Groundwater Level Monitoring Plan for Protecting Public Water Resources from Prolonged Droughts

New Hampshire Water and Watershed Conference
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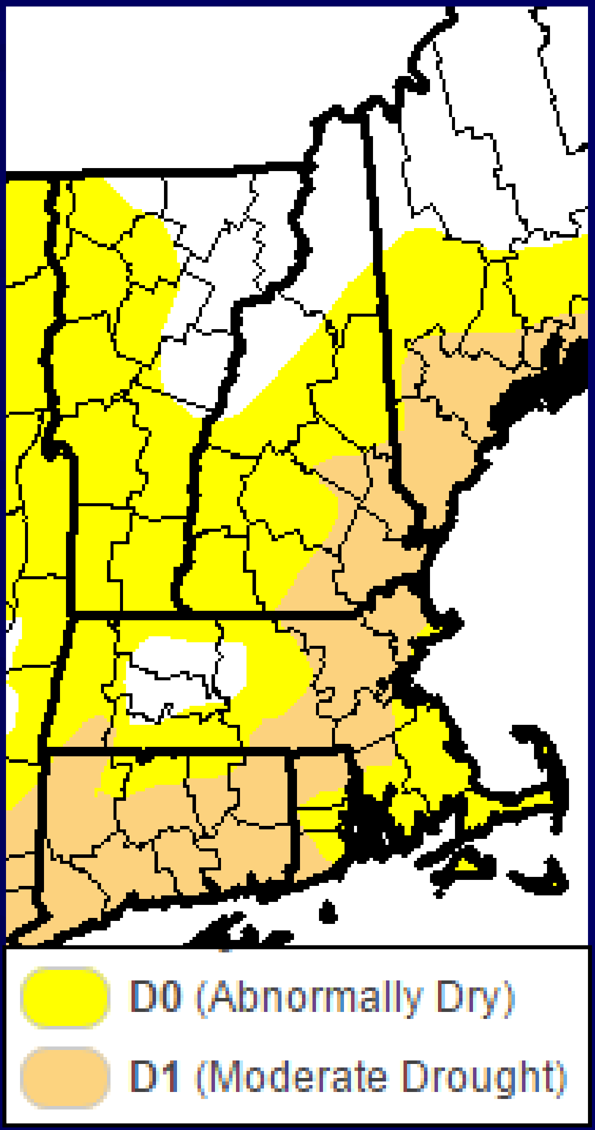
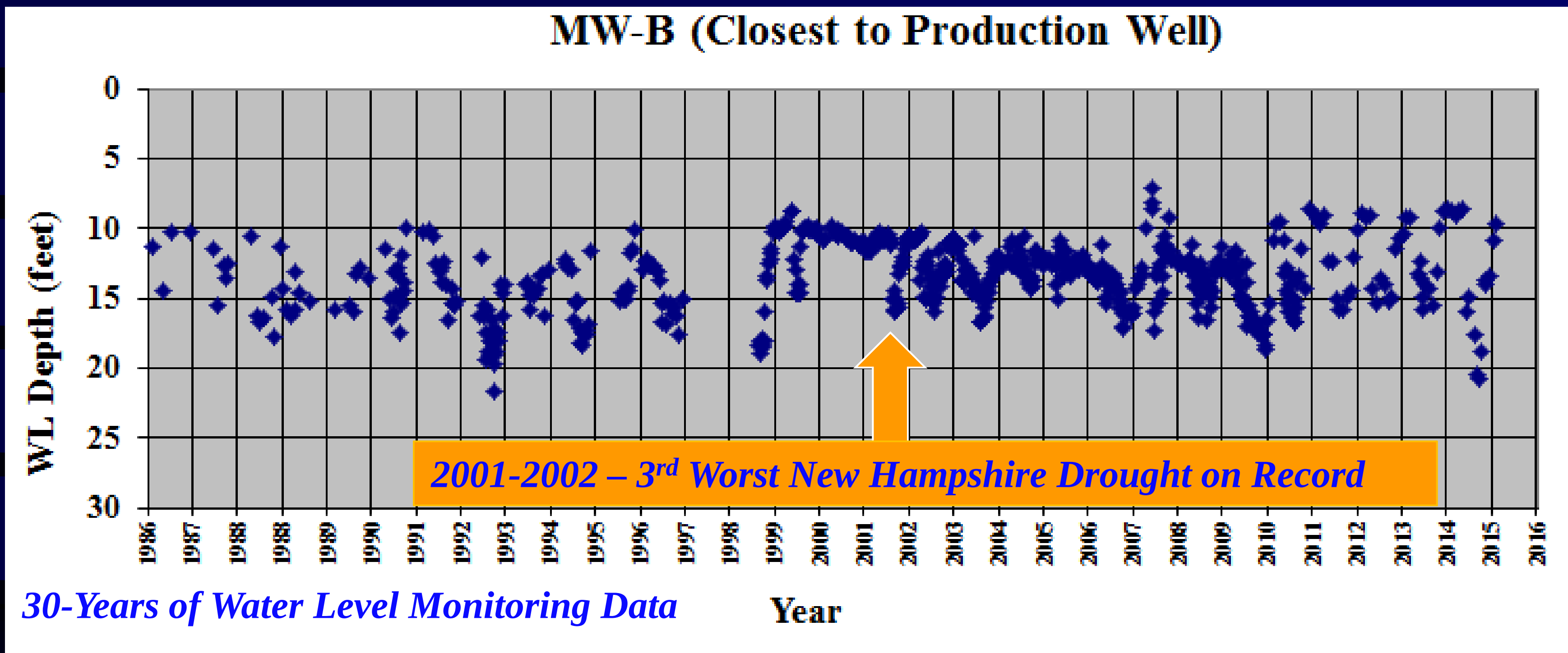


US Drought Monitor September 9, 2015

Why Do We Need to Measure Groundwater Levels?

