TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE F: PUBLIC WATER SUPPLIES
CHAPTER II: ENVIRONMENTAL PROTECTION AGENCY

PART 671
MAXIMUM SETBACK ZONE FOR COMMUNITY WATER SUPPLY WELLS

SUBPART A: INTRODUCTION

Section

SUBPART B: PROCEDURES FOR DETERMINING THE LATERAL AREA OF INFLUENCE OF WELLS UNDER NORMAL OPERATIONAL CONDITIONS

Section

SUBPART C: REQUESTS FOR AGENCY REVIEW AND CONFIRMATION

Section

AUTHORITY: Implementing and authorized by Section 14.3 of the Environmental Protection Act (Ill. Rev. Stat. 1987, ch. 111 1/2, par. 1014.3).

SOURCE: Adopted at 12 Ill. Reg. 14134, effective August 25, 1988.

SUBPART A: INTRODUCTION

Section 671.101 Purpose

a) Section 14.2 of the Act establishes a minimum setback zone for existing or permitted community water supply wells or other potable water supply wells.

b) Section 14.3 of the Act authorizes a maximum setback zone to be established for community water supply wells.

c) In order to establish a maximum setback zone, the lateral area of influence of the well under normal operational conditions must be determined.

d) OWNERS OF COMMUNITY WATER SUPPLIES WHICH UTILIZE ANY WATER WELL, OR ANY COUNTY OR MUNICIPALITY SERVED BY ANY COMMUNITY WATER SUPPLY WELL, MAY DETERMINE THE LATERAL AREA OF INFLUENCE OF THE WELL UNDER NORMAL OPERATIONAL CONDITIONS. THE AGENCY SHALL ADOPT PROCEDURES BY WHICH SUCH DETERMINATIONS MAY BE MADE INCLUDING, WHERE APPROPRIATE, PUMPING TESTS AND ESTIMATION TECHNIQUES. (Section 14.3(a) of the Environmental Protection Act (Ill. Rev. Stat. 1987, ch. 111 1/2, par. 1014.3(a))).

e) The rules set forth in this Part describe the procedures for establishing a maximum setback zone under Sections 14.3(a), 14.3(b), and 14.3(c) of the Act.

f) The rules set forth in Subpart B describe the procedures to be used by owners of community water supplies, by counties, or by municipalities to determine the lateral area of influence of community water supply wells. The rules set forth in Subpart C describe the procedures to be used by counties or municipalities in requesting Agency review and confirmation of this determination.

Section 671.102 Definitions

a) Unless specified otherwise, all terms shall have the meanings set forth in the Act and the Illinois Groundwater Protection Act (Ill. Rev. Stat. 1987, ch. 111 1/2, pars. 7451 et seq.).

b) For purposes of this Part, the following definitions apply:

"Act" means the Environmental Protection Act (Ill. Rev. Stat., 1987, ch. 111 1/2, pars. 1001 et seq., as amended).

"Agency" means the Illinois Environmental Protection Agency.

"Certified professional geologist" means a person certified by the American Institute of Professional Geologists.

"Confined aquifer" means an aquifer bounded above and below by impermeable beds or by shale, clay, or siltstone.

"Drawdown" means the change in the water elevation of the static water level produced by a pumping well.

"Normal operational conditions" mean capability of a well at or under the safe yield rate.

"Professional judgment" means the use of those engineering principles and practices used by engineers when fulfilling their requirements and duties consistent with the specific requirements of this Part and as certified by a Professional Engineer licensed under the Illinois Professional Engineering Act (Ill. Rev. Stat. 1987, ch. 111, par. 5101 et seq.), or the use of those geologic principles and practices used by geologists when fulfilling their requirements and duties consistent with the specific requirements of this Part and as certified by a certified professional geologist who is a member of the American Institute of Professional Geologists (7828 Vance Drive, Suite 103, Arvada, Colorado 80003, January 17, 1988).

"Registered professional engineer" means a person registered under the provisions of the Illinois Professional Engineering Act (Ill. Rev. Stat. 1987, ch. 111, par. 5101 et seq.).

"Safe yield rate" means the rate (in gallons pumped per minute per foot of drawdown) at which water can be withdrawn from an aquifer without depleting the supply.

"Unconfined aquifer" means an aquifer other than a confined aquifer.

Section 671.103 Severability

If any provisions of this Part or the application thereof to any person or in any circumstance is adjudged invalid, such adjudication shall not affect the validity of this Part as a whole or any provision thereof not adjudged invalid.

Section 671.104 Agency Mailing Address

Each request, report, notice, or other document submitted to the Agency under this Part shall be mailed to the following address:

Manager, Groundwater Section
Division of Public Water Supplies
Illinois Environmental Protection Agency
2200 Churchill Road
Post Office Box 19276
Springfield, Illinois 62794-9276

SUBPART B: PROCEDURES FOR DETERMINING THE LATERAL AREA OF INFLUENCE OF WELLS UNDER NORMAL OPERATIONAL CONDITIONS

Section 671.201 Estimation Techniques and Pumping Test

Owners of community water supplies which utilize any water well, or any county or municipality served by any community water supply well, shall determine the lateral area of influence of the well under normal operational conditions in accordance with one or more of the following:

a) The Volumetric Flow Equation set forth in Appendix A;

b) The Theis Equation Using Available Data set forth in Appendix B;

c) The Todd Uniform Flow Equation set forth in Appendix C;

d) The Neuman Equations and Pump Test Procedures for Unconfined or Water Table Aquifers set forth in Appendix D;

e) The Theis Equations and Pump Test Procedures for Confined Aquifers set forth in Appendix E;

f) Hydrogeologic Mapping as set forth in Appendix F; or

g) An alternate estimation technique, pump test, or other procedure approved by the Agency in accordance with Section 671.202.

Section 671.202 Agency Approval of Alternate Estimation Techniques, Pump Tests, or Other Procedures

The Agency shall approve an estimation technique, pump test, or other procedure that, based upon the Agency's professional judgment, is equivalent to one or more of the methods described in Section 671.201(a) through (f).

SUBPART C: REQUESTS FOR AGENCY REVIEW AND CONFIRMATION

Section 671.301 General

WHERE THE RESULTS OF ANY DETERMINATION MADE PURSUANT TO SECTION 671.201 DISCLOSE THAT THE DISTANCE FROM THE WELL TO THE OUTERMOST BOUNDARY OF THE LATERAL AREA OF INFLUENCE OF THE WELL UNDER NORMAL OPERATIONAL CONDITIONS EXCEEDS THE RADIUS OF THE MINIMUM SETBACK ZONE ESTABLISHED FOR THAT WELL PURSUANT TO SECTION 14.2 OF THE ACT, ANY COUNTY OR MUNICIPALITY SERVED BY SUCH WATER SUPPLY MAY IN WRITING REQUEST THE AGENCY TO REVIEW AND CONFIRM THE TECHNICAL ADEQUACY OF SUCH DETERMINATION. (Section 14.3(b) of the Act).

Section 671.302 Contents of a Request

Each county or municipality requesting Agency review and confirmation under Section 14.3(b) of the Act shall complete a request form prescribed by the Agency and shall:

a) Submit proof that the determination made pursuant to Section 671.201 describes the outer boundary of drawdown of the affected groundwater by the well under normal operational conditions. Such proof shall include, but not be limited to, the following:

    1) Geologic logs and well construction details;

    2) Aquifer test data, if an estimation technique or pump test described in Section 671.201(a), (d), or (e) is used;

    3) Hydrogeologic information and the source of that information, if the estimation technique described in Section 671.201(c) is used; and

    4) Geologic maps and the source of those maps, if the procedure described in Section 671.201(f) is used.

b) Submit the proposed ordinance to be adopted pursuant to Section 14.3(c) of the Act.

c) If an estimation technique or pump test described in Section 671.201(c) through (f) is used, include the following certification by a registered professional engineer, certified professional geologist, or other person approved by the Agency under Section 671.303:

I hereby certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief such information is true, complete, and accurate.

Section 671.303 Agency Approval of Alternate Certification

The Agency shall approve the certification under Section 671.302(c) by a person other than a registered professional engineer or a certified professional geologist if the county or municipality proves that such person has a bachelor's degree or a graduate degree in science or engineering, and has work experience in Geology, Hydrogeology, or Earth Science. The proof shall include, but not necessarily be limited to, a resume for such person and the name, address, and telephone number of not fewer than three personal references who can verify the education and work experience of such person.

