Groundwater Abstraction

Monitoring Plan Guidance

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Northern Ireland Environment Agency

Contents

Groundwater Abstraction Monitoring Plan Guidance

Introduction

This guidance document has been written for operators who have applied for a licence to abstract groundwater. Abstraction licences are issued by the Northern Ireland Environment Agency (NIEA) under the Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006. This guidance document explains why operators need to undertake monitoring of their groundwater abstraction, provides guidance on how to produce and implement a monitoring plan and assists the operator with deciding what types of monitoring are most appropriate for their site.

Background

All groundwater abstractions will impact on the water environment leading to a reduction in the volume of water available to different receptors that are dependant on groundwater. It is important to determine whether the extent of the impact caused by an abstraction is within acceptable limits.

New regulations and legislation now mean that the NIEA have increased responsibilities to ensure that the water environment is protected and that abstractions of groundwater are sustainable. All operators who intend to abstract more than 20 cubic metres per day from groundwater are required to submit an application for a licence to abstract the daily volume necessary for their operation. Each application is reviewed to determine if there is a reasonable risk of the proposed abstraction causing an impact on the following receptors:

a) The available groundwater resource
b) Other groundwater abstractors
c) Nearby rivers and lakes
d) Nearby ecosystems dependant on groundwater

In many cases, due to the complex nature of how groundwater flows through the subsurface, it is difficult to accurately assess the risk posed by a groundwater abstraction on a certain receptor. Hydrogeological investigations are therefore necessary to both determine the yield of the borehole (amount of water that it gives out) but also the likely impacts it will have on receptors. Investigations involve controlled pump testing of the abstraction to produce a conceptual or numerical model that can then be used to make long term predictions of not only the yield of the borehole but also the likely impacts it will have on receptors. Pumping tests and groundwater modelling also provide an operator with invaluable information to help manage their water supply needs in the future.

Environmental methods have been developed by UKTAG (United Kingdom Technical Advisory Group for the Water Framework Directive) relating to groundwater abstractions. To apply these methods it is crucial that accurate volumes of how much water is abstracted from groundwater are recorded and that groundwater levels are measured.

The NIEA needs to obtain both accurate abstracted water volumes and groundwater level data to inform the normal licence review process. The collected data also allow the modelling of groundwater bodies to further enhance the accuracy of abstraction risk assessment.

Collecting both sets of monitoring data (volumes and levels) also benefits the operator. Monitoring data can inform an operator of the optimum pumping regime that can be achieved by their abstraction borehole(s). It will be key in determining if there is a need for more boreholes to be drilled and most importantly, where would be best to drill. The low cost of monitoring can be justified by the savings it will lead to in the future.

Monitoring Plan

Where an abstraction is identified as posing a potential risk to one or more receptors, further hydrogeological investigations are required to be carried out by the applicant to assess the level of risk the abstraction poses to the receptor(s). Submission of the results and findings of such work are expected to include a suggested monitoring plan that will be implemented by the applicant if a licence to abstract is granted. It is expected that this plan will include proposals and details for monitoring of resting groundwater levels within the same groundwater unit that the abstraction is from. The monitoring plan must meet the minimum requirements set by the NIEA, as detailed in this document. The monitoring plan should be designed to best fit with the normal operations of the abstraction site. For some cases, manual measurements would be better where as for others, automatic measurements may be best. This document provides useful information to assist an operator with making the decisions necessary to produce a workable monitoring plan.

A monitoring plan should include:

- Details of the method to be used to measure abstracted water volumes.
- If using a metering device, how often measurements will be taken.

- Whether water levels will be monitored in a production borehole or an observation borehole.
- If an observation borehole is to be used for monitoring, its location in relation to the production borehole.
- Details of the method to be used for measuring resting water levels.
- The frequency that resting water levels will be monitored
- What measures will be adopted to ensure the proposed monitoring plan will be implemented.
- If there is a potential risk of saline intrusion identified, detail and frequency of conductivity monitoring.

Abstracted Water Volume Measurement

A licence is granted with a condition for a maximum daily volume of water to be abstracted from groundwater. To ensure compliance with this condition, an operator must accurately record the volume of water abstracted and submit this information annually to the NIEA so that compliance can be assessed. It is the responsibility of the operator to propose and implement a suitable method for accurate recording of abstracted water volumes. The licence holder must determine what method of measurement they will use to record their abstracted water volumes so that they are compliant with the conditions of their licence. Measurements should be recorded using the units cubic metres per day.

