love every drop anglianwater

draft Drought Plan 2027

Appendix 3: Drought Monitoring (Reservoirs, Rivers and Groundwater)

May 2026

Appendix 3 - Drought Monitoring (Reservoirs, Rivers and Groundwater)

1. Introduction

This appendix provides more information on our reservoirs, direct river intakes and groundwater sources focusing on how the drought levels have been created and the scenario testing that has been completed.

2. Reservoir Drought Levels and Scenario Testing

2.1 Introduction

Anglian Water operates eight reservoirs, five of which (Rutland Water, Grafham Water, Pitsford Water, Ravensthorpe and Hollowell) form a partially integrated supply system known as Ruthamford.

The remaining three reservoirs are Covenham, Alton Water and Ardleigh. Ardleigh Reservoir is jointly owned with Affinity Water and operated under the provisions of the Ardleigh Reservoir Order under guidance of the Ardleigh Reservoir Committee (ARC).

Key details of the reservoirs are summarised in Table 2.1. Those with the suffix 'R' form part of the Ruthamford supply system.

Table 2.1 Anglian Water reservoir source details

Reservoir	Gross storage capacity (Ml)	Surface area (km2)	Construction date	Water Resource Zone
Alton	9,720	1.56	1976	Suffolk East
Ardleigh	2,285	0.48	1971	Essex South
Covenham	10,717	0.87	1968	Lincolnshire East
GrafhamR	57,306	6.27	1966	Ruthamford South
HollowellR	2,028	0.51	1938	Ruthamford North
PitsfordR	16,000	2.75	1956	Ruthamford North
RavensthorpeR	1,774	0.45	1891	Ruthamford North
RutlandR	120,825	11.01	1977	Ruthamford North

2.2 Reservoir Drought Levels

Following two significant dry periods during 2022 and 2025 we have reviewed our reservoir levels and believe they still act as useful guidelines to ensure we can manage drought effectively. Therefore, Drought Plan 2027 reservoir levels remain the same as those set out in WRMP24 and Drought Plan 2022.

However, we are currently investigating what impact catchment water quality issues and a more conjunctive system, aided by the increased connectivity provided by the strategic interconnectors, will have. This will continue to be reviewed and amendments made to reservoir levels if required.

Further information on how each of our reservoir drought levels have been derived in the past is included within the sections below.

2.2.1 Target level

Target levels were originally developed in OSAY and have been adopted for use within AQUATOR and PyWR models. The levels were set as an optimum storage 'target' to ensure security of water supply should the reservoir experience a drought equivalent to its reference drought.

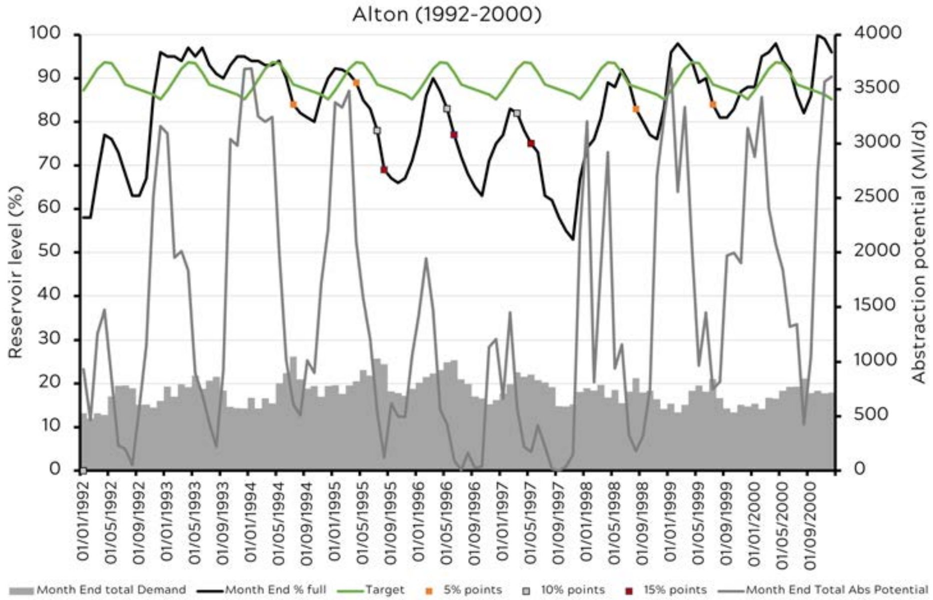
We do not expect our reservoirs to always be on target, various factors can affect the ability for the reservoir to be at this level. Maintenance on our abstraction systems, raw water quality and supply network changes are the key operational influences which affect the level in our reservoirs. These are planned in when possible, with the aim to reduce the overall impact on the reservoir.

2.2.2 Level 1

Level 1 was derived using historic reservoir levels, reservoir demand and abstraction potential data. Reservoir levels are daily telemetered values on the most part from the year 2006 onwards; older data is from monthly or weekly dips. Reservoir demand is telemetered from the point the water exits the draw off tower. Abstraction potential is a measure of the amount of water available for abstraction at the associated abstraction point. It considers current pump capacities, associated MRFs or HOFs and operational details for the site.

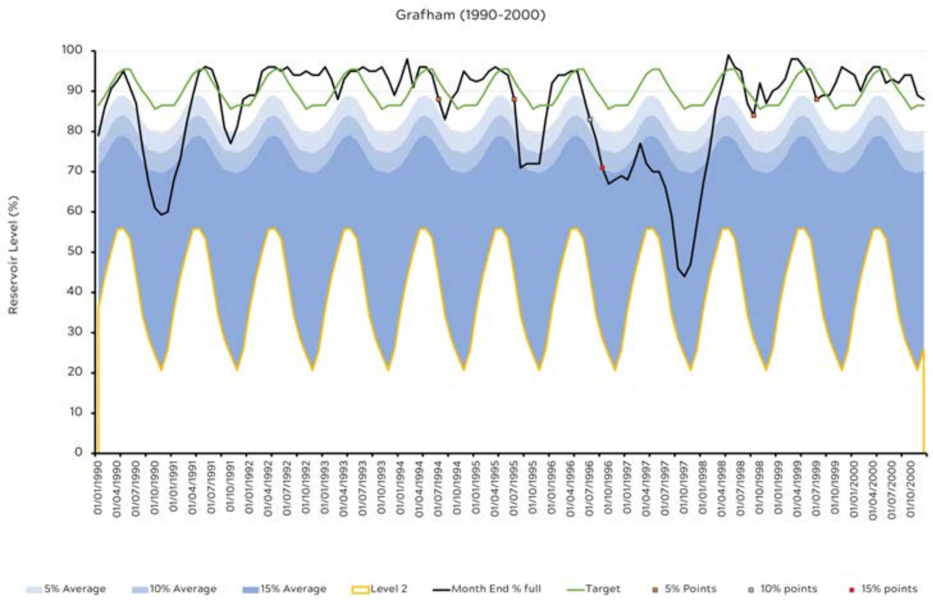
An initial review was completed to look at the number of times the reservoir saw a decline from target. Where a decline occurred that was 5%, 10% or 15% from target this was plotted. Figure 2.1 shows this review on Alton Water looking at data from 1992-2000. Abstraction potential generally drops during the summer months. During this time the reservoir dropped: 5% below target due to demand 5 times, 10% below target due to demand 4 times and 15% below target due to demand 3 times. This review was completed on all reservoirs.

Figure 2.1 Review of abstraction potential and demand for Alton Reservoir 1992-2000



The historic reservoir levels were analysed and averaged to create an average reservoir level. The 5%, 10% and 15% values were then reviewed against this (Figure 2.2). After a review of the data, it was decided that we would remove the 5% line, as in most cases this was crossed every summer and was therefore, deemed normal for a summer period.

Figure 2.2 Review of 5, 10 and 15% values for Grafham Water



After analysis was completed on how often we would cross this level for each reservoir, Level 1 was agreed to be set at 10% below target.

2.2.3 Levels 2, 3 and 4

Levels 2, 3 and 4 were originally developed in OSAY and have been adopted for use within AQUATOR and PyWR models. These levels are used in an operational context which also reflect operational constraints such as maximum fill level.

For modelling purposes demand savings are applied for each of the customer restriction actions which are attributed to each level.

2.2.4 Drought permit application trigger level

Indicative drought permit application trigger levels specific for each reservoir which has a drought permit were created using analysis of historic drought scenarios.

This trigger is based on the median storage a specified number of days (n) before Level 2 was crossed in the historic series. Crossings were only counted where the crossing lasted for at least 90 consecutive days, to avoid double counting the same drought where storage may have oscillated around Level 2. Descriptive statistics were calculated for the data, in which the median storage was found to be most representative.

Comparisons were made between the median storage and the storage value for the reservoir reference drought, n days before Level 2 is crossed. In all cases, the selected median value was higher than that for the reservoir reference drought, thus representing a more conservative level.

The number of days used to develop the level has been considered for each reservoir, to reflect the reservoir and catchment characteristics. We have also reviewed the application process and timeline for the two permits we prepared for the River Nene abstraction points (Rutland Water and Pitsford Water) during 2011-12 and 2025. We consider 60-days to still be an appropriate length of time for preparing drought permits for all our sources and continue to ensure that our permits are ‘application ready’.

As a result, 60-day drought permit application trigger levels remain for all reservoirs with drought permits. For modelling purposes, benefits from drought permit implementation are also applied within certain drought scenarios to understand how the reservoir levels are supported.

2.2.5 Ardleigh drought levels

A slightly different approach has been followed for Ardleigh. Due to its small size the drought levels are very high in the summer and low in the winter. The drought permit is also an extension of a licenced groundwater support source that can be used during dry periods. Both factors have resulted in a different methodology being used to create the Level 1 and drought permit application trigger level.

Level 1 is calculated as 7.5% below the target level. The drought permit application trigger level is calculated as 7.5% below the target level in the summer and 20% below the target level in the winter, to account for the variable shape of the target level. Cross checking Level 1 against recent years’ reservoir levels indicates it is reasonably aligned with the 1 in 5 years crossing frequency, which is what we generally assume for Level 1 in other reservoirs. Due to Ardleigh’s responsive nature, before implementing any Level 1 actions we will consider the time that the reservoir level has spent below Level 1 as well as our other monitoring indicators.

2.3 Reservoir scenario testing

In the Drought Plan a selection of droughts have been used to demonstrate how our drought levels and actions may operate. We have tested against short-, medium- and long-term drought events. When analysing a reservoir, not all drought durations have the same potential to threaten the water supply. Thus, short dry periods, during which time the reservoir can sustain a constant supply by using the previous storage, are not critical. However, longer periods (up to several consecutive months or even years) with a continuous deficit can deplete the existing reserves, but their probability of occurrence is much lower.

The drought scenarios for each reservoir are presented in **Table 2.2**. To determine the years and severity of these droughts, all reservoirs were modelled in Aquator using the full historical dataset (1891-2018) after which the drought years were picked and can differ for each reservoir. Unlike Drought Plan 2022, this analysis modelled reservoirs as part of their respective overall WRZ system rather than individually within a closed system. While this system-based approach may appear less severe than reservoir-specific modelling, it reflects the use of all available resources within a zone or connected zones to avoid reservoir depletion. This method provides a more realistic representation of Anglian Water's operational system, especially in the Ruthamford area, which contains the majority of the company's large reservoirs.

The reference droughts are also shown in **Table 2.2** and were modelled using the same approach but with different timeseries data. The reference drought refers to the 1 in 200-year drought set by the WRMP24 to test the full Anglian Water system resilience.

The drought vulnerability in **Table 2.2** refers to the type of drought that each reservoir is likely to be impacted by:

- Short - typically single-season droughts
- Medium - typically extended single-season droughts
- Long - typically drought lasting two to three years

Stochastic simulation methods, where realistic rainfall totals are drawn at random from a probability distribution, have become an established way for water companies to create a large set of rainfall inputs for hydrological models. This data allows testing beyond the observed record i.e. 1 in 200-year and 1 in 500-year drought events. For WRMP24, to test the full system resilience we carefully selected a single reference drought event for each return period including 1 in 500-year drought events, based on the outputs of the Atkins and Met Office Weather Generators to ensure regional coherence when simulating the impacts of these droughts. These reference droughts inherently include a mixture of short, medium and long term events as well as events that would be high intensity. Outage testing, including an element of water quality impact, is also included within WRMP24 scenario testing. We are working on improving outage and water quality testing for WRMP29. The full details of the technical methods and scenario testing used to assess the drought vulnerability of our water resources can be found in the **WRMP24 Supply Forecast Report**.

The following section demonstrates how the modelled drought scenarios impact the storage of each reservoir. For the reference droughts, it also demonstrates the actions that could be implemented and the impact they have on improving reservoir levels. The actions are limited to restriction-based demand savings and implementation of drought permits (where applicable), with the impact being greater and more visible in smaller reservoirs.

Table 2.2 Reservoir scenario testing details

Reservoir	Drought scenario			Reference drought		Drought vulnerability
	Short	Medium	Long	Year	Drought actions applied	
Alton Water	1921-23	1900-03	1972-75	1975-77	Demand savings	Medium
Ardleigh Reservoir	1921	1989-91	1932-35	1975-77	Demand savings and drought permit	Short
Covenham	1921-22	1989-92	1973-77	1975-77	Demand savings	Long
Grafham Water	1921-22	1975-76	1933-35	1975-77	Demand savings and drought permit	Long
Rutland Water	1922	1975-76	1933-35	1975-77	Demand savings and drought permit	Long
Pitsford Water	2011-12	1975-76	1933-35	1975-77	Drought permit	Medium
Ravensthorpe & Hollowell	2011-12	1975-76	1933-35	1975-77	No options	Short

2.3.1 Alton Water

Figure 2.3, Figure 2.4, Figure 2.5 and Figure 2.6 demonstrate Alton Water's response to short-, medium-, and long-term droughts, as well as the reference drought scenario. Due to its relatively small size, even short-term droughts have a noticeable impact on storage levels. Recovery becomes increasingly difficult as drought severity increases. Since Alton Water does not have a drought permit, the reference drought scenario only considers demand savings, applied during summer months (April-September). This explains why simulated volumes remain unchanged until April 1976. Once storage falls below Level 3, enhanced demand savings are applied, enabling the reservoir to eventually recover to the target level.

Figure 2.3 Modelled behaviour of Alton Water during short-term drought

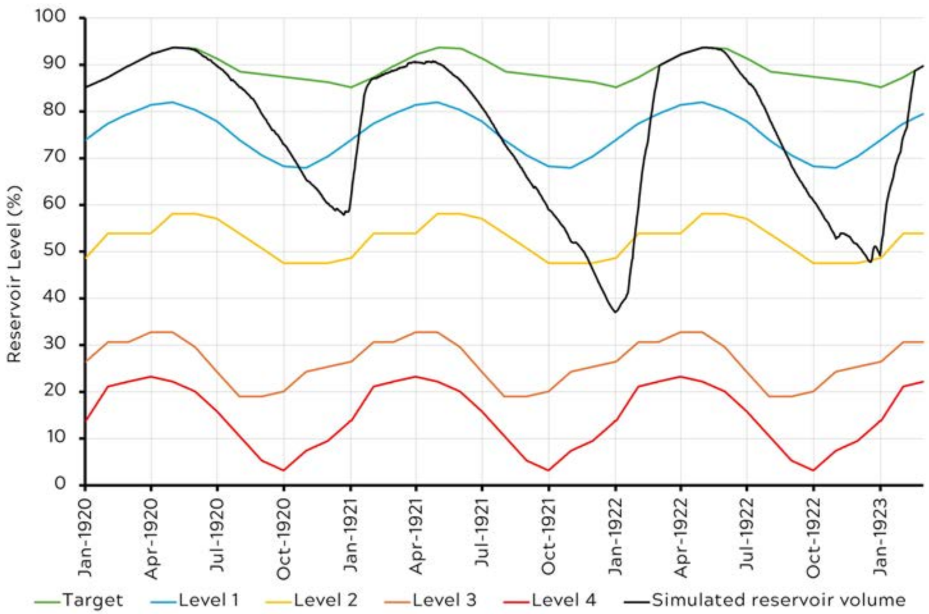


Figure 2.4 Modelled behaviour of Alton Water during mid-term drought

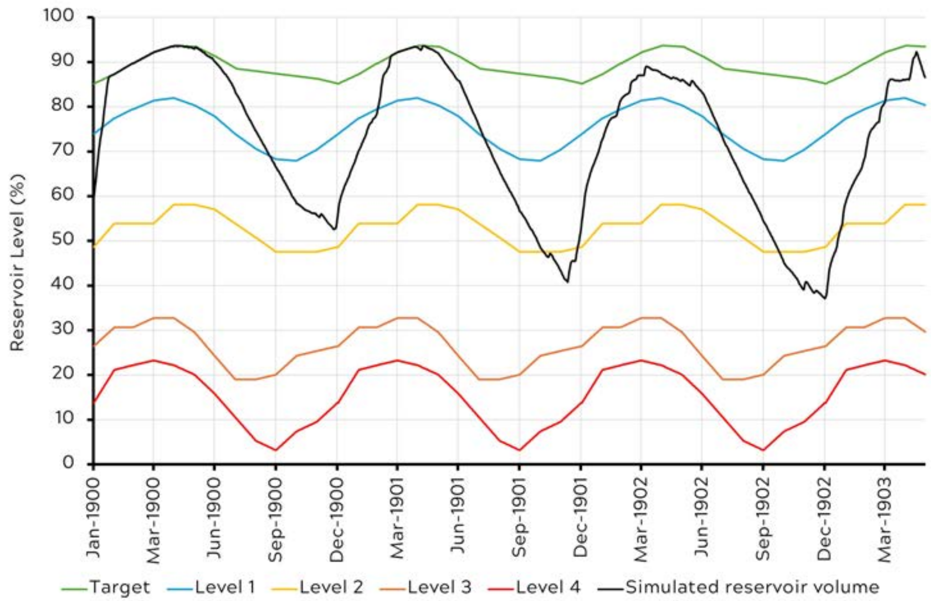


Figure 2.5 Modelled behaviour of Alton Water during long-term drought

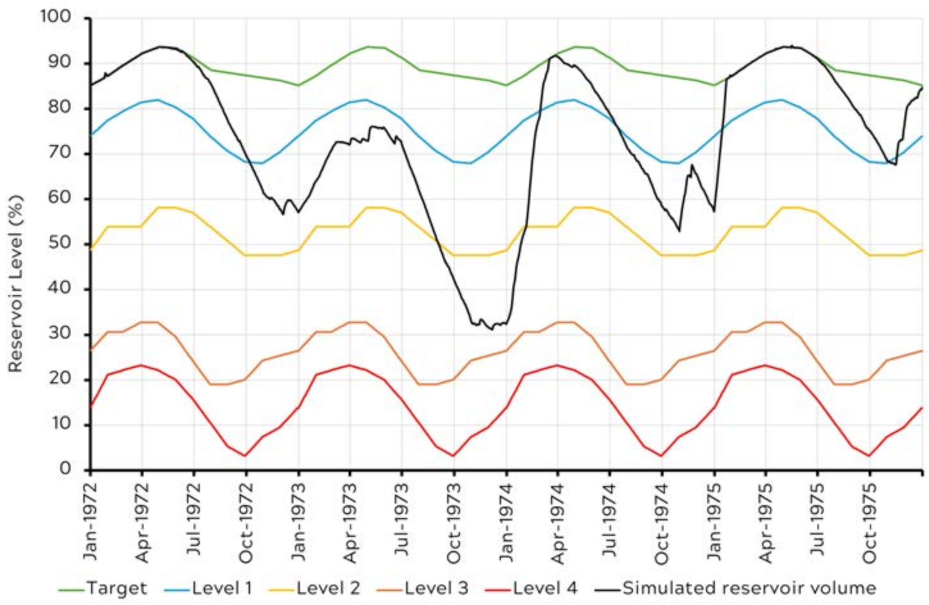
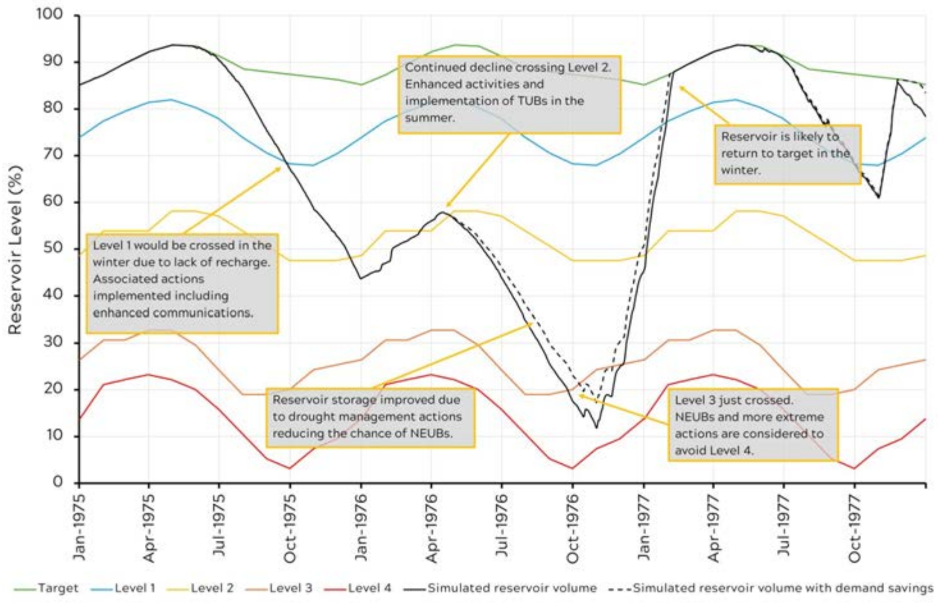