Section 671.304 Agency Review and Confirmation

a) THE AGENCY SHALL, WITHIN 90 DAYS OF ANY WRITTEN REQUEST under Section 14.3(b) of the Act, NOTIFY THE COUNTY OR MUNICIPALITY WHETHER THE DETERMINATION IS TECHNICALLY ADEQUATE FOR DESCRIBING THE OUTER BOUNDARY OF DRAWDOWN OF THE AFFECTED GROUNDWATER BY THE WELL UNDER NORMAL OPERATIONAL CONDITIONS. (Section 14.3(b) of the Act) The Agency will determine if the county or municipality has made a technically adequate determination by using the requirements of this Part.

b) ANY ACTION BY THE AGENCY under this Section SHALL BE IN WRITING AND SHALL CONSTITUTE A FINAL DETERMINATION OF THE AGENCY. (Section 14.3(b) of the Act)

Section 671.305 Adoption of a Maximum Setback Zone Ordinance

a) UPON RECEIPT OF AGENCY CONFIRMATION OF THE TECHNICAL ADEQUACY OF THE DETERMINATION under Section 14.3(b) of the Act, THE COUNTY OR MUNICIPALITY MAY, AFTER NOTICE AND OPPORTUNITY FOR COMMENT, ADOPT AN ORDINANCE SETTING FORTH THE LOCATION OF EACH AFFECTED WELL AND SPECIFYING THE BOUNDARIES OF A MAXIMUM SETBACK ZONE, WHICH BOUNDARIES MAY BE IRREGULAR. IN NO EVENT, HOWEVER, SHALL ANY PORTION OF SUCH A BOUNDARY BE IN EXCESS OF 1,000 FEET FROM THE WELLHEAD. (Section 14.3(c) of the Act).

b) SUCH ORDINANCE SHALL INCLUDE THE AREA WITHIN THE APPLICABLE MINIMUM SETBACK ZONE AND SHALL INCORPORATE REQUIREMENTS WHICH ARE CONSISTENT WITH BUT NOT MORE STRINGENT THAN THE PROHIBITIONS OF THE ACT AND THE REGULATIONS PROMULGATED BY THE BOARD under Section 14.4 of the Act. (Section 14.3(c) of the Act).

c) UPON ADOPTION, THE COUNTY OR MUNICIPALITY SHALL PROVIDE A COPY OF THE ORDINANCE TO THE AGENCY. (Section 14.3(c) of the Act).

d) ANY COUNTY OR MUNICIPALITY WHICH FAILS TO ADOPT SUCH AN ORDINANCE WITHIN 2 YEARS OF RECEIPT OF AGENCY CONFIRMATION OF TECHNICAL ADEQUACY MAY NOT PROCEED UNDER THE AUTHORITY OF SECTION 14.3 OF THE ACT WITHOUT OBTAINING A NEW CONFIRMATION OF THE TECHNICAL ADEQUACY pursuant to Section 14.3(b) of the Act. (Section 14.3(c) of the Act)

Section 671.306 Changing a Maximum Setback Zone

If a county or municipality has established a maximum setback zone by ordinance, the county or municipality shall, upon adoption, provide a copy to the Agency of each ordinance which in any way modifies the maximum setback zone.

Section 671.APPENDIX A Volumetric Flow Equation

For unconfined unconsolidated, or unconfined non-fractured bedrock aquifers the lateral radius of influence can be calculated as follows:

$$r = \sqrt{\frac{Qt}{4524nH}}$$

Where:

r = radius of influence (feet)
Q = daily flow from the well under normal operational conditions (cubic feet per day)
t = time that the well is pumped under normal operational conditions (minutes)
H = open interval or length of well screen (feet)
n = aquifer porosity (see Figure A-1) unless more site specific information is available

Sand	0.21	Sandstone	0.06
Gravel	0.19	Limestones:	
Sand & Gravel	0.15	Primary dolomites,	0.18
		Secondary dolomites	0.18

Figure A-1

Section 671.APPENDIX B Theis Equation Using Available Data

If pump test data is available for an unconfined/confined unconsolidated or non-fractured bedrock aquifer the lateral radius of influence can be calculated as follows:

$$r = \sqrt{\frac{uTt}{2693S}}$$

Where:

r = radius of influence (feet)
t = time well is pumped under normal operational conditions (minutes)
S = aquifer storativity or specific yield (dimensionless)
T = aquifer transmissivity (gallons per day per foot)
u = is a dimensionless parameter related to the well function

$$W(u) = \frac{T(h_O - h)}{114.6Q}$$

Where:

w(u) = well function, the well function is calculated and u is obtained from Table A.
$h_O - h$ = drawdown in the piezometer or observation well (feet)

Q = production well discharge rate under normal operational conditions (gallons per minute)

Section 671.APPENDIX C Todd Uniform Flow Equation

If hydrogeologic information (e.g., transmissivity, porosity, hydraulic gradient, hydraulic conductivity, and saturated thickness of the aquifer) is available the lateral area of influence can be calculated for unconfined/confined unconsolidated or non-fractured bedrock aquifers as follows:

$$X = \frac{1.19\ Q}{Ti} \qquad Y = \frac{7.48\ Q}{Ti}$$

Where:

Q = daily flow from the well under normal operational conditions (cubic feet per day)
i = hydraulic gradient of the water table or potentiometric surface
T = aquifer transmissivity (gallons per day per foot)
X = lateral area of influence or down gradient divide (feet)
Y = maximum width of the lateral area of influence or the maximum width of the influx zone (feet)

The distance to the upgradient divide is established as the distance to the upgradient regional groundwater divide.

Section 671.APPENDIX D Neuman Equations and Pump Test Procedures for Unconfined or Water Table Aquifers

If no data is available for unconsolidated or non-fractured bedrock aquifer constants, a pump test can be conducted to determine the lateral radius of influence as follows:

A. At least one fully penetrating observation well is necessary.

B. The pump test should be conducted for at least 48 hours.

C. The flow equation for unconfined aquifers is given by:

$$T = \frac{114.6Q\ W(u_A, u_B\ э)}{(h_O - h)}$$

Where:

T = transmissivity (gallons per day per food)
Q = production well discharge rate (gallons per minute)
$h_O - h$ = drawdown in the observation well (feet)
$W(u_A, u_B\ э)$ = well function for unconfined aquifers, the well function is calculated and (u_A, э), (u_B, э) is obtained from Table B

$$u_A = \frac{2693r^2\ S}{Tt}\ \text{(Early phase drawn)} \qquad э = \frac{r^2\ K_v}{b^2 Kh}$$

$$u_B = \frac{2693r^2\ Sy}{Tt}\ \text{(late phase drawndown)} \qquad T = Khxb$$

Where:

S = storativity (dimensionless)
Sy = specific yield (dimensionless)
t = time (minutes)
b = aquifer saturated thickness (feet)

K_v = aquifer vertical hydraulic conductivity (gallons per day per square feet)
Kh = aquifer horizontal hydraulic conductivity (gallons per day per square feet)
r = distance from the production well to observation well (feet)

The radius of influence can then be calculated using the following:

$$r = \sqrt{\frac{u_B Tt}{2693Sy}}$$

Where:

t = time pumped under normal operational conditions (minutes).

Two sets of type curves are used (Neuman, 1975). Type-A curves are used for early phase drawdown data, and Type-B curves are used for late phase drawdown. The type curves are used to evaluate field data for time and drawdown, which are plotted on logarithmic paper of the same scale. The following procedure can be used:

1. Overlay time drawdown data on Type-B curves. At any match point, the values of $W(u_B, э)$, u_B, t, and $h_o - h$ are determined. The value of comes from the type curve. The value of T and Sy is calculated using these values and the following equations:

$$T = \frac{114.6Q\ W(u_B, э)}{(h_O - h)} \qquad Sy = \frac{Tt}{2693r^2}$$

2. Use the early phase drawdown Type-A curve to calculate $W(u_A, э)$, u_A, t, $h_O - h$ and S using the э value previously determined for the Type-B curve and the following equation:

$$S = \frac{Ttu_A}{2693r^2}$$

3. The value of horizontal hydraulic conductivity can be determined using:

$$Kh = \frac{T}{b}$$

4. The vertical hydraulic conductivity can be determined using the following:

$$K_v = \frac{эb^2\ Kh}{r^2}$$

5. The lateral radius of influence can then be calculated with the following:

$$r = \sqrt{\frac{u_B Tt}{2693Sy}}$$

Section 671.APPENDIX E Theis Equations and Pump Test Procedures for Confined Aquifers

If no data exists for confined unconsolidated or non-fractured bedrock aquifer constants, a pump test can be conducted to determine the lateral radius of influence as follows:

A. At least one fully penetrating piezometer is necessary.

B. The pump test should be conducted for at least 24 hours.

C. The flow equations for confined aquifers are as follows:

$$T = \frac{114.6Q\ W(u)}{h_O - h}$$

$$u = \frac{2693r^2S}{Tt}$$

$$S = \frac{Ttu}{2693r^2}$$

PROCEDURE

The Theis type curve is used. The type curve is used to evaluate field data for time and drawdown, which are plotted on logarithmic paper of the same scale. The following procedure can be used:

1. Overlay time drawdown data on type curve. At any match point, the values of W(u), u, and h - h are determined (see Table B).

