Title:	**Preparing Water Shortage Response Plans**
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Overview: Water Shortage Response Plan:

The priority of water use in Alberta is based on a “system of prior allocation” principle. While water allocations are often related to the amount of natural flow in streams, the water availability to an applicant (or licensed user) depends on various factors including actual flow at any given time, flow needs for aquatic environment and applicant’s priority in the Alberta water licensing priority system. Since river flow, weather and user requirements can vary, the priority system becomes the only tool that regulates the amount of water licensees can access.

Licences can be issued for water use in periods of low flow because there may be relatively high flow events where more licensees could use water. Water users normally need a long- term assured supply with predictable availability. In situations where a water shortage occurs, the *Water Act* has provisions to allow existing licensed water users to either call priority (Section 30) or share water (Section 33) via an assignment agreement. Under such situations, Alberta Environment and Sustainable Resource Development (ESRD) initiates Water Mastering.

The *Water Act* anticipates risk to users could be too great in some situations. It permits ESRD to refuse applications (Section 53) until the situation can be evaluated to minimize effects (risk) on users and the aquatic environment. This evaluation will likely include a “Water Shortage Response Plan” (WSRP).

Surface water in the South Saskatchewan River Basin (SSRB) has already been significantly allocated to support current and growing water needs. Given the current degree of surface water allocations and Water Conservation Objectives, new allocations (which will have the lowest priority in the system) have a higher risk for water being not available for prolonged periods of time. The situation will get worse during the low flow periods or periodic droughts.

Purpose and Objective:

This document provides a framework that will help the project proponent (water licence applicant) or the licence holder develop a WSRP. The WSRP will ensure:

1. The applicant or licence holder develops full appreciation of the involved risk to the intended purpose of water use.
2. All possible opportunities (to cope with water shortage) are considered and analyzed in advance.
3. The proposed activity is sustainable during water shortage periods.

This information will will assist the designated Director in the decision process.

If a licence is granted, the WSRP becomes an operating plan recognized as a term and condition of the licence.

WSRP Organization:

The process described herein covers three steps:

Step 1: Risk Assessment

Step 2: Options for Dealing with a Water Shortage

Step 3: Plan Implementation

Step 1: Risk Assessment

The first step in developing a WSRP is to identify if a project is likely to have a water shortage. If it is likely to have a water shortage, then the magnitude and frequency of impending shortages needs to be characterized, enabling response development. Water allocation models can be used for assessing the degree of risk involved to the new applicant (junior licensee). The water allocation model should be constructed as realistically as possible by incorporating the following inputs in to the model:

- Physical data (infrastructures, river reaches, tributaries, etc.)
- Water licensing data (including their priorities, restrictions, etc.)
- Instream flow conditions on the licence (minimum flows, IOs, WCOs, etc.)
- Historical natural flow data
- Other data (evaporation and precipitation data to account for losses from storage; operating policies for structures, etc.)

In reality, it is very difficult to estimate the projected magnitude of a shortage because of the difficulty in estimating available future supplies. However, a deterministic modeling approach can be used. This approach is based on the premise that the performance of the system over a lengthy period of recorded conditions includes representative flood and drought periods and provides an insight into how well the system will perform in the future. Here, underlying assumptions are that statistical characteristics of the basin hydrology will be preserved in the future and past recorded hydrology is expected to occur again in the future.

With the help of water allocation simulation modeling you will be able to determine whether you are going to have a water shortage or not. In case of a water shortage, you should be able to quantify your water shortages in terms of magnitude (how much) and frequency (how often it is likely to occur).

Water allocation modeling can become very complex depending upon the system/basin. Moreover, modeling outputs need to be further analysed in detail for potential risk assessment. Considering the complexities involved, it is highly recommended that the project proponent acquire the services of a professional engineer competent to carry out these tasks. ESRD’s Water Resources Management Model (WRMM) is one of the water allocation models available for use.

A few example plots prepared for risk assessment using WRMM modeling output are provided in Appendix-I (Figures 1 to 5). These plots can be used as a guideline for carrying out the risk assessment.

Step 2: Options for Dealing with a Water Shortage

This step requires you to:

- Develop a wide range of options to address potential water shortages (including demand reduction and supply augmentation options);
- Evaluate and select a course of action that is consistent with Options.