Figure 2.6 Modelled behaviour of Alton Water during reference drought



2.3.2 Ardleigh Reservoir

Figure 2.7, Figure 2.8, Figure 2.9 and Figure 2.10 demonstrate Ardleigh's response to short-, medium-, and long-term droughts, as well as the reference drought scenario. Due to its small storage capacity, even short-term droughts can cause levels to approach Level 4, but would be easier to recover to target curve. Under the reference drought–the most severe scenario–storage falls below Level 4 twice within the same year. During summer drought conditions, enhanced demand actions could limit further reduction, with storage potentially remaining just below Level 2.

Figure 2.7 Modelled behaviour of Ardleigh Reservoir during short-term drought

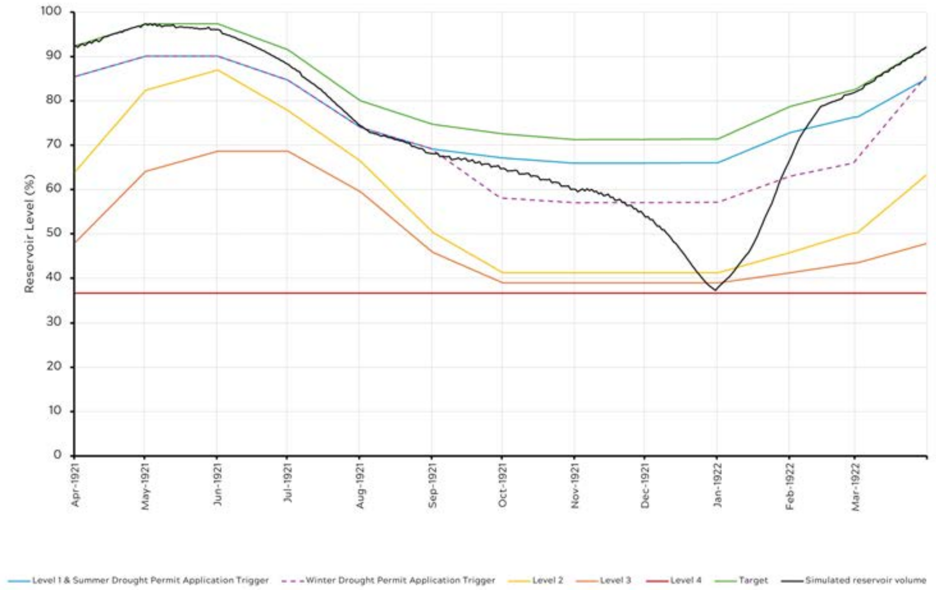


Figure 2.8 Modelled behaviour of Ardleigh Reservoir during mid-term drought

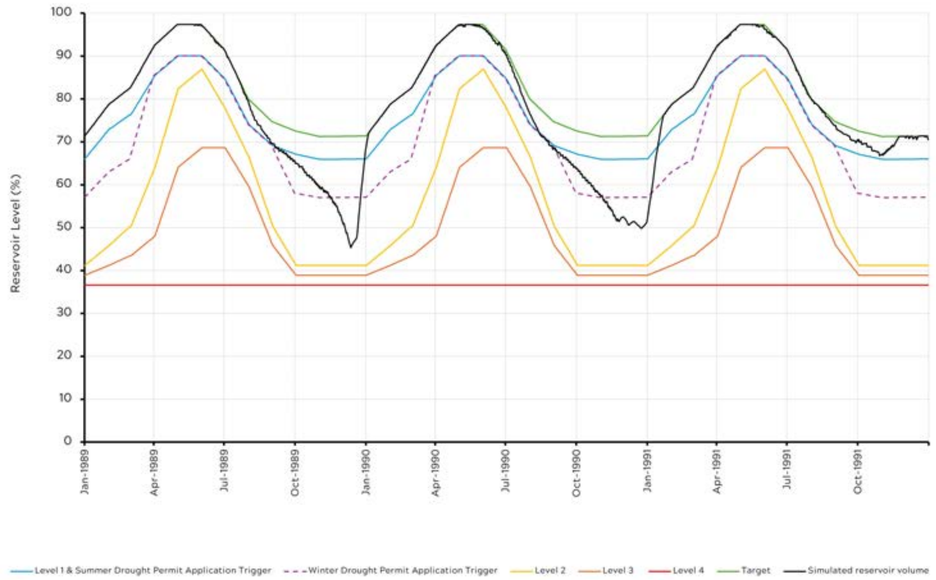


Figure 2.9 Modelled behaviour of Ardleigh Reservoir during long-term drought

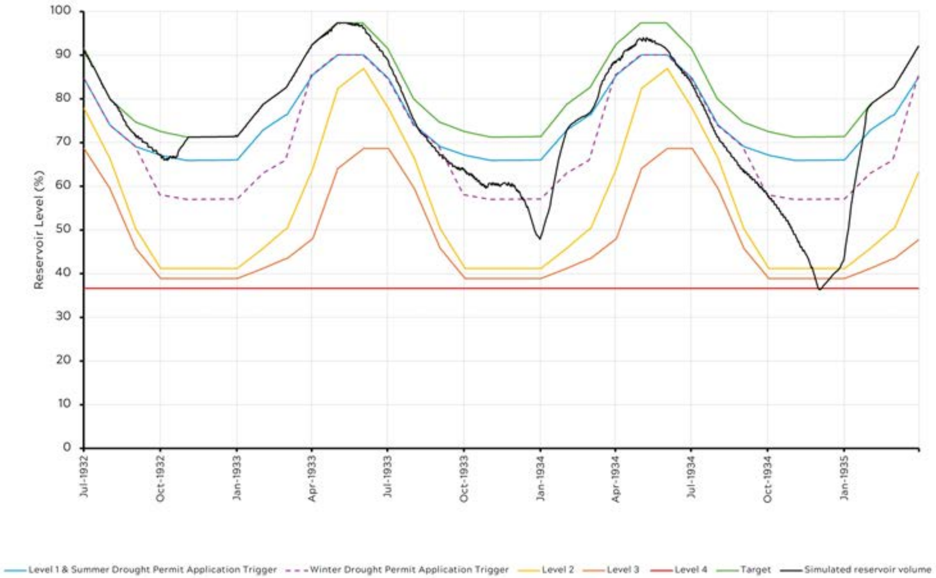
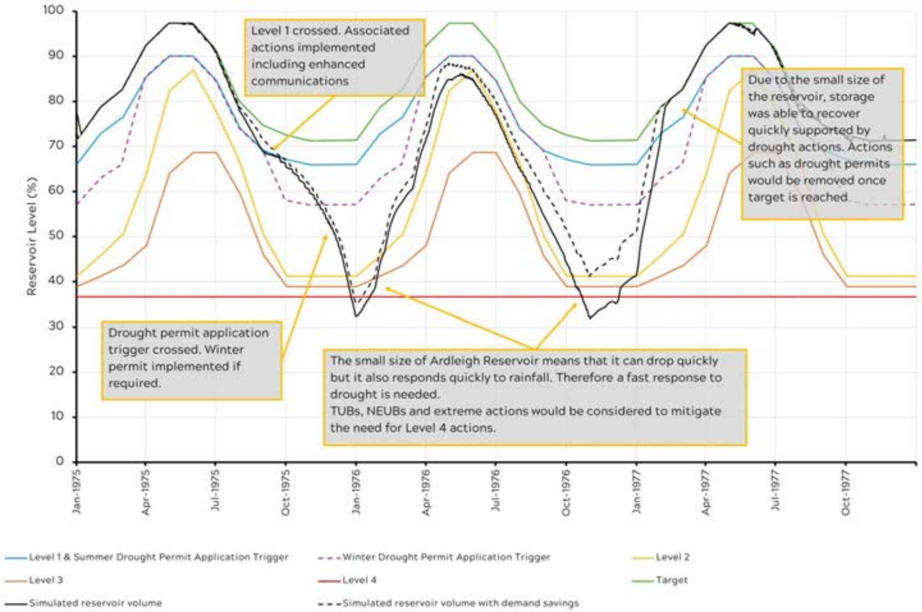


Figure 2.10 Modelled behaviour of Ardleigh Reservoir during reference drought



2.3.3 Covenham Reservoir

The demand on Covenham Reservoir is not sufficient to draw the reservoir down, even during drought. However, abstraction potential is often greatly reduced due to water quality within the source rivers. We are currently developing joint rainfall-runoff, water quality models to capture periods of un-abstractable water and have a better understanding of reservoir yield for public water supply.

2.3.4 Grafham Water

Figure 2.11, Figure 2.12, Figure 2.13 and Figure 2.14 illustrate Grafham Water's response to short-, medium-, and long-duration droughts, as well as the reference drought scenario. As one of the largest reservoirs in the region, Grafham takes longer to recover from drought, particularly prolonged events. In the reference drought scenario, storage falls below the drought permit application trigger and does not recover, eventually dropping below Level 3. Demand savings alone have minimal effect, especially when levels fall below Level 2. However, combining demand savings with a drought permit provides a more noticeable improvement, though the impact remains limited due to Grafham's storage capacity.

Figure 2.11 Modelled behaviour of Grafham Water during short-term drought

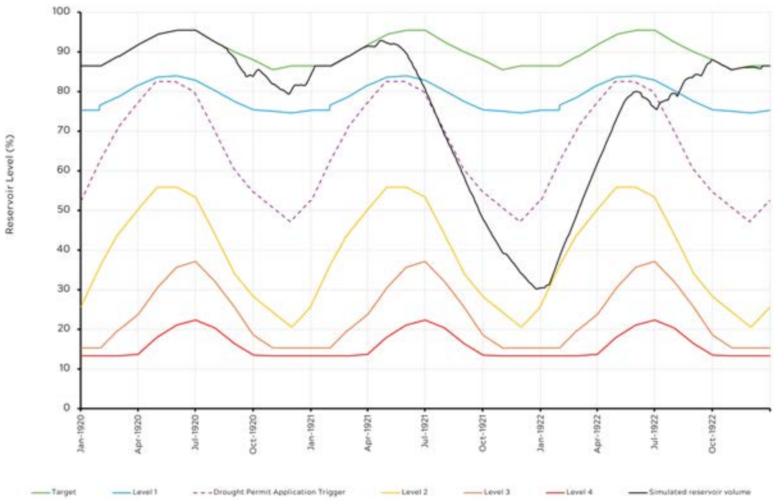


Figure 2.12 Modelled behaviour of Grafham Water during mid-term drought

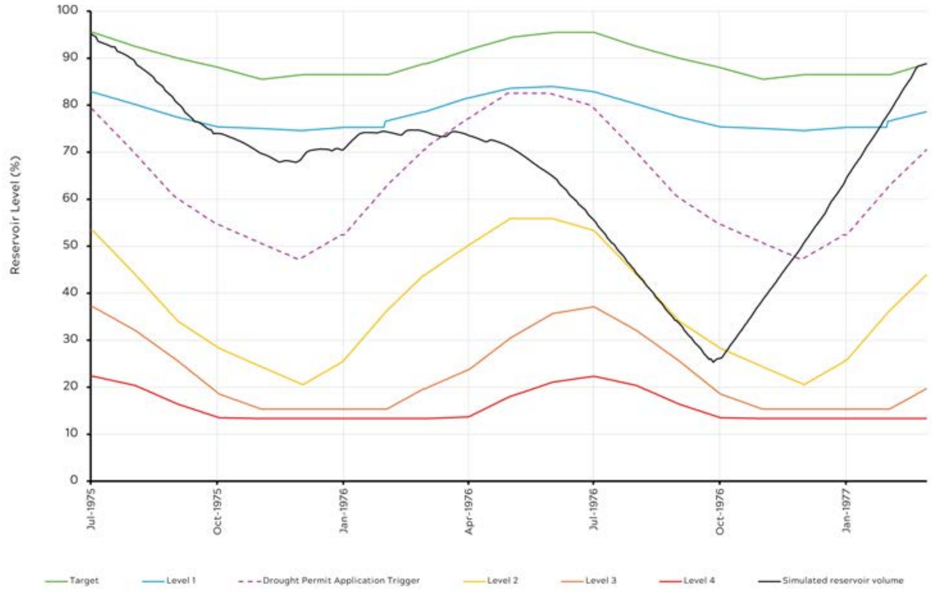


Figure 2.13 Modelled behaviour of Grafham Water during long-term drought

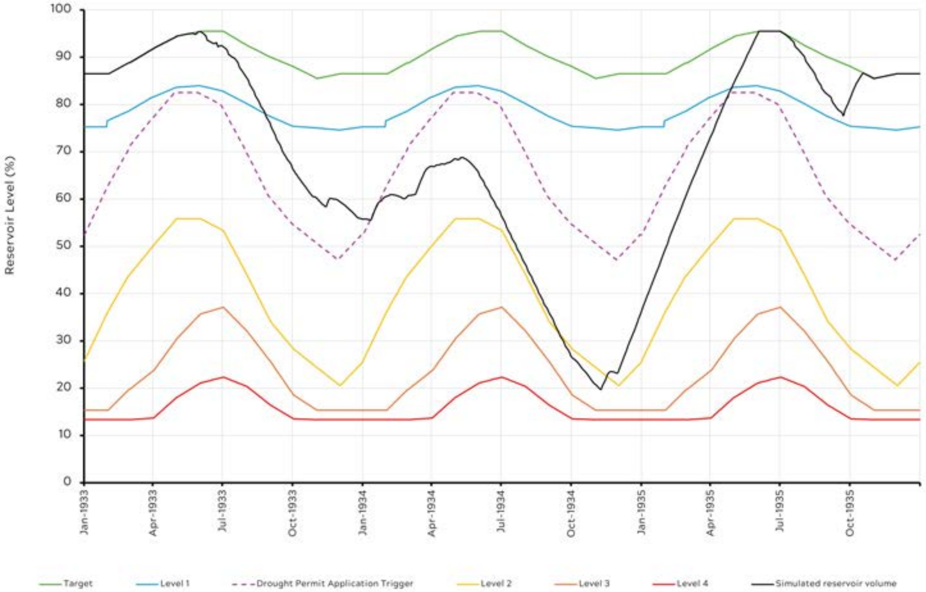
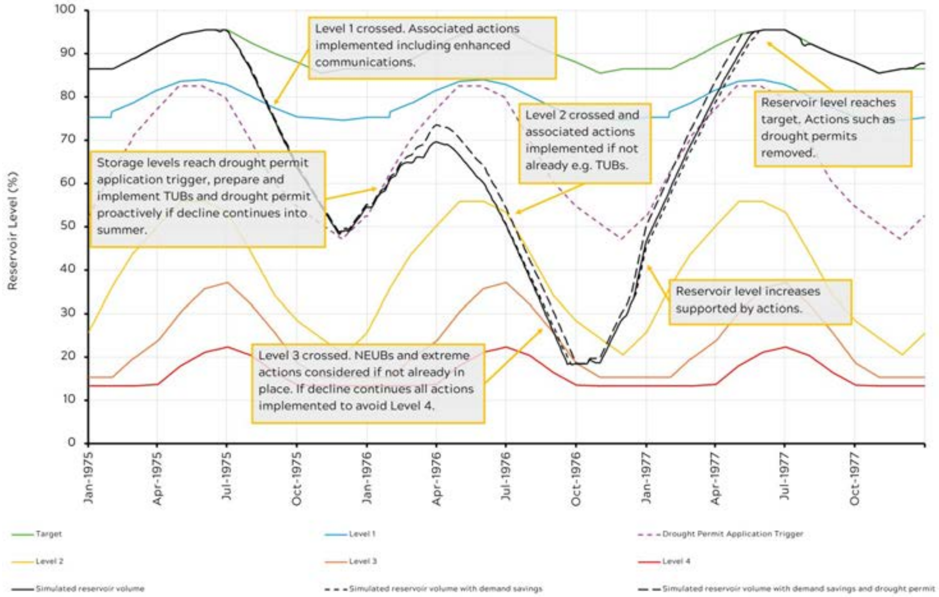


Figure 2.14 Modelled behaviour of Grafham Water during reference drought



2.3.5 Rutland Water

Figure 2.15, Figure 2.16, Figure 2.17 and Figure 2.18 demonstrate Rutland Water's response to short-, medium-, and long-duration droughts, as well as the reference drought scenario. As the largest reservoir in the region, Rutland is the most challenging to recover following drought conditions, particularly during prolonged events. In the reference drought analysis, two options were modelled: demand savings alone and demand savings combined with a drought permit. Demand savings alone have minimal impact because reservoir levels fall below Level 2 late in the summer, resulting in identical simulation curves. The combined approach provides a slight improvement, though the effect remains limited due to Rutland's substantial storage capacity.