2. Transmissivity can be calculated using the values from the match point and the following equation:

$$T = \frac{114.6Q\ W(u)}{h_O - h}$$

3. From the value established above, k can be determined as follows:

$$K = \frac{T}{b}$$

4. From the values established above, S can be calculated as follows:

$$S = \frac{uTt}{2693r^2}$$

5. From all of the above, the lateral radius of influence can be calculated as follows:

$$s = \sqrt{\frac{uTt}{2693S}}$$

Where:

r =	radius of influence (feet)
Q =	production well discharge rate under normal operational conditions (gallons per minute)
S =	aquifer storitivity (dimensionless)
t =	aquifer transmissivity (gallons per day per foot)
u =	is a dimensionless parameter related to well function
W(u) =	well function, the well function is calculated and u is obtained from Table A
$h_o - h$ =	drawdown in the piezometer or observation well
t =	time the well is pumped under normal operational conditions (minutes)

Section 671.APPENDIX F Hydrogeologic Mapping

In many unconfined unconsolidated aquifers and unconfined bedrock aquifers, the fixed radius calculated with any of the previous methods can be supplemented with geologic mapping. A fixed radius could be modified to an irregular shape where impermeable barrier boundary is encountered within 1,000 feet and beyond the minimum setback.

Hydrogeologic mapping may also include mapping of groundwater levels in order to identify groundwater drainage divides.

Hydrogeologic mapping is unconfined karst or unconfined fractured bedrock areas may be the primary means of

delineating the lateral radius of influence. It is extremely difficult to define the actual recharge area of a well in a fractured bedrock setting.

Section 671.TABLE A Well Functions for Confined Aquifers

10^{-10} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-10	22.45	1.00E+10	5.3E-10	20.78	1.89E+09
1.1E-10	22.35	9.09E+09	5.4E-10	20.76	1.85E+09
1.2E-10	22.27	8.33E+09	5.5E-10	20.74	1.82E+09
1.3E-10	22.19	7.69E+09	5.6E-10	20.73	1.79E+09
1.4E-10	22.11	7.14E+09	5.7E-10	20.71	1.75E+09
1.5E-10	22.04	6.67E+09	5.8E-10	20.69	1.72E+09
1.6E-10	21.98	6.25E+09	5.9E-10	20.67	1.69E+09
1.7E-10	21.92	5.88E+09	6.0E-10	20.66	1.67E+09
1.8E-10	21.86	5.56E+09	6.1E-10	20.64	1.64E+09
1.9E-10	21.81	5.26E+09	6.2E-10	20.62	1.61E+09
2.0E-10	21.76	5.00E+09	6.3E-10	20.61	1.59E+09
2.1E-10	21.71	4.76E+09	6.4E-10	20.59	1.56E+09
2.2E-10	21.66	4.55E+09	6.5E-10	20.58	1.54E+09
2.3E-10	21.62	4.35E+09	6.6E-10	20.56	1.52E+09
2.4E-10	21.57	4.17E+09	6.7E-10	20.55	1.49E+09
2.5E-10	21.53	4.00E+09	6.8E-10	20.53	1.47E+09
2.6E-10	21.49	3.85E+09	6.9E-10	20.52	1.45E+09
2.7E-10	21.46	3.70E+09	7.0E-10	20.50	1.43E+09
2.8E-10	21.42	3.57E+09	7.1E-10	20.49	1.41E+09
2.9E-10	21.38	3.45E+09	7.2E-10	20.47	1.39E+09
3.0E-10	21.35	3.33E+09	7.3E-10	20.46	1.37E+09
3.1E-10	21.32	3.23E+09	7.4E-10	20.45	1.35E+09
3.2E-10	21.29	3.13E+09	7.5E-10	20.43	1.33E+09
3.3E-10	21.25	3.03E+09	7.6E-10	20.42	1.32E+09
3.4E-10	21.22	2.94E+09	7.7E-10	20.41	1.30E+09
3.5E-10	21.20	2.86E+09	7.8E-10	20.39	1.28E+09
3.6E-10	21.17	2.78E+09	7.9E-10	20.38	1.27E+09
3.7E-10	21.14	2.70E+09	8.0E-10	20.37	1.25E+09
3.8E-10	21.11	2.63E+09	8.1E-10	20.36	1.23E+09
3.9E-10	21.09	2.56E+09	8.2E-10	20.34	1.22E+09
4.0E-10	21.06	2.50E+09	8.3E-10	20.33	1.20E+09
4.1E-10	21.04	2.44E+09	8.4E-10	20.32	1.19E+09
4.2E-10	21.01	2.38E+09	8.5E-10	20.31	1.18E+09
4.3E-10	20.99	2.33E+09	8.6E-10	20.30	1.16E+09
4.4E-10	20.97	2.27E+09	8.7E-10	20.29	1.15E+09
4.5E-10	20.94	2.22E+09	8.8E-10	20.27	1.14E+09
4.6E-10	20.92	2.17E+09	8.9E-10	20.26	1.12E+09
4.7E-10	20.90	2.13E+09	9.0E-10	20.25	1.11E+09
4.8E-10	20.88	2.08E+09	9.1E-10	20.24	1.10E+09
4.9E-10	20.86	2.04E+09	9.2E-10	20.23	1.09E+09
5.0E-10	20.84	2.00E+09	9.3E-10	20.22	1.08E+09
5.1E-10	20.82	1.96E+09	9.4E-10	20.21	1.06E+09
5.2E-10	20.80	1.92E+09	9.5E-10	20.20	1.05E+09
			9.6E-10	20.19	1.04E+09
			9.7E-10	20.18	1.03E+09
			9.8E-10	20.17	1.02E+09
			9.9E-10	20.16	1.01E+09