In general, options for dealing with a water shortage fall into two categories:

- Demand reduction.
- Augmentation of available supplies (*e.g.* more efficient utility operations, new supply development through groundwater wells, water trucking, assignments or tie-ins with other systems).

The questions that must be answered in this section are:

- How much of my potential deficit can I make up in demand reduction?
- How much should I make up by augmenting supplies?

You may need to combine demand reduction and supply augmentation options depending upon the severity of shortage and potential risk to your project. The potential water shortage can be categorized (e.g. minor, moderate and severe) and selected options should be grouped and linked to the defined categories of water shortage that could exist. Table 1 provides a suggestive list of some of the general options to deal with water shortage. However, choice of a particular option will depend on the type of water use (e.g. stockwatering, agriculture, municipal water supply, industrial water use). Therefore, it is up to the project proponent to explore and develop a comprehensive list of options and identify the most applicable options to their project.

Table 1: General options to deal with water shortage situation

Stage	Water Shortage Condition	Options
1	Minor	• Reducing water losses • Conservation retrofit kits • Water recycle
2	Moderate	• Options for stage 1 plus • Stormwater collection and recycle • Timing of outdoor water use to reduce losses • Water storage capacity
3	Severe	• Options for stage 1 and 2 plus • Water use/sharing agreement with senior priority licensee • Reduction in water consumption

A realistic list of options available to you should be prepared based on the examples provided in Table 1 and any additional options you can think of. Different options require different levels of effort and expense. Ideally, to evaluate each of your selected options, you need to estimate how much extra water will become available under each of selected option and how much money it is going to cost. This allows you to eliminate the least "cost-effective" options; that is, the ones that cost the most while saving or providing the least amount of water. Options like "water storage" and "water use/share agreements with other senior priority licensees" are key for sustainability during the extended periods of water shortage.

Public Health Risk Assessment:

If your project involves public facilities (e.g. washrooms) where water shortage may pose a risk to public health, you should involve local health authorities in development of WSRP. Together you can identify the minimum level of acceptable water supplies (quantity and quality) required to eliminate any potential threat to public health.

Step 3: Plan Implementation

The objective of this step is to develop a program for putting your WSRP into action. This step involves:

- Developing triggering criteria
- Developing a schedule for carrying out your WSRP
- Monitoring its effectiveness (*i.e.*, is your plan producing the desired results; do you need to do more or less?)

Developing Triggering Criteria

It is very difficult to quantify shortages and to tell whether they are getting better or worse. The purpose of this exercise is to develop criteria that tell you generally if a shortage is getting better or worse. Think about how the stages relate to each other. How will you know when a water shortage is developing? List several factors that indicate a water shortage is on the way. Now list several factors that indicate a minor shortage is becoming moderate and that a moderate shortage is becoming severe. These are called "triggering criteria."

To help you develop your criteria, consider the following indicators:

- Condition of storage reservoirs in the basin
- River/creek flows in the basin vs. WCOs/IOs/minimum flow requirements for the protection of the aquatic environment
- Precipitation records (rainfall and snow pack)
- Extended weather forecasts
- Water supply forecast by ESRD
- River water quality
- Ground water table levels in the basin

A wealth of information on these indicators can be obtained from ESRD's web site at:

- Water Supply Outlook for Alberta
- Forecasters Comments
- Archived Advisories & Warnings

Remember that forecasting the severity of a drought is an inexact science. Often, decisions on the level of a demand reduction program to adopt must be made without the support of good technical water supply information.

Developing a schedule for carrying out your WSRP

If you are facing a water shortage, or potential shortage, you need to develop a schedule for putting your plan into effect. Allow ample lead-time for implementing your selected options because some of the selected options cannot be implemented over night. Another consideration is to monitor the water shortage at regular intervals to determine whether to speed up or slow down any planned activities (use the previously developed triggering criteria, as well as the present situation).