Here are two examples of suitable methods that are commonly used to measure abstracted water volumes. Estimates based on pump ratings and approximate average length of time pumping, are not suitable in most cases. Some form of accurate cumulative volume measurement must be performed. You may use another method other than the two below but details should be included in your monitoring plan and approval should be sought from NIEA prior to implementation.

Water Meter

This is the most common method used for measuring water pumped from a borehole. There are different types of water meter that can be fitted to the supply pipe from a rising main out of a borehole. Meters can be easily installed into a new supply system and can also be retrofitted to an existing system. Most meters require an operative to manually record the meter reading periodically.

It is also possible for meters to have an electrical output fitted to enable water volume and flow to be recorded in real time using an external data logging unit. The data can then be downloaded or transferred remotely to a computer where water usage per day/week/month etc. can be viewed and quickly exported to be submitted to NIEA. It is advisable to contact a pumping or plumbing contractor to get the most appropriate system designed for your needs.

See Fig. 1 below

Typical Costs: **Water meter < £500**
Datalogger < £500

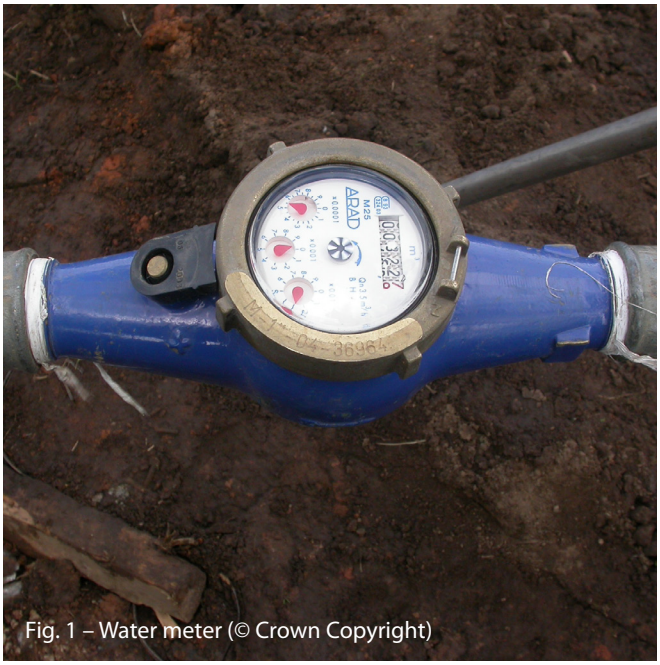


Fig. 1 – Water meter (© Crown Copyright)

V notch weir

This method is applicable to temporary dewatering schemes, pumping tests and quarry dewatering. Pumped water passes through a tank containing baffles and a V notch weir at one end before discharging to sewer or a holding tank. The height of the water behind the weir is monitored either manually or automatically using a water level logging device such as an ultrasonic sensor and then converted to a value of water flow.

A sample record sheet can be found in Appendix 1. An excel version can be downloaded with this document and it is advised to return readings to the NIEA in electronic form. The total volume abstracted in a given calendar year should be totalled before being returned to the NIEA.

Groundwater Level Monitoring

In some cases, the risk of impacting a nearby receptor by over abstraction may be deemed high. The most reliable, simple and effective way to measure if an impact will, or is being caused, is to monitor groundwater levels in the same groundwater unit that the abstraction is from.

By studying the trend of resting water levels over a long period of time, it is possible to establish whether an abstraction is operating sustainably or not. Groundwater levels are typically high in the winter and low in the summer. A trend over a number of years that demonstrates groundwater levels are declining indicates that there is unsustainable abstraction in that area. This information is useful for an operator as it helps them to better manage their water usage and alerts them to any water shortage problems that could severely threaten the operations at their site.

The NIEA expects that monitoring should continue for a period of at least 6 years to acquire a set of data long enough for the trends to be properly analysed.