10^{-9} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-09	20.15	1.00E+09	5.1E-09	18.52	1.96E+08
1.1E-09	20.05	9.09E+08	5.2E-09	18.50	1.92E+08
1.2E-09	19.96	8.33E+08	5.3E-09	18.48	1.89E+08
1.3E-09	19.88	7.69E+08	5.4E-09	18.46	1.85E+08
1.4E-09	19.81	7.14E+08	5.5E-09	18.44	1.82E+08
1.5E-09	19.74	6.67E+08	5.6E-09	18.42	1.79E+08
1.6E-09	19.68	6.25E+08	5.7E-09	18.41	1.75E+08
1.7E-09	19.62	5.88E+08	5.8E-09	18.39	1.72E+08
1.8E-09	19.56	5.56E+08	5.9E-09	18.37	1.69E+08
1.9E-09	19.50	5.26E+08	6.0E-09	18.35	1.67E+08
2.0E-09	19.45	5.00E+08	6.1E-09	18.34	1.64E+08
2.1E-09	19.40	4.76E+08	6.2E-09	18.32	1.61E+08
2.2E-09	19.36	4.55E+08	6.3E-09	18.31	1.59E+08
2.3E-09	19.31	4.35E+08	6.4E-09	18.29	1.56E+08
2.4E-09	19.27	4.17E+08	6.5E-09	18.27	1.54E+08
2.5E-09	19.23	4.00E+08	6.6E-09	18.26	1.52E+08
2.6E-09	19.19	3.85E+08	6.7E-09	18.24	1.49E+08
2.7E-09	19.15	3.70E+08	6.8E-09	18.23	1.47E+08
2.8E-09	19.12	3.57E+08	6.9E-09	18.21	1.45E+08
2.9E-09	19.08	3.45E+08	7.0E-09	18.20	1.43E+08
3.0E-09	19.05	3.33E+08	7.1E-09	18.19	1.41E+08
3.1E-09	19.01	3.23E+08	7.2E-09	18.17	1.39E+08
3.2E-09	18.98	3.13E+08	7.3E-09	18.16	1.37E+08
3.3E-09	18.95	3.03E+08	7.4E-09	18.14	1.35E+08
3.4E-09	18.92	2.94E+08	7.5E-09	18.13	1.33E+08
3.5E-09	18.89	2.86E+08	7.6E-09	18.12	1.32E+08
3.6E-09	18.87	2.78E+08	7.7E-09	18.10	1.30E+08
3.7E-09	18.84	2.70E+08	7.8E-09	18.09	1.28E+08
3.8E-09	18.81	2.63E+08	7.9E-09	18.08	1.27E+08
3.9E-09	18.79	2.56E+08	8.0E-09	18.07	1.25E+08
4.0E-09	18.76	2.50E+08	8.1E-09	18.05	1.23E+08
4.1E-09	18.74	2.44E+08	8.2E-09	18.04	1.22E+08
4.2E-09	18.71	2.38E+08	8.3E-09	18.03	1.20E+08
4.3E-09	18.69	2.33E+08	8.4E-09	18.02	1.19E+08
4.4E-09	18.66	2.27E+08	8.5E-09	18.01	1.18E+08
4.5E-09	18.64	2.22E+08	8.6E-09	17.99	1.16E+08
4.6E-09	18.62	2.17E+08	8.7E-09	17.98	1.15E+08
4.7E-09	18.60	2.13E+08	8.8E-09	17.97	1.14E+08
4.8E-09	18.58	2.08E+08	8.9E-09	17.96	1.12E+08
4.9E-09	18.56	2.04E+08	9.0E-09	17.95	1.11E+08
5.0E-09	18.54	2.00E+08	9.1E-09	17.94	1.10E+08
			9.2E-09	17.93	1.09E+08
			9.3E-09	17.92	1.08E+08
			9.4E-09	17.91	1.06E+08
			9.5E-09	17.89	1.05E+08
			9.6E-09	17.88	1.04E+08
			9.7E-09	17.87	1.03E+08
			9.8E-09	17.86	1.02E+08
			9.9E-09	17.85	1.01E+08

10^{-8} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-08	17.84	1.00E+08	5.1E-08	16.21	1.96E+07
1.1E-08	17.75	9.09E+07	5.2E-08	16.19	1.92E+07
1.2E-08	17.66	8.33E+07	5.3E-08	16.18	1.89E+07
1.3E-08	17.58	7.69E+07	5.4E-08	16.16	1.85E+07
1.4E-08	17.51	7.14E+07	5.5E-08	16.14	1.82E+07
1.5E-08	17.44	6.67E+07	5.6E-08	16.12	1.79E+07
1.6E-08	17.37	6.25E+07	5.7E-08	16.10	1.75E+07
1.7E-08	17.31	5.88E+07	5.8E-08	16.09	1.72E+07
1.8E-08	17.26	5.56E+07	5.9E-08	16.07	1.69E+07
1.9E-08	17.20	5.26E+07	6.0E-08	16.05	1.67E+07
2.0E-08	17.15	5.00E+07	6.1E-08	16.04	1.64E+07
2.1E-08	17.10	4.76E+07	6.2E-08	16.02	1.61E+07
2.2E-08	17.06	4.55E+07	6.3E-08	16.00	1.59E+07
2.3E-08	17.01	4.35E+07	6.4E-08	15.99	1.56E+07
2.4E-08	16.97	4.17E+07	6.5E-08	15.97	1.54E+07
2.5E-08	16.93	4.00E+07	6.6E-08	15.96	1.52E+07
2.6E-08	16.89	3.85E+07	6.7E-08	15.94	1.49E+07
2.7E-08	16.85	3.70E+07	6.8E-08	15.93	1.47E+07
2.8E-08	16.81	3.57E+07	6.9E-08	15.91	1.45E+07
2.9E-08	16.78	3.45E+07	7.0E-08	15.90	1.43E+07
3.0E-08	16.74	3.33E+07	7.1E-08	15.88	1.41E+07
3.1E-08	16.71	3.23E+07	7.2E-08	15.87	1.39E+07
3.2E-08	16.68	3.13E+07	7.3E-08	15.86	1.37E+07
3.3E-08	16.65	3.03E+07	7.4E-08	15.84	1.35E+07
3.4E-08	16.62	2.94E+07	7.5E-08	15.83	1.33E+07
3.5E-08	16.59	2.86E+07	7.6E-08	15.82	1.32E+07
3.6E-08	16.56	2.78E+07	7.7E-08	15.80	1.30E+07
3.7E-08	16.54	2.70E+07	7.8E-08	15.79	1.28E+07
3.8E-08	16.51	2.63E+07	7.9E-08	15.78	1.27E+07
3.9E-09	16.48	2.56E+07	8.0E-08	15.76	1.25E+07
4.0E-08	16.46	2.50E+07	8.1E-08	15.75	1.23E+07
4.1E-08	16.43	2.44E+07	8.2E-08	15.74	1.22E+07
4.2E-08	16.41	2.38E+07	8.3E-08	15.73	1.20E+07
4.3E-08	16.38	2.33E+07	8.4E-08	15.72	1.19E+07
4.4E-08	16.36	2.27E+07	8.5E-08	15.70	1.18E+07
4.5E-08	16.34	2.22E+07	8.6E-08	15.69	1.16E+07
4.6E-08	16.32	2.17E+07	8.7E-08	15.68	1.15E+07
4.7E-08	16.30	2.13E+07	8.8E-08	15.67	1.14E-07
4.8E-08	16.27	2.08E+07	8.9E-08	15.66	1.12E+07
4.9E-08	16.25	2.04E+07	9.0E-08	15.65	1.11E+07
5.0E-08	16.23	2.00E+07	9.1E-08	15.64	1.10E+07
			9.2E-08	15.62	1.09E+07
			9.3E-08	15.61	1.08E+07
			9.4E-08	15.60	1.06E+07
			9.5E-08	15.59	1.05E+07
			9.6E-08	15.58	1.04E+07
			9.7E-08	15.57	1.03E+07
			9.8E-08	15.56	1.02E+07
			9.9E-08	15.55	1.01E+07