Figure 2.15 Modelled behaviour of Rutland Water during short-term drought

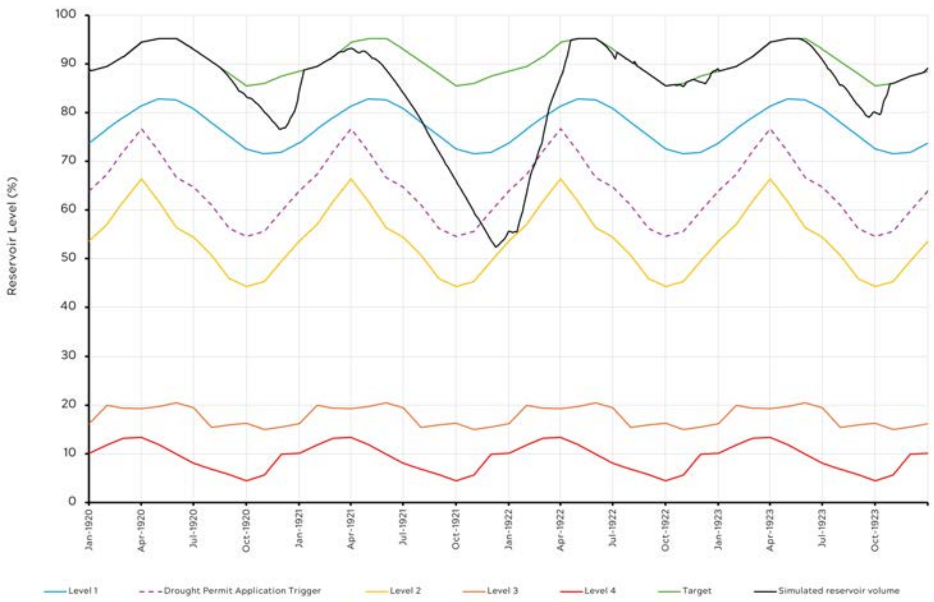


Figure 2.16 Modelled behaviour of Rutland Water during mid-term drought

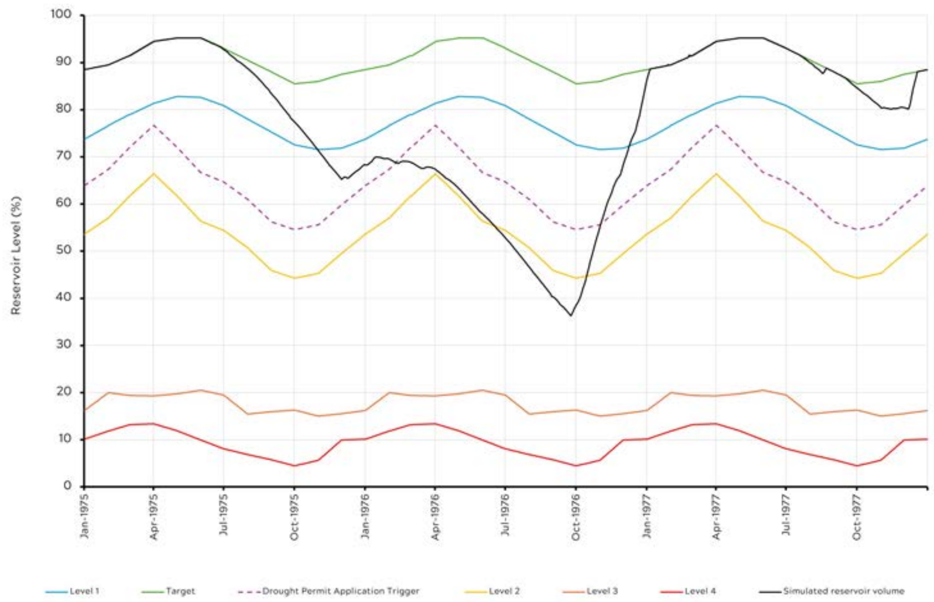


Figure 2.17 Modelled behaviour of Rutland Water during long-term drought

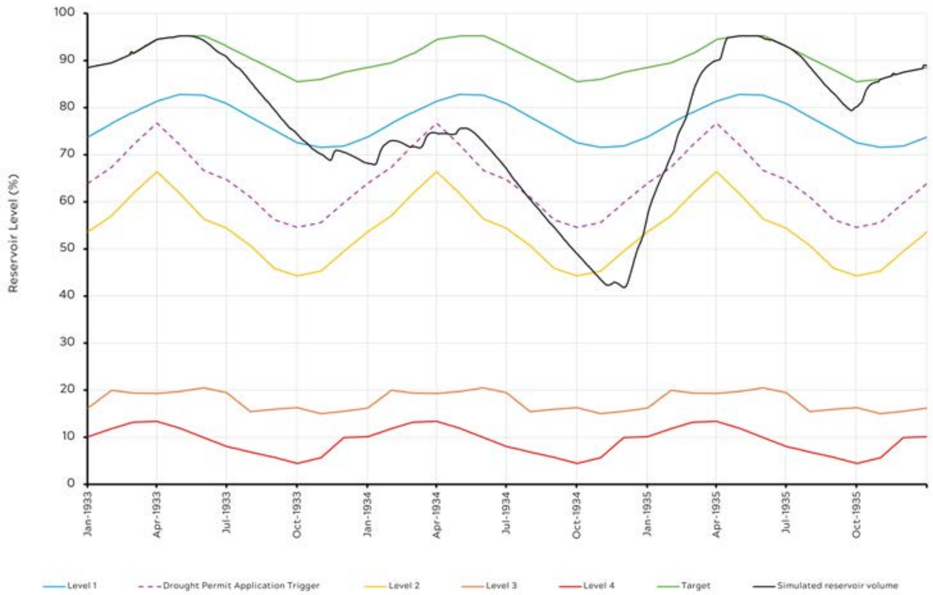
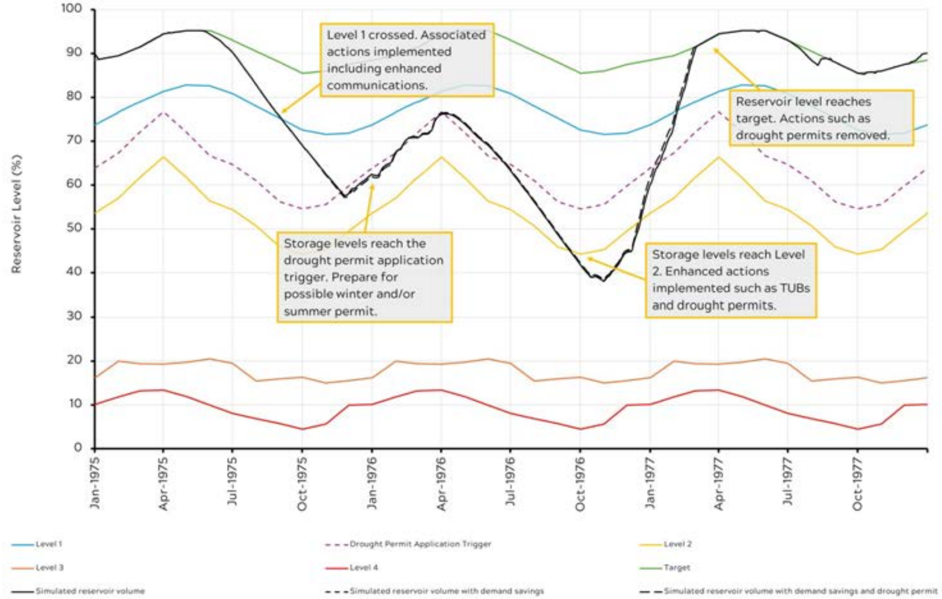


Figure 2.18 Modelled behaviour of Rutland Water during reference drought



2.3.6 Pitsford Water

Figure 2.19, Figure 2.20, Figure 2.21 and Figure 2.22 illustrate Pitsford Water's response to short-, medium-, and long-duration droughts, as well as the reference drought scenario. Due to its relatively small storage capacity, Pitsford is highly responsive to drought conditions, with levels falling below Level 2 even during short-term events. However, its size also enables quicker recovery to the target level compared to larger reservoirs. In the reference drought analysis, the only option modelled was demand savings combined with a drought permit. Because the crossing below Level 2 occurs during winter months, demand savings could not applied; therefore, all observed benefits are due to the drought permit implementation.

Figure 2.19 Modelled behaviour of Pitsford Reservoir during short-term drought

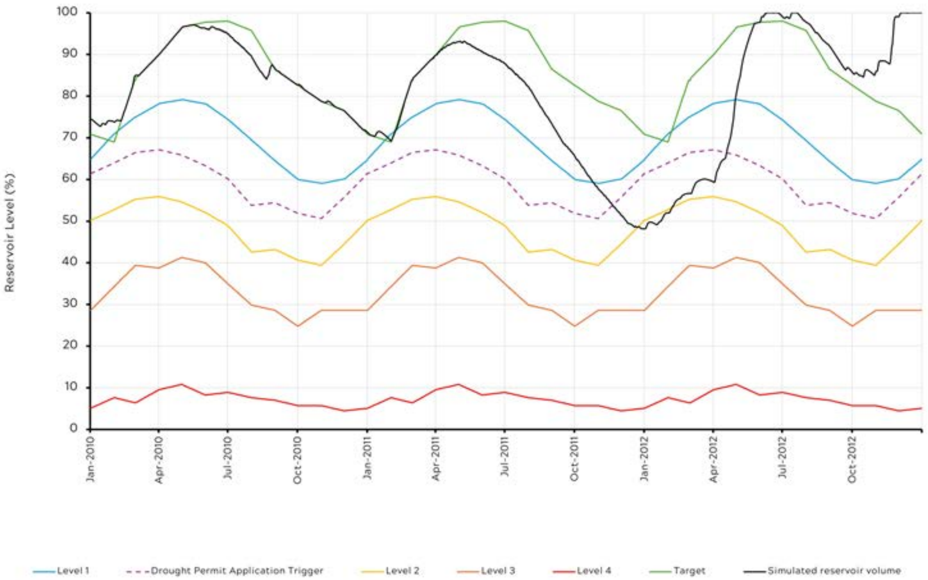


Figure 2.20 Modelled behaviour of Pitsford Reservoir during mid-term drought

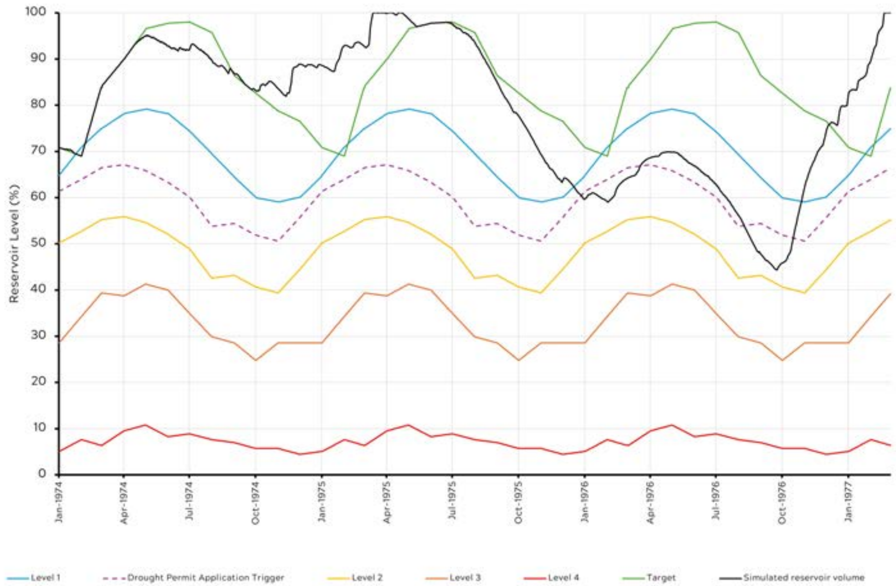


Figure 2.21 Modelled behaviour of Pitsford Reservoir during long-term drought

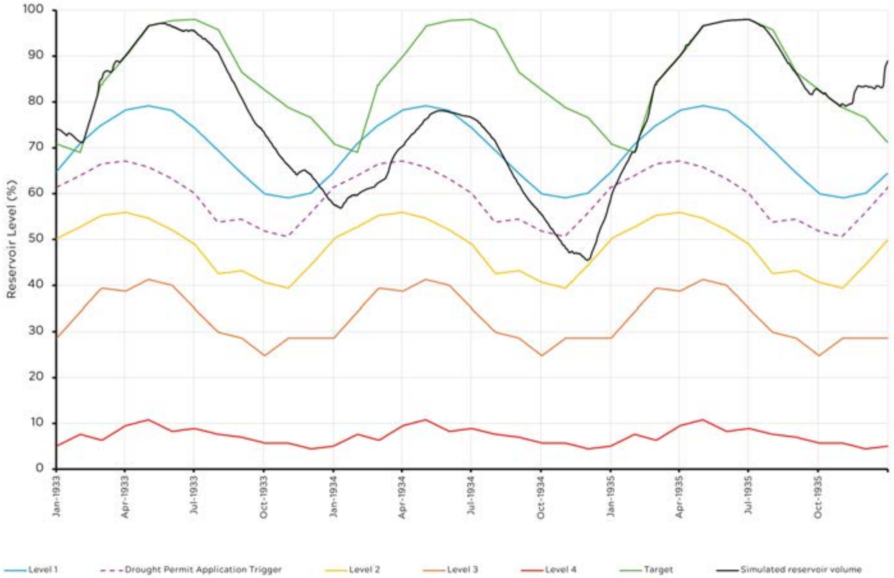
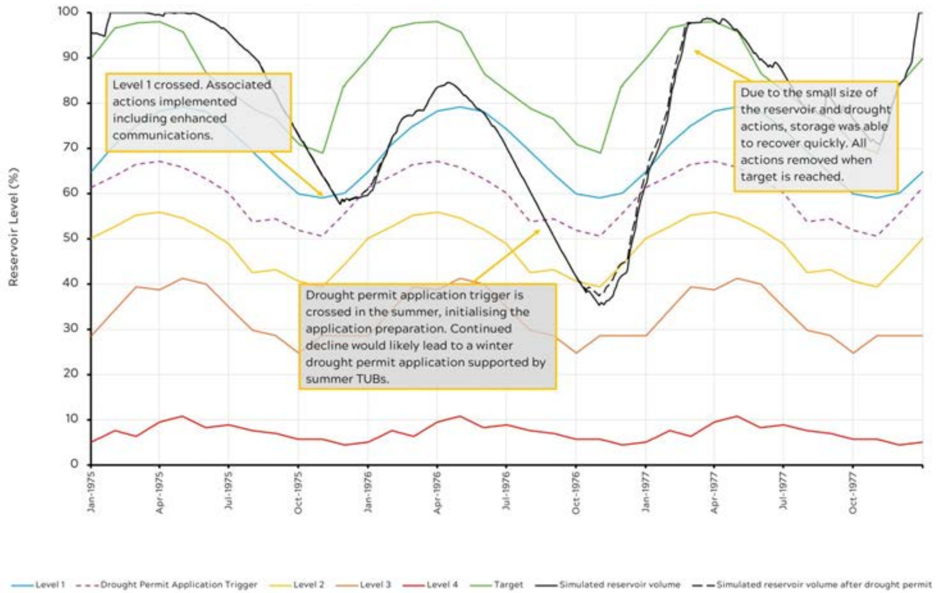


Figure 2.22 Modelled behaviour of Pitsford Reservoir during reference drought



2.3.7 Hollowell and Ravensthorpe Reservoirs

Figure 2.23 and Figure 2.24 illustrate Hollowell and Ravensthorpe's response to the reference drought scenario. Neither reservoir has a Level 1 or drought permit application trigger level, and their overall contribution to the Ruthamford system is relatively small. Because they are small reservoirs reliant solely on natural inflows, there is limited ability to manage their storage levels. In the modelled scenario, storage levels remain above Level 2, meaning no drought management actions would be triggered for these reservoirs. In reality though drought actions for these sources would be aligned with the wider Ruthamford approach.

Figure 2.23 Modelled behaviour of Hollowell Reservoir during reference drought

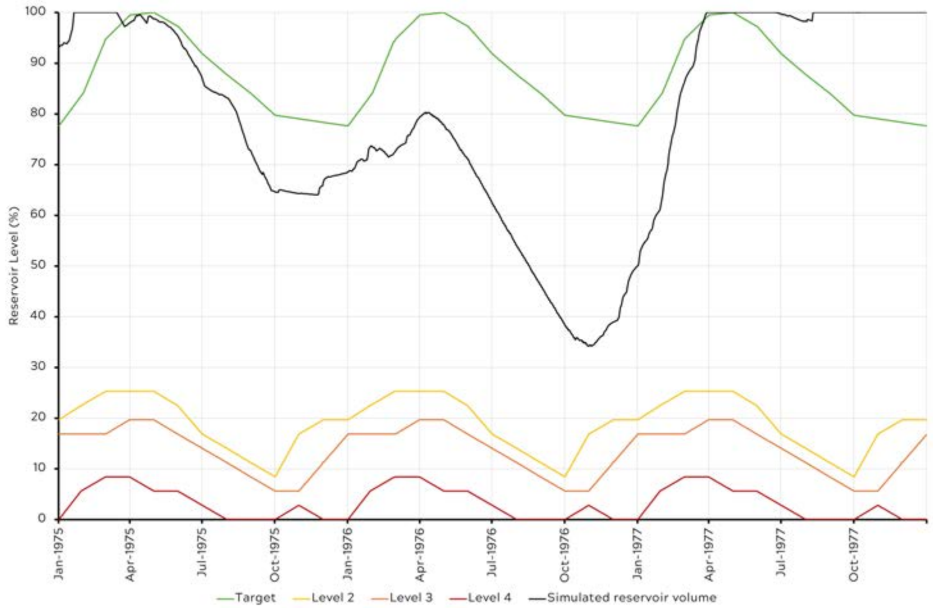
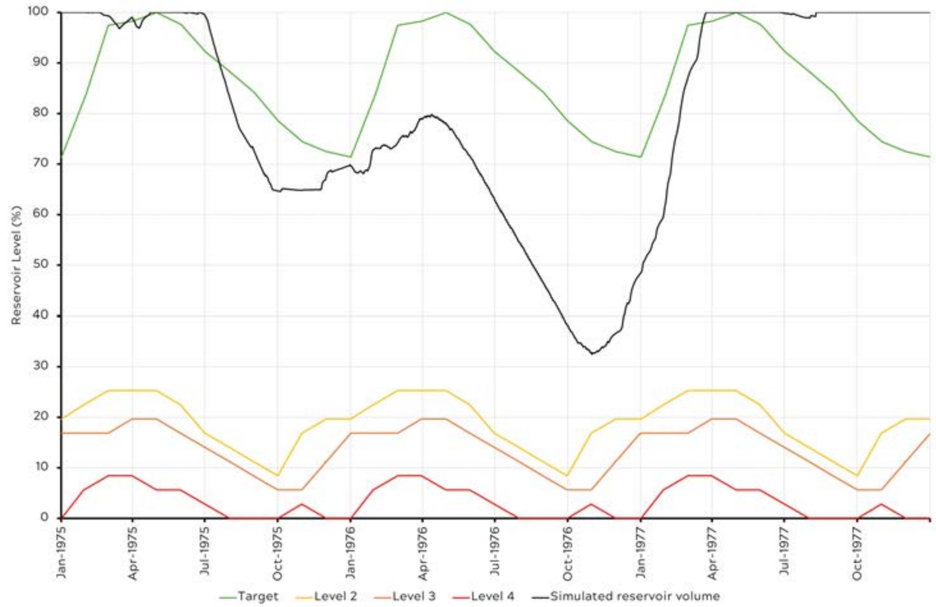


Figure 2.24 Modelled behaviour of Ravensthorpe Reservoir during reference drought



3. Direct River Intake Drought Levels and Scenario Testing

3.1 Introduction

Anglian Water have six main operational direct supply river intakes (Table 3.1) but they only account for approximately 10 per cent of water supplied by Anglian Water.