- *Unlike a reservoir, you can't look at an aquifer and see how much water is stored inside.*
- *To evaluate whether you are using groundwater sustainably.*
- *To identify incipient droughts while there is time to do something about it.*

When do I need to be concerned about water levels in my aquifer?



There was a need for a system to quickly and quantitatively evaluate water level data to identify the level of concern – and guide what actions to take to mitigate potential effects of an impending drought.

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What is Drought?

1. Meteorological Drought

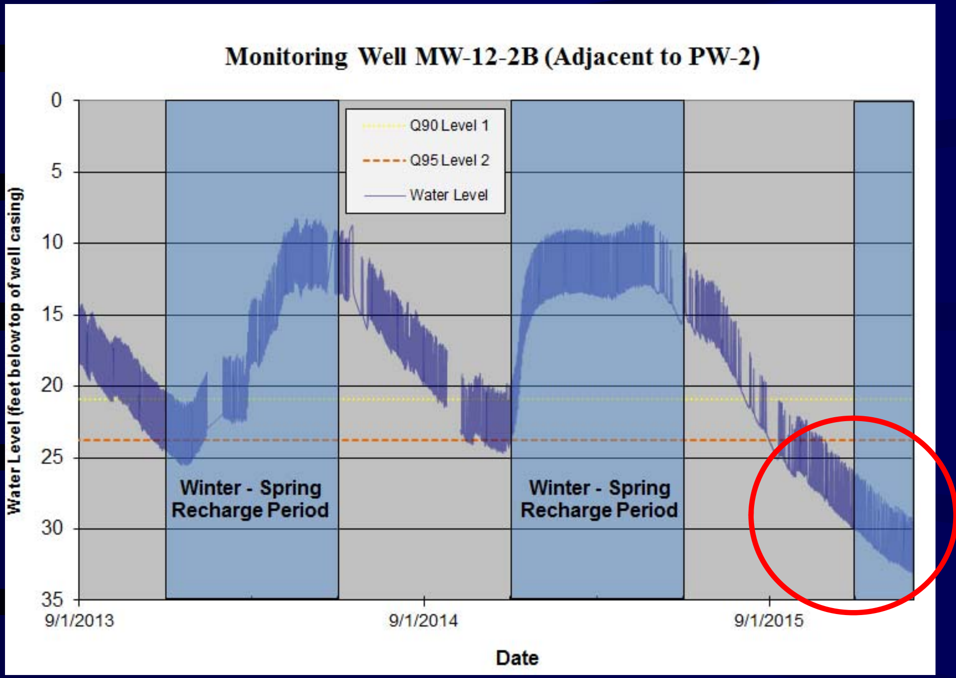
Period of time with a precipitation deficiency.

2. Agricultural Drought

Dry period resulting in soil moisture deficiency leading to plant water stress.

3. Hydrological Drought

Extended dry period resulting in impacts to water supplies, surface water, and groundwater levels.



What Constitutes a Drought for a Water Utility that Uses Groundwater?

Operational Definition:

Period of time when groundwater withdrawals from an aquifer exceed groundwater recharge rates, resulting in abnormally low water levels that are trending downward, potentially threatening the ability of the utility to meet future water demands.

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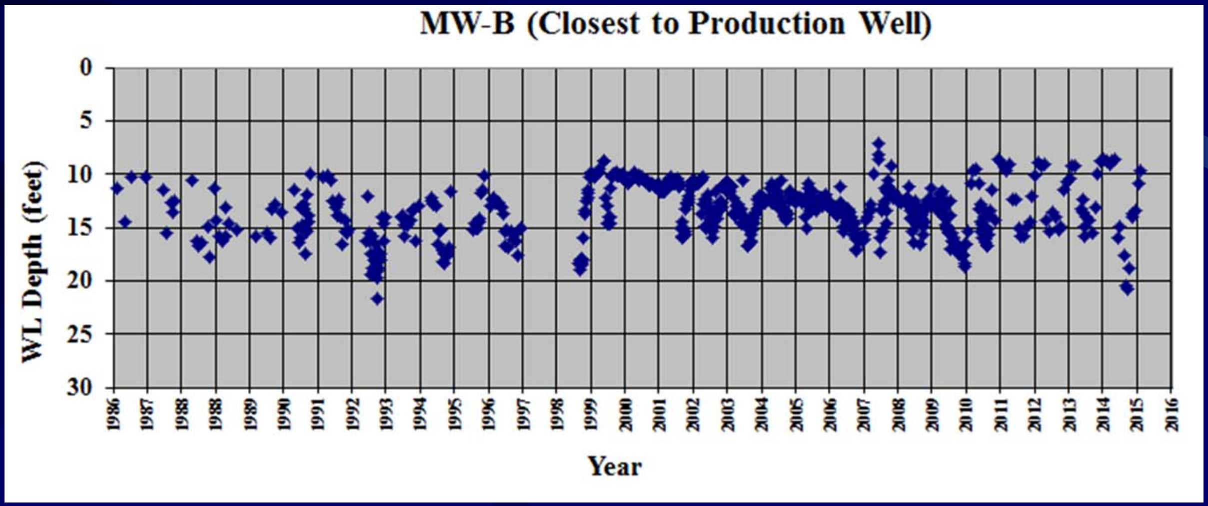
Groundwater in New Hampshire is Generally a Renewable Resource

New Hampshire has a temperate climate and receives, on average, 35-45 inches of precipitation each year. A portion of that precipitation recharges our aquifers – sustaining our groundwater supplies.

Water levels remain fairly stable over a 30-year period in this aquifer utilized by a public water utility.