10^{-7} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-07	15.54	1.00E+07	5.1E-07	13.91	1.96E+06
1.1E-07	15.45	9.09E+06	5.2E-07	13.89	1.92E+06
1.2E-07	15.36	8.33E+06	5.3E-07	13.87	1.89E+06
1.3E-07	15.28	7.69E+06	5.4E-07	13.85	1.85E+06
1.4E-07	15.20	7.14E+06	5.5E-07	13.84	1.82E+06
1.5E-07	15.14	6.67E+06	5.6E-07	13.82	1.79E+06
1.6E-07	15.07	6.25E+06	5.7E-07	13.80	1.75E+06
1.7E-07	15.01	5.88E+06	5.8E-07	13.78	1.72E+06
1.8E-07	14.95	5.56E+06	5.9E-07	13.77	1.69E+06
1.9E-07	14.90	5.26E+06	6.0E-07	13.75	1.67E+06
2.0E-07	14.85	5.00E+06	6.1E-07	13.73	1.64E+06
2.1E-07	14.80	4.76E+06	6.2E-07	13.72	1.61E+06
2.2E-07	14.75	4.55E+06	6.3E-07	13.70	1.59E+06
2.3E-07	14.71	4.35E+06	6.4E-07	13.68	1.56E+06
2.4E-07	14.67	4.17E+06	6.5E-07	13.67	1.54E+06
2.5E-07	14.62	4.00E+06	6.6E-07	13.65	1.52E+06
2.6E-07	14.59	3.85E+06	6.7E-07	13.64	1.49E+06
2.7E-07	14.55	3.70E+06	6.8E-07	13.62	1.47E+06
2.8E-07	14.51	3.57E+06	6.9E-07	13.61	1.45E+06
2.9E-07	14.48	3.45E+06	7.0E-07	13.59	1.43E+06
3.0E-07	14.44	3.33E+06	7.1E-07	13.58	1.41E+06
3.1E-07	14.41	3.23E+06	7.2E-07	13.57	1.39E+06
3.2E-07	14.38	3.13E+06	7.3E-07	13.55	1.37E+06
3.3E-07	14.35	3.03E+06	7.4E-07	13.54	1.35E+06
3.4E-07	14.32	2.94E+06	7.5E-07	13.53	1.33E+06
3.5E-07	14.29	2.86E+06	7.6E-07	13.51	1.32E+06
3.6E-07	14.26	2.78E+06	7.7E-07	13.50	1.30E+06
3.7E-07	14.23	2.70E+06	7.8E-07	13.49	1.28E+06
3.8E-07	14.21	2.63E+06	7.9E-07	13.47	1.27E+06
3.9E-07	14.18	2.56E+06	8.0E-07	13.46	1.25E+06
4.0E-07	14.15	2.50E+06	8.1E-07	13.45	1.23E+06
4.1E-07	14.13	2.44E+06	8.2E-07	13.44	1.22E+06
4.2E-07	14.11	2.38E+06	8.3E-07	13.42	1.20E+06
4.3E-07	14.08	2.33E+06	8.4E-07	13.41	1.19E+06
4.4E-07	14.06	2.27E+06	8.5E-07	13.40	1.18E+06
4.5E-07	14.04	2.22E+06	8.6E-07	13.39	1.16E+06
4.6E-07	14.01	2.17E+06	8.7E-07	13.38	1.15E+06
4.7E-07	13.99	2.13E+06	8.8E-07	13.37	1.14E+06
4.8E-07	13.97	2.08E+06	8.9E-07	13.35	1.12E+06
4.9E-07	13.95	2.04E+06	9.0E-07	13.34	1.11E+06
5.0E-07	13.93	2.00E+06	9.1E-07	13.33	1.10E+06
			9.2E-07	13.32	1.09E+06
			9.3E-07	13.31	1.08E+06
			9.4E-07	13.30	1.06E+06
			9.5E-07	13.29	1.05E+06
			9.6E-07	13.28	1.04E+06
			9.7E-07	13.27	1.03E+06
			9.8E-07	13.26	1.02E+06
			9.9E-07	13.25	1.01E+06

10^{-6} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-06	13.24	1.00E+06	5.1E-06	11.61	1.96E+05
1.1E-06	13.14	9.09E+05	5.2E-06	11.59	1.92E+05
1.2E-06	13.06	8.33E+05	5.3E-06	11.57	1.89E+05
1.3E-06	12.98	7.69E+05	5.4E-06	11.55	1.85E+05
1.4E-06	12.90	7.14E+05	5.5E-06	11.53	1.82E+05
1.5E-06	12.83	6.67E+05	5.6E-06	11.52	1.79E+05
1.6E-06	12.77	6.25E+05	5.7E-06	11.50	1.75E+05
1.7E-06	12.71	5.88E+05	5.8E-06	11.48	1.72E+05
1.8E-06	12.65	5.56E+05	5.9E-06	11.46	1.69E+05
1.9E-06	12.60	5.26E+05	6.0E-06	11.45	1.67E+05
2.0E-06	12.55	5.00E+05	6.1E-06	11.43	1.64E+05
2.1E-06	12.50	4.76E+05	6.2E-06	11.41	1.61E+05
2.2E-06	12.45	4.55E+05	6.3E-06	11.40	1.59E+05
2.3E-06	12.41	4.35E+05	6.4E-06	11.38	1.56E+05
2.4E-06	12.36	4.17E+05	6.5E-06	11.37	1.54E+05
2.5E-06	12.32	4.00E+05	6.6E-06	11.35	1.52E+05
2.6E-06	12.28	3.85E+05	6.7E-06	11.34	1.49E+05
2.7E-06	12.25	3.70E+05	6.8E-06	11.32	1.47E+05
2.8E-06	12.21	3.57E+05	6.9E-06	11.31	1.45E+05
2.9E-06	12.17	3.45E+05	7.0E-06	11.29	1.43E+05
3.0E-06	12.14	3.33E+05	7.1E-06	11.28	1.41E+05
3.1E-06	12.11	3.23E+05	7.2E-06	11.26	1.39E+05
3.2E-06	12.08	3.13E+05	7.3E-06	11.25	1.37E+05
3.3E-06	12.04	3.03E+05	7.4E-06	11.24	1.35E+05
3.4E-06	12.01	2.94E+05	7.5E-06	11.22	1.33E+05
3.5E-06	11.99	2.86E+05	7.6E-06	11.21	1.32E+05
3.6E-06	11.96	2.78E+05	7.7E-06	11.20	1.30E+05
3.7E-06	11.93	2.70E+05	7.8E-06	11.18	1.28E+05
3.8E-06	11.90	2.63E+05	7.9E-06	11.17	1.27E+05
3.9E-06	11.88	2.56E+05	8.0E-06	11.16	1.25E+05
4.0E-06	11.85	2.50E+05	8.1E-06	11.15	1.23E+05
4.1E-06	11.83	2.44E+05	8.2E-06	11.13	1.22E+05
4.2E-06	11.80	2.38E+05	8.3E-06	11.12	1.20E+05
4.3E-06	11.78	2.33E+05	8.4E-06	11.11	1.19E+05
4.4E-06	11.76	2.27E+05	8.5E-06	11.10	1.18E+05
4.5E-06	11.73	2.22E+05	8.6E-06	11.09	1.16E+05
4.6E-06	11.71	2.17E+05	8.7E-06	11.07	1.15E+05
4.7E-06	11.69	2.13E+05	8.8E-06	11.06	1.14E+05
4.8E-06	11.67	2.08E+05	8.9E-06	11.05	1.12E+05
4.9E-06	11.65	2.04E+05	9.0E-06	11.04	1.11E+05
5.0E-06	11.63	2.00E+05	9.1E-06	11.03	1.10E+05
			9.2E-06	11.02	1.09E+05
			9.3E-06	11.01	1.08E+05
			9.4E-06	11.00	1.06E+05
			9.5E-06	10.99	1.05E+05
			9.6E-06	10.98	1.04E+05
			9.7E-06	10.97	1.03E+05
			9.8E-06	10.96	1.02E+05
			9.9E-06	10.95	1.01E+05

10^{-5} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-05	10.94	1.00E+05	5.1E-05	9.31	1.96E+04
1.1E-05	10.84	9.09E+04	5.2E-05	9.29	1.92E+04
1.2E-05	10.75	8.33E+04	5.3E-05	9.27	1.89E+04
1.3E-05	10.67	7.69E+04	5.4E-05	9.25	1.85E+04
1.4E-05	10.60	7.14E+04	5.5E-05	9.23	1.82E+04
1.5E-05	10.53	6.67E+04	5.6E-05	9.21	1.79E+04
1.6E-05	10.47	6.25E+04	5.7E-05	9.20	1.75E+04
1.7E-05	10.41	5.88E+04	5.8E-05	9.18	1.72E+04
1.8E-05	10.35	5.56E+04	5.9E-05	9.16	1.69E+04
1.9E-05	10.29	5.26E+04	6.0E-05	9.14	1.67E+04
2.0E-05	10.24	5.00E+04	6.1E-05	9.13	1.64E+04
2.1E-05	10.19	4.76E+04	6.2E-05	9.11	1.61E+04
2.2E-05	10.15	4.55E+04	6.3E-05	9.10	1.59E+04
2.3E-05	10.10	4.35E+04	6.4E-05	9.08	1.56E+04
2.4E-05	10.06	4.17E+04	6.5E-05	9.06	1.54E+04
2.5E-05	10.02	4.00E+04	6.6E-05	9.05	1.52E+04
2.6E-05	9.98	3.85E+04	6.7E-05	9.03	1.49E+04
2.7E-05	9.94	3.70E+04	6.8E-05	9.02	1.47E+04
2.8E-05	9.91	3.57E+04	6.9E-05	9.00	1.45E+04
2.9E-05	9.87	3.45E+04	7.0E-05	8.99	1.43E+04
3.0E-05	9.84	3.33E+04	7.1E-05	8.98	1.41E+04
3.1E-05	9.80	3.23E+04	7.2E-05	8.96	1.39E+04
3.2E-05	9.77	3.13E+04	7.3E-05	8.95	1.37E+04
3.3E-05	9.74	3.03E+04	7.4E-05	8.93	1.35E+04
3.4E-05	9.71	2.94E+04	7.5E-05	8.92	1.33E+04
3.5E-05	9.68	2.86E+04	7.6E-05	8.91	1.32E+04
3.6E-05	9.65	2.78E+04	7.7E-05	8.89	1.30E+04
3.7E-05	9.63	2.70E+04	7.8E-05	8.88	1.28E+04
3.8E-05	9.60	2.63E+04	7.9E-05	8.87	1.27E+04
3.9E-05	9.57	2.56E+04	8.0E-05	8.86	1.25E+04
4.0E-05	9.55	2.50E+04	8.1E-05	8.84	1.23E+04
4.1E-05	9.52	2.44E+04	8.2E-05	8.83	1.22E+04
4.2E-05	9.50	2.38E+04	8.3E-05	8.82	1.20E+04
4.3E-05	9.48	2.33E+04	8.4E-05	8.81	1.19E+04
4.4E-05	9.45	2.27E+04	8.5E-05	8.80	1.18E+04
4.5E-05	9.43	2.22E+04	8.6E-05	8.78	1.16E+04
4.6E-05	9.41	2.17E+04	8.7E-05	8.77	1.15E+04
4.7E-05	9.39	2.13E+04	8.8E-05	8.76	1.14E+04
4.8E-05	9.37	2.08E+04	8.9E-05	8.75	1.12E+04
4.9E-05	9.35	2.04E+04	9.0E-05	8.74	1.11E+04
5.0E-05	9.33	2.00E+04	9.1E-05	8.73	1.10E+04
			9.2E-05	8.72	1.09E+04
			9.3E-05	8.71	1.08E+04
			9.4E-05	8.70	1.06E+04
			9.5E-05	8.68	1.05E+04
			9.6E-05	8.67	1.04E+04
			9.7E-05	8.66	1.03E+04
			9.8E-05	8.65	1.02E+04
			9.9E-05	8.64	1.01E+04