Some intakes are also associated with bankside storage, offering some short-term localised water storage to buffer against fluctuations in river flows. Bankside storage is determined as storage that contains enough water to support a system for greater than 24 hours.

Table 3.1 Direct river intakes and the associated bankside storage and river flow gauging station(s)

Direct river intake	Bankside storage	River flow gauging station(s)	Water Resource Zone
River Trent at Hall	Hall Reservoir	North Muskham	Lincolnshire Central
River Ancholme at Cadney	Cadney Carrs Reservoir	Bishops Bridge	Lincolnshire Central
River Great Ouse at Clapham	N/A	Roxton	Ruthamford South
River Wensum at Heigham	Heigham Large Deposit Reservoir	Costessey Mill (Wensum) and Costessey Park (Tud)	Norfolk Norwich and the Broads
River Nar at Marham	N/A	Marham	Fenland
River Wissey at Stoke Ferry	N/A	Northwold (River Wissey) and Whitebridge (Stringside Drain)	Fenland

3.2 Direct River Intake Drought Levels and Scenario Testing

Following two significant dry periods during 2022 and 2025 we have reviewed how we operate our direct river intakes within the context of the conjunctive supply systems that they sit within. To help support decision making and drought management we have created some indicative drought levels similar to our existing groundwater levels.

We have only created indicative drought levels for the river intake sources that already have drought permit options assigned to them as they are the sources that are more at risk from drought events and require supporting drought actions ahead of an application. The drought permit options ensure that the intakes will remain secure against a severe drought event. The sources in question are the River Trent at Hall, River Wensum at Heigham and River Wissey at Stoke Ferry.

As our direct river intakes only contribute approximately ten percent to our overall supply and sit within complex conjunctive systems it is important to note that the levels created are indicative and are not designed to directly result in specific drought actions or restrictions at the respective levels. Due to the aforementioned reasons, we also haven't included Level 3 and Level 4 curves at these direct river intake sites. The full suite of drought levels and associated appropriate actions that are required in each WRZ will be determined by taking into account the status of all sources, any operational pressures acting in the area and the indicators included in the drought management framework (**Table 2.2, Main Plan**).

Due to the complex nature of these abstraction points and some limited time series data we used a mixture of methods and analysed different data sets to determine the levels including:

- A range of rainfall-runoff models such as GR6J and G2G
- Historic drought event gauged river flows
- Qualitative information from experienced operational colleagues

For each river intake data from the 1976 or 1991 drought events has been used an example for scenario testing. As mentioned in **Section 2.3**, the **WRMP24 Supply Forecast Report** includes the testing that has been completed to ensure full system resilience against the full range of return periods and types of drought including 1 in 500-year events.

The general methodologies to determine each level are summarised below. However, as each river intake is different some of the levels have been developed using alternative methods, these differences are noted when appropriate in the following sub-sections.

Levels 1 and 2

Used as an indicator for when the implementation of actions associated to each level may need to be considered. Other factors to be considered before implementing any actions would include the time of year and the health of the other sources within the WRZ.

These levels were developed using return-period analysis of drought events from the full records supplied by rainfall-runoff models as well as operational feedback gathered during drought events.

Pre-drought permit application trigger level

Used as an indicator to check the latest river flows and forecasts. If forecasts suggest a potential risk, then drought permit application documentation can start to be reviewed.

This level has been developed using the same analysis carried out for the drought permit application trigger level. However, instead of the level being determined using a 60-day trigger a more appropriate longer time period is used.

Drought permit application trigger level

Used as an indicator for when we may need to prepare and apply for a drought permit. The timing of crossing the level and the forward-looking forecast is crucial when determining whether a drought permit application may be necessary. For instance, if the river flow recedes below the level in spring or early summer an application would be considered. However, if the level is crossed in late summer or autumn, there is a much higher chance that the river flow will recover over the remaining months of the year meaning that an application may not be required.

To determine this level, the river flow observed 60 days prior to each MRF or HoF crossing was identified. The MRF or HoF serves as the threshold for initiating drought permit implementation. This was calculated for all crossings in the different historic and modelled series, where the crossing lasted for at least 60 consecutive days. The different historic and model outputs where then reviewed in the context of how the system is operated to determine which level was the most appropriate to use. The level should provide sufficient time for us to complete the necessary permit application process. However, depending on the situation we may choose to prepare and implement actions such as drought permits ahead of crossing the suggested levels.

3.2.1 River Trent at Hall

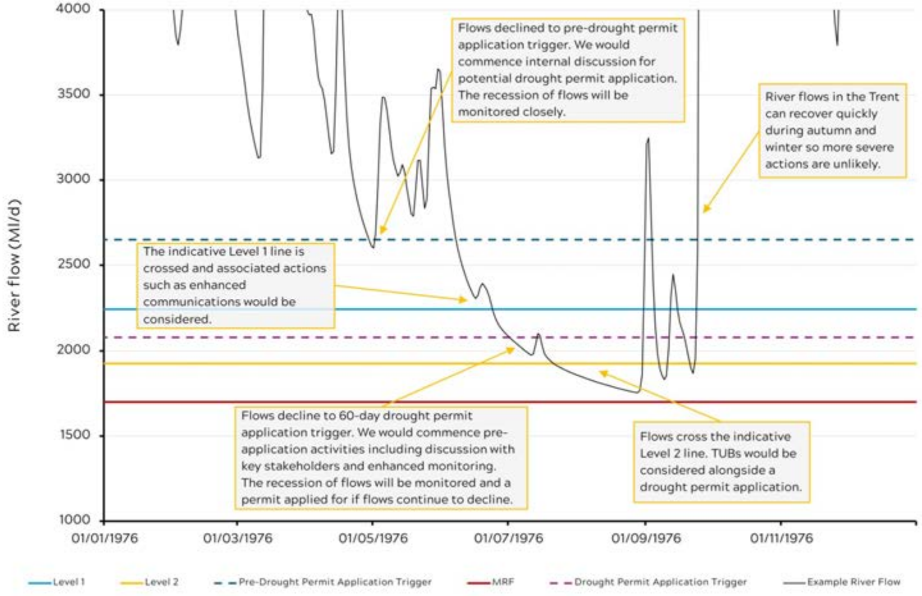
The levels set for the River Trent at Hall intake follow the general methodology set out above but with the only difference being that the pre-drought permit application trigger level was set as the River Trent catchment HoF. This catchment HoF is the level at which most other abstractors from the River Trent have to switch off leaving our intake to continue operating.

Table 3.2 and Figure 3.1 set out the exact levels and an example scenario of how actions may be delivered against a river flow series.

Table 3.2 River Trent at Hall drought levels

Drought Levels	Flow (Ml/d)
Pre-drought permit application trigger	2650
Level 1	2245
Drought permit application trigger	2079
Level 2	1927

Figure 3.1 Example River Trent at Hall flow scenario



3.2.2 River Wensum at Heigham

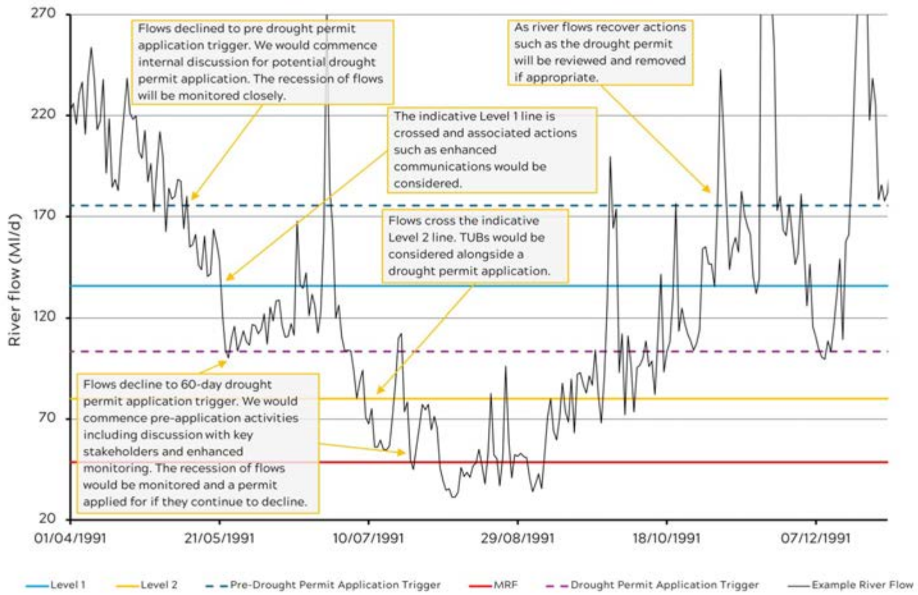
The levels set for the River Wensum at Heigham intake follow the general methodology set out above.

Table 3.3 and Figure 3.2 set out the exact levels and an example scenario of how actions may be delivered against a river flow series.

Table 3.3 River Wensum at Heigham drought levels

Drought Levels	Flow (Ml/d)
Pre-drought permit application trigger	175
Level 1	136
Drought permit application trigger	104
Level 2	80

Figure 3.2 Example River Wensum at Heigham flow scenario



3.2.3 River Wissey at Stoke Ferry

The operation of the River Wissey abstraction point is highly complex and therefore some slightly different approaches have been taken to setting the drought levels, in some cases favouring operational knowledge over the modelled flow analysis. Some additional drought levels and bandings have also been added.

The key difference for creating the drought permit application trigger levels is that there isn't a definitive MRF or HoF instead there are a range of licenced flow conditions:

- **Normal Operation (Upstream Rivers flows > 54 Ml/d)** = Normal abstraction can occur and no compensation is required
- **Licence Condition 1 (54 Ml/d > Upstream River Flows > 27 Ml/d)** = Abstraction can't exceed 18 Ml/d and flows downstream need to be maintained above 27 Ml/d using compensation if required
- **Licence Condition 2 (Upstream River Flows < 27 Ml/d)** = Abstraction can't exceed 18 Ml/d and compensation has to equal the rate of abstraction.

Therefore, an indicative HoF was set in the lower flow levels of Licence Condition 1 and the 60-day application trigger determined from that river flow.

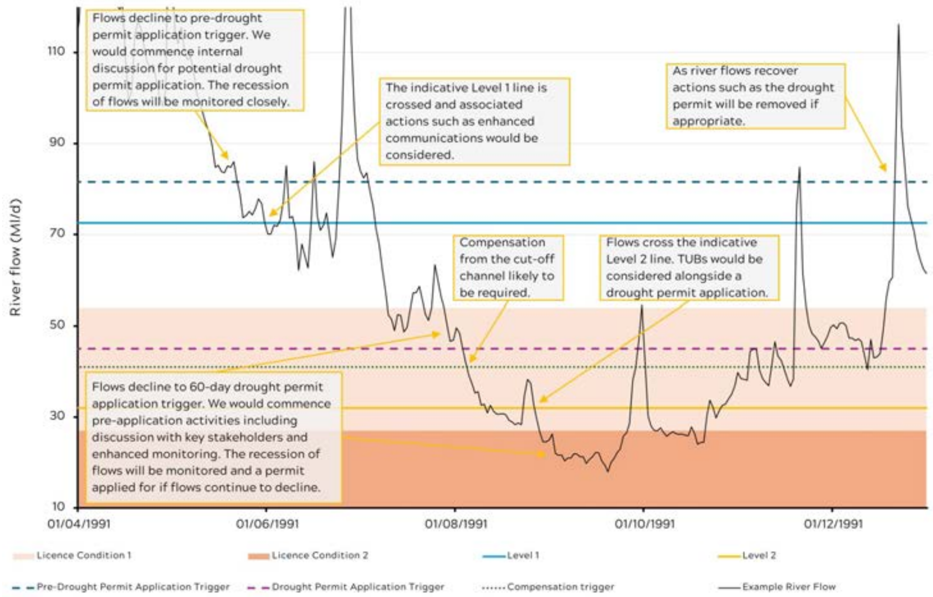
To aid with drought management of this source a Compensation trigger level has also been added which is set at the point at which compensation is likely to be required using recent abstraction data.

Table 3.4 and Figure 3.3 set out the exact levels and an example scenario of how actions may be delivered against a river flow series.

Table 3.4 River Wissey at Stoke Ferry drought levels.

Drought Levels	Flow (Ml/d)
Pre-drought permit application trigger	82
Level 1	73
Drought permit application trigger	45
Compensation trigger	41
Level 2	32

Figure 3.3 Example River Wissey at Stoke Ferry flow scenario



4. Groundwater Drought Levels and Scenario Testing

4.1 Introduction

We rely predominantly on groundwater for public water supply in the east and north of our region. The principal aquifer that we abstract from is the Chalk and around 50 per cent of our public water supply is provided by groundwater abstraction. The remaining groundwater sources abstract from the Lincolnshire Limestone, Sherwood Sandstone, Magnesian Limestone, Lower Greensand, Spilsby Sandstone, Sandringham Sands and a combination of Crag, Sands and Gravels. The spread of our groundwater sources across the Anglian region is shown in Figure 4.1.

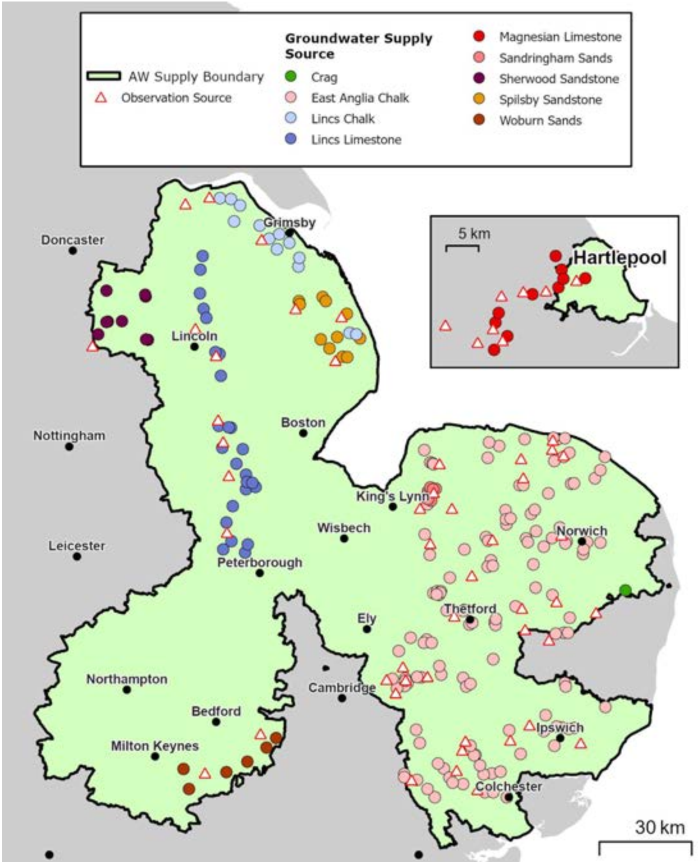
Groundwater can be a relatively drought resilient source of water, due to the large amount of storage in below ground aquifers. However, the Anglian region contains a range of aquifer types, which can respond to drought in different ways. Groundwater levels in sandstone sources tend to change very slowly, whereas groundwater levels in chalk aquifers may increase much more rapidly in response to rainfall and decline much more rapidly during prolonged dry conditions, due to its lower storage properties.

As a drought progresses, the amount of groundwater we can abstract may reduce due to:

- Reduction in yield from groundwater sources due to low groundwater levels caused by drought
- Abstraction licence conditions linked to river flow or groundwater levels that may limit the abstracted volume during low river flows or groundwater levels, caused by drought.
- Deteriorating water quality due to low groundwater levels or recharge of groundwater levels following rainfall events

The methodology used for assessing drought yields from groundwater sources is presented in **Section 4.2**. **Section 4.3** then presents how groundwater sources are highlighted according to vulnerability to drought, and how we monitor the severity and potential for impacts in groundwater using observation sources. Drought related licence conditions on our groundwater sources are detailed in **Section 4.4**. **Section 4.5** and **Section 4.6** sets out the groundwater drought levels that we have created for our sources.

Figure 4.1 Anglian Water groundwater sources by aquifer and Environment Agency observation sources used by Anglian Water for drought and aquifer monitoring



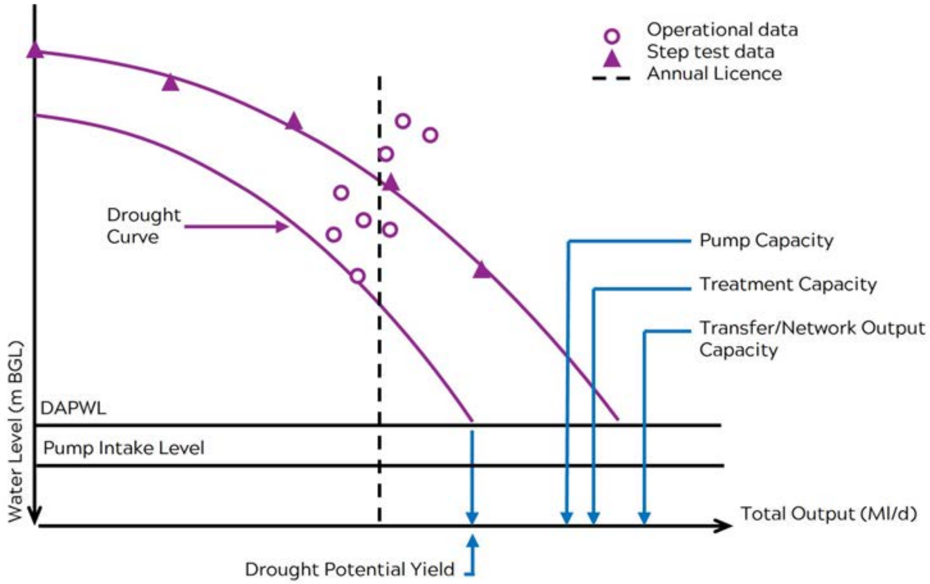
4.2 Yield Assessment

The potential yield for each of our groundwater sources is calculated in accordance with the industry-accepted UKWIR methodology[1]. This is calculated for both the worst historic drought experienced, and a 1 in 500-year event (extreme drought), in line with the level of supply resilience tested in WRMP24.

