-	195	259	-	-	299	-	-
6-5/8	24.00	-	-	320	373	-	370	430	562
6-5/8	28.00	-	-	-	434	-	-	511	669
6-5/8	32.00	-	-	-	506	-	-	582	762
7	17.00	118	160	-	-	-	-	-	-
7	20.00	-	191	154	-	-	-	-	-
7	23.00	-	-	30	350	-	344	400	-
7	26.00	-	-	345	402	-	395	460	602
7	29.00	-	-	-	454	-	-	520	681
7	32.00	-	-	-	505	-	-	578	756

7	35.00	-	-	-	554	-	-	634	031
7	38.00	-	-	-	600	-	-	688	900
7-5/8	20.00	138	-	-	-	-	-	-	-
7-5/8	24.00	-	227	-	-	-	-	-	-
7-5/8	26.40	-	-	333	387	-	378	439	-
7-5/8	26.70	-	-	-	446	-	-	505	661
7-5/8	33.70	-	-	-	513	-	-	581	760
7-5/8	39.00	-	-	-	596	-	-	676	885
8-5/8	24.00	161	-	-	-	-	-	-	-
8-5/8	28.00	-	-	-	-	-	-	-	-
8-5/8	32.00	-	295	393	-	-	437	-	-
8-5/8	36.00	-	-	448	522	-	499	581	-
8-5/8	40.00	-	-	-	589	-	-	655	858
8-5/8	44.00	-	-	-	654	-	-	729	952
8-5/8	49.00	-	-	-	729	-	-	812	1062
9-5/8	29.30	185	-	-	-	-	-	-	-
9-5/8	32.30	-	279	-	-	-	-	-	-
9-5/8	36.00	318	442	-	-	462	-	-	-
9-5/8	40.00	-	-	477	555	-	521	606	-
9-5/8	43.00	-	-	-	614	-	-	670	872
9-5/8	47.00	-	-	-	666	-	-	727	952
9-5/8	53.00	-	-	-	770	-	-	841	1100
10-3/4	32.75	196	265	-	-	-	-	-	-
10-3/4	40.50	-	338	450	-	-	478	-	-

10-3/4	45.50	-	-	518	-	-	550	-	-
10-3/4	51.00	-	-	585	680	890	622	624	-
10-3/4	55.50	-	-	-	750	981	-	798	-
10-3/4	60.70	-	-	-	-	1031	-	-	-
10-3/4	65.70	-	-	-	-	1180	-	-	-
11-3/4	38.00	222	-	-	-	-	-	-	-
11-3/4	42.00	-	336	-	-	-	-	-	-
11-3/4	47.00	-	-	507	-	-	-	-	-
11-3/4	54.00	-	-	593	-	-	526	-	-
11-3/4	60.00	-	-	668	778	-	614	-	-
13-3/8	48.00	260	352	-	-	-	694	807	-
13-3/8	54.50	-	-	545	-	-	454	-	-
13-3/8	61.00	-	-	613	-	-	614	-	-
13-3/8	68.00	-	-	695	-	-	695	-	-
13-3/8	72.00	-	-	-	868	-	-	868	-
16	55.00	258	-	-	-	-	-	-	-
16	55.00	258	-	-	-	-	-	-	-
16	65.00	-	230	-	-	-	-	-	-
16	75.00	-	-	662	-	-	-	-	-
16	84.00	-	-	753	-	-	-	-	-
20	90.00	341	461	-	-	-	-	-	-
20	94.00	359	487	-	-	-	-	-	-

Appendix (1) continued

Minimum Collapse of various API Sizes and grades of steel casing collapse, psi (no safety factor)

O.D. (in)	Weight Ib/ft	Grade F-25	Grade H-40	Grade J-55	Grade N-80	Grade P-110
6	15.00	1.540	-	3.620	4.740	-
6	18.00	-	-	-	5.690	-
6	20.00	-	-	-	7.180	10380
6	23.00	-	2.360	-	-	12380
6	26.00	1.370	-	3.060	-	-
6-5/8	17.00	-	-	4.250	5.550	-
6-5/8	2.00	-	-	-	7.110	7850
6-5/8	24.00	-	1.370	-	8.490	10290
6-5/8	28.00	-	1.920	-	-	12280
6-5/8	32.00	1.100	3.290	2.500	-	-
7	17.00	-	-	3.290	4.300	-
7	20.00	-	-	4.060	5.320	-
7	23.00	-	-	-	6.370	7220
7	26.00	-	-	-	7.400	9220
7	29.00	-	-	-	8.420	10700
7	32.00	-	-	-	9.80	12180
7	35.00	-	-	-	-	-
7	38.00	-	-	-	-	-

7-5/8	20.00	1.100	-	-	-	-
7-5/8	24.00	-	1.979	-	-	-
7-5/8	26.40	-	-	3.010	3.930	6180
7-5/8	26.70	-	-	-	4.910	6180
7-5/8	33.70	-	-	-	6.070	7880
7-5/8	39.00	-	-	-	7.530	10900
8-5/8	24.00	9500	-	1730	-	-
8-5/8	28.00	-	1.580	-	-	-
8-5/8	32.00	-	2.110	2.740	-	-
8-5/8	36.00	-	-	3.420	4.470	-
8-5/8	40.00	-	-	-	5.390	7420
8-5/8	44.00	-	-	-	6.320	9140
8-5/8	49.00	-	-	-	7.370	10660
9-5/8	29.30	80	-	-	-	-
9-5/8	32.30	-	1.320	-	-	-
9-5/8	36.00	-	1.710	2.220	-	-
9-5/8	40.00	-	-	2.770	3.530	-
9-5/8	43.00	-	-	-	4.280	4760
9-5/8	47.00	-	-	-	4.900	6120
9-5/8	53.00	-	-	-	6.110	8830
10-3/4	32.75	-	-	-	-	-
10-3/4	40.50	650	880	-	-	-
10-3/4	45.50	-	1.340	1.730	-	-

10-3/4	51.00	-	-	2.300	-	-
10-3/4	55.50	-	-	2.870	3.750	3750
10-3/4	60.70	-	-	-	4.420	5040
10-3/4	65.70	-	-	-	-	8540
11-3/4	38.00	620	-	-	-	6790
11-3/4	42.00	-	940	-	-	8540
11-3/4	47.00	-	-	1.630	-	-
11-3/4	54.00	-	-	2.270	-	-
11-3/4	60.00	-	-	2.840	-	-
13-3/8	48.00	560	740	-	-	-
13-3/8	54.50	-	-	1.140	-	-
13-3/8	61.00	-	-	1.670	-	-
13-3/8	68.00	-	-	2.140	-	-
13-3/8	72.00	-	-	-	2.880	-
16	55.00	290	-	-	-	-
16	65.00	-	640	-	-	-
16	75.00	-	-	1.010	-	-
16	84.00	-	-	1.480	-	-
20	90.00	340	440	-	-	-
20	94.00	414	500	-	-	-

Appendix (1) continued

Minimum Resistance of various sizes and degree of API casing to damage by internal pressure: in thousands of pounds

O.D. (in)	Weight Ib/ft	Thickness (inch)	Grade F-25	Grade H-40	Grade J-55	Grade N-80	Grade P-110
6	15.00	0.233	1.740	-	-	-	-
6	18.00	0.288	0.288	3.360	4.620	6.720	-
6	20.00	0.324	0.324	-	-	7.560	-
6	23.00	0.380	0.380	-	-	8.870	12.190
6	26.00	0.434	0.434	-	-	-	13.920
6-5/8	17.00	0.245	0.245	-	-	-	-
6-5/8	2.00	0.288	0.288	3.040	4.180	-	-
6-5/8	24.00	0.350	0.350	-	5.110	7.440	10.230
6-5/8	28.00	0.417	0.417	-	-	8.810	12.120
6-5/8	32.00	0.475	0.475	-	-	10.040	13.800
7	17.00	0.231	0.231	2.310	-	-	-
7	20.00	0.272	0.272	2.720	3.740	-	-
7	23.00	0.317	0.317	-	3.360	6.340	-
7	26.00	0.362	0.362	-	4.980	7.240	9.960
7	29.00	0.403	0.403	-	-	8.160	11.220
7	32.00	0.450	0.450	-	-	9.060	12.760

7	35.00	0.490	-	-	-	9.960	13.690
7	38.00	0.540	-	-	-	10.800	17.850
7-5/8	20.00	0.225	1.430	-	-	-	-
7-5/8	24.00	0.300	-	2.750	-	-	-
7-5/8	26.40	0.320	-	-	4.140	6.020	-
7-5/8	26.70	0.375	-	-	-	6.890	9.470
7-5/8	33.70	0.430	-	-	-	7.890	10.860
7-5/8	39.00	0.500	-	-	-	9.180	12.630
8-5/8	24.00	0.264	1.340	-	2.950	-	-
8-5/8	28.00	0.304	-	2.470	-	-	-
8-5/8	32.00	0.350	-	2.860	3.930	-	-
8-5/8	36.00	0.400	-	-	4.460	6.490	-
8-5/8	40.00	0.400	-	-	-	7.300	10.040
8-5/8	44.00	0.450	-	-	-	8.120	11.150
8-5/8	49.00	0.557	-	-	-	9.040	12.430
9-5/8	29.30	0.28	1.200	-	-	-	-
9-5/8	32.30	0.312	-	-	-	-	-
9-5/8	36.00	0.350	-	2.560	3.500	-	-
9-5/8	40.00	0.390	-	-	3.950	5.750	-
9-5/8	43.00	0.455	-	-	-	6.330	8.700
9-5/8	47.00	0.470	-	-	-	6.870	9.4400
9-5/8	53.00	0.545	-	-	-	7.930	10.900
10-3/4	32.75	0.350	-	2.280	3.130	-	-
10-3/4	40.50	0.279	1.140	1.820	-	-	-

10-3/4	45.50	0.400	-	-	35.580	-	-
10-3/4	51.00	0.450	-	-	4.030	5.860	8.060
10-3/4	55.50	0.490	-	-	-	6.450	8.860
10-3/4	60.70	0.545	-	-	-	-	9.760
10-3/4	65.70	0.595	-	-	-	-	10.660
11-3/4	38.00	0.300	1.120	-	-	-	-
11-3/4	42.00	0.333	-	1.980	-	-	-
11-3/4	47.00	0.7375	-	-	3.070	-	-
11-3/4	54.00	0.435	-	-	3.560	-	-
11-3/4	60.00	0.499	-	-	4.010	-	-
13-3/8	48.00	0.330	1.080	1.730	-	-	-
13-3/8	54.50	0.380	-	-	2.730	-	-
13-3/8	61.00	0.430	-	-	3.090	-	-
13-3/8	68.00	0.840	-	-	3.450	-	-
13-3/8	72.00	0.514	-	-	-	5.380	-
16	55.00	0.3125	850	-	-	-	-
16	65.00	0.375	-	1.640	-	-	-
16	75.00	0.4375	-	-	2.630	-	-
16	84.00	0.490	-	-	2.980	-	-
20	90.00	0.418	940	1.450	-	-	-
20	94.00	0.430	960	1.530	-	-	-

Source: API 1954

Appendix (2)

Drilling engineer: Job description and activities

Job description

A drilling engineer develops plans, costs, schedules and supervises the operations necessary in the process of drilling oil and gas wells. They are involved from initial well design to testing, completion and abandonment. Engineers are employed on land, on offshore platforms or on mobile drilling units either by the operating oil company, a specialist drilling contractor or a service company.