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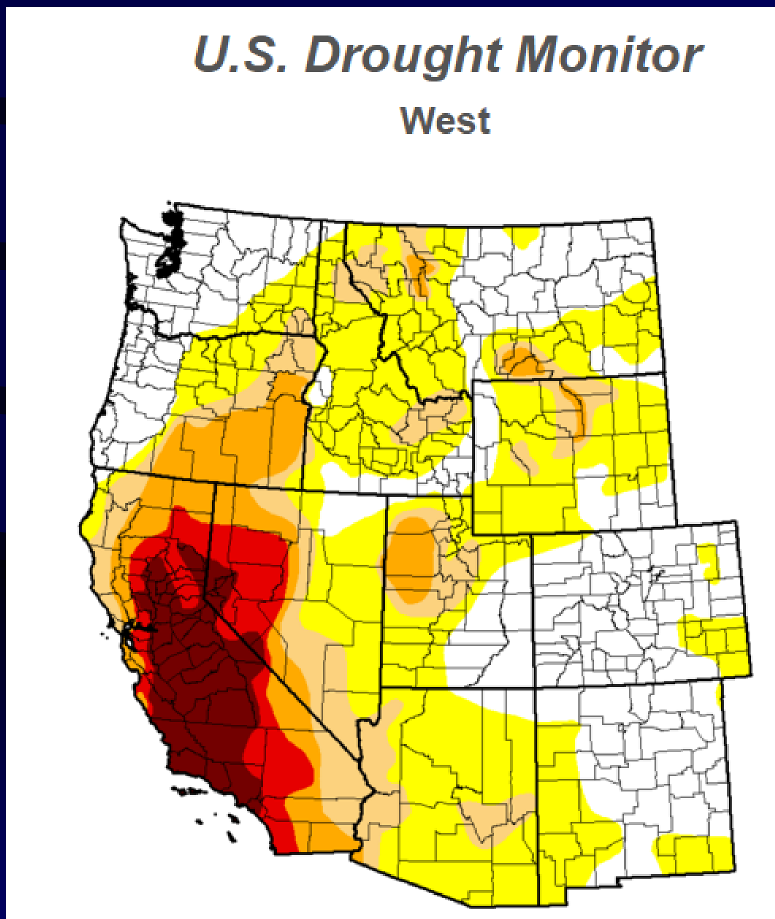
Can a Prolonged Severe Drought Occur in New Hampshire?



Source: *USDA Website*

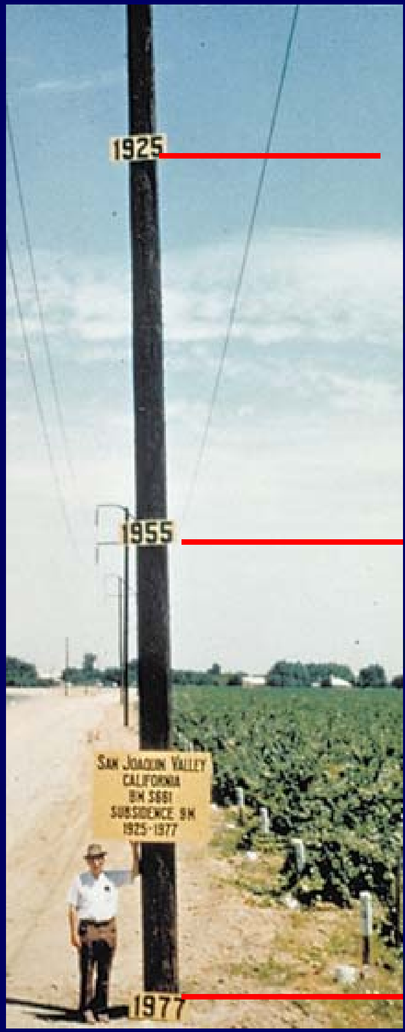


Photo illustrating ground subsidence due to mining of groundwater in an arid landscape in California.