The potential yield is the amount of water that a groundwater source can reliably provide under a given set of climatological and abstraction conditions. The summary diagrams show the relationship between abstraction rate and groundwater level and can be populated with both theoretical curves based on test pumping data, and observed abstraction rates and levels using operational data. In a drought situation, the rest water level (where abstraction = 0 Ml/d) will be at a low level, and depending on the available data, may result in the downwards shift of the defined drought curve. Where the drought curve intersects the Deepest Advisable Pumped Water Level (DAPWL) defines the potential yield of the source. The DAPWL is determined by expert judgement and may typically coincide with the top of the aquifer or a critical flow horizon. According to the UKWIR methodology, a potential yield is defined for average (200 day) and peak (7 day) demand. These are known as the Average PY (AVPY) and Peak Daily PY (PDPY) respectively. The potential yield is purely an aquifer and groundwater source physical measure.

Extreme drought (1 in 500-year) potential yields were reviewed for WRMP24. This analysis involved the use of 200 sets of 91-year, stochastically generated rainfall and temperature data. These data were used to derive aquifer storage values from Lumped Parameter Models (LPM) for groundwater. Relationships were derived between the LPM storage and key groundwater observation sources, from which the level was projected onto the source summary diagram. Judgments were then made, taking account of water quality and critical flow horizons, to assess the yield under severe events picked from the stochastic series.

Figure 4.2 Methodology for assessing groundwater yields. Reproduced based on UKWIR



1 UK Water Industry Research (1995) A methodology for the determination of outputs for groundwater sources

4.3 Drought Vulnerability

4.3.1 Drought Vulnerability Tiers and Classification Method

During periods of drought, there is the increased risk of operational pumping water levels reaching their defined DAPWL. Once the water level drops below the DAPWL, the yield may drastically reduce, or there may be water quality problems limiting the utility of the source. A classification scheme with three tiers of drought vulnerability was introduced in Drought Plan 2014 to highlight different levels of vulnerability of sources to drought. In essence, this relates to the likelihood of water levels dropping in a source to the point at which it either impacts the yield or source output. The same classification scheme was carried forward to Drought Plan 2022, with drought yields updated to reflect re-assessments of Strategic Regional options (SROs) made for WRMP19.

For Drought Plan 2027, we have added an additional vulnerability tier and amended how they are defined (Figure 4.3). This is to more effectively highlight the most vulnerable sources where, operationally, we would expect to first begin to see a drought impact. Previously, sources were classified as T1 due to the yield limiting the output of the source in a drought. In reality, for some of these sources we would not expect to see a drought impact because they are operated well below their licence constraints. T1 still includes boreholes where the Potential Yield (PY) is below the annual abstraction licence, but crucially, the drought PY must also be below the recent utilisation of the source. The utilisation criteria for each source is defined as the maximum of the annual abstraction in the previous 5 years plus 20% (capped at the annual licence), to allow for additional variability in utilisation and to capture the potential for increased demand during drought beyond what has been recently experienced.

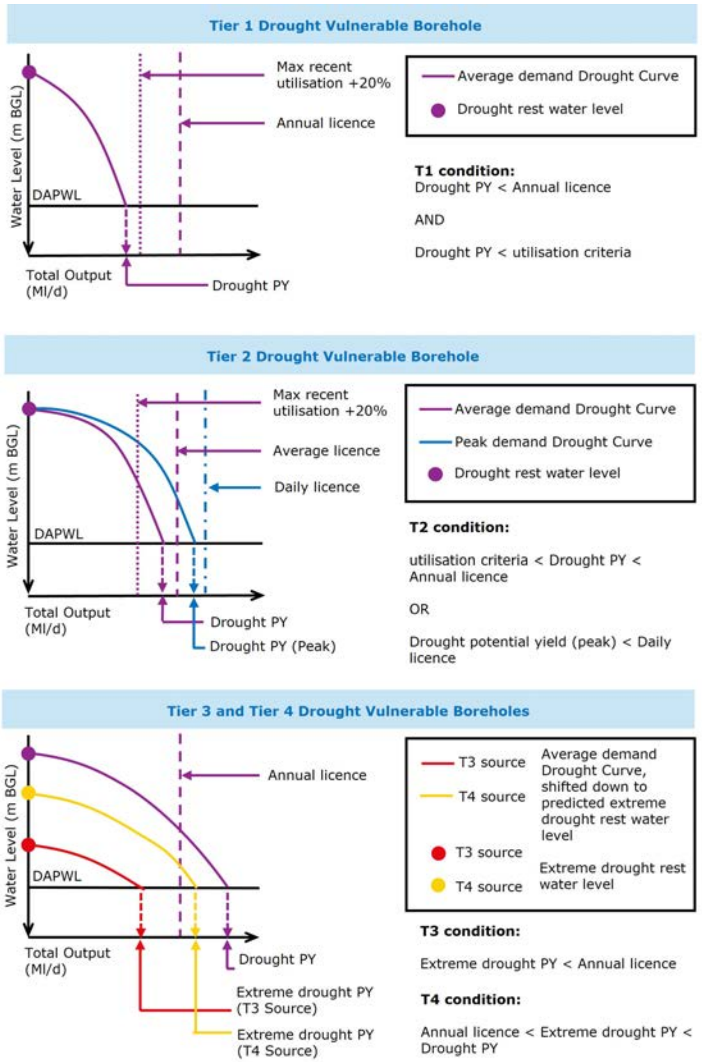
T2 captures all sources impacted by drought by comparing dry year Average PY and Peak Daily PY to the annual and daily licences, respectively. This effectively means that all sources which could not achieve either the annual average abstraction for 200 days, or maximum daily licenced abstraction for 7 consecutive days during a drought, are included. Figure 4.3 shows two drought curves - for average and peak demand, either of which would result in a T2 classification. It should be noted that some T2 sources will not be able to achieve the annual licenced abstraction, some will not be able to achieve daily peak, and some will not be able to achieve either in a drought. This is a conservative classification, as in reality, there may be other operational factors that constrain source outputs to below the drought yield such that this is no longer limiting. Previously, T2 included all sources with a drought impact on yield, but no expected supply impact due to another factor being limiting (e.g. pumping rate, treatment capacity, source works output). This assessment used unique source Average Demand Source Output (ADSO) and Peak Demand Source Output (PDSO) values, however, these are no longer used in water resources modelling for WRMP24 and as a result have not been used here.

Tier 3 is a further group of groundwater sources that are expected to be impacted in extreme droughts. In this Drought Plan, Tier 3 includes sources where the yield may reduce to less than the licence for events up to a 1 in 500-year drought, following the assessment of 1 in 500-year yields for WRMP24. The 1 in 500-year drought yields for annual average abstraction were derived by inputting stochastically generated weather data into regional LPMs, to estimate aquifer storage in a selected drought events from the time series. to assess yields for situations potentially more severe than we have experienced in the historical record extending the stochastic methodology used to define the 1 in 200-year drought yields. For many sources, the yields are expected to be very similar, however, some additional sources have a reduced yield at a 1 in 500-year severity, but not 1 in 200-year. In order to be classified as vulnerable at T3, the extreme drought yield must be below the annual licence. Therefore, in an extreme drought it is expected that T3 sources would not be able to be fully utilised to achieve their annual abstraction licence.

The newly created T4 includes all sources that show a reduction in yield in severe drought but is not expected to reduce the output of the source due to the licence constraint.

Where sources have or are operated under a group licence, for the purpose of comparing a yield against an allowable rate, full utilisation of the individual source licence has been assumed. This is considered to be a conservative approach, as it is extremely unlikely that a source would be operated in this way given that there will be two or more other sources whose combined outputs constrain the annual abstraction. Additionally, no other constraints to source outputs beyond the yields and licence conditions have been considered. In reality, pump specification, treatment capacity, and connectivity to the wider supply network may constrain the source output, any of which may be more restrictive than the drought yield. Again, this is considered to be a conservative approach but is considered to be warranted as these constraints are often difficult to define in a well-connected supply system. These may also be overcome by operational changes that could be actioned in a drought (for example, additional treatment capacity, pump replacement).

Figure 4.3 Classification criteria for a drought vulnerable source or borehole (DVB)



4.3.2 Drought vulnerable groundwater sources

We have identified 15 operational sources that are considered to be drought vulnerable at the Tier 1 level which is a reduction from 17 in Drought Plan 2022. Seven of these were previously T1 and have not changed classification. Two formerly T2 sources, and two formerly T3 sources have moved up to T1. This was due to a reduction in drought yields identified in WRMP24, reducing them to below annual licenced volumes, where previously the drought yields were not expected to impact supply. Four newly classified drought vulnerable sources have been included because the drought yield is less than the annual licence, and the drought yield is expected to be significantly limiting compared to recent utilisation of the sources.

Nine former T1 sources have been downgraded to T2. This has been for one of two reasons; either the sources are not currently being utilised to the extent that an impact would be expected, or, drought is expected to impact the ability to meet peak demand only (i.e. the daily licence cannot be achieved). T2 comprises 30 sources, 14 of which were not previously considered drought vulnerable, but are considered drought vulnerable in this Drought Plan. Of these 14 sources, seven of these are expected to be able to supply the annual licenced quantity in drought but could not respond to peak demand through full utilisation of their daily licences.

T3 includes 14 sources where the output is expected to be impacted in extreme drought. WRMP24 showed that 67 sources would have a reduced potential yield in a 1 in 500-year drought. 51 out of these 67 sources would be impacted such that they would be unable to deliver their annual licenced volume in a 1 in 500-year drought. 37 of these sources are already assigned to T1 or T2, leaving 14 sources with an extreme drought impact on their ability to meet licenced abstraction and assigned as T3.

21 sources have been identified as T4. This grouping is dominated by sources in the Lincolnshire Limestone (18). The reason for the high prevalence of sources from this aquifer is due its low-storage, fractured flow characteristic. As a result, a slightly different, and more conservative approach to estimating extreme drought yields was adopted in the approach for WRMP24.

By defining drought vulnerability in this way, the tiers are consistent with the expected pattern of impact that would occur as drought progresses and becomes more severe. The 15 T1 sources are those where drought impacts would be expected to be encountered first, because drought would reduce the yield to below the typical source utilisation. The 30 T2 sources would be expected to not initially be impacted, because although drought would be expected to impact on the ability to abstract either annual or daily quantities, the drought yield would remain above typical utilisation. Progression of the drought would result in some of the T1 sources losing more output, potentially greater reliance on groundwater sources in general, and increased demand for water in general. These factors would lead to higher utilisation such that as these sources start to respond to the increased demand, drought yields may constrain their output. As the drought progressed, exceeding the severity of droughts in the historical record, output from T3 sources would be expected to reduce. A drought exceeding the 1 in 500-year severity would be expected to reduce the output of T4 sources and because of this these sources are presented for information only as this level of resilience falls outside of the Drought Plan remit.

Figure 4.4 shows the locations of all the drought vulnerable sources and the associated observation sources. Table 4.1 sets out how many sources are in each drought vulnerability tier and what changes have been made since Drought Plan 2022. Table 4.2 lists out the drought vulnerable tier 1 sources and then Table 4.5 at the end of this appendix incudes the full list of drought vulnerable sources against their associated tiers.

Figure 4.4 Observation sources and drought vulnerable supply sources. Numbers within the sources refer to the drought vulnerability tier

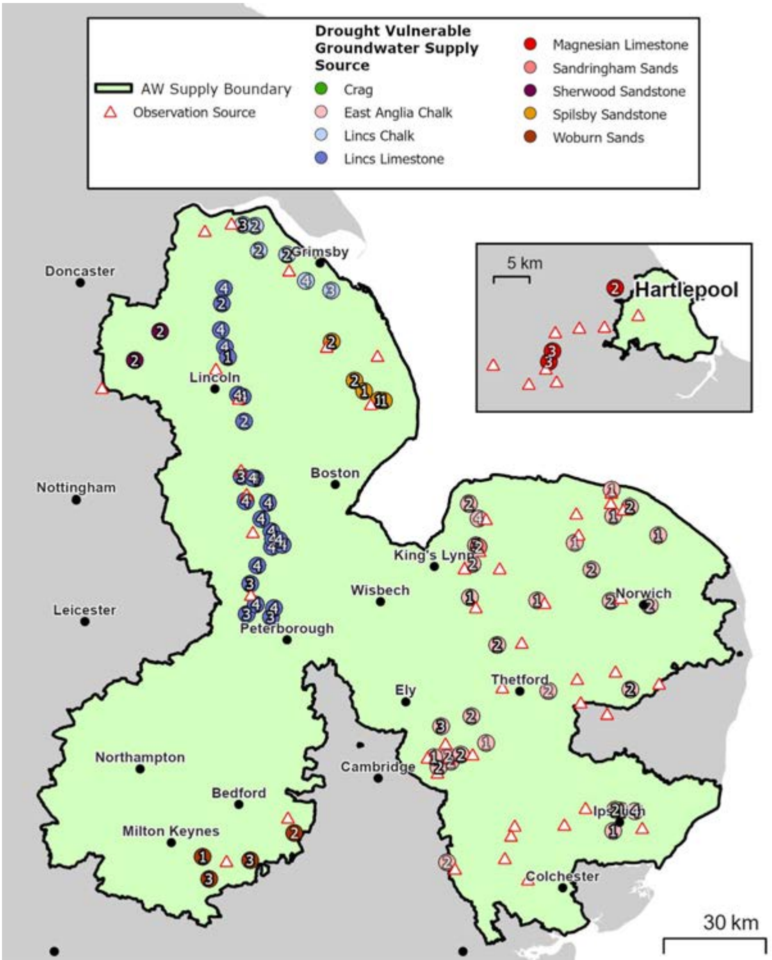


Table 4.1 Drought Plan 2027 drought vulnerability tiers and comparison with Drought Plan 2022

Tier	Drought Plan 2022 drought vulnerable sources		Drought Plan 2027 drought vulnerable sources	
	Source cont	Description	Source count	Description
T1	17	Drought impact on yield and supply	15	Drought reduces potential yield to < maximum of the average annual utilisation in last 5 years (+20%), capped to annual licenced volume
T2	9	Drought impact on yield but licence limits supply impact	30	Drought impact on ability to meet either average or daily licence
T3	20	Uncertain severe drought risk or risk is for droughts >1 in 200-year severity	14	Extreme drought (1 in 500-year) impact on ability to achieve licenced abstraction
T4	-	-	21	Extreme drought reduction in potential yield

Table 4.2 Drought vulnerable tier 1 sources

Source	Aquifer	WRZ	Drought Plan 2027 Tier	Drought vulnerability tier comment
Risby	East Anglia Chalk	Bury Haverhill	1	No change. Risk to supply in drought
Welton	Lincolnshire Limestone	Central Lincs	1	No change. Risk to supply in drought
Candlesby	Spilsby Sandstone	East Lincs	1	Not previously considered drought vulnerable. Average demand drought yield of 1.6 M/d. DAPWL constraining this is set to be the top of the Spilsby Sandstone
Fordington	Spilsby Sandstone	East Lincs	1	Upgraded from T3. Drought yields revised in WRMP24 and limit ability to achieve annual and daily licence
Welton le Marsh	Spilsby Sandstone	East Lincs	1	Upgraded from T3. Drought yields revised in WRMP24 and limit ability to achieve annual and daily licence
Belstead	East Anglia Chalk	East Suffolk	1	No change. Risk to supply in drought
Westerfield	East Anglia Chalk	East Suffolk	1	No change. Risk to supply in drought
Southfields	East Anglia Chalk	Newmarket	1	No change. Risk to supply in drought
West Bradenham	East Anglia Chalk	Norfolk Rural North	1	Not previously considered drought vulnerable, but this is supported by the SRO diagram
Matlaske	East Anglia Chalk	North Norfolk Coast	1	Upgraded from T2. Drought yields limit ability to achieve annual and daily licence
North Walsham	East Anglia Chalk	North Norfolk Coast	1	No change. Risk to supply in drought
Sheringham (Bodham)	East Anglia Chalk	North Norfolk Coast	1	Not previously considered drought vulnerable. Risk to supply identified in WRMP24. Shared annual licence, however, drought yield is below recent utilisation
Wood Norton / Foulsham	East Anglia Chalk	North Norfolk Coast	1	Not previously considered drought vulnerable. Risk to supply identified in WRMP24, with the drought yield less than the annual licence
Birchmoor	Lower Greensand	RHF South	1	Upgraded from T2. Drought yields revised in WRMP24 and limit ability to achieve annual and daily licence
Marham	East Anglia Chalk	South Fenland	1	No change. Drought expected to impact ability to meet recent utilisation of the source

*All the drought vulnerable sources are listed in Table 4.5 at the end of this appendix.

4.4 Drought-related groundwater source licence conditions

In addition to the drought risk at groundwater sources arising from low groundwater levels impacting on the source yield, there are some sources with licences subject to dry weather or drought restrictions which may constrain the Deployable Output (DO).

These constraints on the DO are already accounted for in our WRMP24 planning and do not therefore require any specific drought management actions.

The sources where we have groundwater level related licence conditions for environmental reasons were reviewed and are included in **Table 4.3**. The groundwater monitoring sources specified in these restrictions are included in monthly monitoring reports that we receive from the Environment Agency.

An agreement also exists with the Environment Agency for Anglian Water groundwater sources in the Northern Lincolnshire Chalk, which results in abstraction licence reductions at times of low water levels to minimise risk of saline intrusion to the aquifer. The introduction of licence controls depends on the outcome of regional groundwater modelling as carried out by the Environment Agency towards the end of the recharge season.