Monitoring

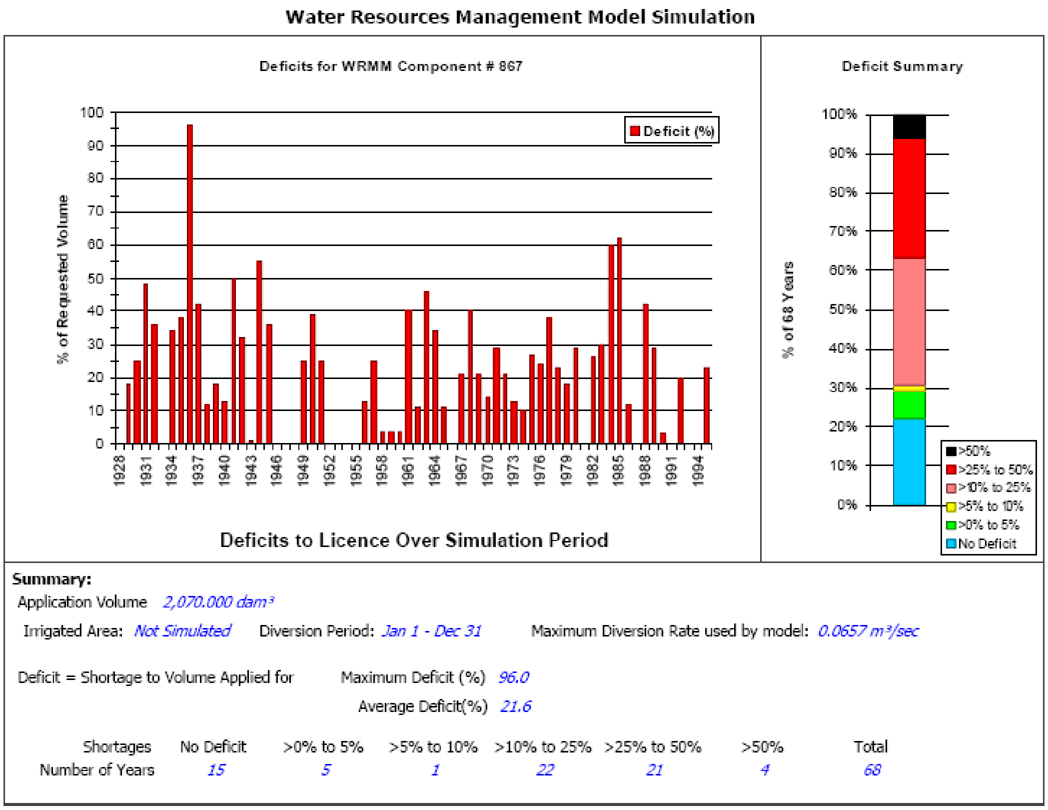
The last thing that needs to be incorporated into your plan is a monitoring program. You need to track existing or potential water shortages very closely and develop a strategy for responding to changes in water supply outlooks. You also need to evaluate how well your WSRP is working. Is your plan working the way you intended? If not, what is the problem? Thorough evaluation of your plan will identify areas and actions that worked well and those that need to be improved for next time. What adjustments should be made? Determine how you will make this evaluation.

Original signed by ______________________ Date: March 20, 2014

Andy Ridge, Executive Director
Environment and Sustainable Resource Development
Water Policy

APPENDIX I

Figure 5



The plot on left shows the yearly deficit volume as percentage of requested allocation. The absence of a bar in a given year indicates no deficit to the project, whereas a 100% value would represent the project not getting any water in a given year.

The summary section provides more details on frequency and magnitude of annual deficits including maximum annual deficit and average annual deficit expected during the simulation period. These annual deficits (frequency and magnitude) are depicted in the form of a stacked bar on right hand side plot. This plot provides a quick glance of overall water availability situation.