Drought History in New Hampshire – 1895 - 2008

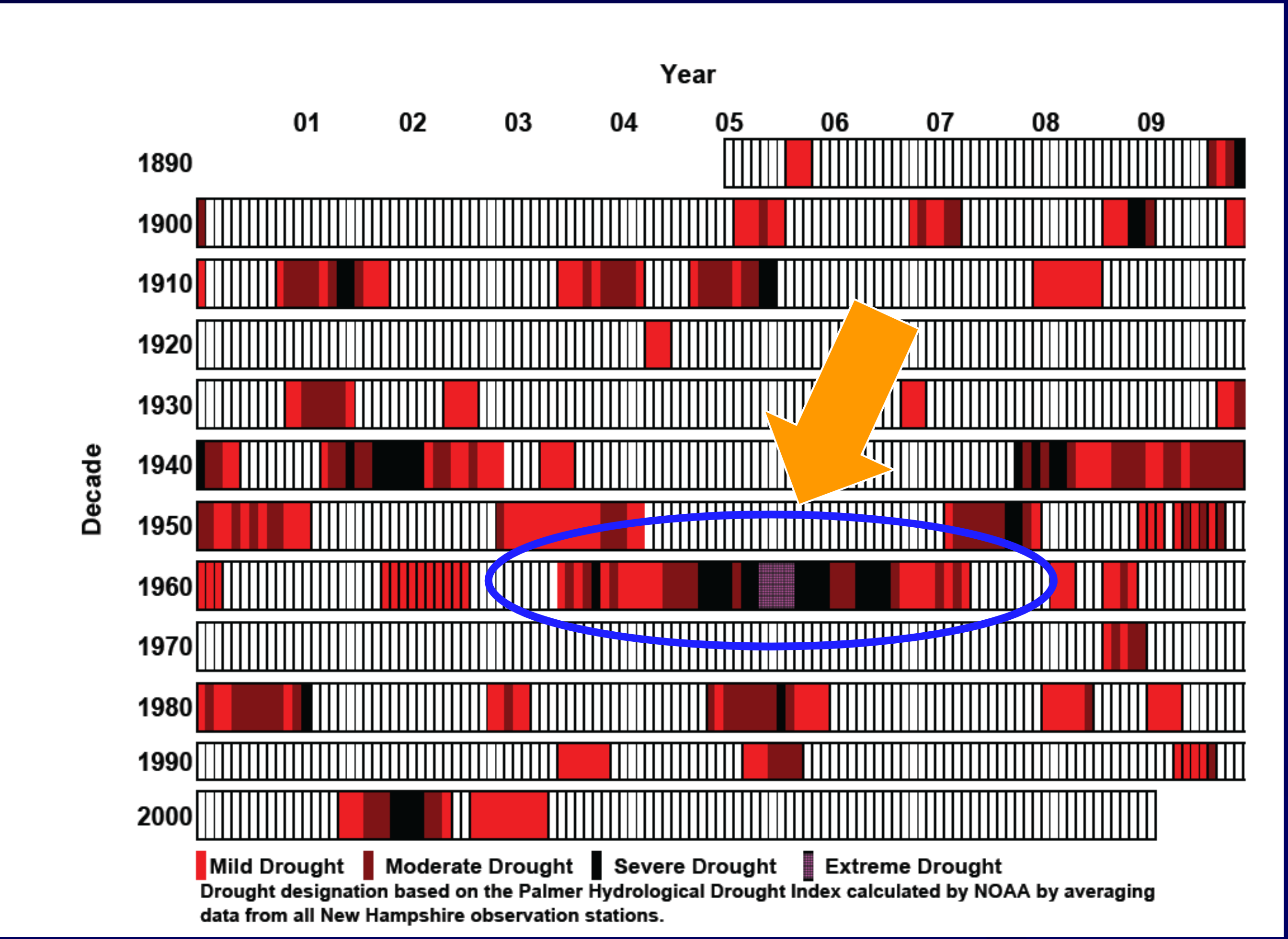


Diagram illustrating periods of drought in New Hampshire.

The last major multi-year drought event occurred during the 1960s.

According to the US Census, the population of NH has more than doubled since the prolonged drought of the 1960s.

Source: NHDES Water Resources Primer, 2008, Chapter 12, R-WD-08-23

Prolonged Droughts have Occurred in the Past, and Presumably will Occur again in the Future.

Is there a way to use groundwater monitoring data and our knowledge of the aquifer systems to identify when dropping water levels require action so there is enough time to react before production wells are adversely impacted?

Drought Magnitude Levels

Based on NHDES Drought Management Plan - 1990

Level 1 – *Alert* *Incipient Drought*

Level 2 – *Warning* *Moderate Drought*

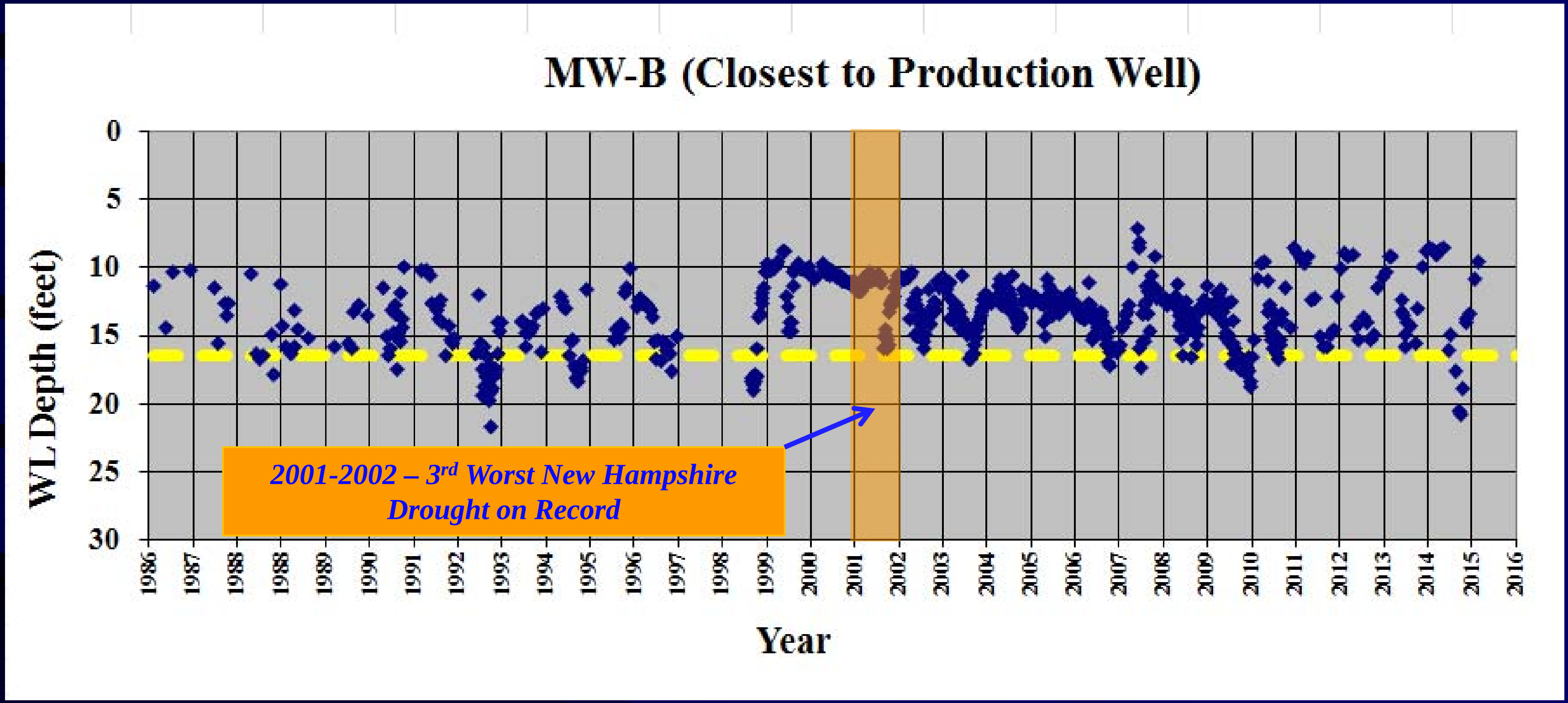
Level 3 – *Emergency* *Severe Drought*

Level 4 – *Disaster* *Extreme Drought*

The drought levels increase based on the severity and duration of the precipitation deficit.