The role can involve administering drilling and service contracts, engineering design, the planning of wells and supervising the drilling crew on site.

Drilling engineers work with other professionals, such as geologists and geoscientists, to monitor drilling progress, oversee safety management and ensure the protection of the environment.

Typical work activities

Typical work activities include:

- preparing well data sheets;
- designing and selecting well-head equipment;
- drawing up drilling programmes, taking account of desired production flow rates;
- obtaining relevant data, carrying out analysis on site and recommending immediate actions as necessary;
- carrying out full engineering analyses of rig site data and preparing regular well reports;
- monitoring the daily progress of well operations and current daily costs, comparing actual costs with cost expenditure proposals and recommending changes or improvements to rig work techniques, which could lead to optimisation of expenditure;
- liaising with specialist contractors and suppliers, such as cement companies or suppliers of drilling fluids;
- monitoring safety and ensuring the good maintenance of the well;
- adhering to environmental protection standards, in some cases through direct discussion with local governments to ensure compliance with legislative requirements;
- establishing and administering drilling and service contracts;
- co-ordinating and supervising the work of the drilling team;

- undertaking engineering design and the planning of wells (including development work);
- designing directional well paths (horizontally or multi-laterally, as appropriate);
- managing operations on behalf of small clients;
- contributing to conceptual field development design;
- working with multidisciplinary professionals to evaluate the commercial viability of the well and monitor progress during drilling;
- returning the site to its natural environmental setting if drilling is not to be pursued.

Source: Drilling Engineer job description website

Appendix (3)

Local Agreement Version

Well Drilling Agreement

The following have been agreed to between (Company) …… first party and (client) …… second party:
1- The first party agreed to drill a well to the second party in ……..... with the specification and prices shown in the following bill of quantities:

Item No.	Description	Unit	Qty	Unit Price	Total price
1	Transportation	lot	1		
2	drilling ……. inches borehole	foot			
3	supply and installation of casing … inches	foot			
4	supply and installation of screen … inches	foot			
5	supply and installation of gravel	lot			
6	development and test	lot			
7	well cap	lot			
8	well file	lot			
9	total				

2- The first party agreed to start work within two weeks from the date of signing the contract.

3- The first party is not responsible of the quantity or the quality of water produced by the well.

4- The second party agreed to pay 50% of the total sum to the second party on signing this contract.

5- The rest amount (50%) is agreed to be paid after finishing the well.

The first party
Name: …….
Signature: ……...

The second party
Name: …….
Signature: ……...

Witness:
Name: ……
Signature: ……..
Name: ……
Signature: ……..

Appendix (4)

RULES OF TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION DIVISION OF WATER SUPPLY

CHAPTER 1200-4-9

WATER WELL LICENSING REGULATIONS AND WELL CONSTRUCTION STANDARDS

1200-4-9-.02 REQUIREMENTS. After the effective date of this regulation, applicants for driller's and installer's licenses shall meet the following requirements to qualify for licensing under the Act:

(1) Be at least 18 years of age;

(2) Have a minimum of two (2) years experience, prior to the date of application, working in the occupation for which a license is being sought;

(3) Complete grade 10 in high school or submit proof of equivalent achievement demonstrated by successful completion of approved short courses or written examinations. Up to four years of full-time employment may be substituted for equal years of education. This shall be in addition to the experience requirements in paragraph (2); and (4) Pass an examination as prescribed by the Board.

Authority: T.C.A. §§4-5-201 et seq., 69-11-106(1), and 69-11-107(d).

Administrative History: Original rule filed

February 21, 1990; effective April 7, 1990. Amendment filed October 12, 1998; effective December 26, 1998.

1200-4-9-.03 SATISFACTORY PROOF OF EXPERIENCE Satisfactory proof of experience shall consist of either of the following methods.

(1) A list of ten (10) wells the applicant has constructed or worked on during a minimum of the last two years prior to the date of making the application for a license. The information shall include for each well the following:

(a) Name and address of the owner or owners of each well;

(b) Location and intended use of each well;

(c) Major construction features such as depth, type of casing, backfill, yield and water quality;

(d) Date of completion; and

(e) Work done by applicant and approximate customer cost.

(2) Copies of occupational licenses or certificates covering two years and indicating that the applicant has

been engaged in the occupation for which a license is being sought.

Authority: T.C.A. §§4-5-201 et seq., 69-11-106(1), and 69-11-107(d).

Administrative History: Original rule filed

February 21, 1990; effective April 7, 1990.

1200-4-9-.04 APPLICATIONS

(1) All applications for licensing shall be submitted to the Director on the form prescribed by the Board and provided by the office of the Director.

(2) An application will not be accepted for processing unless the application is complete, accompanied by the fee required by the Act, and signed by the applicant.

(3) No fee received with an application will be returned. This includes the fee received from an applicant who fails to pass an examination or meet the requirements of Rule 1200-4-9-.02 (1),(2) and (3).

(4) The individual who signs the application must meet the requirements of Rule 1200-4-9-.02 and 1200-4-9-.05 (1).

(5) Applicants who do not meet the requirements of Rule 1200-4-9-.02(1), (2) and (3) will be notified that their application has been denied and the reasons therefore.

(6) Any person whose application has been denied may request in writing to the Board within thirty (30) days of receipt of the letter of denial, an informal meeting with the Board for the purpose of explaining, or supplementing the application. Based on the person's explanation, the Board may accept the application for processing.

(7) An applicant whose application has been denied may not file a new application for a period of thirty (30) days following the date of the letter of denial. A new application must be resubmitted with the required application fee.

Authority: T.C.A. §§4-5-201 et seq., 69-11-106(1), and 69-11-107(d).
Administrative History: Original rule filed
February 21, 1990; effective April 7, 1990. Amendment filed October 12, 1998; effective December 26, 1998.
Repeal and new rule filed December 1, 2004; effective February 14, 2005.

1200-4-9-.05 EXAMINATIONS.

(1) All applicants who meet the requirements of rule 1200-4-9-.02 (1), (2) and (3) will be required to take a written examination and thereafter appear before the Board for an interview.

(2) Written examinations to be given to applicants shall be approved by the Board.

(3) Applicants admitted to the written examination will be required to take a general examination related to borehole construction standards and related subjects including basic ground water hydrology.

Closed loop installer applicants are not required to take a general exam. All applicants will be required to take one or more specialty examinations

designed to test the competence and ability of the applicant to perform the work of a driller or installer. The specialty examinations may include, but are not limited to, the following:

(a) For Driller applicants:

1. Cable tool drilling;
2. Air rotary drilling;
3. Mud rotary drilling;
4. Reverse Circulation;
5. Monitor well;
6. Geothermal well drilling for closed loop geothermal boreholes; and
7. Well closure and abandonment.

(b) For Installer applicants:

1. Pump installation for water wells;
2. Installation of water treatment devices; and
3. Closed loop installation for closed loop geothermal boreholes.

(4) Examinations shall be offered at least four times annually in a manner and at a time and place prescribed by the Director. Applicants will not be allowed to carry any reference materials into either the written examination room or oral interview area. Each examination shall be monitored by such person(s) as may be designated by the Director, or by one or more members of the Board. No persons, other than members of the Board, monitors, and examinees will be permitted in the room while the written examination is being administered.

(5) The grade score d by each applicant on the written examination shall be posted in the space provided upon the examinee's application form. Each applicant will be notified of his or her grade scored on the examination by first-class mail, sent to the address appearing on the application.

(6) A minimum grade of seventy (70) percent on the general and seventy (70) percent on any other specialty exam category is required to pass the written exam, and be eligible for an interview with the Board. Individuals whose license or combination of licenses have been revoked, refused to renew or suspended must retake and pass all applicable exams.

(7) A person failing an examination may apply for reexamination the next time examinations are offered by the Department, but no sooner than thirty (30) days from the date of the previous examination.

(8) Interviews of applicants will be conducted before at least three members of the Board. Questioning by individual Board members to the quality and quantity of the applicant's experience will include, but not be limited to, the following:

(a) Where and when it was obtained;

(b) Types of equipment used;

(c) What was the applicant's level of responsibility;

(d) Familiarity of the applicant with addressing problems such as:

1. Construction techniques used in each type well drilled for each license applied for.

2. Operation of drilling equipment used in drilling wells or boreholes.

3. Installation techniques and principles of operation for pumps and or water treatment devices.

(e) Knowledge of State well construction standards; and

(f) Responsibilities of licensees to the well owner and the Department.

(9) Based on the applicant's answers to the questions in the interview, each Board member will vote for or against issuance of a license to the applicant. An applicant must receive a passing vote from a majority of the quorum present to be recommended for licensing.

(10) Applicants who pass both the written exam and interview with the Board will be recommended for licensing to the Commissioner.

(11) Holders of Tennessee Water Well Driller License who apply for a monitor or geothermal driller license before January 1, 2004, will not be required to appear for an oral interview provided they pass the required geothermal or monitor specialty exam.