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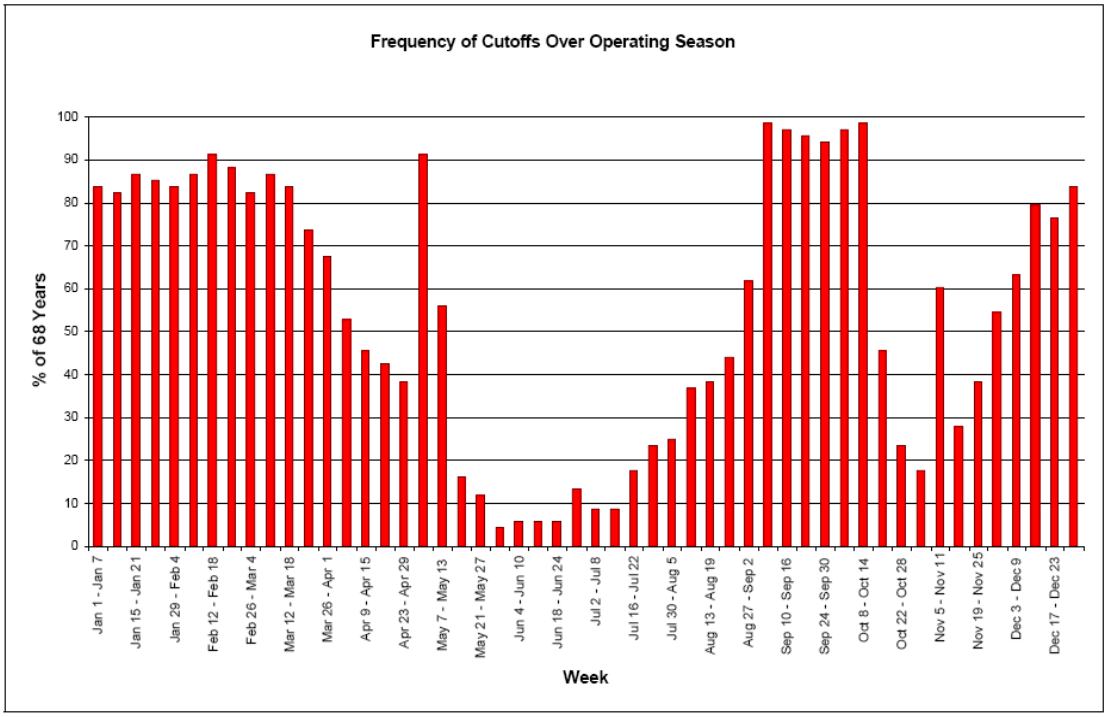
Figure 6

Water Resources Management Model Simulation



This plot shows frequency of cut-offs over the project-operating season. It provides an estimate of when (out of 52 weeks) and at what frequency the project can potentially be cut- off during the season. No bar (or spike) in a week means the project is not expected to be cut-off, while a 100% spike would mean the project is cut-off during all simulation years (here it is 68 years). The literal meaning of project cut-off is when the model is not able to meet the requested demand of the project in the simulated time step (here it is a week).

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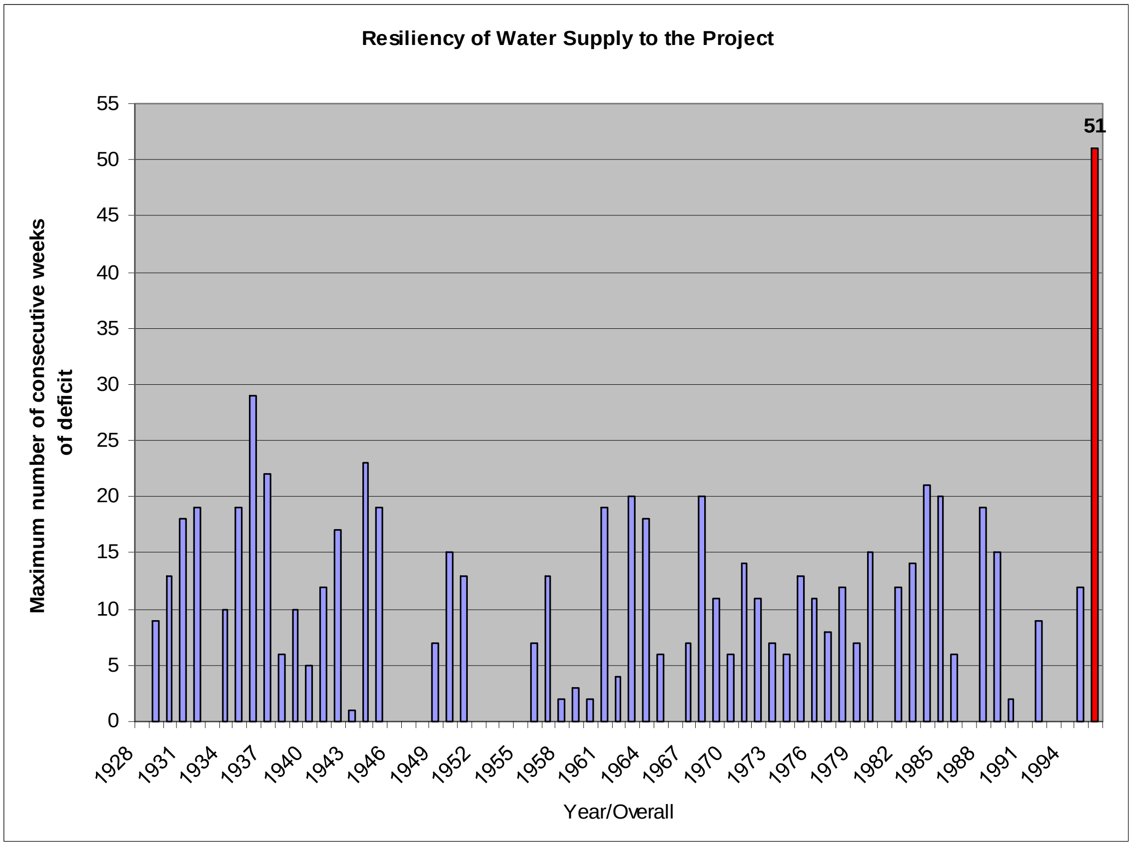
Figure 7