Level 1 – Alert

Developing Aquifer Specific Trigger Water Levels



Selected the Q90 Value for Level 1 Alert

90% of the water level measurements are above the Q90 value.

Used several hundred water level measurements collected over a 25+ year period.

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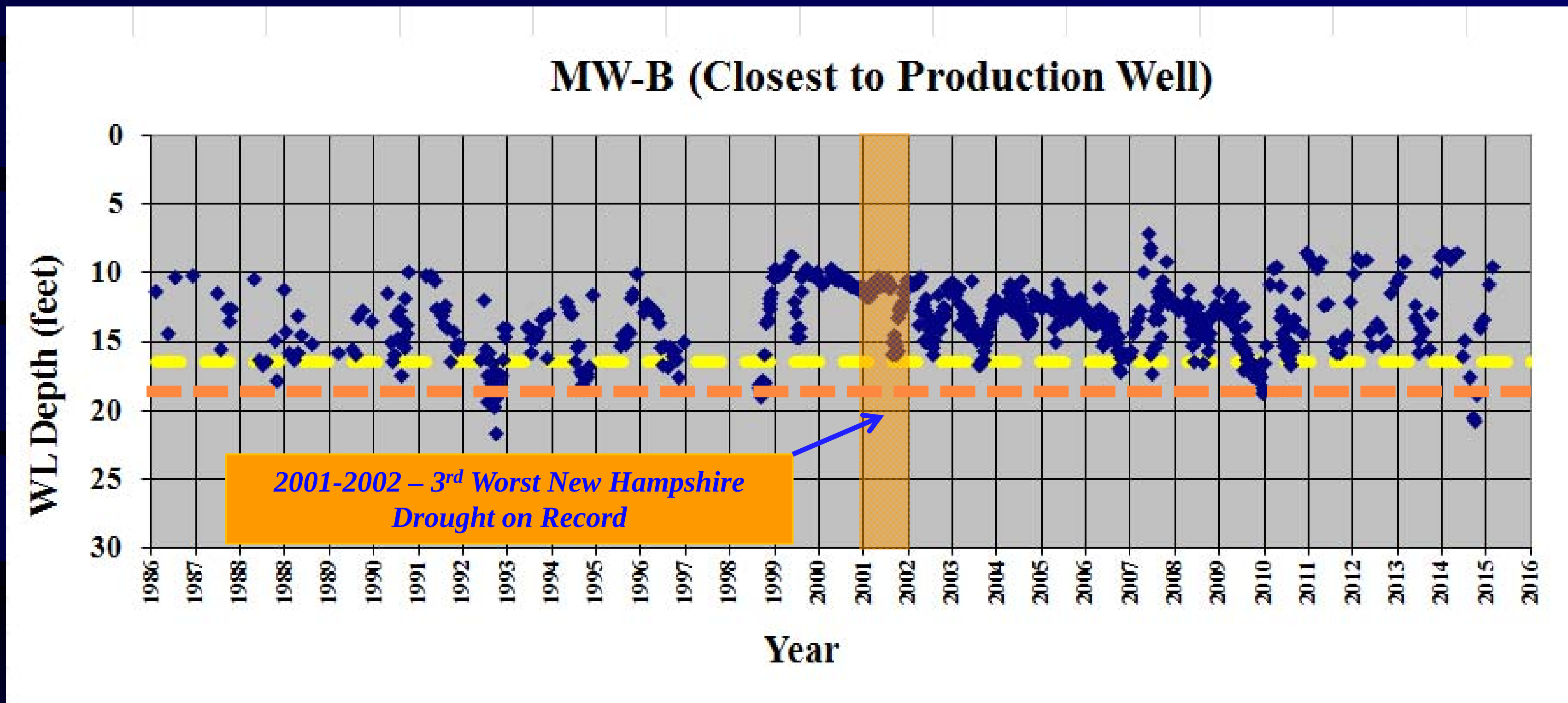
Level 2 – Warning

Developing Aquifer Specific Trigger Water Levels



Selected the Q95 Value for Level 2 Warning

95% of the water level measurements are above the Q95 value.

Used several hundred water level measurements collected over a 25+ year period.

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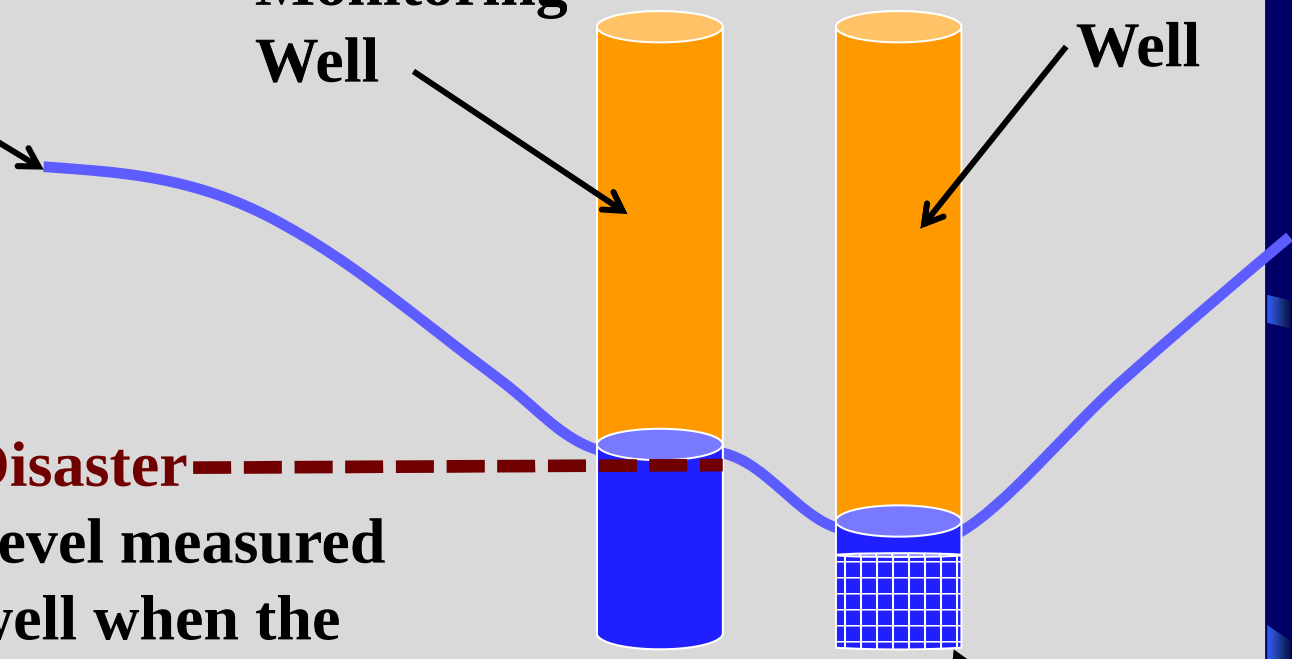
Level 4 – Disaster