An operator has three decisions to make regarding their plan for measuring groundwater levels:

A. Will water levels be measured in an observation borehole or the main production borehole?

B. Will water levels be measured manually or using an automatic logging device?

C. How often will measurements be taken (referred to as frequency)?

Below is guidance to assist an operator with making these decisions to ensure that they acquire appropriate data in a manner that is suitable for their operations.

A. Production borehole versus Observation borehole

If there is another borehole between 100 m and 1000 m (1 km) away from any production boreholes that the operator has ownership of or access to that is not used for abstraction, then this observation borehole should be considered as a possible location for monitoring water levels. The observation borehole must be drilled into and screened across the same aquifer unit that the abstraction is from. In most cases no observation boreholes will have been drilled close by and the operator will have no choice but to monitor resting water levels in their production borehole unless they decide to drill a new observation borehole.Water levels in observation boreholes are affected less by pumping in the production borehole and are therefore better for monitoring water levels. Water levels in observation boreholes more accurately represent how the aquifer is responding to the abstraction, as shown in Fig. 2 below.

Some operators require that observation boreholes be drilled and tested prior to the drilling of the main production borehole. This helps to site the production borehole in the best location to optimise the yield from the production borehole. They are also then used during normal production to monitor the state of the aquifer to ensure the borehole will not run dry, affecting the operations of the site. In most cases, observation boreholes will not be drilled along with a main production well.

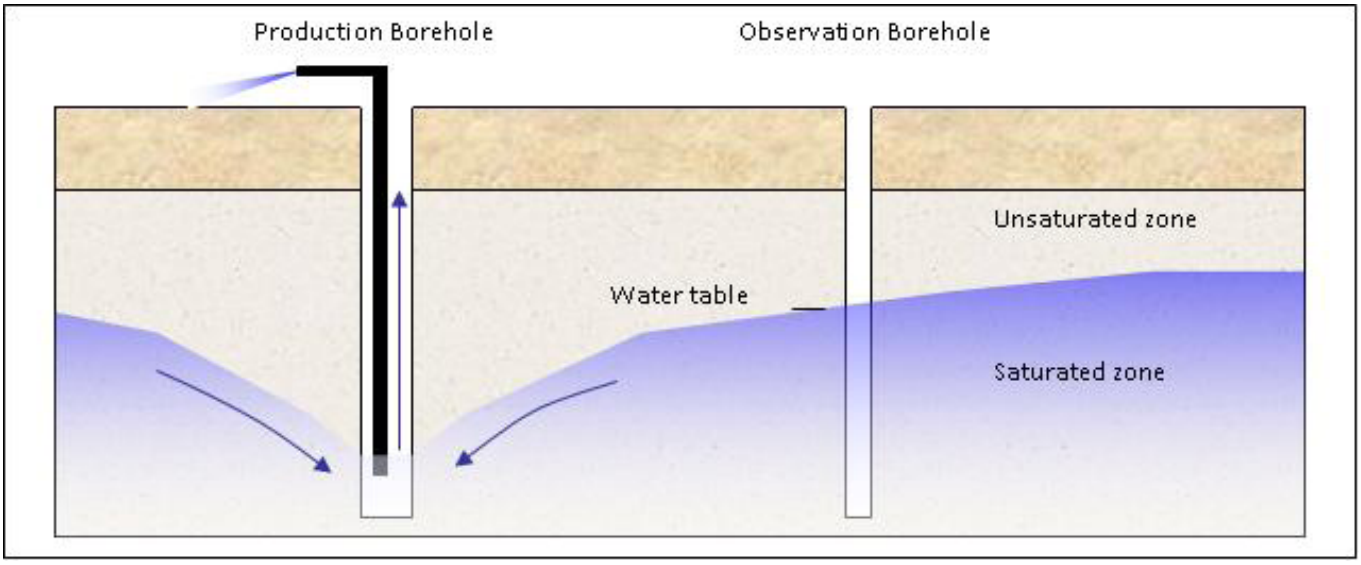


Fig. 2 – Relationship between groundwater levels in a production borehole and an observation borehole

An operator must decide whether water level monitoring will be performed in their production borehole or if a suitable observation borehole is available. This should be clearly stated in their monitoring plan along with a map accurately showing the location of the observation borehole and pumping borehole. An operator is not required to commission the drilling of an observation borehole if one is not available but can do so if they feel it would be more suitable for them.

