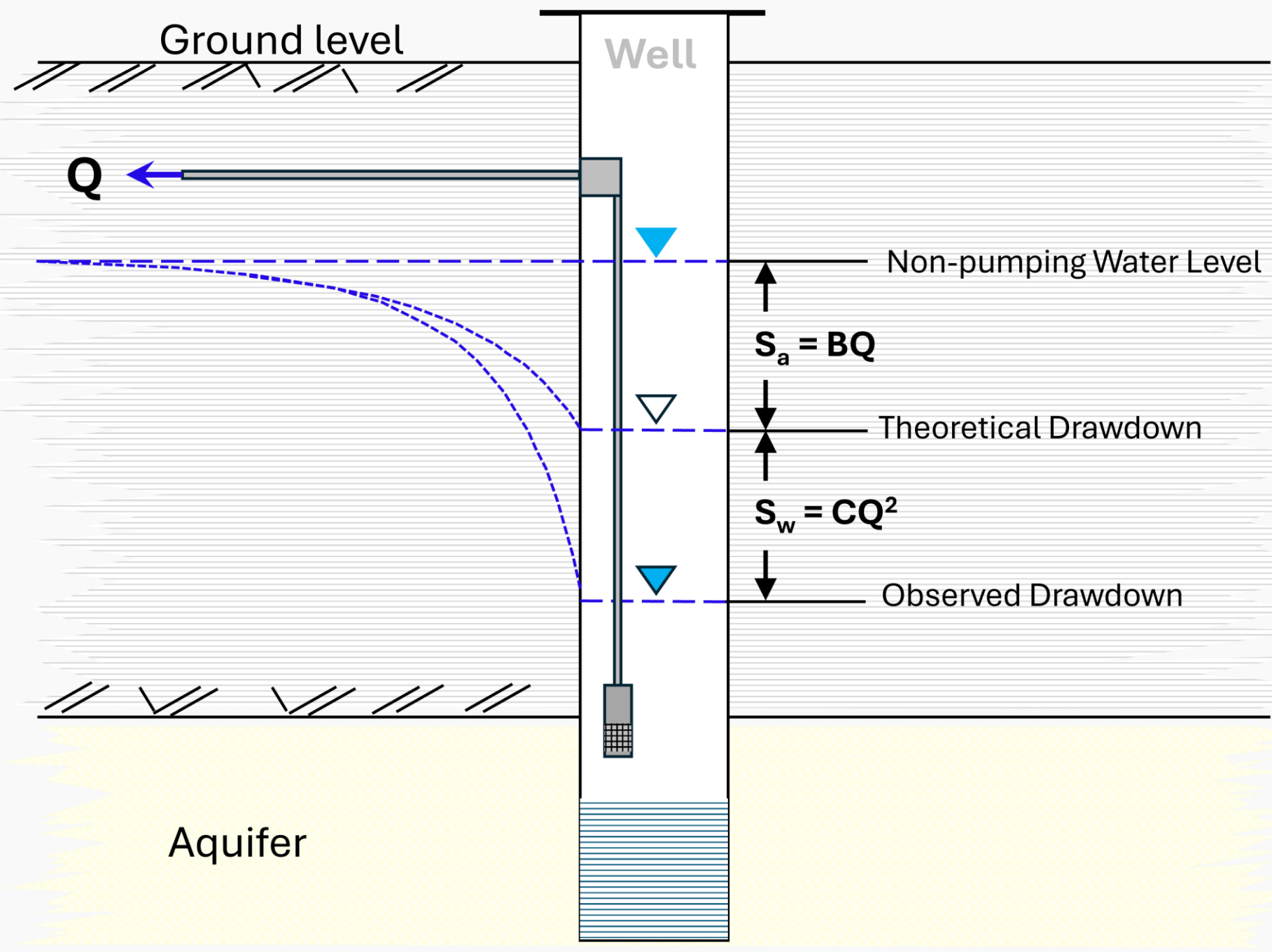


How to analyze well efficiency without any graphs



The Kasenow Solution

Well loss coefficient:

$$C = \frac{s_y Q_x - s_x Q_y}{Q_x Q_y^2 - Q_y Q_x^2}$$

Aquifer loss coefficient:

$$B = \frac{s_x Q_y^2 - s_y Q_x^2}{Q_x Q_y^2 - Q_y Q_x^2}$$

Equations & Variables

Symbol	Units	Description	Details
B	T/L ²	Aquifer loss coefficient	$B = \frac{s_x Q_y^2 - s_y Q_x^2}{Q_x Q_y^2 - Q_y Q_x^2}$
C	T ² /L ⁵	Well loss coefficient	$C = \frac{s_y Q_x - s_x Q_y}{Q_x Q_y^2 - Q_y Q_x^2}$
s_x	L	Observed drawdown in the well at the end of Step X*	Field measurement
s_y	L	Observed drawdown in the well at the end of Step Y*	Field measurement
Q_x	L ³ /T	Pumping rate during Step X	Field Measurement
Q_y	L ³ /T	Pumping rate during Step Y	Field Measurement
BQ	L	Observed drawdown due to aquifer (laminar) flow	See drawing
CQ²	L	Observed drawdown due to well (turbulent) flow	See drawing