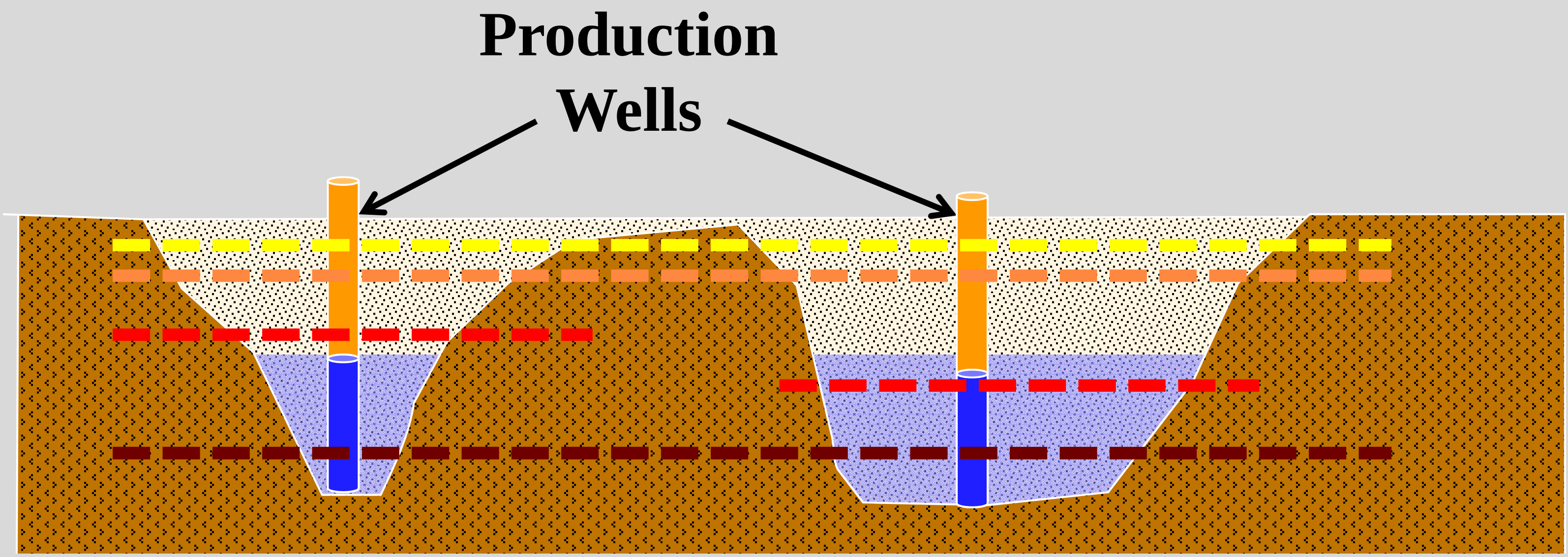
The goal is to maintain the water level in the production well above the screen.



The Level 4 Disaster Trigger is the water level measured in the monitoring well when the pumping water level is at the top of the screen in the production well.

Level 3 – Emergency

Evaluate the geometry of the aquifer to select an Emergency Trigger Level.



All things being equal, the rate of water level decline is going to accelerate in the aquifer on the left because there is less groundwater in storage as the aquifer tapers with depth. To account for this anticipated rapid drawdown, the Level 3 Emergency Trigger Level is set higher relative to the aquifer on the right.

Groundwater Models

Groundwater models can quantify the alert trigger levels.