Table 4.3 Groundwater sources with drought related licence conditions

Source	Licence restriction trigger	Impact on abstraction licence
Aslackby	Observation borehole (ref 3-901) Aslackby New Red Lion =<8 m AOD	Aslackby / Rippingale combined licence reduced to 18.1 Ml/d
Rippingale		
Pinchbeck (Jockey)		West Pinchbeck / Jockey combined abstraction reduces to 9 Ml/d
West Pinchbeck		
Haconby		Group licence reduction
Billingborough		
Raithby	Observation borehole (ref 7-071). Raithby = <28 m AOD for 6-months (consecutive). Manby / Grimoldby = <24.5 m AOD for 6-months	Reduce annual abstraction to 3,683 Ml/yr
Hubbards Hill		
Manby		Reduce annual abstraction to 925 Ml/yr
Grimoldby		
Billingborough	Cowgate Drain = <2 l/s for 3-months (consecutive)	Abstraction reduces to 200 Ml/yr
Bury St Edmunds	Lark flow < 91 l/s Lark flow between 91 l/s and 150 l/s Lark flow between 151 l/s and 200 l/s	No abstraction Reduce abstraction to 2 Ml/d Reduce abstraction to 4 Ml/d
Rushbrooke	Lark flow < 91 l/s Lark flow between 91 l/s and 150 l/s Lark flow between 151 l/s and 200 l/s	No abstraction Reduce abstraction to 2 Ml/d Reduce abstraction to 4 Ml/d
Congham	Springs flow at gauging station = <40 l/s	Licence reduction to 2.27 Ml/d
Costessey No. 2	Costessey Pits level < 5.6 m AOD	No abstraction
Costessey Pits		
East Watton	Observation boreholes <45 and 37 m AOD	Monthly abstraction licence reduction
Hope House	Abstraction borehole <5.82 m AOD	Abstraction from boreholes to cease
Hopper House	Abstraction borehole <17.95 m AOD	Abstraction from boreholes to cease
Tetney	Blowwells = <0.73 m AOD Boreholes = <1.95 m AOD	Abstraction from boreholes to cease
Waterloo	Abstraction borehole >52.13 m BOD	Abstraction from boreholes to cease
Branston Booths	Chloride in Albert's Hole observation borehole at TF061697 > 200 mg/l Chloride in Albert's Hole observation borehole at TF061697 > 400 mg/l	Abstraction reduces to 2273 m3/d Aggregate with Fosters Bridge reduces to 5500 m3/d
Fosters Bridge	Chloride in Albert's Hole observation borehole at TF061697 > 400 mg/l	Aggregate with Moors Farm reduces to 5500 m3/d
Kirkby La Thorpe	Chloride at Asgarby West observation borehole between 400 and 500 mg/l Chloride at Asgarby West observation borehole >500 mg/l	Abstraction limit reduces to 2 Ml/d No abstraction
Winterton Carrs and Winterton	Scabcroft observation borehole chloride > 400 mg/l	2250 m3/d limit
Winterton Holmes		3928 m3/d limit

4.5 Groundwater drought levels

Groundwater drought levels can provide an early and emerging trend of a drought's development. Furthermore, when coupled with forecasting methods can help indicate the potential severity of the drought and the likely interventions required to mitigate. The observation sources utilise a network of observation sources that are monitored by both Anglian Water and the Environment Agency. Using a network of observation sources allows us to get an understanding of aquifer health and groundwater resources across the Anglian Water region.

When selecting observation sources to inform operational decisions a key consideration is the representativeness of the data collected. The observation sources should be representative of the aquifer(s) being abstracted from and correlate well with our drought vulnerable sources. Length of record is an important consideration when selecting observation sources. Records which include observations during historic droughts can be useful to assess links between the historic drought levels and possible yield impacts at an abstraction source. A further consideration is the observation source levels should not be influenced by pumping. Since the Drought Plan 2022 the observation source network has increased to ensure each drought vulnerable source has a linked observation source and each aquifer unit abstracted from is monitored by at least one observation source. There are areas where aquifer units will be covered by more than one observation source to reflect local changes in hydrogeology. Following the new definition of drought tiers within this Plan the observation source network will be reviewed to ensure each drought vulnerable source has a linked observation source.

The aim of the observation source drought levels are to provide an indication of the potential onset of drought and link to mitigation measures, which may be required, to reduce the impact of the drought. The levels consider the seasonal variation experienced in groundwater levels, the lowest groundwater level recorded and where possible this is linked by theoretical or known impacts at abstraction sources. Groundwater droughts in East Anglia are often preceded by at least one or possibly two dry winters. However, building on the review of Drought Plan 2022 and the events experienced in 2022 and 2025 it is understood that it is possible for a rapid recession of groundwater levels in spring and summer, leading to a possible loss in yield at drought vulnerable sources.

The observation source drought levels methodology allows for differences in aquifer characteristics and the variable response of individual observation sources. The method is agile to allow for rapid realignment of drought levels as known impacts become apparent and can be attributed to groundwater drought, or where theoretical assessment of yield, such as UKWIR yield diagram updates, are reassessed and a positive correlation between groundwater levels in the observation source and abstraction source can be established.

The methodology involves identifying the monthly Long-Term Average (LTA) groundwater level for the observation source using the whole record up to the end of 2024. The whole record is considered the most suitable LTA calculation due to length of monitoring record and frequency of data collection across many of the observation sources. The three drought levels are then calculated and adjusted to historic droughts;

- **Level 1:** 35%* below the LTA monthly level.
- **Level 2:** 70%* below the LTA monthly level.
- **Level 3:** Historic minimum for the observation source**.

**The % below the LTA can be adjusted for specific observation sources where there is a strong link between observation source levels and known yield impacts at PWS sources.*

*** Where a historic dip in the observed record seems erroneous for conservatism the next lowest rank level is utilised.*

For observation sources with a short record which do not include a drought period these have not been assigned levels. However, the observation source will still be monitored to help build up a record to allow future drought level development. Below is the sequence of observation sources linked to tier one drought vulnerable sources and their calibration to select the drought level placement against historic droughts.

Due to the connectivity of WRZs there are zones abstracting multiple sources of raw water from different parts of the aquifer and in some cases mixed between surface water and groundwater. The different sources of raw water have differing responses to drought and yield impacts. Therefore, it can be difficult to definitively attribute drought level actions to a specific observation source level. For this reason, a drought level 4 curve has not been added to the observation sources and the drought levels that are assigned are indicative and act as a guideline for when associated drought actions may be required which are more appropriately linked to yield impacts as operational data becomes available.

The full suite of drought levels and associated appropriate actions that are required in each WRZ will be determined by taking into account the status of all sources, any operational pressures acting in the area and the indicators included in the drought framework (**Table 2.2, Main Plan**). To support the groundwater drought levels a decision support matrix indicating qualitative criteria has been developed alongside the drought levels (Table 4.4).

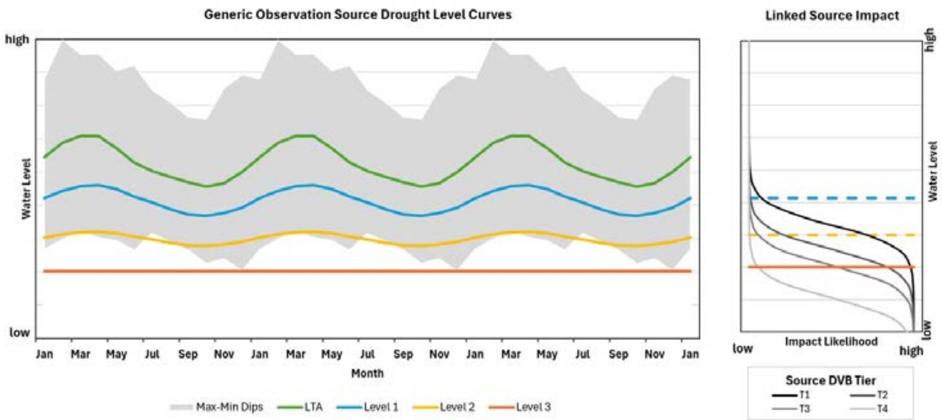
Table 4.4 Drought level decision support matrix

Primary criteria	Secondary criteria	Drought level consideration
• Drought Level 1 exceeded for 3 consecutive months • Conjunctive sources or neighbouring aquifer units showing the same trends	• Outside or towards end of recharge period • Forecast suggests groundwater levels will continue falling • Some possible minor operational impacts	Consider moving WRZ to drought level 1 status
• Drought Level 2 exceeded for 3 consecutive months • Conjunctive sources or neighbouring aquifer units showing the same trends	• Outside or towards end of recharge period • Forecast suggests groundwater levels will continue falling • Operational sources approaching DAPWLs with, probable minor operational impacts	Consider moving WRZ to drought level 2 status
• Drought Level 3 exceeded for 3 consecutive months. • Conjunctive sources or neighbouring aquifer units showing the same trends	• Outside or towards end of recharge period • Groundwater levels forecast to continue to fall • Operational impacts likely	Consider moving WRZ to drought level 3 status

4.6 Groundwater drought levels scenario testing

Conceptually as a drought progresses and becomes more severe, we would expect the likelihood of yield impacts to tier 1 drought vulnerable sources to increase. As the drought progresses and becomes more severe the likelihood of impacts to the lower tier drought vulnerable abstraction sources also increases. Figure 4.5 helps to represent this theoretical risk position relative to the groundwater drought levels. However, given the large variation in droughts experienced, length of observation source records and data of specific impacts which can be solely attributed to drought is often hard to verify.

Figure 4.5 Conceptual figure of probability of yield impact at drought vulnerable sources as drought progress through the level curves



For the Drought Plan scenario testing each observation source has been assessed against the full historic observed record to ensure the levels capture historic droughts including various examples of short, medium and long term events. For East Anglia the most notable long duration droughts are during 1976-78 and 1989-1993 with short duration droughts experienced in 2011-2012. The scenario testing is applied to all the observation sources to assess the appropriate placement of Levels 1 and 2 with respect to the historic observed data. The levels are further validated against drought actions taken at the time, ensuring they align with the new drought framework and any known yield impacts at linked groundwater abstraction sources.

[Figure 4.6](#) is an example of the drought levels plotted against the observed water level for the full historic record of Environment Agency source TL89-019 in the North West Norfolk Wisey Chalk. [Figure 4.7](#) is an example of higher temporal resolution during specific observed droughts in the historic record, which is used to help select the drought levels.

Figure 4.6 Observed water levels across the full historic record

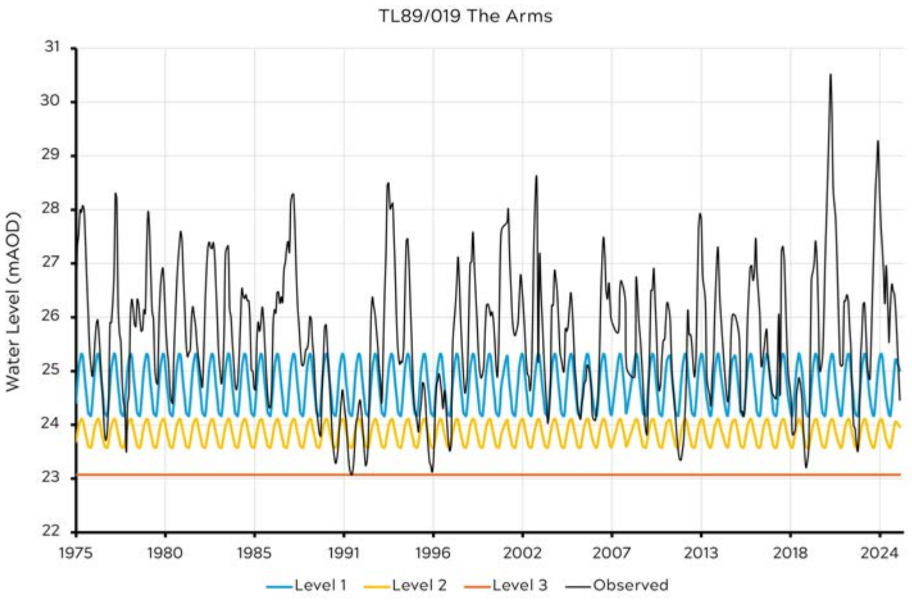
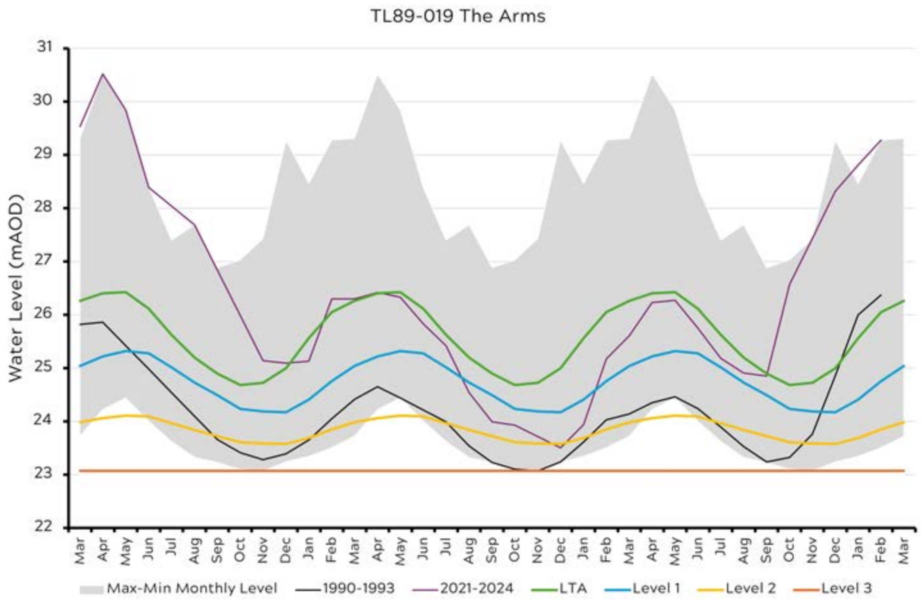


Figure 4.7 Observed groundwater levels during 1992 drought and 2011



Further scenario testing has been undertaken to compare long duration droughts, where they exist in the observed observation record, and short duration high intensity droughts. The figures below demonstrate how the groundwater drought levels may be used in conjunction with the decision support matrix, operational knowledge and forecast information. [Figure 4.8](#) is tested against a long duration drought scenario and [Figure 4.9](#) against a short duration drought.

Figure 4.8 Long duration drought scenario

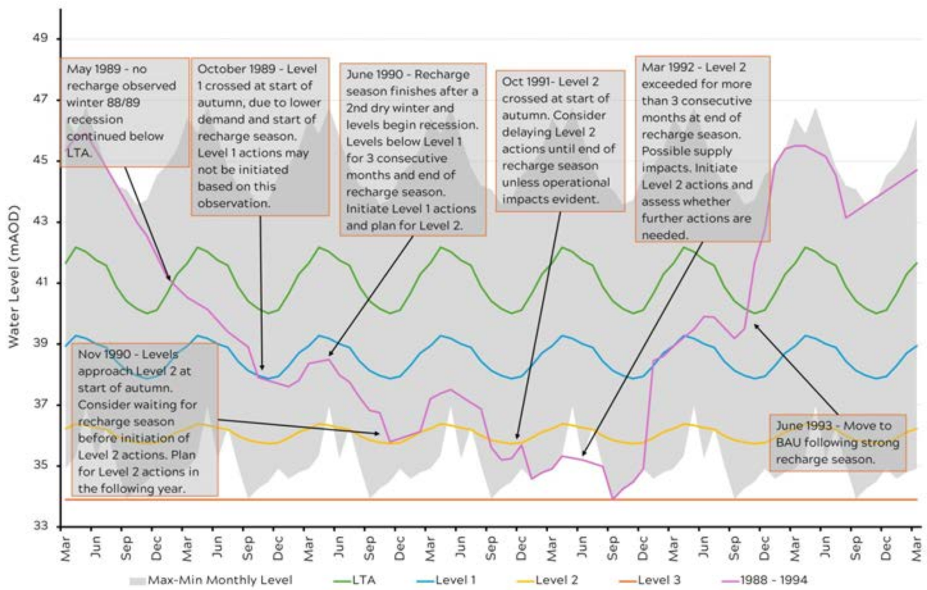
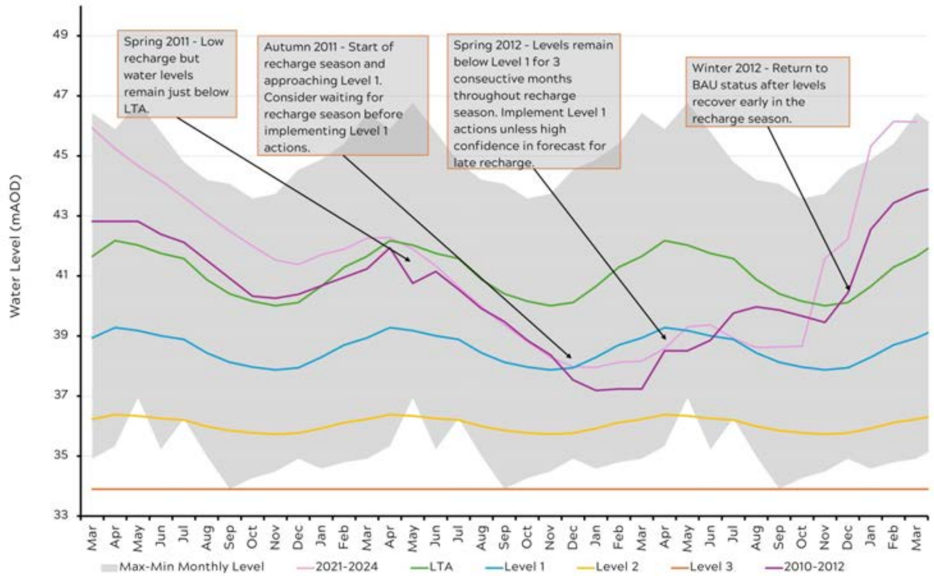


Figure 4.9 Short duration drought scenario



As mentioned in **Section 2.3**, the **WRMP24 Supply Forecast Report** includes the testing that has been completed to ensure full system resilience against the full range of return periods and types of drought including 1 in 500-year events.

We will continually review the use of these groundwater levels to ensure that they are indicative of drought actions being taken in the future. The drought levels for a selection of the key Environment Agency observation boreholes are plotted against observed historic groundwater levels in the following figures.