B. Manual Measurement

The water level in a borehole is measured by running a water level dip meter down the borehole until the moisture sensor starts to bleep, indicating the top of the resting water level. There are a number of suppliers who sell dip meters in the UK. These can vary in price depending on the length of tape you require but can cost up to £500. A dip meter with 50 m of tape is normally suitable for measuring water levels in Northern Ireland.

Measurements should be taken only after a period when there has been no abstraction. This could be after a weekend or a holiday period such as in December and July. If the site operations are continuous and there are no shut down periods then manual measurement is not suitable and automatic monitoring should be considered (unless measurement is from a suitable observation borehole. See section A for more information).

To be compliant with the condition for monitoring water levels, a minimum of 2 manual measurements (at least four months apart should be recorded each year.) However, it is recommended that an operator should aim to take at least 4 readings per year to ensure that they guarantee acquiring their minimum of 2 readings to be compliant. It is advised that measurements should be taken at the end of each shut down period.

It is important that the precise date and time of measurement are recorded along with the resting water level reading. Measurements should be recorded using metres as the unit of measurement. Using paint, place a small mark on the side and top of the borehole casing to indicate the point to which all measurements are taken. This is to ensure that measurements are consistent and can be compared against each other. Further guidance on how to take an accurate manual measurement can be found in Appendix 2. A sample recording sheet can be found in Appendix 3.

C. Automatic Measurement

In recent years, various different methods have become commercially available that enable water level measurements to be made automatically in boreholes. Most involve the use of some form of pressure sensor or float and a data logger to record measurements made. Measurements can be recorded continuously or at regular intervals from one second to twelve hours.

If a borehole is continuously pumped with no clearly defined shut down period and/or the use of automatic measurement is better suited to the site operations, then automatic measurement should be used to record water levels in a production or suitable observation borehole (see section A).

The most common, affordable and easy to use method involves submersing a small data logging unit into a borehole suspended on a steel wire that records the pressure above it at regular intervals, such as the unit shown in Fig. 3.

Fig. 3 – Submersible data logger for automatically recording changes in water levels in a borehole

Data loggers typically cost around £500. To ensure that data loggers work properly, it is important that they are properly deployed. It is advised that this is done by someone specifically trained in their use who can also advise on what type of unit should be purchased for each individual case. An environmental consultant with hydrogeological experience should be able to deploy the unit, download the data collected each year and compile the data ready for return to the NIEA. Some suppliers of water level data loggers also run training courses in their use.

If using an automatic water level logging device, the interval between readings should be set at one hour and acquired on the hour. This will enable the effects of pumping to be recognised and accounted for when the collected data is analysed. The NIEA collect barometric pressure readings on the hour so it is not necessary to deploy a barometric logger by the operator and perform a compensation of the logged water level data, thus reducing the cost of deployment. Automatic water level logging devices can fail, particularly if deployed incorrectly. It is advised that after a few months of operation, the device is downloaded to ensure that it is working properly.

Return of Measurements

Standard measurement sheets can be found in Appendix 1 and 3 for recording abstracted volumes and water level measurements. Where possible, measurements should be completed electronically using a spreadsheet table, such as the one that can be downloaded with this document. Submission of monitoring data can then easily be e-mailed to NIEA at ail@doeni.gov.uk.

Any difficulties complying with the monitoring conditions should be included with the return of measurements. If no measurements have been acquired then the NIEA should be informed using the above e-mail address stating the reasons and the measures that have been implemented to ensure future compliance.

Monitoring Plan Checklist

Your monitoring plan should include the following:

1. Details of the method to be used to measure abstracted volumes
2. If using a metering device, how often measurements will be taken
3. Whether water levels will be monitored in a production borehole or an observation borehole
4. If an observation borehole is to be used for monitoring, its location in relation to the production borehole
5. Whether manual or automatic water level monitoring will be conducted.
6. If using manual measurement of water levels, on what dates measurements will be taken and what methods will be used to ensure that no abstraction has taken place for a few days.
7. If using automatic monitoring, details of when the monitoring device will be installed, who will install it and if known, what device will be installed
8. If there is a potential risk of saline intrusion identified, detail and frequency of conductivity monitoring

Photographs of boreholes to be monitored, installed meters and the deployment of automatic water level monitoring devices are all welcomed in a monitoring plan, if available.