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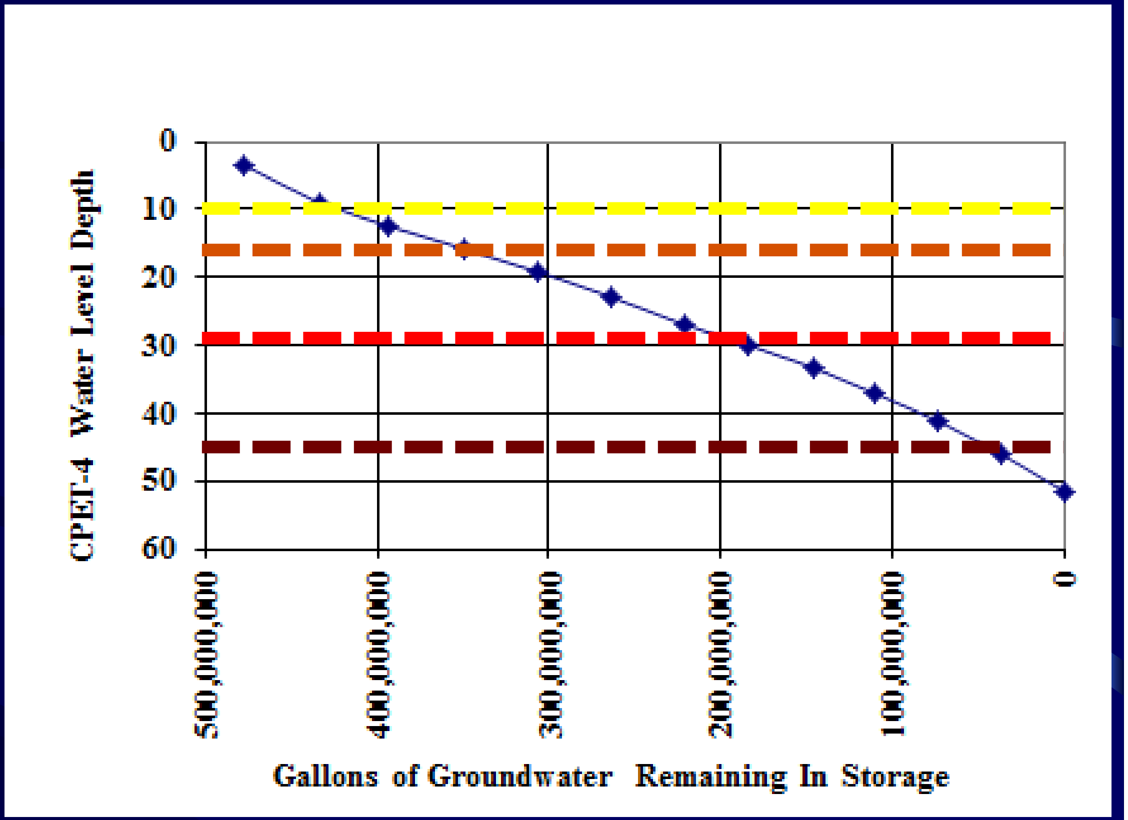

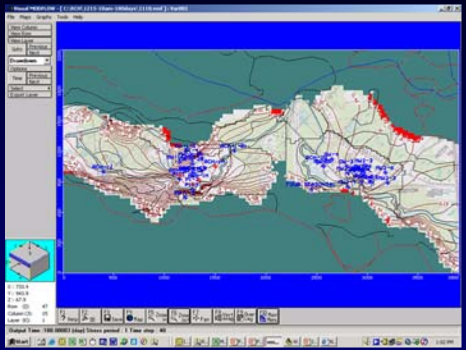

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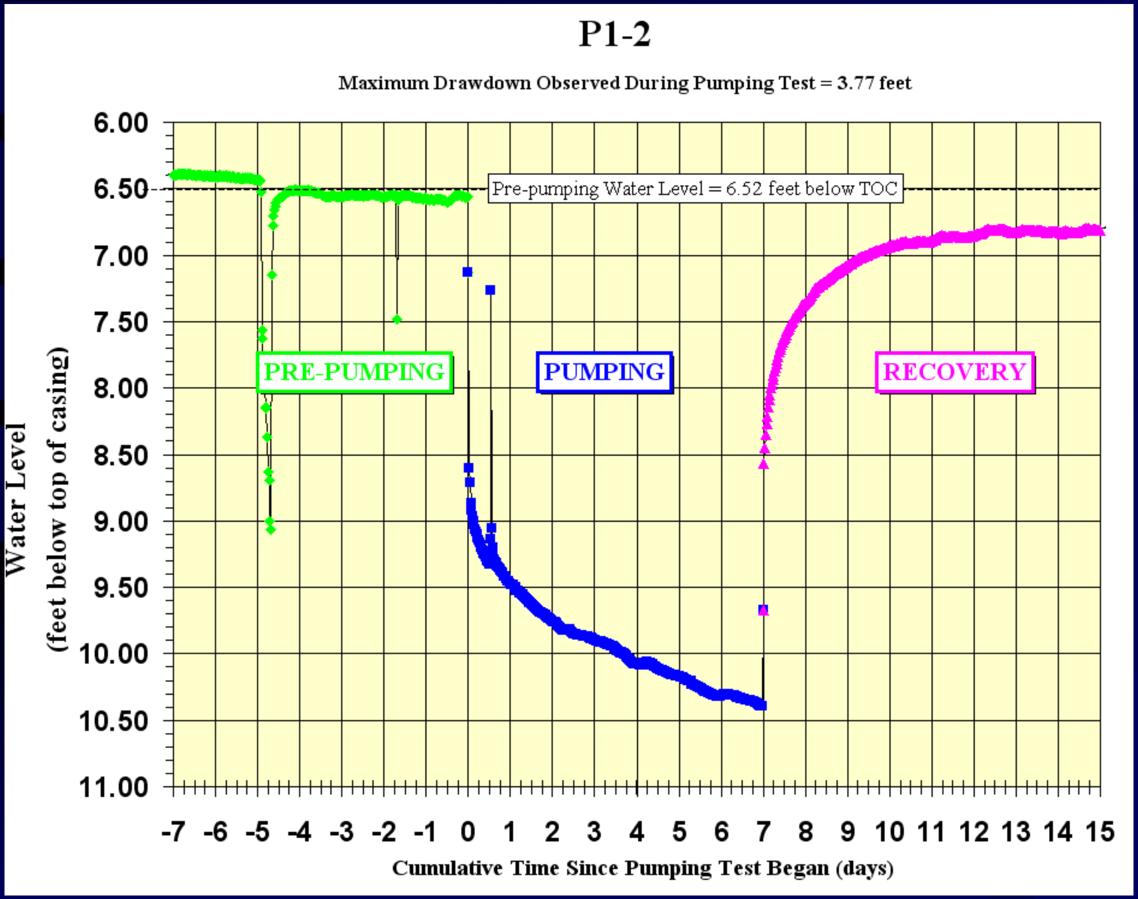
Pumping Test Data

In the absence of a long-term water level record, the alert trigger levels can be identified using pumping test data.