Figure 4.10 TL76/110 linked to Risby DVB

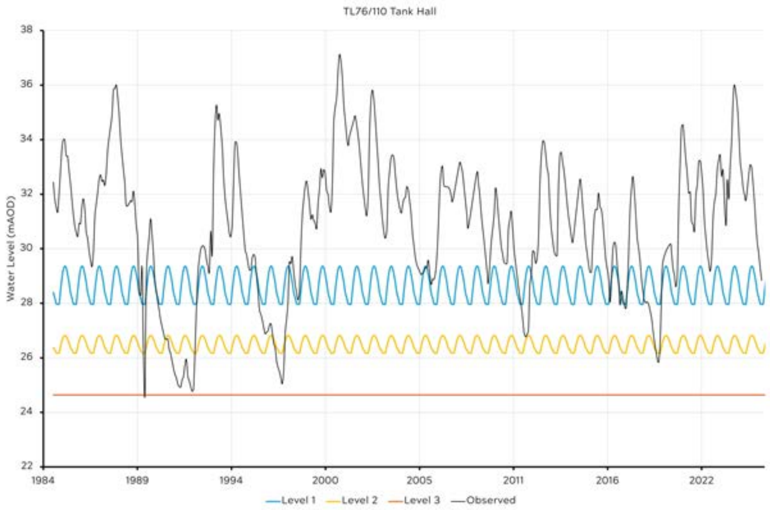


Figure 4.11 TL76/110 historic drought calibration

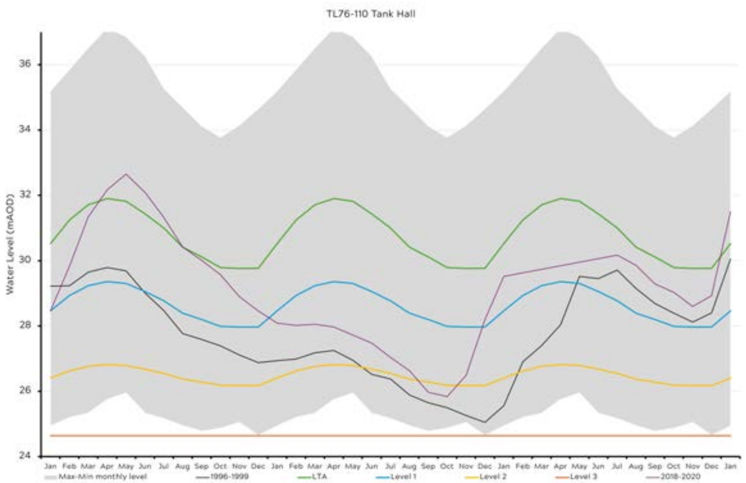


Figure 4.12 1-610 linked to Welton DVB

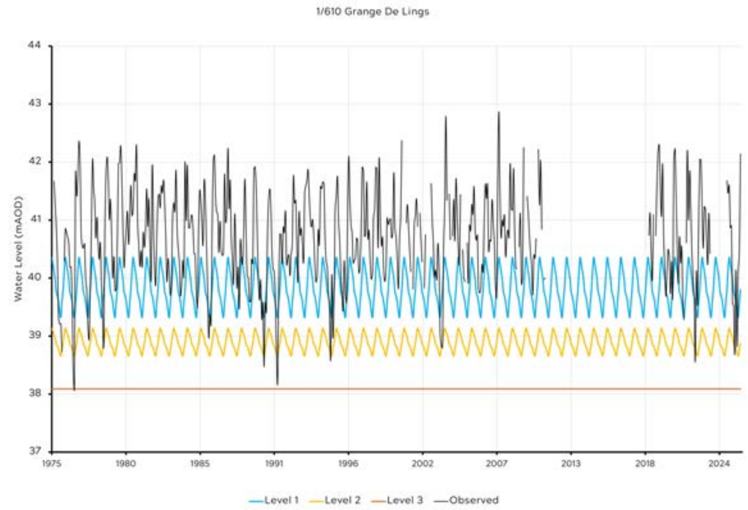


Figure 4.13 1/610 historic drought calibration

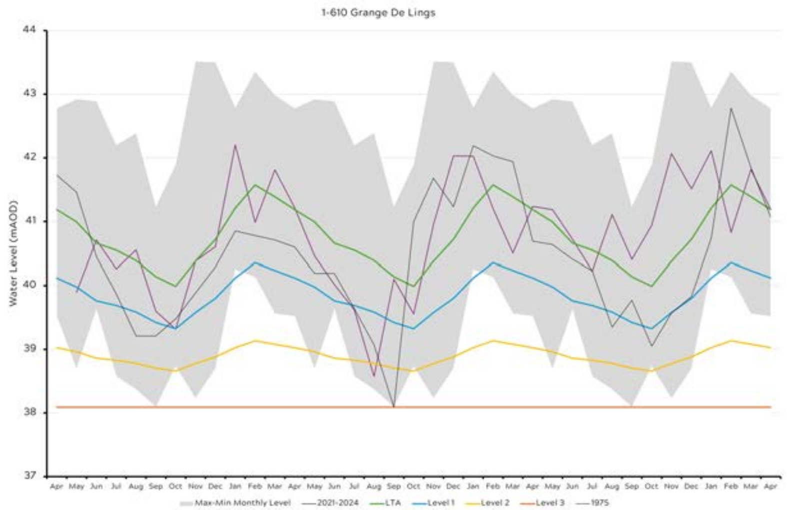


Figure 4.14 7-071 linked to Candelsby, Welton Le Marsh and Fordington

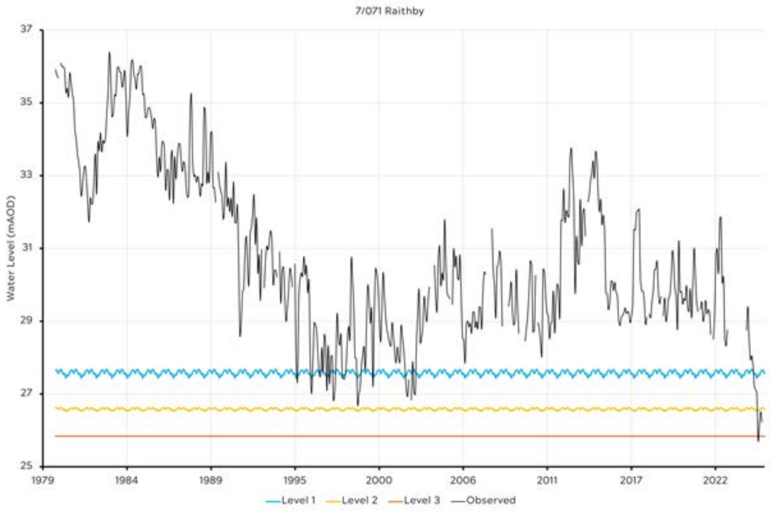


Figure 4.16 7-121 linked to Candelsby, Welton Le Marsh and Fordington

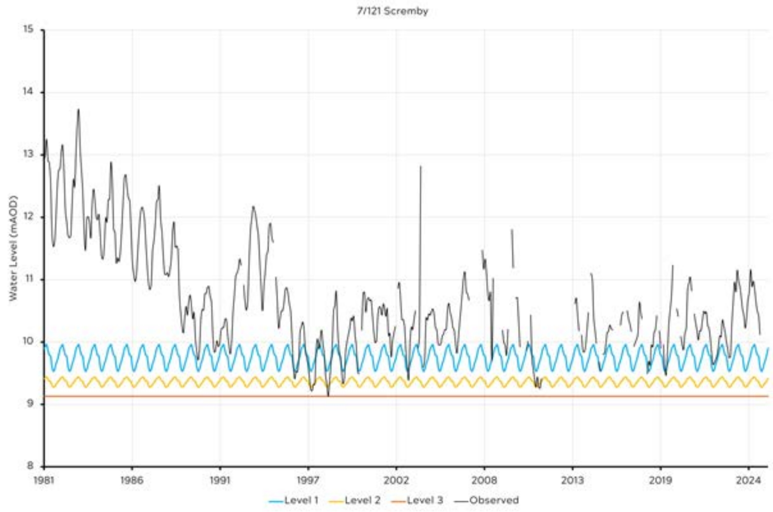


Figure 4.15 7/071 historic drought calibration

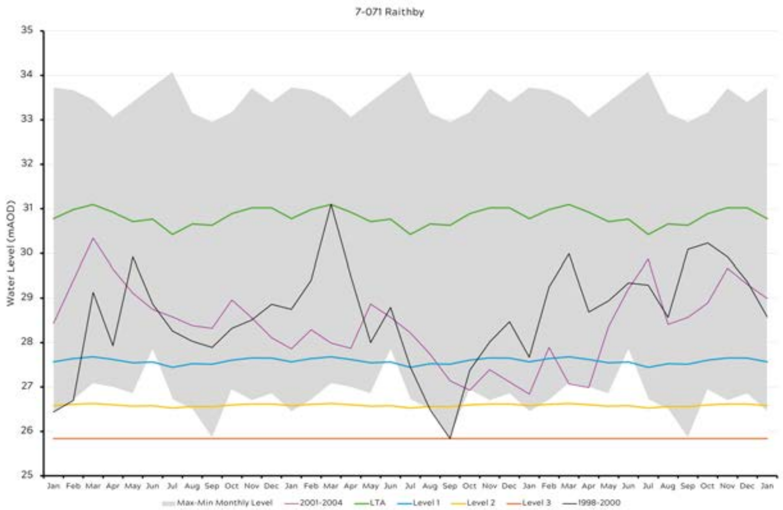


Figure 4.17 7/121 historic drought calibration

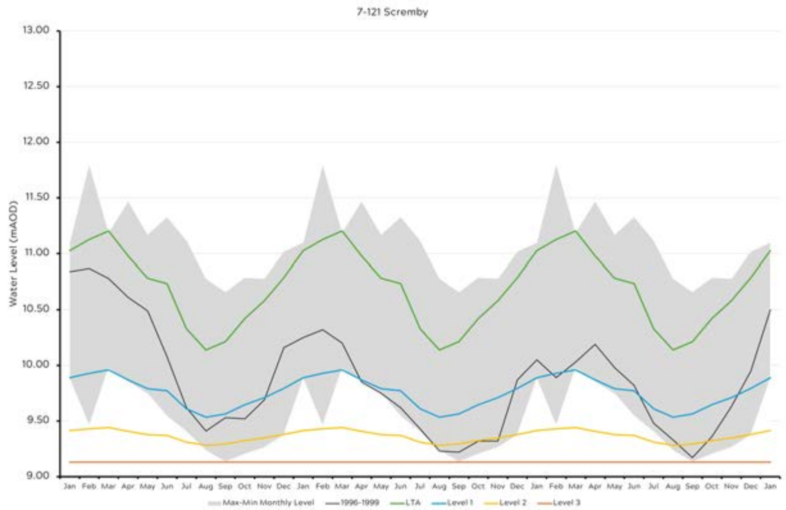


Figure 4.18 TM04/695 linked to Belstead and Westerfield

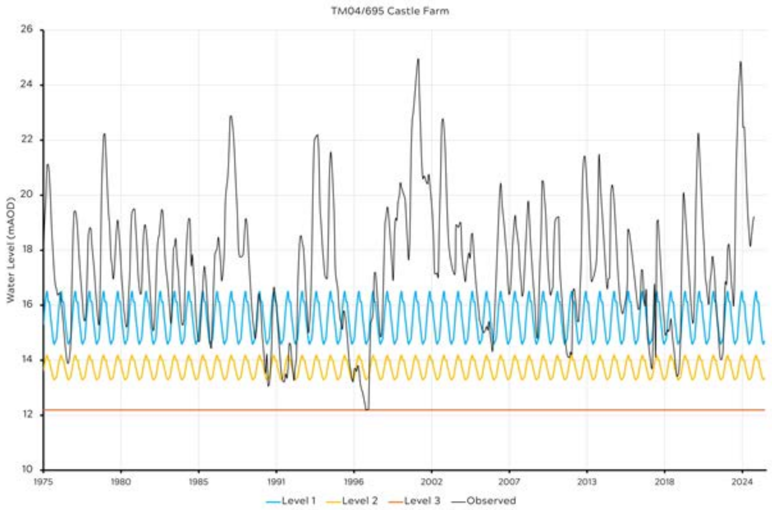


Figure 4.19 TM04/695 historic drought calibration

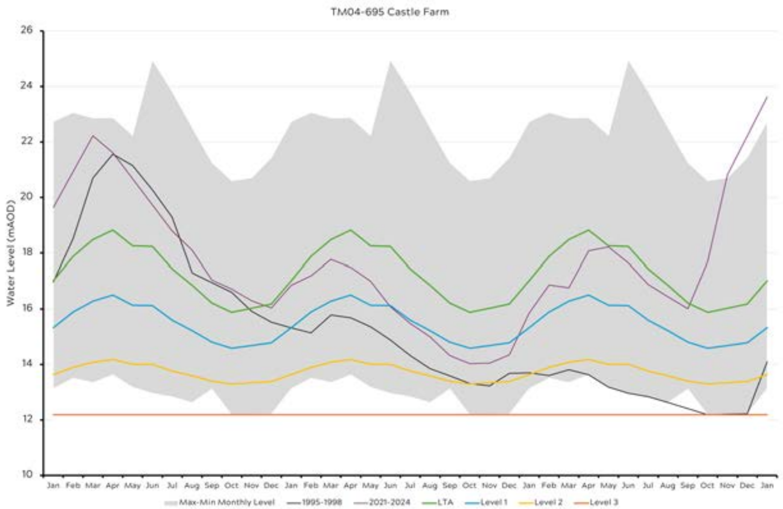


Figure 4.20 TL66/094 linked to Southfields

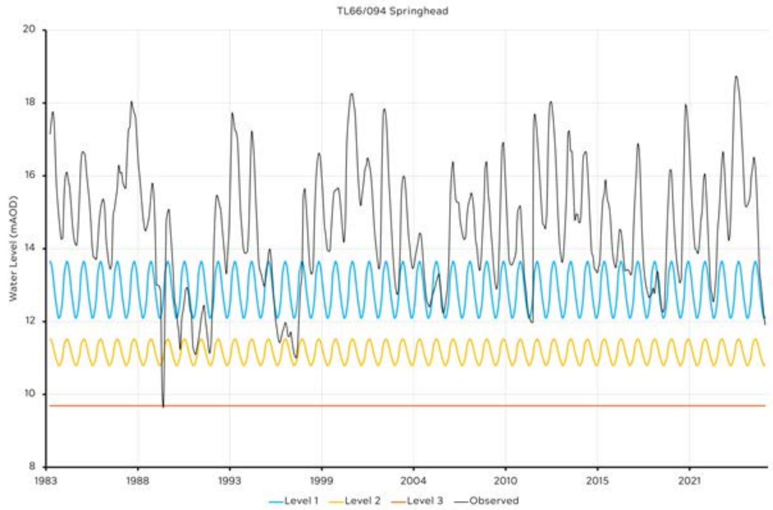


Figure 4.21 TL66/094 historic drought calibration

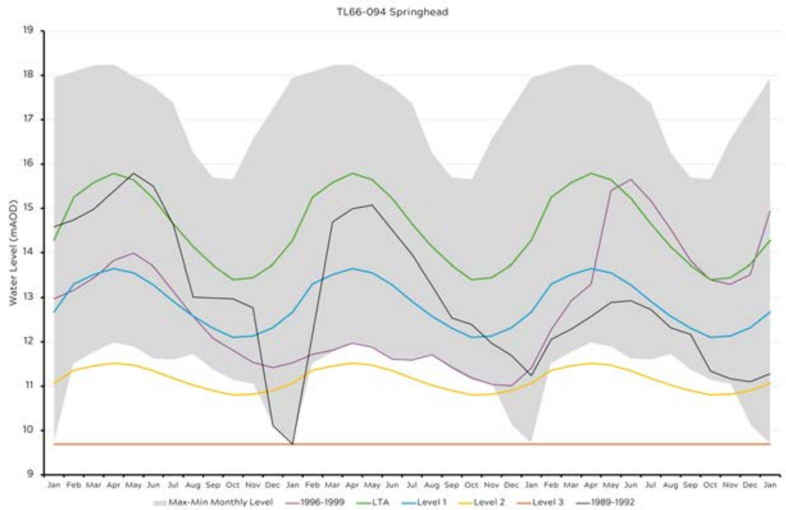


Figure 4.22 TF90/001 linked to West Bradenham

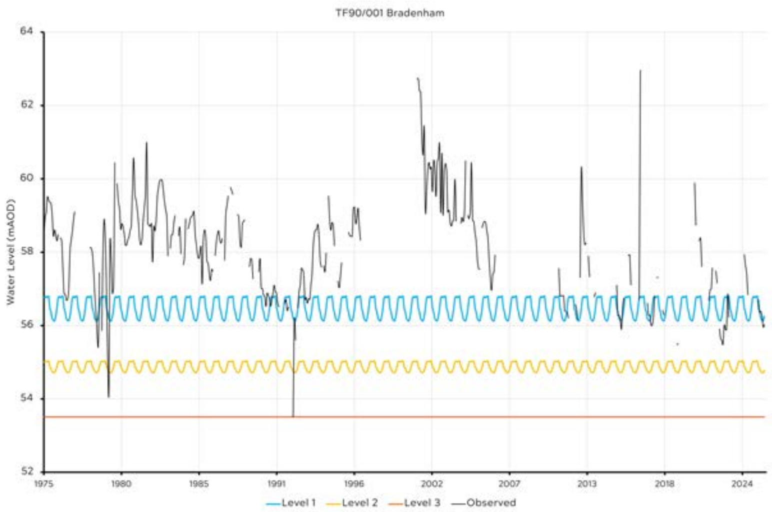


Figure 4.24 TG13/765A linked to Matlaske, Metton and North Walsham

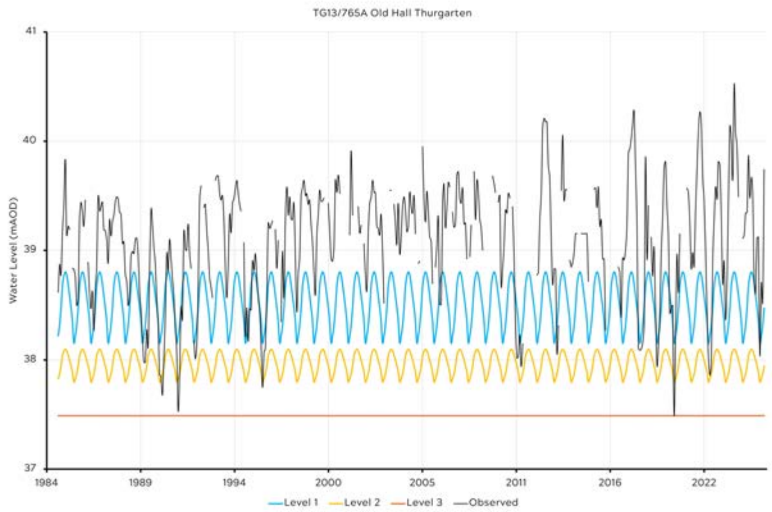


Figure 4.23 TF90/001 historic drought calibration