(12) Experience as required in Rule 1200-4-9-.03 obtained in monitor well drilling or water well drilling by all applicants will satisfy the requirements of experience required for a geothermal well driller's license.

Authority: T.C.A. §§4-5-201 et seq., 69-11-106(1), and 69-11-107(d).

Administrative History: Original rule filed

February 21, 1990; effective April 7, 1990. Amendment filed October 12, 1998; effective December 26, 1998.

Repeal and new rule filed December 1, 2004; effective February 14, 2005.

1200-4-9-.06 LICENSES.

(1) Issuance. An applicant recommended by the Board and approved by the Commissioner or the Commissioner's designee shall be issued a license to engage in the type of business for which he has applied and has demonstrated a satisfactory level of competency to perform. The Commissioner or the Commissioner's designee may issue a restrictive license, which may allow a license holder to operate under limited conditions such as well closure operations only.

(a) Driller applicants shall be issued either one or combination of four licenses:

1. A water well driller license to construct wells for the production of water, (W for water wells).

2. A geothermal well driller license to drill closed loop geothermal boreholes and install closed loops in closed loop geothermal boreholes, (G for geothermal).

3. A monitor well driller license to construct wells for monitoring ground water, (M for monitor).
4. A well closure license to close and abandon wells, (C for well closure and abandonment).
(b) Installer applicants shall be issued one or a combination of three licenses:
1. A license to install pumps on water wells, (P for pump installation on water wells).
2. A license to install closed loops or droplines for heat transfer in closed loop geothermal wells, (L for closed loop or dropline installation in closed loop geothermal boreholes).
3. A license to install water treatment on water wells, (T for Treatment on water wells).
(c) A wallet-sized card bearing the name of the licensee, type or class of license, expiration date, license number and signature of the Commissioner or the Commissioner's designee will be issued to the licensee and shall be carried on the person whenever engaged in the well or drilling contracting or installer business.
(d) All licenses issued pursuant to these rules shall be valid for a period not to exceed one year and shall expire on July 31 following the date of issuance.
(e) Reciprocity to drillers and installers licensed in other states will be granted by the Department provided the applicant makes a written request for reciprocity and the applicant meets the requirements of the written exam as required under Rule 1200-4-9-.05, (6), the applicant is currently licensed in the state for the same category and in good standing in that state and reciprocal privileges have been granted by that state to a licensee in Tennessee. An oral interview will not be required.

(f) A licensee shall not allow any individual to operate under his license unless the individual to be supervised by the licensee is employed by the licensee and holds an installer or rig operator card. Proof of employment must be on file with the Department prior to commencement by the employee of any activities requiring supervision. Proof of employment shall consist of a notarized Affidavit of Supervision.

(g) All persons licensed by the Department under these rules shall keep the Department advised of their current address and must readily accept all mail sent to them by the Department.

1. The Department shall be notified of any change of address, phone number, company name or addition of a company name within thirty (30) days of the change.

2. For purposes of these rules, registered or certified mail sent with proper postage to the licensee's last known address shall be considered adequate notification regardless of whether it is accepted or returned unclaimed.

3. Because of the Department's duty to supervise license holders and because written communication is a necessary aspect of such supervision, a licensee's refusal to accept mail or failure to claim registered or certified mail is a violation of these regulations and may result in enforcement action.

(h) All holders of licenses shall, when requested by the Director of the Division of Water Supply, give twenty-four (24) hour advance notice to the Division of Water Supply upon which any well construction or reconstruction for any part thereof, any well closure, well development or the installation of any pumping equipment or water treatment devices shall take place. This notification shall include the owner's name, address and location of the work site.

(i) In order to renew any license or combination of licenses, the licensee shall submit to the Commissioner satisfactory proof of the required credit

hours of training approved by the Board of Ground Water Management or Director completed during the previous license year. Three (3) credit hours will be required to renew any license for the license period beginning August 1,
2004 and ending July 31, 2005. Five (5) credit hours will be required for all applicants who wish to renew a license or combination of licenses for all license years after July 31, 2005. First year license holders not previously licensed for any installer or driller category will not be required to obtain continuing education credits for their first year of renewal. Second and subsequent year license holders will be required to obtain continuing education credits thereafter to renew a license or combination of licenses.

(j) Approved training shall be designed to improve, advance or extend the licensee's professional skill and knowledge relating to the ground water industry such as well drilling, pump installation and water treatment courses. Training may consist of any of the following, provided there is satisfactory proof of completion acceptable to the Commissioner or Board:

1. Courses, seminars, workshops or lectures;

2. Extension studies and correspondence courses;

3. Papers published in professional journals and requiring peer review;

4. Lectures and scheduled courses at national or regional meetings of the National Ground
Water Association, Tennessee Water Well Association or its successors;

5. College-level or postgraduate course work given by accredited college or university.

6. Assignment of Credit

(i) For courses for which continuing education units (CEUs) have been assigned, one

CEU is equal to fifty minutes of instruction that is approved by the Board;

(ii) Credits shall be approved on an hour for hour basis for attendance at an approved training program;

(iii) Credits are approved on a two for one hour basis for the instructor of an approved program;

(iv) One credit hour is approved for attendance at the annual National Ground Water Association Convention or South Atlantic Jubilee;

(v) One credit hour is approved for attendance at a state association convention;

(vi) Credits are approved on a credit hour for credit hour basis for a course, seminar or workshop approved by the National Water Well Association for continuing education;

(vii) Credit hours may not be carried over to a new CEU cycle.

7. Procedures for Approval of Activities

(i) Activities submitted for approval shall be on a form provided by the Director and shall include the following information:

(I) Description of course or activity matter;

(II) Length of activities in hours;

(III) Name of instructor and qualifications;

(IV) Date, time and location.

(ii) A change in subject matter, length or instructor requires approval by the Director.

8. Proof of Continuing Education

(i) The licensee is responsible for the submission of proof of all approved training.

Inability of the applicant to substantiate credit hours submitted is grounds for disallowance of the credits in question.

(ii) Proof of continuing education consists of:

(I) Official transcripts from educational institution;
(II) A certificate or other documentation signed by the instructor or sponsor of the training attesting to the satisfactory completion of the training;
(III) Other documentation determined by the Director in light of the nature of training, to establish that training was actually received by the applicant.
(iii) A licensee who fails to satisfactorily complete the required continuing education credits due to an unusual event such as an incapacitating illness or similar unavoidable circumstances may make a written request to the Board of Ground Water Management for an extension of time. The board may set conditions as deemed appropriate to renew a license. All requests by licensees for an extension of time must be made in writing with supporting documentation.
(2) Renewal. Before a license can be renewed, a license holder in good standing must file an application for renewal on a form made available by the Director and submit with the completed application the annual fee as specified in the Act and continuing education credits on or before July 31 of each year.
(a) Upon approval by the Commissioner a renewal license will be issued for a period not to exceed one year and shall expire on July 31.
(b) A renewal certificate shall consist of a wallet-sized card in duplicate containing at least the name of the license, type or class of license, license number, expiration date and signature of the Commissioner or the Commissioner designee. One section of the card shall be kept with the original license certificate and the duplicate shall be carried by the licensee whenever engaged in the water well business

(c) If the application and fee for renewal of a licensee is not received by the Director by the date of expiration, that license cannot be renewed and the license holder must file a new application to obtain a valid license
(d) A duplicate license to replace any lost, destroyed or mutilated license will be issued by the Director upon receipt of written request from the licensee and a payment of fifteen dollars
($15.00) to cover the cost of reissuance.
(e) If a licensee's employees will at any time be in charge of well or borehole construction, or pump or water treatment installation, or closed loop installation in the absence of the licensee, he shall request the Director to issue a wallet-sized identification operator card for them. This card shall bear the name of the employee to whom it is being issued and the signature and license number of the licensee under whose supervision the work is being performed. The card shall be carried by the licensee's employee at all times at the work site.
(f) A decal shall be issued for identification purposes for each drilling rig, water truck, pump truck, and water treatment equipment vehicle used by a drilling contractor or installer. The decal shall be prominently displayed where it can be seen at all times from outside the vehicle.
(g) Decals furnished for drilling rigs and service vehicles are not transferable. The decals shall be removed and destroyed when a drilling rig or service vehicle is sold, traded or otherwise disposed of. A new decal for a newly acquired drilling rig or service vehicle will be provided without cost upon receipt of a written notice of acquisition of a different drilling rig or service vehicle.
(h) All drill rigs, water trucks, pump trucks, and water treatment equipment vehicles used by drillers and installers shall be permanently and prominently marked on the driver side door of the rig or vehicle for easy identification with the company name or name of the license holder.

The letters shall be bold in print, on a background of contrasting color, and not less than two (2) inches in height. Portable magnetic signs will not be allowed unless the signs are permanently attached to the vehicle.

(i) If the application, renewal fee or requirements for continuing education are not received by the Director by the date of expiration, the license shall expire. Expired licenses may be reissued without examination or board appearance if the renewal fee and application are submitted within twelve (12) months of the date of expiration, all requirements for continuing education have been met and no additional monies are owed to the Department.

Authority: T.C.A. §§4-5-201 et seq., 69-11-103(a)(2), 69-11-106(1), and 69-11-107(d). Administrative History:

Original rule filed February 21, 1990; effective April 7, 1990.

Amendment filed October 12, 1998; effective

December 26, 1998. Repeal and new rule filed December 1, 2004; effective February 14, 2005.

1200-4-9-.07 SUSPENSION AND REVOCATION.

(1) The Commissioner may suspend or revoke a license or operator card and/ or refuse to issue or renew a license or operator card if he finds that the applicant for, or holder of such license:

(a) Has intentionally made a material misstatement in the application for such license;

(b) Has willfully violated any provision of this chapter or any rule or regulation promulgated pursuant thereto;

(c) Has obtained or attempted to obtain, such license by fraud or misrepresentation;

(d) Has been guilty of fraudulent or dishonest practices;

(e) Has demonstrated a lack of competence as a driller of wells or as an installer;

(f) Has failed to comply with an order or assessment issued by the Commissioner; or

(g) Has been convicted of a felony.

(2) A holder of a license which has been revoked in accordance with this rule, after a waiting period of not less than one (1) year after the license was revoked, may petition the Commissioner for a hearing for reinstatement of his license.