During periods of water shortages, projects can be cut-off for a consecutive number of weeks (simulation time step). The plot shows the maximum number of consecutive weeks in any given year a project would expect to be cut-off (or experience water shortage). The last bar shows the maximum number of consecutive weeks of cut-offs (deficits) in the whole simulation period. This could happen as a result of back-to-back cut-offs (deficits) in successive years.

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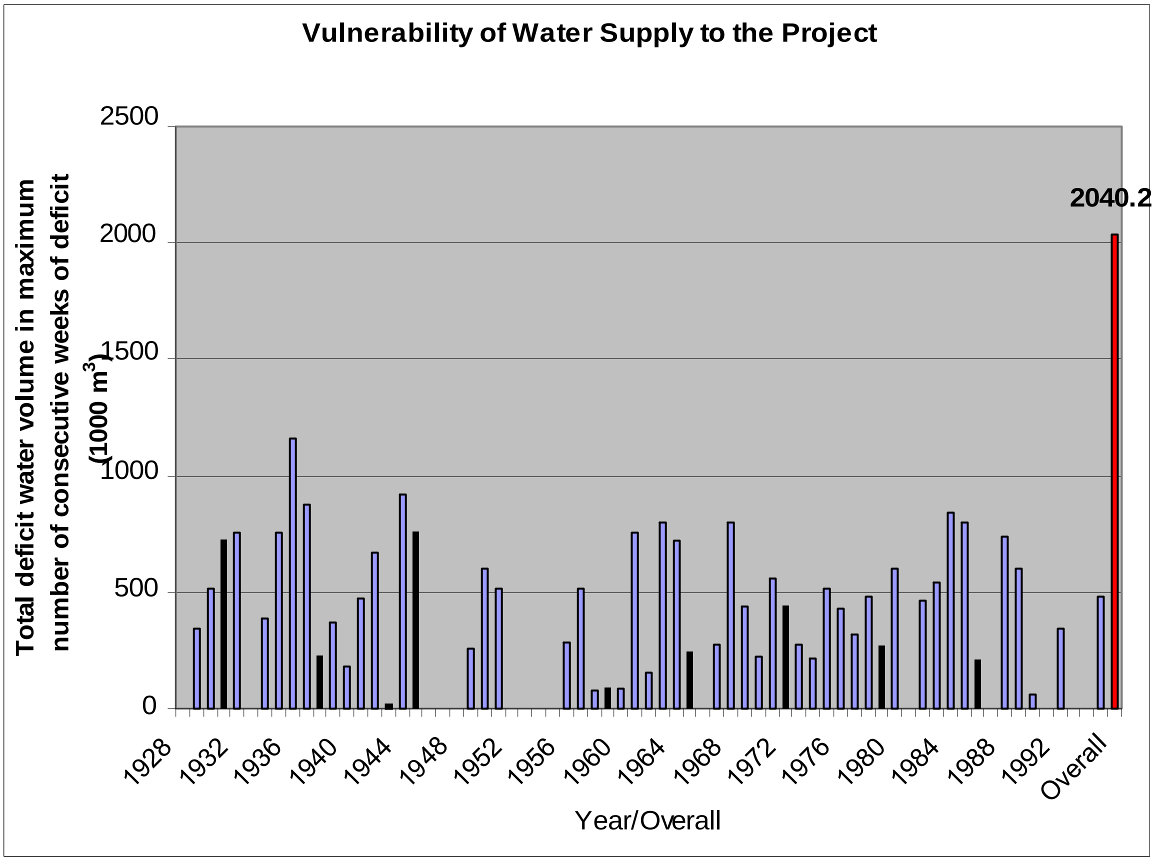
Figure 8