Contact

For further information please contact, help or advice with producing a monitoring plan or its implementation, please contact the NIEA Groundwater Team at:

Abstraction & Impoundment Licensing Team
Northern Ireland Environment Agency
Water Management Unit
17 Antrim Road
Lisburn
BT28 3LA
Tel: (028) 9263 3485
email: AIL@doeni.gov.uk
http://www.doeni.gov.uk/niea/water-home/water_resources/abstraction.htm

References

Groundwater Monitoring Compliance Document (2011)

Appendix 1 –

Abstracted Volume Measurements Record Sheet

Abstraction Licence No.	AIL/	
Operator's name		
Start date of records		
End date of records		
Page of		
Date and time of reading	Meter Reading	Volume abstracted (m^3/d)

Appendix 2

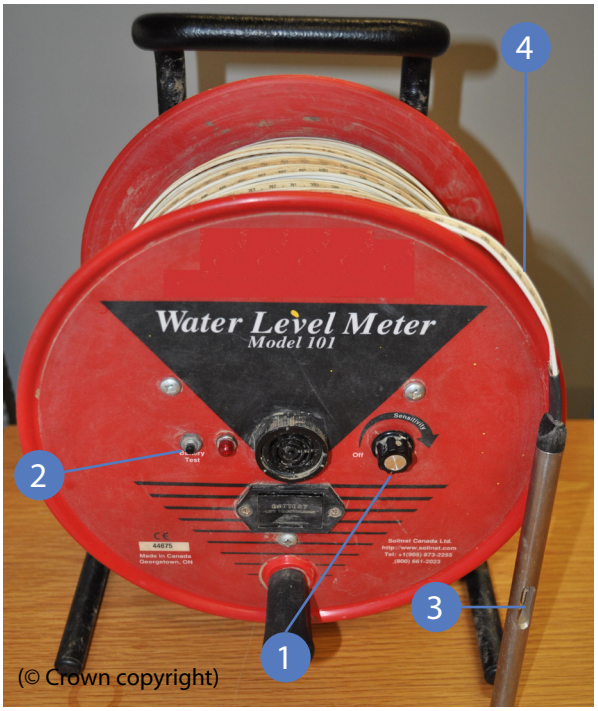
Guidance for Manually Recording Groundwater Levels

This document is designed to be a guide for abstractors of groundwater, who are required, as a condition of their abstraction licence from the Northern Ireland Environment Agency (NIEA), to monitor their weekly abstracted volumes and groundwater levels.

How do I monitor groundwater levels?

This is done quite simply by recording the level of the water in a borehole at regular intervals using a water level dip meter (a measuring tape with a moisture sensor to detect the top of the water). These can be purchased from a groundwater specialist supplier which can be found by doing an internet search for 'Water Level Dip Meter'. An image of a dip meter is shown below. Main parts of a dip meter are:

1. On-off Switch (in example below turn on-dial anti-clockwise).
2. The battery test – Once turned on, push this button to make sure it is on. You should hear a bleep.
3. Moisture sensor – The needle inside the weight at the bottom of the tape detects water, completing the circuit, causing the unit to bleep.
4. Tape – This is marked in centimetres and metres. Once water is detected by the sensor, the measurement of the tape against the top of the borehole is the depth to groundwater.



Note: There is a clamp on the reverse of the spool to stop the tape from unravelling. Loosen the clamp just before placing the tape into the borehole. It is best to set the spool on the ground and use one hand to lower the tape down the borehole and the other to control the spool. Do not unravel the tape too quickly otherwise the spool will go out of control and damage the tape.