(3) Upon suspension, revocation or non-renewal of a license or combination of licenses, the Commissioner may with advice from the Board, impose such terms and conditions as in his judgment shall be considered just.

(4) Any person whose license is suspended, revoked or non-renewed shall not perform the duties of a well driller or installer in the State of Tennessee, or work under the supervision of a licensed driller or installer.

Authority: T.C.A. §§4-5-201 et seq. and 69-11-105. Administrative History: Original rule filed February 21, 1990; effective April 7, 1990. Repeal and new rule filed December 1, 2004; effective February 14, 2005.

1200-4-9-.08 ROLE OF COMPLAINTS IN ENFORCEMENT DECISIONS RELATED TO LICENSEES.

(1) In making determinations as to whether to issue an order for corrective action, a penalty assessment, or a license revocation, the Commissioner may utilize information obtained from complaints by any persons.

(2) The Board may utilize its expertise to evaluate any complaints received from the public. The Board may then make a recommendation to the Commissioner as to what enforcement options are appropriate.

(3) In reaching these conclusions about enforcement action, the Commissioner and the Board may, in addition to any other investigation

conducted by the Division, interview both the complainant and the licensee who is the subject of the complaint.

(4) If a licensee takes action to correct any violation of the Act or rules that is the subject of a complaint, such action and the degree of the effectiveness of the action are factors to be considered by the Commissioner and the Board in their decisions regarding appropriate enforcement action.

Authority: T.C.A. §§4-5-201 et seq., 69-11-106(2), (3), and (4), and 69-11-107(a) and (d). Administrative History:

Original rule filed February 21, 1990; effective April 7, 1990.

Any person whose application is denied for any reason may request a review of the denial in accordance with the provisions of the Uniform Administrative Procedures Act (T.C.A. Section 4-5-101 et seq.) by filing that request with the Commissioner within thirty (30) days of receipt of the denial.

Authority: T.C.A. §§4-5-201 et seq. and 69-11-110(j). Administrative History: Original rule filed February 21,

1990; effective April 7, 1990.

1200-4-9-.10 WELL CONSTRUCTION STANDARDS.

These rules will apply solely to wells constructed for the production of water from underground sources and have no application to wells constructed for quarry blast holes or mineral prospecting, or any purpose other than production of water.

(1) Requirements

(a) No person shall construct, reconstruct, or repair, or cause to be constructed or reconstructed or repaired any water well; nor shall any person install, repair, or cause to be installed or repaired any pump, pumping equipment, water filter or water treatment device to be used on a

water well except in accordance with the provisions of the Wells Act (T.C.A. 69-11-101 et seq.) and these rules.

(b) Every well driller, within sixty (60) days after completion of a water well, shall submit a report on the construction or reconstruction of the well to the Department. The well completion report shall be made on a form provided by the Department or a reasonable facsimile approved by the Department.

(c) A Notice of Intent to drill water well must be submitted by the property owner or the licensed well driller to the Director in the manner prescribed by the Department, prior to commencement of drilling a water well in Tennessee. The licensed driller is required to have sufficient documentation that a Notice of Intent was submitted to the Division of Water Supply before beginning operations at a drill site. Sufficient documentation for a Notice of Intent being filed may include one of the following:

1. Fee receipt of the Notice of Intent.
2. Confirmation number of the Notice of Intent or other approved format approved by the Director and issued by the Department.

(d) The Notice of Intent fee or copy of the receipt for a Notice of Intent fee shall accompany the submission of the driller's report. No well or borehole shall be drilled unless the driller has documentation that a Notice of Intent has been filed. All well reports shall be submitted with documentation of the Notice of Intent fee being paid. Documentation of the fee being paid shall consist of the receipt originating from a Notice of Intent or money collected and enclosed with the original driller's report by the driller for the Notice of Intent. A Notice of Intent and fee is not required for well closure, deepening or reworking any water well or closed loop geothermal borehole. The amount of the Notice of Intent fee

shall be reviewed by the Department at least every five (5) years and shall currently be scheduled as follows:

1. Water wells for production of water per property site $75.00

(e) The requirement to furnish the Department a Notice of Intent fee payment shall not apply to water wells drilled in any local jurisdiction which is authorized, by private act or pursuant to the provisions of an adopted “home rule” charter, to regulate the location and construction of these wells and which has established a fee for the inspection of both geothermal and water wells approved by the Commissioner.

(f) A Notice of Intent fee shall not apply to any property owner, who within the past five years has filed a notice of intent and paid the fee for the same property. The property owner or driller must identify on the new Notice of Intent submitted for the property the identification number from the first Notice of Intent fee submitted.

(g) Checks returned for insufficient funds will be charged an established check processing fee and the Division will seek payment from the individual responsible for writing the check.

(h) A Notice of Intent shall expire one hundred and eighty days from the original date filed by the well driller or homeowner.

(i) When strict compliance with these standards is impractical, the driller or installer shall make application to the Department for approval of an alternative standard prior to the work being done. The Department may grant the request for an alternative standard if it determines the proposed standards offer an equivalent or higher level of protection to the environment. In an emergency or in exceptional instances, the Department will respond to a verbal request provided the applicant submits a written application within ten (10) days of the verbal application.

(j) Every well driller or person holding a well closure license, within sixty (60) days of abandonment of a water well, shall submit a report of the abandonment of the well or borehole to the Department. The abandonment report shall be made on a form provided by the Department or a reasonable facsimile approved by the Department. The report shall include the same information as required on the completion report and shall include specific information on how the well was closed and the placement and type of backfill placed in the well bore. The abandonment report shall be signed by the licensed driller or person holding a well closure license. All well closure reports shall include a diagram showing the location and distance in feet of the closed well from one specific landmark and septic system or sewer systems on the property.

(2) Location

(a) The construction of a water well is prohibited at other than a safe distance from any known potential source of contamination. The minimum safe distances shown in Table A shall apply for the sources of contamination listed therein:

(b) A water supply well may be constructed in an area subject to flooding provided the top of the water tight casing extends not less than two (2) feet above the one hundred (100) year flood plain.

(c) Relation to buildings, pits, and basements:

1. A well located adjacent to a building shall be so located that the center line of the well extended vertically will clear any projection from the building by not less than five (5) feet.

2. New wells shall not be constructed in pits or basements.

(d) New wells shall not be located closer than ten (10) feet from a property line. New wells located from ten (10) feet to twenty-five (25) feet from a property line shall require a minimum of thirty-five (35) feet of casing installed below land surface with impervious material such as

cement grout or bentonite chips, tablets or bentonite grout backfilled in the annular space to a depth of thirty-five feet.

TABLE A

MINIMUM DISTANCES TO SEPARATE WATER WELLS
FROM POTENTIAL SOURCES OF CONTAMINATION

SOURCES OF CONTAMINATION	MINIMUM DISTANCES
Animal pens or feed lots	100 feet
Leaching Pits; sewage lagoons	200 feet
Pit Privys	75 feet
Sewer lines	50 feet
Sludge and septage disposal sites	100 feet
Septic tanks and drain fields	50 feet
House to septic tank connections, if the line is tight	10 feet

(3) Source of Water Supply

(a) The source of water for any well shall be at least nineteen (19) feet below the surface of the ground.

1. In the event that no other ground water source is available, a source of less than nineteen (19) feet deep may be developed provided that:

(i) Prior to the installation of the casing in the well, the Division of Water Supply Central Office is notified by phone regarding:

(I) County and street address of the well

(II) Name and phone number of the well owner

(III) Street address of owner if different from address of the well

(ii) A minimum of ten (10) feet of casing is installed below ground surface.

(iii) The well is sealed from land surface to a minimum ten (10) feet below ground with either cement grout or bentonite.

(iv) The owner of the well is advised by the driller concerning the development of a water bearing zone less than nineteen (19) feet deep by

sending a written report to the homeowner and to the Division, at the time the completion report is submitted, containing the following advisory:
(I) The owner may need to place a chlorinator on the well to treat the water for potential problems with microbiological contamination.
(II) A shallow water bearing zone may be more subject to surface contamination surrounding the well and the well yield may diminish over time.
(III) The homeowner should provide a copy of the report and disclaimer to any prospective buyer prior to any resale of the property where the well is located.
(b) The driller shall develop the most favorable water-bearing zone(s) and seal off any source(s) of less desirable quality.
(c) It shall be the duty of any person attempting to construct a water well to seal off salt water, oil, gas, or any other fluid or material which might contaminate a source of fresh water.
(4) Drilling Fluids for Water Wells
(a) Water used during the construction of a water well shall be obtained from a public water supply, water well or protected spring box. Water taken from ponds, lakes, streams or other surface sources shall not be used.
(b) All water used shall also be treated with enough liquid bleach or hypochlorite granules to retain a free chlorine residual of at least two (2) parts per million.
(c) The driller shall denote on the water well report submitted to the Department from what source his drilling process water was obtained.
(d) Drilling fluids and additives shall be materials specified by the manufacturer for use in water well construction and approved by the Department.

(e) During the course of drilling a water well with air rotary equipment, a minimum of one (1) gallon of water per minute must be injected or added into the air stream. The amount of water injected shall be sufficient to control dust and to keep the hole cleaned out.

(f) The amount of rock drill oil used to lubricate down hole drilling hammers shall not exceed hammer manufacturer's recommendations. The oil used to lubricate the hammer shall be specifically designed for that purpose.

(g) Petroleum based products or byproducts spilled or leaked from a drill rig or pump truck in any quantity greater than one (1) quart shall be removed from the area within a twenty-five (25) foot radius around the well by the driller or installer responsible for the spill before the drill rig or pump truck leaves the site.

(5) Casing

(a) Wells drilled for the production of water shall be cased with watertight casing extending from at least nineteen (19) feet below the land surface to a minimum of six (6) inches above land surface. For wells located in areas subject to flooding, see rule 1200-4-9-.10(2)(b). For water sources less than nineteen (19) feet deep see Rule 1200-4-9-.10 (3) (a).

1. The watertight casing in wells constructed to obtain water from a consolidated rock formation shall be firmly seated and sealed below all crevices that release inferior quality water or mud into the well or to a depth of at least five (5) feet below the top of the consolidated rock whichever is greater.