This plot is similar to Figure 3, except the y-axis shows the total quantity of water deficit in those maximum numbers of consecutive weeks of deficits.

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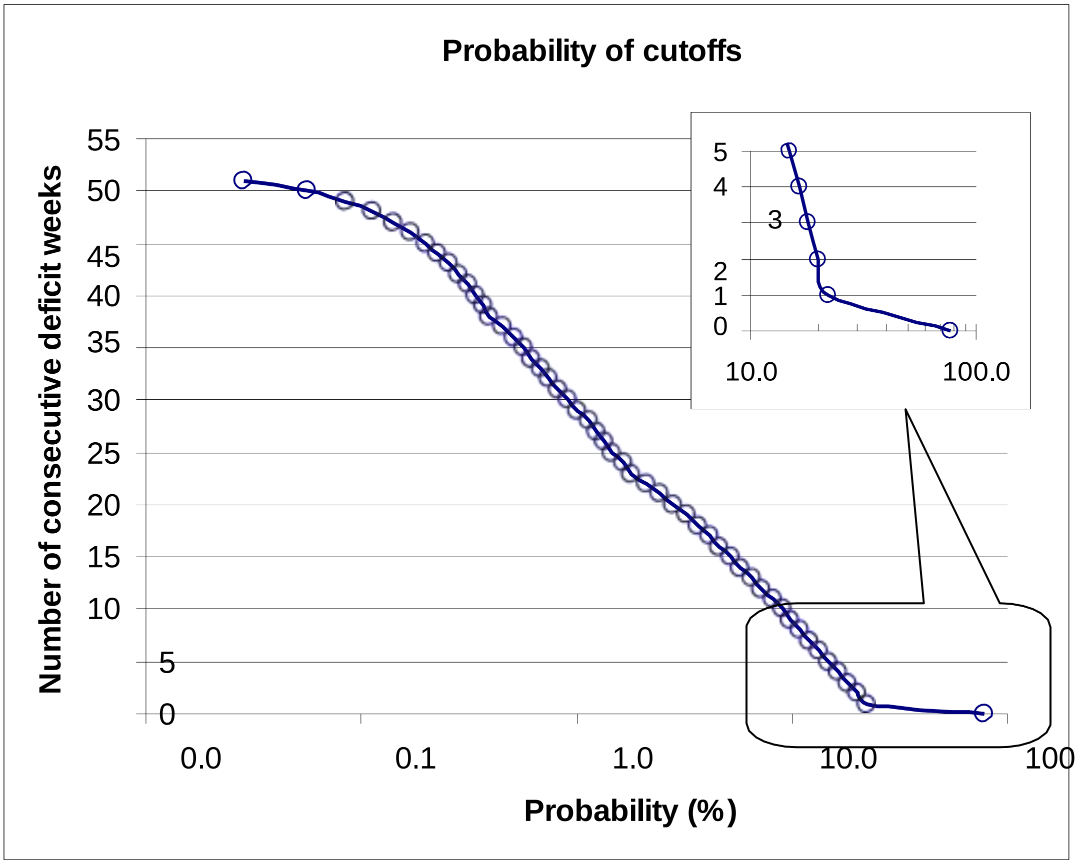
Figure 9



This plot shows the probability of consecutive weeks of cut-offs (deficits) based on the historical simulation period.

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