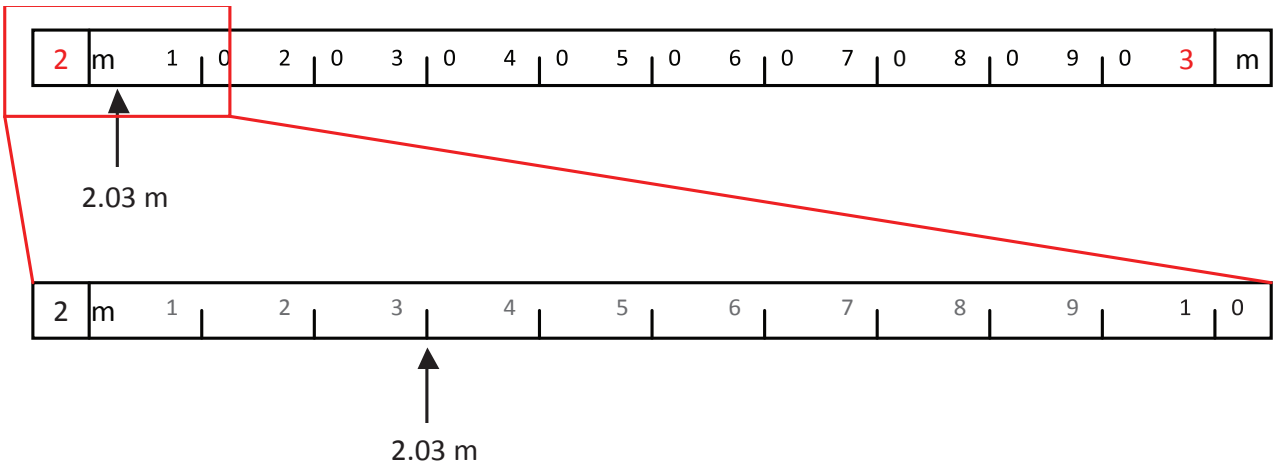
To take a reading, simply follow the step-by-step guide below:

1. Take the reading when the pump has been switched off for a period of time. Ideally the pump would have been off for a few hours, or alternatvely a measurement can be taken just before the pump is to be switched on again. For weekly reading it might be easier to take the reading at the same time, although it is not essential (as long as date and time of the reading is recorded).
2. If you are unsure how long it has been since the pump was last running, take a reading, wait 5 minutes and take another reading. If the second reading is less than the first then the pump was recently on (and so the water levels are still rising), otherwise if the two readings are the same, then use this as your reading.
3. Please do not take a reading when the pump is running.
4. Important: make a mark on the side and top edge of the borehole using a permanent marker or paint. This is your base point against which you will take all your future readings.

5. Switch on the water level dip meter and unravel it down the borehole. As soon as it bleeps, stop the tape with your hand and pull it back up until the bleeping stops.

6. Slowly lower it down again listening for the bleep. Again, when it sounds lift the tape out. Repeat this process, each time lowering and pulling the tape out by less until you are confident the sensor is resting on the surface of the water.
7. Use your thumb nail to grab the tape where it meets the mark on your borehole, pull the tape up and read the measurement on the tape, to the nearest centimetre.
8. Slowly pull the tape up out of the borehole to read the corresponding metre measurement. To read the corresponding metre measurement you need to look down the tape (which was in the borehole) and not up the tape.
9. It is good practice to repeat the reading in order to eliminate any errors or to get somebody else to check the measurement.
10. Date and time (to the nearest hour) of the measurement need to be recorded. Please see the attached record sheet template in Appendix 3.
11. Take a note of any unusual observation, for instance the water level is up at the top of the borehole and it is flowing out over it.

A 1 m section of the tape is illustrated underneath together with a close-up section of 10 cm of tape below that.



Appendix 3 –

Water Level Measurements Record Sheet

Abstraction Licence No.	AIL/
Operator's name	
Start date of records	
End date of records	
Page of	
Date and time of reading	Water Level Reading (m)

Appendix 4

Monitoring Plan

1. Method of measuring abstracted water volumes:

_____

2. How often will meter readings be taken:

_____

3. Is the borehole to be used for monitoring groundwater levels a production or observation borehole?
   (Circle or highlight answer)

Production
Observation

Irish grid reference of observation borehole Easting:_____ Northing: _____

Irish grid reference of pumping borehole Easting:_____ Northing: _____

4. Primary method of measuring groundwater levels: (Circle or highlight answer)

Manual dip meter measurements

Automatic logger measurements

Manual dip meter measurements

a. Dates manual measurements will be taken:

_____

b. How will the operative manually measuring water levels in a production borehole ensure that there has been no abstraction for a few days?

_____

Automatic logger measurements (using device with built-in data logger)

a. When will an automatic logger be installed?

_____

b. Who will install the logger?

_____

c. If known, what logger will be installed?

_____

5. If required, details and frequency of electrical conductivity monitoring of abstracted water

_____

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