2. The watertight casing in wells constructed to produce water from an unconsolidated aquifer (such as saturated gravel or sand) shall extend at least to the top of the aquifer or to a depth of 19 feet which ever is greater.

(b) Except as otherwise specified in these regulations, the permanent well casing shall:

1. Casing shall be new or in like new condition. Such casing or pipe shall not be used unless free of leaks, corrosion, and dents; is straight and true, and not out of round, seamless or welded, black or galvanized steel pipe conforming to the weights and dimensions given in Table B and meeting the American Society for Testing and Materials (ASTM) Standards A53-87b or A589-85. Reject pipe shall not be used;

2. Have watertight joints that may be welded, or threaded and coupled; and

3. Be equipped with a drive shoe if the casing is to be driven.

4. Pipe sizes that are not listed in Table B and are less than ten (10) inches in diameter shall match listed values as closely as possible.

5. Pipe sizes that are ten (10) inches in diameter or larger shall be Schedule 20 pipe as a minimum.

(c) Thermoplastic well casing may be installed in wells constructed to obtain water from unconsolidated aquifers (such as saturated gravel, sand or overburden) provided:

1. The casing is new;

2. The casting meets or exceeds the requirements of ASTM Standard F-480-88 and bears the NSF (National Sanitation Foundation) seal in each section of casing;

3. The Standard Dimension Ratio (SDR) shall not exceed 26;

4. The casing is installed after the borehole has been drilled to the final depth of the finished well, and no additional drilling takes place after the casing has been installed; and

5. Joints shall be solvent cemented with quick-setting cement, or threaded and coupled.

(d) In areas where the water is obtained from overburden above the consolidated rock surface, the casing shall be set at or just above the consolidated rock. A screen may be attached to the bottom of the casing or the lowermost few feet of the casing may be slotted or perforated to allow water to enter the well provided the top of the screen or the topmost perforation in the casing is at least 20 feet below land surface. The completed well shall be finished so that extraneous material such as sediment cannot enter the well.

(e) Water well casing shall extend a minimum of six inches above the finished land surface unless, site conditions dictate that the well head will be better protected below ground surface and the upper terminus is constructed in the following manner:

1. The casing is terminated just below ground surface in a watertight manhole cover.
2. The manhole cover lid and skirt shall be all cast steel or aluminum construction.
3. The manhole cover shall have a sufficient diameter to use a well cap below the manhole lid.
4. The manhole shall be secured by a concrete pad two inches thick and no less than 24 inches in diameter.
5. The manhole cover shall be equipped with a positive drain to an area where water cannot enter from flooding or where excessive runoff could back up through the drain to the well head. The drain may be located in the basement area of a house.
6. The manhole cover shall be clearly marked on the cover as a "water well".

(f) The upper terminus of the well head shall be capped with a watertight well seal or cap specifically designed for capping the well.

(6) Backfilling and Grouting

(a) The grout material used in the backfilling or grouting of a water well shall consist of a mixture of Portland Class A cement or quick setting cement in a ratio of not over six (6.0) gallons of water per ninety-four (94) pound sack of cement, or a high solids mixing bentonite grout with a minimum of 20% solids and a weight of no less than nine and two tenths (9.2) pounds per gallon as measured by a standard mud balance. The use of bentonite, in chip or tablet form, ranging in size from one-quarter inch (1/4) to three-quarters of an inch (3/4) will be allowed as an alternate seal to slurry grouting. The bentonite shall be mixed and applied in accordance with the manufacturer's recommendations. The use of low solids bentonite drilling clay designed for use as a drilling fluid to form a filter cake on the side walls of the borehole and to increase viscosity of water) is prohibited for use as a grout or sealing material except as an additive. Only bentonite grout, bentonite tablets, or bentonite chips approved by the National Sanitation Foundation (NSF) or American National Standards Institute (ANSI) certified parties as meeting NSF product standard 60 or 61 shall be approved by the Department as appropriate grouting or sealing material.

(b) For wells completed with either steel or plastic well casing, the annular space between the casing and borehole wall of the well from a depth of three (3) feet to ten (10) feet below land surface shall be backfilled with an impervious material of either cement grout or bentonite as defined in Rule 1200-4-9-.10 (6) (a) . The remaining annular space between the casing and borehole wall shall be backfilled with an impervious material or combination of materials such as cement, bentonite, sand, puddled clay or well cuttings. However, the department recommends that the remaining annular space between the casing and the borehole wall of the well to the bottom of the watertight casing, be filled with the same grout or sealing material used from three to ten feet.

(c) Placement of the backfill material shall be done in such a way that there are no bridges or gaps in the annulus. The top of the backfill material shall remain level with the land surface surrounding the well.
(d) If bentonite is used for backfill, it shall be placed in accordance with the manufacturer's recommendations. For example, the product "Holeplug" from Baroid requires the annular space in a well to be one and one half inches (1-1/2") in clearance or more when "Holeplug" three fourths inch (3/4") is used. The annular space must be a minimum of three fourths inch (3/4") in clearance in the event that "Holeplug" three eighths inch (3/8") bentonite is used.
(e) If cement based grout or bentonite based grout is used for backfill, it shall be placed around the casing by one of the following methods:
1. Pressure
The annular space between the casing and the borehole wall shall be a minimum of one and five-tenths (1.5) inches, and grout shall be pumped or forced under pressure through the bottom of the casing until it fills the annular space around the casing and overflows at the surface; or
2. Pumping
The annular space between the casing and formation shall be a minimum of one and five tenths (1.5) inches and grout shall be pumped into place through a pipe or hose extended to the bottom of the annular space which can be raised as the grout is applied, but the grout pipe or hose shall remain submerged in grout during the entire application; or
3. Other
The annular space between the casing and the borehole wall shall be a minimum of two (2) inches and the annular space shall be completely filled with grout by any method that will insure complete filling of the space, provided the annular area does not contain water or other fluid. If

the annular area contains water or other fluid, it shall be evacuated of fluid or the grout shall be placed by the pumping or pressure method.

(7) Well Screens

(a) Any water well finished in an unconsolidated rock formation shall be equipped with a screen or perforated pipe that will adequately prevent the entrance of soil or formation material into the well after the well has been developed and completed by the well contractor.

(b) The well screen shall:

1. Be of steel, stainless steel, plastic or other Department approved material and shall be of a strength to satisfactorily withstand chemical and physical forces applied to it during and after installation;

2. Be of a design to permit optimum development of the aquifer with minimum head loss consistent with the intended use of the well;

3. Have openings designed to prevent clogging and shall be free of rough edges, irregularities or other defects that may accelerate or contribute to corrosion or clogging; and

4. Be provided with such fittings as are necessary to seal the top of the screen to the watertight casing and to close the bottom. If the screen is installed through the casing, a packer, seal or other approved design shall be used to prevent the entry of ground water into the well through any openings other than the screen.

(c) Multi-screened wells shall not connect aquifers or zones which have differences in:

1. Water quality to the extent that intermixing of the waters would result in deterioration of the water quality in any aquifer or zone.

2. Static water levels that would result in depletion of water from any aquifer or zone, or significant loss of head in any aquifer or zone.

(8) Gravel-Packed Wells

(a) In constructing a gravel-packed well:

1. The gravel shall be composed of quartz, granite, or similar rock material and shall be clean, rounded, uniform, water-washed and free from clay, silt, or other deleterious material.
2. The gravel shall be placed in the annular space around the screens and casing by any method that will insure accurate placement and avoid bridging or segregation.
3. The gravel pack shall have a minimum thickness of at least one-inch and shall be placed a minimum of nineteen feet below land surface.
4. The gravel shall be disinfected using water with a free chlorine residual of at least 50 parts per million (ppm).
(b) The gravel pack shall not connect aquifers or zones which have differences:
1. In water quality that would result in deterioration of the water quality in any aquifer or zone.
2. In static water levels that would result in depletion of water from any aquifer or significant loss of head in any aquifer or zone.
(9) Large Diameter Wells
(a) Large-diameter bored or augered wells may be cased with concrete pipe provided such wells are constructed as follows:
1. The bore hole shall have a minimum diameter of six (6) inches larger than the outside diameter of the casing.
2. The annular space around the casing shall be filled with grout to a depth at least five feet below the static water level or twenty (20) feet below land surface, whichever is greater.
The grout shall be placed in accordance with the requirements of rule 1200-4-9-.10(6)(d).
3. The annular space around the casing below the grout shall be completely filled with sand or gravel that has been disinfected with water containing a free-chlorine residual of at least 50 parts per million (ppm).

4. The sand or gravel material shall be composed of quartz, granite, or similar rock material and shall be clean, rounded, uniform, water-washed and free from clay, silt, or other deleterious material.

(b) The wellhead shall be completed in the same manner as required for other water-supply wells.

(10) Well Development. Prior to completion of a well for water supply, the driller shall take all steps necessary to:

(a) Remove any mud, drill cuttings, or other foreign matter from the well that would render the well useless for its intended purpose;

(b) Correct any damage to the aquifer that might have occurred during drilling; and

(c) Disinfect the well.

(d) Fracturing as an aid in water well development:

1. Fracturing includes the use of explosives, acid or pumping fluids or air into water well in an attempt to increase the yield of the well. General water well disinfection procedure with chlorine is not considered fracturing. A licensed driller shall supervise fracturing and submit a rework report for each site.

2. Water used in fracturing must be obtained from a public water supply, water well or protected springbox and chlorinated a minimum of two (2) parts per million chlorine residual prior to injection.

3. Wells located closer than fifty (50) feet from known sources of pollution shall not be fractured. Known sources of pollution include but are not limited to septic tanks field lines and sewers.

4. All packers set in a zone to be fractured by fluid or air must be placed at depths greater than fifty feet below land surface or a depth greater than twenty feet below the bottom of water tight casing, or whichever is greater in depth from land surface.

5. The driller shall submit a report of driller within sixty (60) days upon completion of fracturing the well reworking the well, and denote in the comments section the zone fractured, water used and amount of pressure induced on each zone.

(11) Wellhead Completion

(a) The top of the casing shall be cut off smooth and level, be free from dents and cracks, and shall erminate at least six (6) inches above the land surface. All wells shall be capped with an approved well cap.