*Step X is any step in the step-rate testing that precedes Step Y

When to use this

1. Estimate well efficiency from a step-rate test
2. Use C to estimate additional well drawdown at pumping rate
3. Use B and C to estimate operating pump depth

Advantages of Kasenow

1. Doesn't require transforming the field data & a more stable calculation than Jacob solution
2. Doesn't require graphing
3. Doesn't require knowing aquifer transmissivity or storativity
4. Can be used on confined or unconfined aquifers
5. Can determine inconsistency in B & C values between steps

Definitions

Aquifer Loss Coefficient (B): this is the laminar head losses as groundwater enters the well

Well Loss Coefficient (C): turbulent head losses as the groundwater enters the well

More Information

To see how the Kasenow Solution is derived go to:

<https://anaqsim.com/well-performance-jacobs-test-2/>

Original derivation:

Kasenow, M. 2006. Aquifer Test Data: Analysis and Evaluation. Water Resources Publication. Co. USA

ISBN 1-887201-41-6

Analysis of Well Loss Coefficient Values

C (min ² /m ⁵)	C (ft/gpm ²)	Condition of the Well
< 0.5	< 0.000025	Excellent well development
0.5 to 1.0	0.000025 To 0.000050	Acceptable but improvable performance
1.0 to 4.0	0.000050 To 0.00020	Substantial well losses requiring redevelopment
> 4.0	> 0.00020	Damaged and may be difficult to restore to original yield

Results Interpretation

1. Similar B and C values between steps suggest a stable, sufficiently developed production well
2. Large changes in B or C between steps may indicate the well needs further development
3. High C suggests higher well losses and possible well-performance problems

Example Data & Calculations

Step	Discharge (m ³ /d)	Drawdown (m)	Calculated B d/m ²	Calculated C d ² /m ⁵
1	1306	4.25	-	-
2	1693	5.95	0.00238	6.73E-07
3	2423	8.75	0.00329	1.33E-07
4	3261	12.15	0.00328	1.37E-07
5	4094	15.8	0.00320	1.60E-07
6	5019	20	0.00330	1.36E-07

Example calculations between Steps 4 & 5:

$$B = \frac{s_x Q_y^2 - s_y Q_x^2}{Q_x Q_y^2 - Q_y Q_x^2} = \frac{(12.15)(4094^2) - (15.8)(3261^2)}{(3261)(4094^2) - (4094)(3261^2)} = 0.00320$$

$$C = \frac{s_y Q_x - s_x Q_y}{Q_x Q_y^2 - Q_y Q_x^2} = \frac{(15.8)(3261) - (12.15)(4094)}{(3261)(4094^2) - (4094)(3261^2)} = 1.60 \times 10^{-7}$$

Unit conversion :

$$C = 1.60 \times 10^{-7} \frac{d^2}{m^5} \times \frac{1440 \text{ min}}{d} \times \frac{1440 \text{ min}}{d} = 0.33 \frac{\text{min}^2}{m^5}$$

= Excellent well development

Example calculation comparison and source

Hantush-Bierschenk graphical method:

Kruseman et al. (2000) reported the following analysis results using the Hantush-Bierschenk graphical method. The authors chose to exclude the first point because it does not fall on the best-fit line:

$$B = 0.00326 \text{ d/m}^2$$

$$C = 1.45 \times 10^{-7} \text{ d}^2/\text{m}^5$$

Kasenow Solution:

B and C calculated at each step, and then averaged across steps 2 through 6:

$$B = 0.00327 \text{ d/m}^2$$

$$C = 1.41 \times 10^{-7} \text{ d}^2/\text{m}^5$$

Source:

Kruseman, G.P., de Ridder, N.A., & Verweij, J.M. 2000. *Analysis and Evaluation of Pumping Test Data* (2nd ed., completely revised). International Institute for Land Reclamation and Improvement (ILRI), Publication 47. [Example 14.1, Pg 203]

Drawdown Calculation Example

From Step 6 of Example:

$$Q = 5019 \text{ m}^3/\text{d}$$

$$S = 20\text{m}$$

$$B = 0.00320 \text{ d}/\text{m}^2$$

$$C = 1.41 \times 10^{-7} \text{ d}^2/\text{m}^5$$

Estimated drawdown due to aquifer head loss (S_a)

$$S_a = BQ \text{ (see drawing)}$$

$$S_a = (0.00327 \text{ d}/\text{m}^2) (5019 \text{ m}^3/\text{d})$$

$$\mathbf{S_a = 16.41m}$$

Estimated drawdown due to well head loss (S_w)

$$S_w = CQ^2 \text{ (see drawing)}$$

$$S_w = (1.41 \times 10^{-7} \text{ d}^2/\text{m}^5) (5019 \text{ m}^3/\text{d})$$

$$\mathbf{S_w = 3.56 m}$$