10^{-4} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-04	8.63	1.00E+04	5.1E-04	7.00	1.96E+03
1.1E-04	8.54	9.09E+03	5.2E-04	6.98	1.92E+03
1.2E-04	8.45	8.33E+03	5.3E-04	6.97	1.89E+03
1.3E-04	8.37	7.69E+03	5.4E-04	6.95	1.85E+03
1.4E-04	8.30	7.14E+03	5.5E-04	6.93	1.82E+03
1.5E-04	8.23	6.67E+03	5.6E-04	6.91	1.79E+03
1.6E-04	8.16	6.25E+03	5.7E-04	6.89	1.75E+03
1.7E-04	8.10	5.88E+03	5.8E-04	6.88	1.72E+03
1.8E-04	8.05	5.56E+03	5.9E-04	6.86	1.69E+03
1.9E-04	7.99	5.26E+03	6.0E-04	6.84	1.67E+03
2.0E-04	7.94	5.00E+03	6.1E-04	6.83	1.64E+03
2.1E-04	7.89	4.76E+03	6.2E-04	6.81	1.61E+03
2.2E-04	7.84	4.55E+03	6.3E-04	6.79	1.59E+03
2.3E-04	7.80	4.35E+03	6.4E-04	6.78	1.56E+03
2.4E-04	7.76	4.17E+03	6.5E-04	6.76	1.54E+03
2.5E-04	7.72	4.00E+03	6.6E-04	6.75	1.52E+03
2.6E-04	7.68	3.85E+03	6.7E-04	6.73	1.49E+03
2.7E-04	7.64	3.70E+03	6.8E-04	6.72	1.47E+03
2.8E-04	7.60	3.57E+03	6.9E-04	6.70	1.45E+03
2.9E-04	7.57	3.45E+03	7.0E-04	6.69	1.43E+03
3.0E-04	7.53	3.33E+03	7.1E-04	6.67	1.41E+03
3.1E-04	7.50	3.23E+03	7.2E-04	6.66	1.39E+03
3.2E-04	7.47	3.13E+03	7.3E-04	6.65	1.37E+03
3.3E-04	7.44	3.03E+03	7.4E-04	6.63	1.35E+03
3.4E-04	7.41	2.94E+03	7.5E-04	6.62	1.33E+03
3.5E-04	7.38	2.86E+03	7.6E-04	6.61	1.32E+03
3.6E-04	7.35	2.78E+03	7.7E-04	6.59	1.30E+03
3.7E-04	7.33	2.70E=03	7.8E-04	6.58	1.28E+03
3.8E-04	7.30	2.63E+03	7.9E-04	6.57	1.27E+03
3.9E-04	7.27	2.56E+03	8.0E-04	6.55	1.25E+03
4.0E-04	7.25	2.50E+03	8.1E-04	6.54	1.23E+03
4.1E-04	7.22	2.44E+03	8.2E-04	6.53	1.22E+03
4.2E-04	7.20	2.38E+03	8.3E-04	6.52	1.20E+03
4.3E-04	7.17	2.33E+03	8.4E-04	6.51	1.19E+03
4.4E-04	7.15	2.27E+03	8.5E-04	6.49	1.18E+03
4.5E-04	7.13	2.22E+03	8.6E-04	6.48	1.16E+03
4.6E-04	7.11	2.17E+03	8.7E-04	6.47	1.15E+03
4.7E-04	7.09	2.13E+03	8.8E-04	6.46	1.14E+03
4.8E-04	7.06	2.08E+03	8.9E-04	6.45	1.12E+03
4.9E-04	7.04	2.04E+03	9.0E-04	6.44	1.11E+03
5.0E-04	7.02	2.00E+03	9.1E-04	6.43	1.10E+03
			9.2E-04	6.41	1.09E+03
			9.3E-04	6.40	1.08E+03
			9.4E-04	6.39	1.06E+03
			9.5E-04	6.38	1.05E+03
			9.6E-04	6.37	1.04E+03
			9.7E-04	6.36	1.03E+03
			9.8E-04	6.35	1.02E+03
			9.9E-04	6.34	1.01E+03

10^{-3} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-03	6.33	1.00E+03	5.1E-03	4.71	1.96E+02
1.1E-03	6.24	9.09E+02	5.2E-03	4.69	1.92E+02
1.2E-03	6.15	8.33E+02	5.3E-03	4.67	1.89E+02
1.3E-03	6.07	7.69E+02	5.4E-03	4.65	1.85E+02
1.4E-03	6.00	7.14E+02	5.5E-03	4.63	1.82E+02
1.5E-03	5.93	6.67E+02	5.6E-03	4.61	1.79E+02
1.6E-03	5.86	6.25E+02	5.7E-03	4.60	1.75E+02
1.7E-03	5.80	5.88E+02	5.8E-03	4.58	1.72E+02
1.8E-03	5.74	5.56E+02	5.9E-03	4.56	1.69E+02
1.9E-03	5.69	5.26E+02	6.0E-03	4.54	1.67E+02
2.0E-03	5.64	5.00E+02	6.1E-03	4.53	1.64E+02
2.1E-03	5.59	4.76E+02	6.2E-03	4.51	1.61E+02
2.2E-03	5.54	4.55E+02	6.3E-03	4.50	1.59E+02
2.3E-03	5.50	4.35E+02	6.4E-03	4.48	1.56E+02
2.4E-03	5.46	4.17E+02	6.5E-03	4.47	1.54E+02
2.5E-03	5.42	4.00E+02	6.6E-03	4.45	1.52E+02
2.6E-03	5.38	3.85E+02	6.7E-03	4.44	1.49E+02
2.7E-03	5.34	3.70E+02	6.8E-03	4.42	1.47E+02
2.8E-03	5.30	3.57E+02	6.9E-03	4.41	1.45E+02
2.9E-03	5.27	3.45E+02	7.0E-03	4.39	1.43E+02
3.0E-03	5.23	3.33E+02	7.1E-03	4.38	1.41E+02
3.1E-03	5.20	3.23E+02	7.2E-03	4.36	1.39E+02
3.2E-03	5.17	3.13E+02	7.3E-03	4.35	1.37E+02
3.3E-03	5.14	3.03E+02	7.4E-03	4.34	1.35E+02
3.4E-03	5.11	2.94E+02	7.5E-03	4.32	1.33E+02
3.5E-03	5.08	2.86E+02	7.6E-03	4.31	1.32E+02
3.6E-03	5.05	2.78E+02	7.7E-03	4.30	1.30E+02
3.7E-03	5.03	2.70E+02	7.8E-03	4.28	1.28E+02
3.8E-03	5.00	2.63E+02	7.9E-03	4.27	1.27E+02
3.9E-03	4.97	2.56E+02	8.0E-03	4.26	1.25E+02
4.0E-03	4.95	2.50E+02	8.1E-03	4.25	1.23E+02
4.1E-03	4.92	2.44E+02	8.2E-03	4.23	1.22E+02
4.2E-03	4.90	2.38E+02	8.3E-03	4.22	1.20E+02
4.3E-03	4.88	2.33E+02	8.4E-03	4.21	1.19E+02
4.4E-03	4.85	2.27E+02	8.5E-03	4.20	1.18E+02
4.5E-03	4.83	2.22E+02	8.6E-03	4.19	1.16E+02
4.6E-03	4.81	2.17E+02	8.7E-03	4.18	1.15E+02
4.7E-03	4.79	2.13E+02	8.8E-03	4.16	1.14E+02
4.8E-03	4.77	2.08E+02	8.9E-03	4.15	1.12E+02
4.9E-03	4.75	2.04E+02	9.0E-03	4.14	1.11E+02
5.0E-03	4.73	2.00E+02	9.1E-03	4.13	1.10E+02
			9.2E-03	4.12	1.09E+02
			9.3E-03	4.11	1.08E+02
			9.4E-03	4.10	1.06E+02
			9.5E-03	4.09	1.05E+02
			9.6E-03	4.08	1.04E+02
			9.7E-03	4.07	1.03E+02
			9.8E-03	4.06	1.02E+02
			9.9E-03	4.05	1.01E+02