(b) Underground installations leading from the well shall employ a pitless adapter which does not require welding at the casing. Pitless units or adapters shall comply with the Water Systems Council's Pitless Adapter Division (PAD) PAS-1 (6th Ed., March 1987) and shall bear the PAD symbol of certification or shall otherwise have been approved by the Department.

(c) Pitless units or adapters shall be constructed and installed so as to prevent the entrance of contaminants into the well or potable water supply, conduct water from the well, protect the water from freezing, and provide access to water system parts within the well.

(d) Surface drainage shall be diverted away from the well head so that water is not allowed to stand around the casing.

Authority: T.C.A. §§4-5-201 et. seq. and 69-11-106. Administrative History: Original rule filed June 21, 1993;
effective August 5, 1993. Amendment filed October 12, 1998; effective December 26, 1998. Amendments filed
December 1, 2004; effective February 14, 2005.

1200-4-9-.11 INSTALLATION OF PUMPS, FILTERS, AND WATER TREATMENT UNITS. Primary responsibility for compliance with the provisions set forth herein for the installation of water well pumps, filters and water treatment units rests with the installer of these devices.

(1) The capacity of the pump shall be consistent with the intended use and yield characteristics of the well.

(2) The pump and related equipment for the well shall be conveniently located to permit easy access and removal for repair and maintenance.

(3) The base plate of a pump placed directly over the well shall be designed to form a watertight seal with the well casing or pump foundation.

(4) In installations where the pump is not located directly over the well, the annular space between the casing and pump intake or discharge piping shall be closed with a watertight seal designed specifically for this purpose.

(5) The well shall be properly vented at the wellhead to allow for pressure changes within the well. The vent shall be screened to prevent entry of insects.

(6) Any suction line installed underground between the well and pump shall be surrounded by six (6) inches of impervious material such as cement, or encased in a larger pipe that is sealed at each end.

(7) All conduits, valves and other plumbing fixtures used to convey water from a water-supply well to any building or other outlet shall be installed in accordance with manufacturer's requirements.

(8) All pressure tanks shall be installed above ground unless the tank is specifically designated by the manufacturer for below ground burial.

(9) The electrical wiring and equipment used in connection with the installation of a water well pump shall:

(a) Meet underwriters specifications;

(b) Be installed in accordance with the National Electrical Code or local codes and ordinances if the latter are more restrictive;

(c) Be equipped with a fused or circuit breaker disconnect switch.

(d) Be served by an entirely separate circuit from other equipment.

(10) Water filters and water treatment units shall be installed and serviced to accommodate water quality problems as determined by physical, chemical or bacteriological evaluation or field test; and the function of the equipment shall achieve the results specified by the manufacturer. In servicing and installing treatment units the sanitation of the water supply shall be protected.

Source: RTDEC website

Appendix (5)

Sample Job Description

Board Chair Job Description

The following description was adapted from materials from BoardSource. Note that materials apply to both for-profit and nonprofit unless otherwise noted.

1. Is a member of the Board
2. Serves as the Chief Volunteer of the organization *(nonprofit only)*
3. Is a partner with the Chief Executive in achieving the organization's mission
4. Provides leadership to the Board of Directors, who sets policy and to whom the Chief Executive is accountable.
5. Chairs meetings of the Board after developing the agenda with the Chief Executive.
6. Encourages Board's role in strategic planning
7. Appoints the chairpersons of committees, in consultation with other Board members.
8. Serves *ex officio* as a member of committees and attends their meetings when invited.
9. Discusses issues confronting the organization with the Chief Executive.
10. Helps guide and mediate Board actions with respect to organizational priorities and governance concerns.
11. Reviews with the Chief Executive any issues of concern to the Board.
12. Monitors financial planning and financial reports.
13. Plays a leading role in fundraising activities *(nonprofit only)*
14. Formally evaluates the performance of the Chief Executive and informally evaluates the effectiveness of the Board members.
15. Evaluates annually the performance of the organization in achieving

its mission.

16. Performs other responsibilities assigned by the Board.

Vice Chair Job Description

The following description was adapted from materials from Board Source. Note that materials apply to both for-profit and nonprofit unless otherwise noted.

This position in typically successor to the Chair position. In addition to the responsibilities outlined in the Committee Member job description, this position:

1. Is a member of the Board
2. Performs Chair responsibilities when the Chair cannot be available (see Chair Job Description)
3. Reports to the Board's Chair
4. Works closely with the Chair and other staff
5. Participates closely with the Chair to develop and implement officer transition plans.
6. Performs other responsibilities as assigned by the Board.

Committee Chair Job Description

The following description was adapted from materials from BoardSource. Note that materials apply to both for-profit and nonprofit unless otherwise noted.

1. Is a member of the Board
2. Sets tone for the committee work.
3. Ensures that members have the information needed to do their jobs.
4. Oversees the logistics of committee's operations.
5. Reports to the Board's Chair.
6. Reports to the full Board on committee's decisions/recommendations.

7. Works closely with the Chief Executive and other staff as agreed to by the Chief Executive.
8. Assigns work to the committee members, sets the agenda and runs the meetings, and ensures distribution of meeting minutes.
9. Initiates and leads the committee's annual evaluation.

Board Member Job Description

The following description was adapted from materials from BoardSource. Note that materials apply to both for-profit and nonprofit unless otherwise noted.

1. Regularly attends board meetings and important related meetings.
2. Makes serious commitment to participate actively in committee work.
3. Volunteers for and willingly accepts assignments and completes them thoroughly and on time.
4. Stays informed about committee matters, prepares themselves well for meetings, and reviews and comments on minutes and reports.
5. Gets to know other committee members and builds a collegial working relationship that contributes to consensus.
6. Is an active participant in the committee's annual evaluation and planning efforts.
7. Participates in fund raising for the organization *(nonprofit only).*

Board Secretary Job Description

The following description was adapted from materials from the National Center for Nonprofit Boards. Note that materials apply to both for-profit and nonprofit unless otherwise noted.

1. Is a member of the Board
2. Maintains records of the board and ensures effective management of organization's records
3. Manages minutes of board meetings

4. Ensures minutes are distributed to members shortly after each meeting
5.Is sufficiently familiar with legal documents (articles, by-laws, IRS letters, etc.) to note applicability during meetings

Board Treasurer Job Description

The following description was adapted from materials from the National Center for Nonprofit Boards. Note that materials apply to both for-profit and nonprofit unless otherwise noted.

1. Is a member of the Board
2. Manages finances of the organization
3. Administrates fiscal matters of the organization
4. Provides annual budget to the board for members' approval
5. Ensures development and board review of financial policies and procedures.

Source: Sample Job Description B of D (website)

Appendix (6)

Training Program Contents:

Program starts at 8:15 am and ends at 5:00 pm - Lunch is provided

8:15 – 8:30

Andrew Stone, Executive DiProgram starts at 8:15 am and ends at 5:00 pm - Lunch is provided

8:15 – 8:30

Andrew Stone, Executive Director, American Ground Water Trust, Concord, NH

OVERVIEW OF THE WORKSHOP PROGRAM

Costs of delivering water

Ground water as an economic resource

8:30 – 9:30

Jack Warburton, Senior Vice President, Brown and Caldwell, Seattle, WA

Steffran Neff, Northwest Asset Management Practice Leader, Brown and Caldwell, Seattle, WA

ASSET MANAGEMENT PRINCIPLES

Why "asset management" concepts are becoming increasingly important

Why a large withdrawal well user should develop an "asset" maintenance plan

Case studies of economic benefit (more gallons at less energy cost) of treating and maintaining wells.

Decision making models/ methods to select methods and timing of treatment

9:30 – 10:20

Neil Mansuy, Vice President, Subsurface Technologies, Kansas City, MO

DECLINE IN WELL PERFORMANCE

Chemical, microbiological and physical reasons for well problems

Understanding typical “declining yield” problems

Case studies of well yield declines attributable to encrustation

Diagnostic characteristics for rock wells, screened wells, horizontal wells and ASR wells

10:20 – 10:40 BREAK

10:40 – 11:20

Jack Sowers, Senior Field Sales Representative, Baroid Industrial Drilling Products, Yakima, WA

WELL DESIGN FOR HIGH CAPACITY PERFORMANCE

Importance of initial well design

Drilling fluids to ensure maximum well yield

The importance of post-construction well development

11:20 – 12:10

Jim Bailey, Principal Hydrologist, Kleinfelder, Bellevue, WA

METHODS FOR IMPROVING WELL PERFORMANCE

Key well performance indicators

The Full Tool-Kit of treatment options

Mechanical Methods

Chemical Methods

How do decide on treatment options

Solving well performance issues in the Northwest

12:10 – 1:10 LUNCH

1:10 – 1:50

Henry Hunt, Project Manager, Collector Wells International, Columbus, OH

ALTERNATIVE WELL DESIGNS

When to consider a horizontal collector well

Advantages of riverbank filtration well systems

Maintaining high yields from large diameter wells

1:50 – 2:30

Jeremy Osborne, Program Controls Manager, MWH, Cape Coral, FL

ASSET MANAGEMENT STRATEGIES

How to compile and interpret true costs

Assessment of well field economics in the context of overall Utility assets

Value of an economic model template in rehabilitation/ replacement decisions

2:30 – 3:30

Tom Morris, Hydrologist, ASR Systems, Las Vegas, NV

PREDICTIVE MAINTENANCE PROGRAMS FOR PRODUCTION WELLS

Identification of the well facility processes that can be measured and evaluated

Definition of baseline performance and monitoring programs

How to manipulate data to evaluate aquifer, pump or wellbore issues

How to determine the costs of well performance losses

WELL PERFORMANCE TRACKING SOFTWARE

Efficiency indices used to maximize cost savings by deciding when to repair, rehabilitate or replace

Explanation of the Well Field Maintenance Guide and Performance Tracking Software

All participants will be provided with complimentary CD copies of the: "Well Performance Tracking Software" and "Wellfield Maintenance Guide"

3:30 – 3:40 BREAK

3:40 – 4:40

Neil Mansuy, Vice President, Subsurface Technologies, Kansas City, MO

PREVENTION IS MORE COST EFFECTIVE THAN CURE

Cost / Benefit evaluation of well rehabilitation techniques

Case studies on effective well maintenance

Preventive maintenance procedures

4:40 – 5:00

WORKSHOP WRAP-UP

Questions (all presenters)

Attendance sign-out

5:00pm

ADJOURNMENT rector, American Ground Water Trust, Concord, NH

OVERVIEW OF THE WORKSHOP PROGRAM

Costs of delivering water

Ground water as an economic resource

8:30 – 9:30

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Why a large withdrawal well user should develop an "asset" maintenance plan

Case studies of economic benefit (more gallons at less energy cost) of treating and maintaining wells.