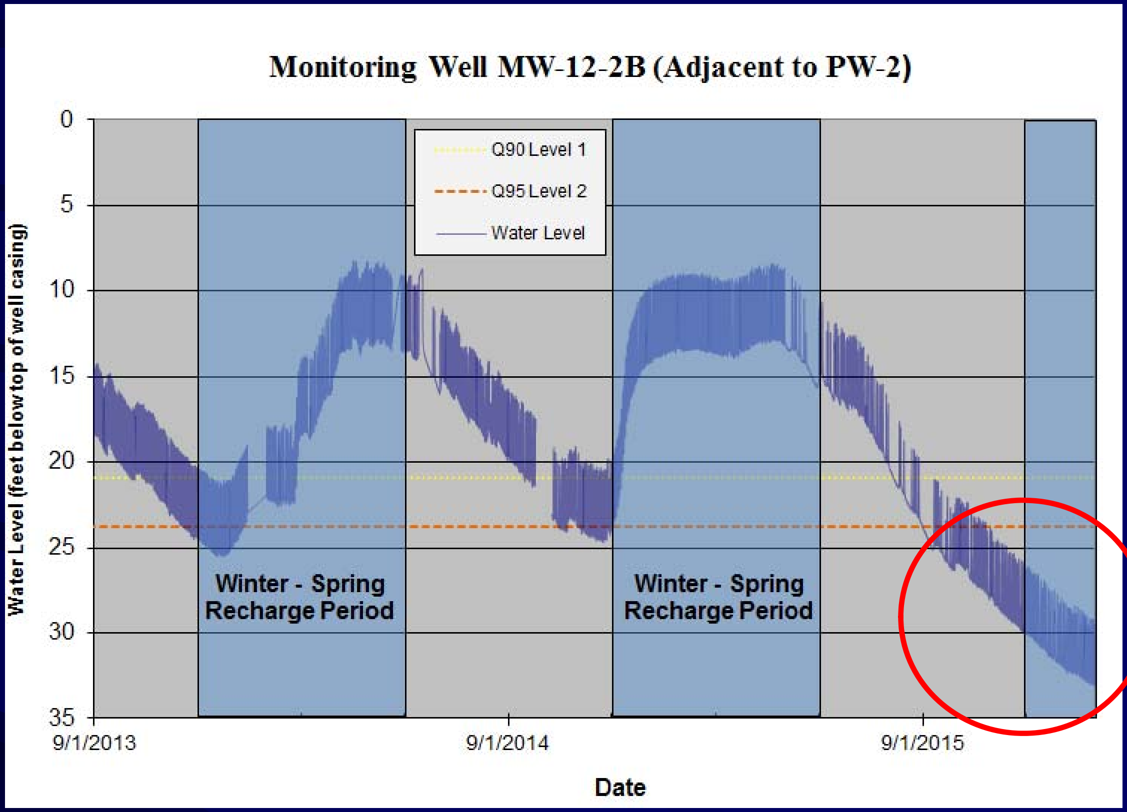
Pumping test data can be used to identify trigger levels in sand and gravel aquifers, as well as in fractured bedrock aquifers.

How Can a Utility Use the Trigger Levels to Maintain Groundwater Resources during a Drought?

- Collect water level data throughout the year.
- Continuously evaluate the data to see if trigger levels are reached.
- Implement measures to address impending drought conditions.

Timing is an Important Component of Evaluating Whether to Implement Mitigation Measures

Water levels are typically lowest at the end of the summer – a Level 1 Alert at the end of the summer may not be a problem as the end of the demand season approaches the prospect of recharge becomes likely. A Level 1 Alert that occurs at the end of Spring is a much bigger concern as recharge is likely to diminish and demand increase.



New Hampshire Drought Management Plan – Recommended Responses –

Level 1 – *Alert* *Incipient Drought -*

Level 2 – *Warning* *Moderate Drought*

Level 3 – *Emergency* *Severe Drought*

Level 4 – *Disaster* *Extreme Drought*

Level 1	Alert	Incipient	Increase water level monitoring frequency; monitor drought forecast and water demand.
Level 2	Warning	Moderate	Consider implementing voluntary and / or mandatory water restrictions. Consider source management to minimize groundwater impacts.
Level 3	Emergency	Severe	Implement mandatory water restrictions. Implement source management to optimize groundwater levels.
Level 4	Disaster	Extreme	Shutdown or reduce water level withdrawals from source at these levels.

Long Term Drought Resiliency / Supply Augmentation Solutions

1. Develop Backup Sources

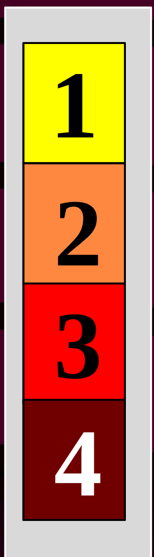
Placing an alternate source online during dry periods can reduce demand on the primary aquifer(s) and provides greater flexibility for water resource management.

2. Perform Artificial Recharge

Artificial recharge has been used to augment natural recharge in aquifers throughout drought-prone portions of the US and the World. It is gaining attention in the Northeast where population and demand growth are placing additional stress on existing water sources.

This is an attractive option, particularly as high intensity storms with lots of runoff become more frequent due to a changing climate.

Aquifer-Specific Drought Monitoring System can Help Communicate Drought Threat and Status



- Provides a framework to effectively communicate the severity of Drought Levels to the Public and to Public Officials.
- Provides justification for drought mitigation practices that are based data and scientific evaluation of the hydrogeology of the aquifer.

Conclusions:

- *Monitor groundwater levels in your aquifer*
- *Identify Action Levels and appropriate Triggers to identify incipient droughts*
- *Develop an incremental approach to mitigate the impacts of potential droughts.*

Reservoir for the City of Atlanta
Drought of 2007
~ 3 Months of Water Remaining