10^{-2} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-02	4.04	1.00E+02	5.1E-02	2.45	1.96E+01
1.1E-02	3.94	9.09E+01	5.2E-02	2.43	1.92E+01
1.2E-02	3.86	8.33E+01	5.3E-02	2.41	1.89E+01
1.3E-02	3.78	7.69E+01	5.4E-02	2.39	1.85E+01
1.4E-02	3.71	7.14E+01	5.5E-02	2.38	1.82E+01
1.5E-02	3.64	6.67E+01	5.6E-02	2.36	1.79E+01
1.6E-02	3.57	6.25E+01	5.7E-02	2.34	1.75E+01
1.7E-02	3.51	5.88E+01	5.8E-02	2.33	1.72E+01
1.8E-02	3.46	5.56E+01	5.9E-02	2.31	1.69E+01
1.9E-02	3.41	5.26E+01	6.0E-02	2.30	1.67E+01
2.0E-02	3.35	5.00E+01	6.1E-02	2.28	1.64E+01
2.1E-02	3.31	4.76E+01	6.2E-02	2.26	1.61E+01
2.2E-02	3.26	4.55E+01	6.3E-02	2.25	1.59E+01
2.3E-02	3.22	4.35E+01	6.4E-02	2.23	1.56E+01
2.4E-02	3.18	4.17E+01	6.5E-02	2.22	1.54E+01
2.5E-02	3.14	4.00E+01	6.6E-02	2.21	1.52E+01
2.6E-02	3.10	3.85E+01	6.7E-02	2.19	1.49E+01
2.7E-02	3.06	3.70E+01	6.8E-02	2.18	1.47E+01
2.8E-02	3.03	3.57E+01	6.9E-02	2.16	1.45E+01
2.9E-02	2.99	3.45E+01	7.0E-02	2.15	1.43E+01
3.0E-02	2.96	3.33E+01	7.1E-02	2.14	1.41E+01
3.1E-02	2.93	3.23E+01	7.2E-02	2.12	1.39E+01
3.2E-02	2.90	3.13E+01	7.3E-02	2.11	1.37E+01
3.3E-02	2.87	3.03E+01	7.4E-02	2.10	1.35E+01
3.4E-02	2.84	2.94E+01	7.5E-02	2.09	1.33E+01
3.5E-02	2.81	2.86E+01	7.6E-02	2.07	1.32E+01
3.6E-02	2.78	2.78E+01	7.7E-02	2.06	1.30E+01
3.7E-02	2.76	2.70E+01	7.8E-02	2.05	1.28E+01
3.8E-02	2.73	2.63E+01	7.9E-02	2.04	1.27E+01
3.9E-02	2.71	2.56E+01	8.0E-02	2.03	1.25E+01
4.0E-02	2.68	2.50E+01	8.1E-02	2.02	1.23E+01
4.1E-02	2.66	2.44E+01	8.2E-02	2.00	1.22E+01
4.2E-02	2.63	2.38E+01	8.3E-02	1.993	1.20E+01
4.3E-02	2.61	2.33E+01	8.4E-02	1.982	1.19E+01
4.4E-02	2.59	2.27E+01	8.5E-02	1.971	1.18E+01
4.5E-02	2.57	2.22E+01	8.6E-02	1.960	1.16E+01
4.6E-02	2.55	2.17E+01	8.7E-02	1.950	1.15E+01
4.7E-02	2.53	2.13E+01	8.8E-02	1.939	1.14E+01
4.8E-02	2.51	2.08E+01	8.9E-02	1.929	1.12E+01
4.9E-02	2.49	2.04E+01	9.0E-02	1.919	1.11E+01
5.0E-02	2.47	2.00E+01	9.1E-02	1.909	1.10E+01
			9.2E-02	1.899	1.09E+01
			9.3E-02	1.889	1.08E+01
			9.4E-02	1.879	1.06E+01
			9.5E-02	1.869	1.05E+01
			9.6E-02	1.860	1.04E+01
			9.7E-02	1.851	1.03E+01
			9.8E-02	1.841	1.02E+01
			9.9E-02	1.832	1.01E+01

10^{-1} Well Functions

U	W(U)	1/U	U	W(U)	1/U
1.0E-01	1.823	1.00E+01	5.1E-01	0.548	1.96E+00
1.1E-01	1.737	9.09E+00	5.2E-01	0.536	1.92E+00
1.2E-01	1.660	8.33E+00	5.3E-01	0.525	1.89E+00
1.3E-01	1.589	7.69E+00	5.4E-01	0.514	1.85E+00
1.4E-01	1.524	7.14E+00	5.5E-01	0.503	1.82E+00
1.5E-01	1.464	6.67E+00	5.6E-01	0.493	1.79E+00
1.6E-01	1.409	6.25E+00	5.7E-01	0.483	1.75E+00
1.7E-01	1.358	5.88E+00	5.8E-01	0.473	1.72E+00
1.8E-01	1.310	5.56E+00	5.9E-01	0.464	1.69E+00
1.9E-01	1.265	5.26E+00	6.0E-01	0.454	1.67E+00
2.0E-01	1.223	5.00E+00	6.1E-01	0.445	1.64E+00
2.1E-01	1.183	4.76E+00	6.2E-01	0.437	1.61E+00
2.2E-01	1.145	4.55E+00	6.3E-01	0.428	1.59E+00
2.3E-01	1.110	4.35E+00	6.4E-01	0.420	1.56E+00
2.4E-01	1.076	4.17E+00	6.5E-01	0.412	1.54E+00
2.5E-01	1.044	4.00E+00	6.6E-01	0.404	1.52E+00
2.6E-01	1.014	3.85E+00	6.7E-01	0.396	1.49E+00
2.7E-01	0.985	3.70E+00	6.8E-01	0.388	1.47E+00
2.8E-01	0.957	3.57E+00	6.9E-01	0.381	1.45E+00
2.9E-01	0.931	3.45E+00	7.0E-01	0.374	1.43E+00
3.0E-01	0.906	3.33E+00	7.1E-01	0.367	1.41E+00
3.1E-01	0.882	3.23E+00	7.2E-01	0.360	1.39E+00
3.2E-01	0.858	3.13E+00	7.3E-01	0.353	1.37E+00
3.3E-01	0.836	3.03E+00	7.4E-01	0.347	1.35E+00
3.4E-01	0.815	2.94E+00	7.5E-01	0.340	1.33E+00
3.5E-01	0.794	2.86E+00	7.6E-01	0.334	1.32E+00
3.6E-01	0.774	2.78E+00	7.7E-01	0.328	1.30E+00
3.7E-01	0.755	2.70E+00	7.8E-01	0.322	1.28E+00
3.8E-01	0.737	2.63E+00	7.9E-01	0.316	1.27E+00
3.9E-01	0.719	2.56E+00	8.0E-01	0.311	1.25E+00
4.0E-01	0.702	2.50E+00	8.1E-01	0.305	1.23E+00
4.1E-01	0.686	2.44E+00	8.2E-01	0.300	1.22E+00
4.2E-01	0.670	2.38E+00	8.3E-01	0.294	1.20E+00
4.3E-01	0.655	2.33E+00	8.4E-01	0.289	1.19E+00
4.4E-01	0.640	2.27E+00	8.5E-01	0.284	1.18E+00
4.5E-01	0.625	2.22E+00	8.6E-01	0.279	1.16E+00
4.6E-01	0.611	2.17E+00	8.7E-01	0.274	1.15E+00
4.7E-01	0.598	2.13E+00	8.8E-01	0.269	1.14E+00
4.8E-01	0.585	2.08E+00	8.9E-01	0.265	1.12E+00
4.9E-01	0.572	2.04E+00	9.0E-01	0.260	1.11E+00
5.0E-01	0.560	2.00E+00	9.1E-01	0.256	1.10E+00
			9.2E-01	0.251	1.09E+00
			9.3E-01	0.247	1.08E+00
			9.4E-01	0.243	1.06E+00
			9.5E-01	0.239	1.05E+00
			9.6E-01	0.235	1.04E+00
			9.7E-01	0.231	1.03E+00
			9.8E-01	0.227	1.02E+00
			9.9E-01	0.223	1.01E+00