Decision making models/ methods to select methods and timing of treatment

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Case studies on effective well maintenance

Preventive maintenance procedures

4:40 – 5:00

WORKSHOP WRAP-UP

Questions (all presenters)

Attendance sign-out

5:00pm

ADJOURNMENT

Source: American Trust website

Appendix (7)

WB + AD Morgan

Our new Klemm 709W drill rig

Assets

Drilling rigs

- 1 x Klemm 709W top head drive rotary drill rig mounted on new 8 x 4 Mercedes Actros 32/35 truck ***more info***
- 2 x Beretta T151 compact drill rig track mounted ***more info***
- 1 x Halco V666 Varitork on 6x4 chassis
- 1 x Halco Tiger on 4x4 all wheel steer chassis / low ground pressure wheels
- 1 x Knebel Drilling A/S HY-97T-BR

Compressors

- 1 x Ingersoll Rand 17/25 trailer mounted
- 2 x Ingersoll Rand 17/25 compressors mounted on Daf LF45 trucks with integral hose reels.
- 1 x 400 175 Ingersoll Rand tow-able

Our new Ingersoll compressors

Ancillary equipment

- Grout mixers
- Mud pumps
- Grout pumps
- Various petrol/diesel trash and water pumps
- Portable bunded fast-tow fuel tankers
- 1 x Mini excavator

Support vehicles

- 1 x 110 Hi Cap Landrover
- 5 x Toyota Hi-Lux 4x4
- 4 x VW Service Vehicles
- 1 x 4x2 18 tonne Mercedes flatbed with Palfinger Crayler rear mounted rough terrain fork lift truck **[NEW 2007]**
- 1 x 6x4 Mercedes tractor unit with 23 tonne/metre

Palfinger PK23002 crane **[NEW 2007]**

Mobile Mud Cleaning Machine [NEW 2006]

- 1 x MC80 high performance mud cleaner mounted on a 14m trailer.The MC80 unit includes a double deck VSM 300 [***more info***] [**press release**]

Available to hire

- Wide range of test pumps and generators to 80 KVA
- Bunded fuel facilities
- Mobile weir tanks
- Discharge pipes and water meters
- Diesel engine water pumps

Full workshop facilities for servicing and repair, including large diameter test well.

Additional information

Klemm 709W top head drive rotary drill rig mounted on new 8 x 4 Mercedes Actros 32/35 truck.This rig has automatic rod handling and carries 160m x 140mm diameter heavy-duty drill rods in its magazine. The machine is fitted with safety trip wires and interlocked guards to meet the latest H & S requirements. The hydraulic system has been designed for use with biodegradable oils and its Caterpillar 3056 DI-T power pack meets all current European emissions and is EPA certified. The Mercedes 32/35 also meets all current emissions legislation and is fitted with disc brakes and ABS as added safety features.

The rig is equipped with a 10m mast and has both a service winch and heavy-duty winch of 6.6 tonnes capacity. The rig has 508mm clamping and breaking tables to facilitate ease of use during rod change and handling of casings from 150mm diameter to 500mm, thus considerably minimising manual handling.

This machine has a depth range of 300m+ and is especially suited to difficult drilling conditions due to its high torque, variable speed, hydraulic top drive head.The machine is fitted with 3" hoses to facilitate either air flush or fluid drilling and perfectly partners the MC80 Mud Cleaning system.We believe this will be the most advanced water-well drilling package currently available in the UK and is ideally mated to our environmental objectives and code of safe working practice.

Beretta T151 drill rig, built in Milan by Beretta Alfredo srl, this compact tracked rig powered by a 98kW Deutz engine, it has a small footprint, and can even be operated by remote radio control if needs be.

Drilling to a diameter of 324mm its dual head system contra-rotates the outer casing, so achieving terminal depth is faster, particularly in unstable overburdens. There is a triple clamping system for surface casings and drill rods, and the centre clamp has a 30 tonne jack-up system - exceptionally powerful for this size of machine - essential to retrieve stuck surface casings.

It is ideally suited to drilling geothermal boreholes where space is at a premium.

Environmental issues are fully addressed, as a fitted preventer system discharges arisings horizontally through a pipe into a skip, helping keep the site clean.

This equipment was added to our assets in 2007.

MC80 mobile high performance mud cleaner. Mounted on a 14m trailer, the unit includes a double deck VSM 300, fifth generation, shaker mounted on a hollow section steel frame with underflow tank, mud feed chute, clean mud compartment, Svedala 100 x 75 centrifugal hydrocyclone feed pump with 22 kw motor, 4 No. 5" hydrocyclones, interconnecting pipework, fold-up front access platform, 3 phase compressor, electrical controls and 15m of armoured power cable.

The shaker used on the MC80 is a Rigtech VSM 300, high performance, linear motion, double motor shaker with inverter speed control. It has a top deck that uses pre-tensioned panels held in place by pneumatic bladders. The top deck is normally fitted with 10 to 30 mesh screens for the removal of clay balls, lumps of soil, grass, roots, timber, gravels, course sands and other large particles. The lower deck uses 4 No. pre-tensioned stainless steel, fine mesh screen panels with pneumatic screen clamping. Lower deck screens of 84, 105, 140, 165, 200 or 250 mesh.

Source: WB+ AD Morgan website

Appendix (8)

-Water Well Drilling Agreement Example

This agreement is designed to prevent misunderstandings between the well owner and drilling contractor. It benefits both parties and can establish costs for materials and services.

.Identification

Items 1-4 identify the parties involved in the agreement.

1. Well owner

_____

Address _____

2 Drilling contractor

_____

Address

_____

Drilling contractor approval no.

_____

3. Land location of well

Qtr_____ Sec _____ Twp_____ Rge_____ W

of_____ Meridian

Lot_____ Block_____

Plan_____

4. Proposed starting date

_____

Proposed completion date

_____

.Water Requirements

5. Proposed well use: Household_____ Livestock_____ Irrigation_____

The well use should be specified as being for household, livestock, irrigation or a combination. Municipal and industrial wells are usually covered by a detailed contract.

6. Desired water quality

Finding water with suitable water quality is important for all water uses. A drilling contractor can use a field testing kit to get a rough estimate of some parameters such as iron, hardness, pH and total dissolved solids, but only the tests done in a laboratory are really reliable.

The laboratories use the Guidelines for Canadian Drinking Water Quality to assess water quality. If testing shows some of the parameters are higher than these guidelines, water treatment equipment may be necessary.

7. Desired yield _____L/s (gpm) Min. acceptable yield _____L/s (gpm)

The desired yield is the flow rate of water, in gallons per minute (gpm), from an individual well. To calculate the desired yield, refer to the worksheet "Average Daily and Annual Water Requirements" in Module 2, "Planning Your Water System". Using this worksheet, calculate your daily and peak water use requirements. In some areas the desired yield is simply not available because of slow yielding aquifers. In such cases, the desired yield should be expressed as the normal yield for the area. A certain minimum yield should be established so if the well produces less than this minimum, it is not considered economically feasible to develop as a water well.

8. Groundwater supply options based on existing records _____

The well driller or well owner should review groundwater information on local wells to determine appropriate design considerations. Information is available from the Groundwater Information Centre.

.Well Construction

9. Maximum desired depth_____ m (ft.)

A maximum desired depth should be established. Factors affecting this include the known depth of productive aquifers, and the water quality at the various depths. Also personal finances will be a factor.

Consolidated Bedrock,

Paskapoo Formation Sandstone units — 30 to 60 m (100 to 200 ft.)

10. Type of drilling

_____

11. Diameter of hole

_____

The type of drilling equipment, aquifer composition, yield required and depth determine the type of well produced. Rotary drilled and cable tool drilled wells are typically 100-200 mm (4-8 in.) in diameter; bored wells range in diameter from 45-90 cm (12-36 in.).

The water well drilling industry is required by law to construct wells with casings 102 mm (4 in.) or more to accommodate submersible pumps.

12. Flowing well control

_____

In cases where a flowing well is anticipated, provision must be made to equip the well with a control device that allows the flow to be shut off completely and to prevent freezing.

13. Well connection

_____

Where the connection of the pumping equipment to the well casing is made below the ground surface, a pitless adaptor is required under the

Water (Ministerial) Regulation. Well pits are no longer permitted. If a jet pump is being used, a pump house that houses only the well and the pumping equipment is allowed.

14. Formation logging procedure

Logging the geological formations during drilling provides key information about aquifer location and quality. The information is especially important to accurately place well screens. There can be several types of formation logging.

_ Descriptive logging records the material encountered as drilling proceeds (lithology).

_ Electric logging, or E logging, verifies and supplements descriptive logging. It can only be performed in an uncased hole that is filled with drilling fluid. Basically it reveals the character of the material and relative quality of water in the formation. A limited number of drilling contractors in Alberta possess this equipment.

_ Gamma-ray logging can be performed in cased holes without drilling fluid and reveals the character of the material present. Very few drilling contractors in Alberta have this equipment. A combination of descriptive logging and electric or gamma-ray logging provides very accurate information about the formations through which the well is constructed.

15. Annulus or casing seal

All wells must be constructed to prevent contaminated surface water from entering groundwater aquifers through the space (annulus) between the well casing and the bore hole.

The annulus must be filled from immediately above the producing zone up to ground surface.

The method of sealing is dependent on the type of rig the driller operates and design of the well.

16. Artificial sand pack

_____

The grain size distribution of the aquifer affects the efficiency of the screen during development. If the aquifer has a relatively uniform grain size, a well cannot be effectively developed without the installation of an artificial sand pack. This "pack" provides a natural filter which holds back the finer aquifer materials.

17. Well Development Method

Backwashing_____ Jetting_____ Surging_____

Heavy pumping_____ Bailing_____

By regulation, the drilling contractor is responsible for ensuring a well is completed in a manner that ensures no damage will be incurred to the pumping system, plumbing or fixtures due to sediment in the water. If a newly constructed well produces sediment, it is usually because the drilling contractor did not properly develop it. Different types of well completion require different development techniques. In the rare case where a well cannot be adequately developed to produce sediment-free water, a sediment filter could be installed in the water distribution system. However, this alternative should be used only when it is evident that sufficient development of the well has been done, and the landowner is in agreement.

18. Hydrofracing

_____

Hydrofracing is a development technique used to increase well yield in bedrock aquifers.

It involves pressurizing the aquifer to increase the size of the fractures and thereby increase well production. This technique is used in poorly fractured bedrock aquifers.

.Material

19. Casing material

_____

Inside diameter_____ wt. per m (ft.)_____ wall thickness_____

20. Well cover *manufactured well cap*. Distance from top of casing to ground surface_____

Minimum requirement is 20 cm (8") above ground surface or 60 cm (2") above the highest flood record unless a watertight cover is used. A vented well seal (cap) or tight-fitting or vermin-proof well cover should be specified.

The well cap should be removable for monitoring water level in the well. Alternatively, for wells with difficult to remove caps, a cap with a hole leading to a dip tube can be used for easier monitoring of the water level. A removable plug should be used to plug the hole.

21. Liner material

_____

Inside diameter_____ wt. per m(ft.)_____ wall thickness_____

See Appendix 1. Plastic PVC or ABS casing lasts indefinitely because it does not rust through like metal casing. It should be protected at the ground surface with metal casing.

22. Screen

Manufacturer

_____

Length

_____

Material

_____

Nominal diameter

_____

Wells completed in unconsolidated aquifers, such as sand or gravel, should be screened.

The length of screen required depends on the volume of water to be pumped and the ability of the aquifer to transmit water.

.Yield Testing

23. Yield testing duration (hours)

_____

The drilling contractor should conduct a yield test following completion of the well.

The purpose of the yield test is to measure the well's yield so that the most suitable pumping equipment can be selected. This also serves as a benchmark for monitoring future well performance. The test should include the following information:

a) non-pumping (static) water level

b) water removal rate in gpm (L/s)

c) depth to the pumping water level as determined over a period of time at one or more constant pumping rates (drawdown)

d) the length of time the well is pumped at each rate

e) the recovery of the water level over a 2 hour period or until 90 percent recovery of the non-pumping water level is reached.

.Disinfection

24. Disinfection

_____

The well and new pumping equipment should be disinfected for a minimum of 12 hours with at least 200 mg/L of chlorine prior to use. Use Table 1, Amount of Chlorine to Obtain a Chlorine Concentration of 1000 PPM, and the example in Step 3 on page 51 to calculate the amount of chlorine for 1000 ppm. Then divide the total litres of chlorine by 5 to get the amount required for 200 mg/L.

25. Well head finishing

_____

Well head finishing includes the clean up of mud and aquifer debris and removal of material scraps.

.Costs

26. Test holes per meter (foot)

_____

27. Reaming per meter (foot)

_____

28. Drilling/boring per meter (foot)

_____

29. Casing per meter (foot)

_____

30. Liner per meter (foot)

_____

31. Screen

_____

32. Sand pack_____

33. Development

_____

34. Hydrofracing

_____

35. Labor per hour

_____

36. Water testing

_____

37. Reclamation of unused well

_____

38. Payment schedule

_____

_____

39.Guarantee

_____

Workmanship and materials should be guaranteed for a specific period of time.

Source: WWDA mht (website

Appendix (9)

Water Well Driller Job Description, Career as a Water Well Driller, Salary, Employment - Definition and Nature of the Work, Education and Training Requirements, Getting the Job

Education and Training: High school plus training
Salary: Median—$33,570 per year
Employment Outlook: Fair

Definition and Nature of the Work

Water well drillers sink wells into the earth to tap natural water supplies. They drill agricultural wells for irrigation, commercial or industrial wells, and wells for homes that are not served by municipal water systems. They keep records of wells drilled and, in many states, report their work to government officials.

Usually drillers hire a crew consisting of well driller helpers, pump service rig operators, and pump service rig helpers. They set up a truck-mounted derrick or rig with the drill and other required equipment. Once the drilling rig is set up and working, the drillers continue to monitor the operation.

As the well shaft goes into the ground, the drillers line the shaft with steel or plastic pipe to prevent the ground from caving in and to keep out water that may be polluted. The drillers fill the shaft with fluid to keep the bit cool. They may adjust the pressure or impact of the drilling rig and change the bit as it penetrates different layers of the earth. The well drillers or their helpers may splice worn or broken cable and use welding and cutting equipment to do repairs. Sometimes they use special fishing or retrieval tools to recover broken or lost drill bits and pieces of pipe.

When they drill the well, they install a pump designed for the depth, diameter, and capacity of the well. They sterilize the entire system to prevent the growth of bacteria. Finally, they start the pump to bring water up through the system.

Water well drillers do not always work on new wells. They may set up a rig to repair or restore wells that have stopped producing. They may also plug or cap deteriorated wells to prevent contamination of the groundwater.

Education and Training Requirements

A high school diploma or its equivalent is required. High school courses such as geology, chemistry, and physics will explain rock formations, minerals, and the properties of water. Shop classes will provide a background in running and maintaining machines and small tools. Algebra, trigonometry, and English are also important.

After high school, an apprenticeship with a certified water well driller is recommended. Apprenticeships include classroom study and on-the-job training and last from two to four years, depending on the state. After completing an apprenticeship, a trainee becomes eligible to take a state certification test.

Several two-year colleges offer well drilling technology programs with courses in geology, mathematics, and inorganic chemistry. Techniques for finding good-quality water, methods of drilling, and equipment operation are explained. Other classes cover equipment maintenance and repair, setting specifications, inspection and quality control, and record keeping and accounting.

Getting the Job

In many states, water well drillers have to be certified by passing a written exam. Many states also require that a water well driller serve an apprenticeship before being certified. In addition, a voluntary certification

program is sponsored by the National Ground Water Association. That certification can be helpful in getting a job.

Prospective apprentices will find employers listed in the Yellow Pages under "Water Well Drilling and Service" and "Drilling and Boring Contractors." Other sources of job information are drilling-rig manufacturers, geological consulting firms, newspaper classified ads, Internet job banks, and state and local employment offices. Technical school graduates can check with the placement offices of their schools.

Advancement Possibilities and Employment Outlook

Water well drillers are already at the top of their craft. Most work for drilling contractors, and others may work as consultants, sales representatives, or service technicians for equipment manufacturers. They may also work for state or federal agencies concerned with the use and control of water resources. After some years of experience, they may set up their own drilling businesses.

Employment for water well drillers is expected to grow more slowly than the average for all jobs through 2014. As with most jobs in construction, employment mainly depends on general economic conditions. However, there will always be a demand for drillers because an increasing population always needs more water. Groundwater supplies must also be found to replace surface water supplies that are often polluted and too expensive to clean up.

Working Conditions

Water well drillers perform hard physical labor in all kinds of weather. They stoop, squat, and crawl to do their work. They often work on narrow, slippery surfaces. They lift heavy equipment. They may suffer muscle strains, bruises, and cuts from handling the material and equipment associated with the job. Noise and vibration may require the use of ear plugs and other safety devices.

The number of working hours in a week depends on the completion dates. Usually water well drillers work about fifty hours per week. The hours may be irregular because of emergencies.

Earnings and Benefits

The median income of water well drillers in 2004 was $33,570 per year. Benefits may include health plans, pensions, and paid vacations.

Source: mhtml (net)

Appendix (10)

Questionnaire to Groundwater Industry Employees

Participants are encouraged to provide honest and constructive feedback to help the research improve the quality of the future groundwater industry performance.

Please answer the following questions completely.
1- Age: ☐

2- Quality and activity of your organization:

☐ Exploration
☐ Drilling
☐ Completion
☐ Installation
☐ Construction
☐ Other [please specify]

3- My position is, was:

☐ Manager
☐ Head department
☐ Drilling engineer
☐ Geophysical engineer
☐ Geological engineer
☐ Hydro geological engineer
☐ Tanks and pumps engineer
☐ Technician
☐ Command labor
☐ Labor

☐ Other [please specify]

4- On a scale where 1 represents [strongly agree] and 5 represents [strongly disagree], how would you rate each of the following statement?

	Strongly agree	Agree	Neither agree nor disagree	disagree	Strongly disagree
Your management system is satisfactory..	☐	☐	☐	☐	☐
Your work is closely supervised…..	☐	☐	☐	☐	☐
No contracting leakages…….	☐	☐	☐	☐	☐
Your company has good employee benefits and salaries……	☐	☐	☐	☐	☐
Your work has no negative impacts on the environment……..	☐	☐	☐	☐	☐
All materials used are selected properly..	☐	☐	☐	☐	☐
Your work is usually executed in the appropriate time…….	☐	☐	☐	☐	☐
Supplies were just in time……..	☐	☐	☐	☐	☐
The production was never less than the anticipated……	☐	☐	☐	☐	☐
Legislations and regulations governing the work are satisfactory……	☐	☐	☐	☐	☐

5- Do you feel there is a need for taking improvement steps to this industry? Yes/No ☐ ☐

If yes, are you ready to co-operate?

Yes/No ☐ ☐

If yes, how your co-operation would be?

☐

6- Overall assessment

Please indicate your general level of satisfaction regarding your job	Circle your answer
	1 2 3 4 5

Addional comments

Optional section
Company or corporation name: ----------

Branch: ----------

Employee name: ----------

Signature of employee: ----------
---- Date ----------

Thanks for your participation

Appendix (11)

Utilization of The Research Outcome

The results, conclusions and recommendations of the study would be useful to the following sectors:

1- Ministry of Irrigation and Water Resources.

2- Ministry of Environment.

3- Ministry of Urban Planning.

4- Ministry of Justice.

5- The National Water Corporation.

6- Khartoum State Water Corporation

7- The Regional Water Corporations.

8- The Engineering Council.

9- The relevant Contractors.

10- The relevant United Nations Organizations.

11- The NGOs dealing with groundwater sectors.

12- The relevant Educational Organizations.

13- The Public, if widely disseminated through the media and websites.