10 Well Functions

U	W(U)	1/U
1.0E+00	0.219	1.00E+00
1.1E+00	0.186	9.09E-01
1.2E+00	0.158	8.33E-01
1.3E+00	0.135	7.69E-01
1.4E+00	0.116	7.14E-01
1.5E+00	0.100	6.67E-01
1.6E+00	0.086	6.25E-01
1.7E+00	0.075	5.88E-01
1.8E+00	0.065	5.56E-01
1.9E+00	0.056	5.26E-01
2.0E+00	0.049	5.00E-01
2.1E+00	0.043	4.76E-01
2.2E+00	0.037	4.55E-01
2.3E+00	0.033	4.35E-01
2.4E+00	0.028	4.17E-01
2.5E+00	0.025	4.00E-01
2.6E+00	0.022	3.85E-01
2.7E+00	0.019	3.70E-01
2.8E+00	0.017	3.57E-01
2.9E+00	0.015	3.45E-01
3.0E+00	0.013	3.33E-01
3.1E+00	0.011	3.23E-01
3.2E+00	0.010	3.13E-01
3.3E+00	0.009	3.03E-01
3.4E+00	0.008	2.94E-01
3.5E+00	0.007	2.86E-01
3.6E+00	0.006	2.78E-01
3.7E+00	0.005	2.70E-01
3.8E+00	0.005	2.63E-01
3.9E+00	0.004	2.56E-01
4.0E+00	0.004	2.50E-01
4.1E+00	0.003	2.44E-01
4.2E+00	0.003	2.38E-01
4.3E+00	0.003	2.33E-01
4.4E+00	0.002	2.27E-01
4.5E+00	0.002	2.22E-01
4.6E+00	0.002	2.17E-01
4.7E+00	0.002	2.13E-01
4.8E+00	0.001	2.08E-01
4.9E+00	0.001	2.04E-01
5.0E+00	0.001	2.00E-01

Section 671.TABLE B Well Functions for Unconfined or Water Table Aquifers

$1/u_A$ =6.0	= 0.001	= 0.01	= 0.06	= 0.2	= 0.6	= 1.0	= 2.0	= 4.0
4.0×10^{-1}	2.48×10^{-2}	2.41×10^{-2}	2.30×10^{-2}	2.14×10^{-2}	1.88×10^{-2}	1.70×10^{-2}	1.38×10^{-2}	9.33×10^{-3}	6.39×10^{-3}
8.0×10^{-1}	1.45×10^{-1}	1.40×10^{-1}	1.31×10^{-1}	1.19×10^{-1}	9.88×10^{-2}	8.49×10^{-2}	6.03×10^{-2}	3.17×10^{-2}	1.74×10^{-2}
1.4×10^{0}	3.58×10^{-1}	3.45×10^{-1}	3.18×10^{-1}	2.79×10^{-1}	2.17×10^{-1}	1.75×10^{-1}	1.07×10^{-1}	4.45×10^{-2}	2.10×10^{-2}
2.4×10^{0}	6.62×10^{-1}	6.33×10^{-1}	5.70×10^{-1}	4.83×10^{-1}	3.43×10^{-1}	2.56×10^{-1}	1.33×10^{-1}	4.76×10^{-2}	2.14×10^{-2}
4.0×10^{0}	1.02×10^{0}	9.63×10^{-1}	8.49×10^{-1}	6.88×10^{-1}	4.38×10^{-1}	3.00×10^{-1}	1.40×10^{-1}	4.78×10^{-2}	2.15×10^{-2}
8.0×10^{0}	1.57×10^{0}	1.46×10^{0}	1.23×10^{0}	9.18×10^{-1}	4.97×10^{-1}	3.17×10^{-1}	1.41×10^{-1}		
1.4×10^{1}	2.05×10^{0}	1.88×10^{0}	1.51×10^{0}	1.03×10^{0}	5.07×10^{-1}				
2.4×10^{1}	2.52×10^{0}	2.27×10^{0}	1.73×10^{0}	1.07×10^{0}					
4.0×10^{1}	2.97×10^{0}	2.61×10^{0}	1.85×10^{0}	1.08×10^{0}					
8.0×10^{1}	3.56×10^{0}	3.00×10^{0}	1.92×10^{0}						
1.4×10^{2}	4.01×10^{0}	3.23×10^{0}	1.93×10^{0}						
2.4×10^{2}	4.42×10^{0}	3.37×10^{0}	1.94×10^{0}						
4.0×10^{2}	4.77×10^{0}	3.43×10^{0}							
8.0×10^{2}	5.16×10^{0}	3.45×10^{0}							
1.4×10^{3}	5.40×10^{0}	3.46×10^{0}							
2.4×10^{3}	5.54×10^{0}								
4.0×10^{3}	5.59×10^{0}								
8.0×10^{3}	5.62×10^{0}								
1.4×10^{4}	5.62×10^{0}	3.46×10^{0}	1.94×10^{0}	1.08×10^{0}	5.07×10^{-1}	3.17×10^{-1}	1.41×10^{-1}	4.78×10^{-2}	2.15×10^{-2}

SOURCE: Adapted from S. P. Neuman, Water Resources Research, 11(1975): 329-42.

ERATTA SHEET

REVISIONS to:

TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE F: PUBLIC WATER SUPPLIES
CHAPTER II: ENVIRONMENTAL PROTECTION AGENCY

PART 671
MAXIMUM SETBACK ZONE FOR COMMUNITY WATER SUPPLY WELLS

SUBPART A: INTRODUCTION

Section 671.104 Agency Mailing Address

Each request, report, notice, or other document submitted to the Agency under this Part shall be mailed to the following address:

Manager, Groundwater Section
Division of Public Water Supplies
Illinois Environmental Protection Agency
1021 North Grand Avenue East ~~2200 Churchill Road~~
Post Office Box 19276
Springfield, Illinois 62794-9276

SUBPART B: PROCEDURES FOR DETERMINING THE LATERAL AREA OF INFLUENCE OFWELLS UNDER NORMAL OPERATIONAL CONDITIONS

Section 671.APPENDIX E Theis Equations and Pump Test Procedures for Confined Aquifers

PROCEDURE

The Theis type curve is used. The type curve is used to evaluate field data for time and drawdown, which are plotted on logarithmic paper of the same scale. The following procedure can be used:…

5. From all of the above, the lateral radius of influence can be calculated as follows:

$$s = \sqrt{\frac{uTt}{2693S}}$$

Where: The Theis type curve is used. The type curve is used to evaluate field data for time and drawdown, which are plotted on logarithmic paper of the same scale. The following procedure can be used:

r = radius of influence (feet)
Q = production well discharge rate under normal operational conditions (gallons per minute)
S = aquifer storitivity (dimensionless)
T ~~t~~ = aquifer transmissivity (gallons per day per foot)
u = is a dimensionless parameter related to well function
W(u) = well function, the well function is calculated and u is obtained from Table A
h_o - h = drawdown in the piezometer or observation well
t = time the well is pumped under normal operational conditions (minutes)