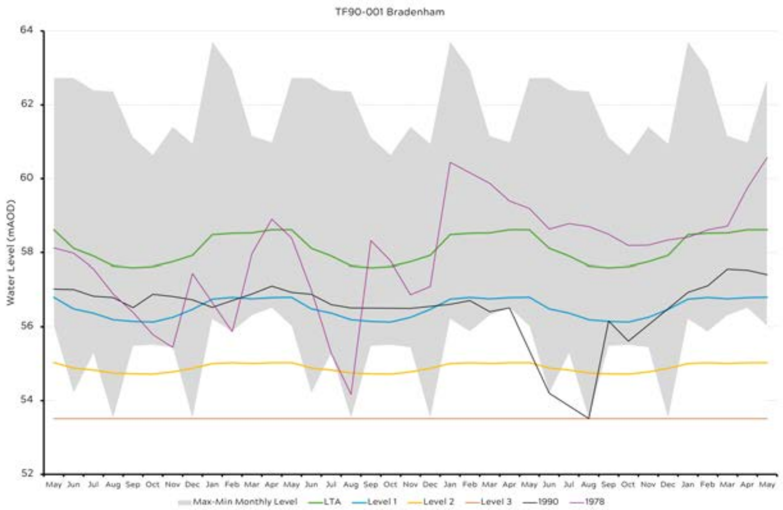


Figure 4.25 TG13/765A historic drought calibration

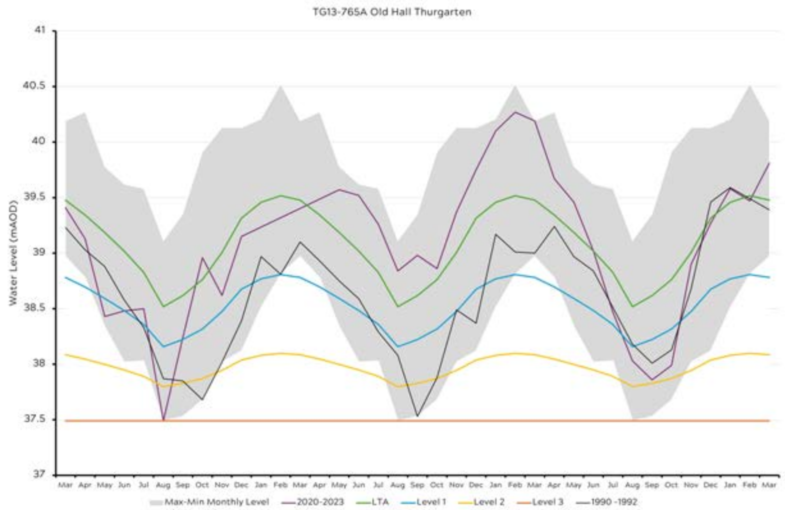


Figure 4.26 TG14/410 Upper Sheringham - Bodham

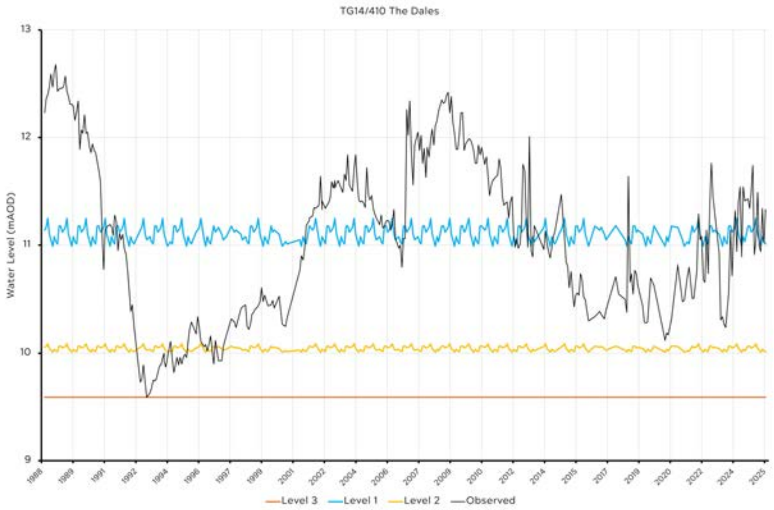


Figure 4.27 TG14/410 historic drought calibration

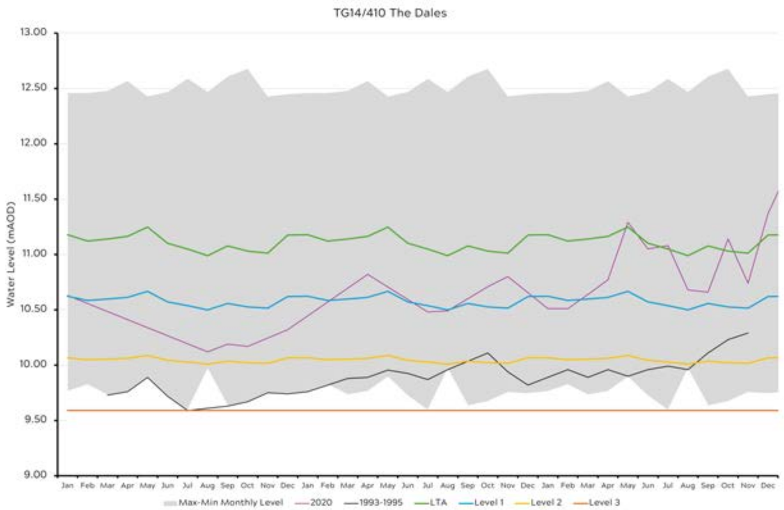


Figure 4.28 TG02/494 linked to Matlaske, Metton, North Walsham & Foulsham

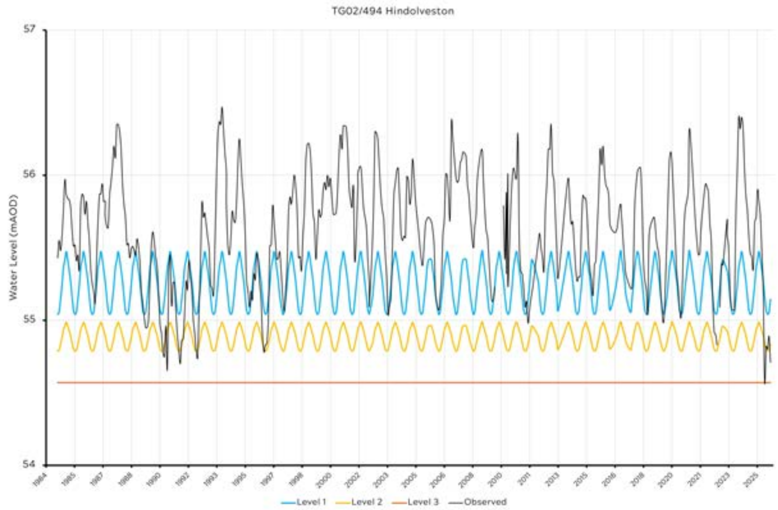


Figure 4.29 TG02/494 historic drought calibration

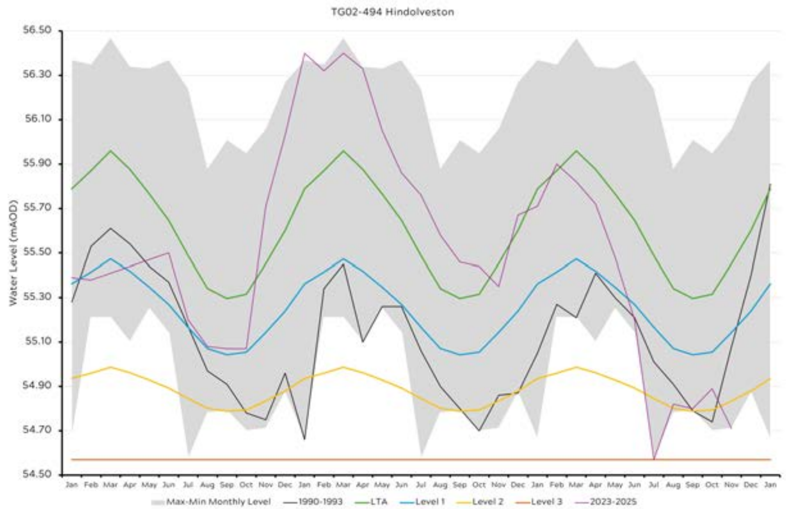


Figure 4.30 TL14/001 linked to Birchmoor

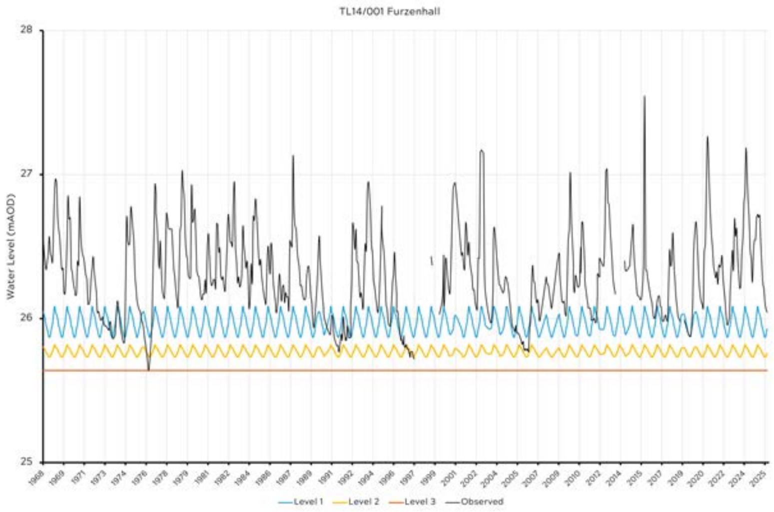


Figure 4.31 TL14/001 historic drought calibration

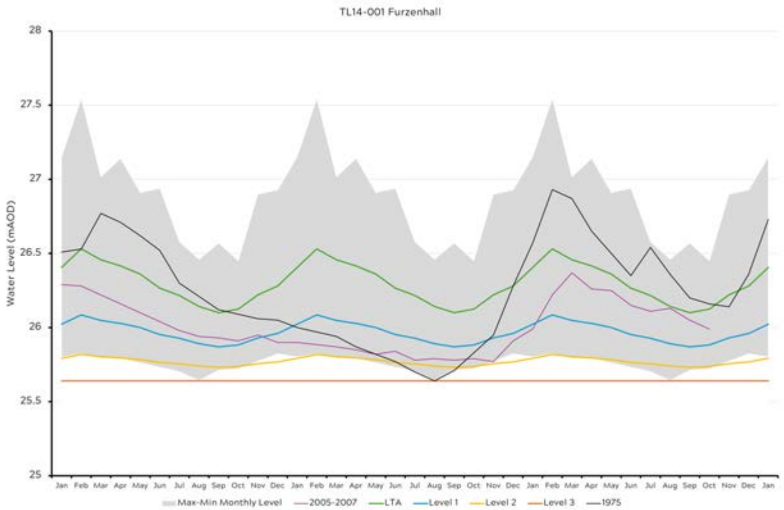


Figure 4.32 TL03/168 linked to Birchmoor

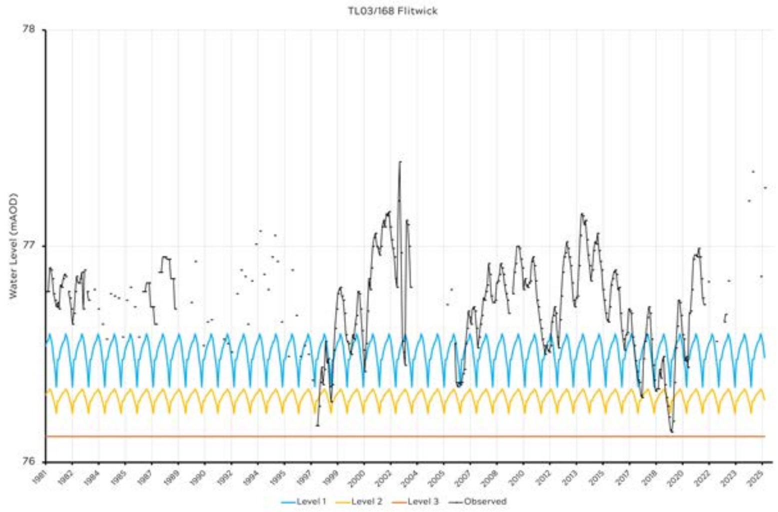


Figure 4.33 TL03/168 historic drought calibration

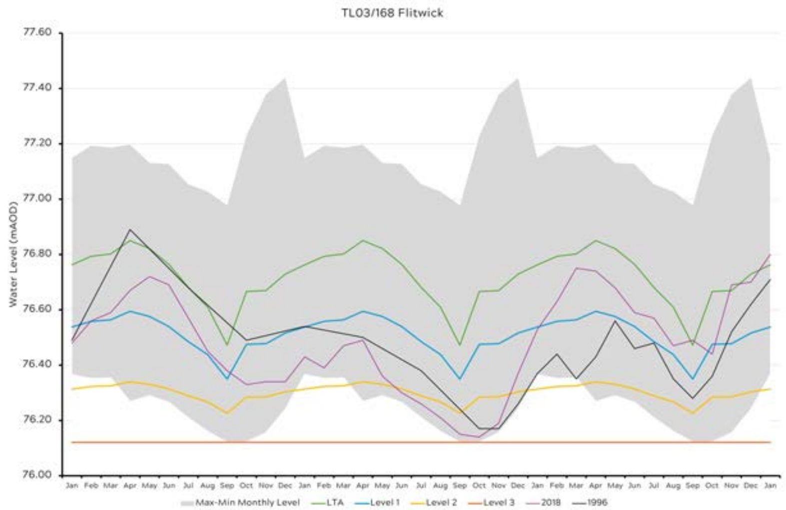


Figure 4.34 TF70/034 linked to Marham and Beachamwell

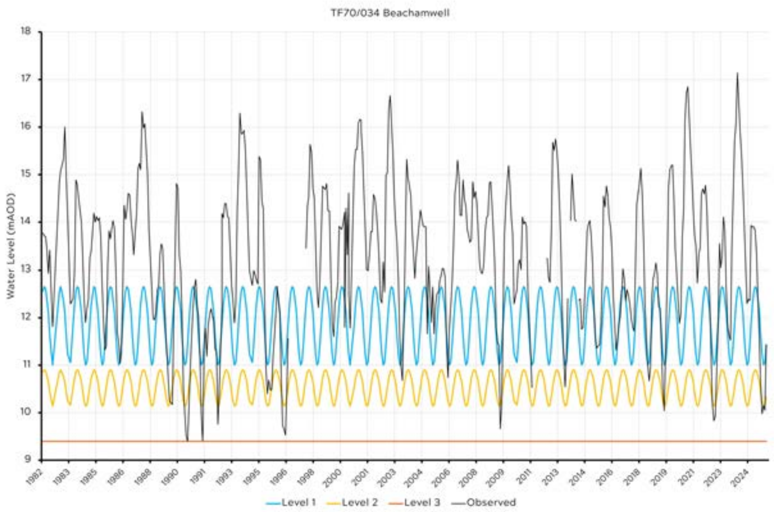


Figure 4.36 TF81/010 linked to Marham

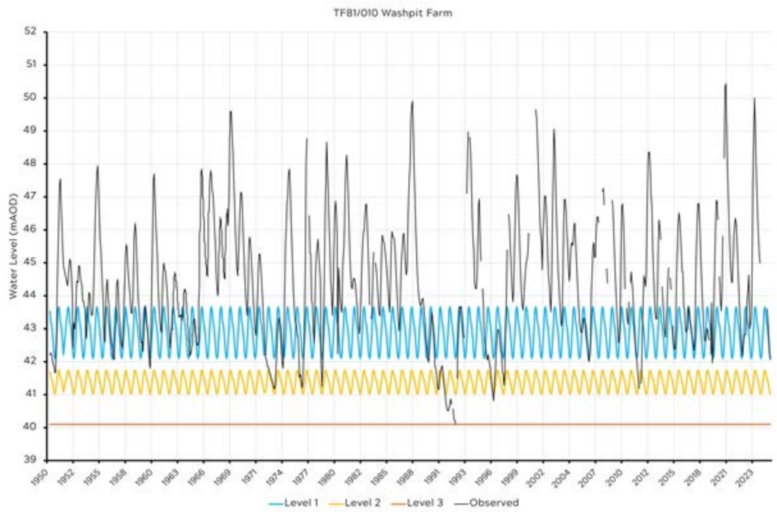


Figure 4.35 TF70/034 historic drought calibration

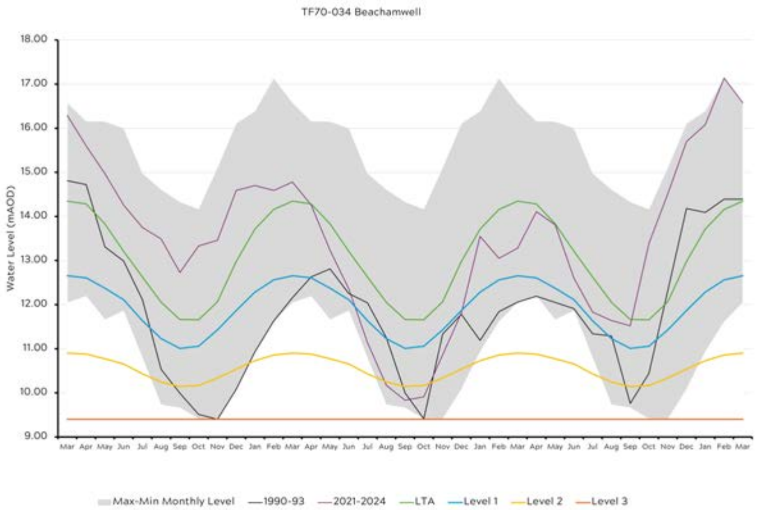


Figure 4.37 TF81/010 historic drought calibration

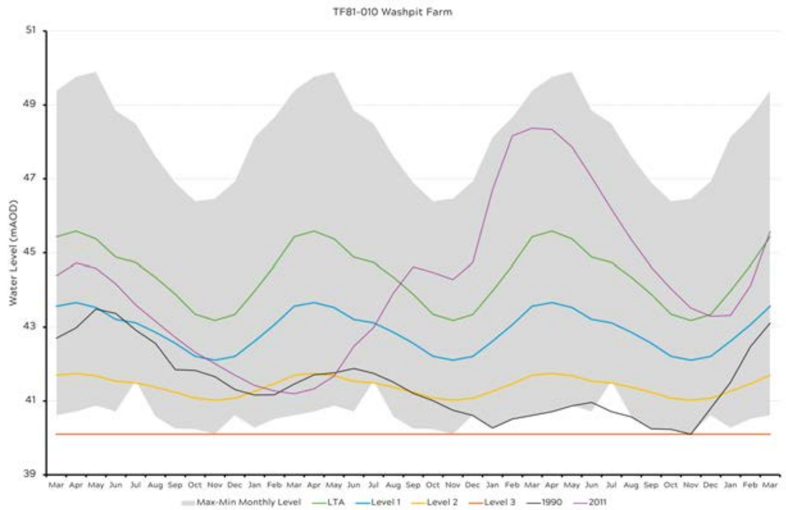


Figure 4.38 TL89/019 linked to Wellington Wellfield

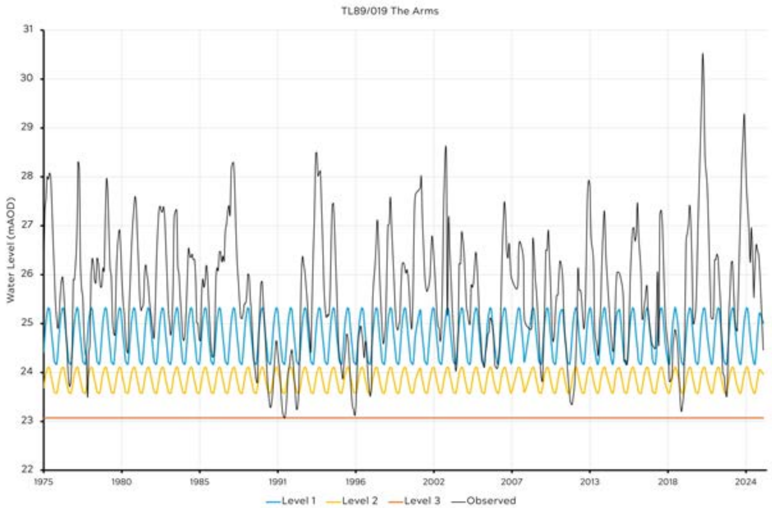


Figure 4.39 TL89/019 historic drought calibration

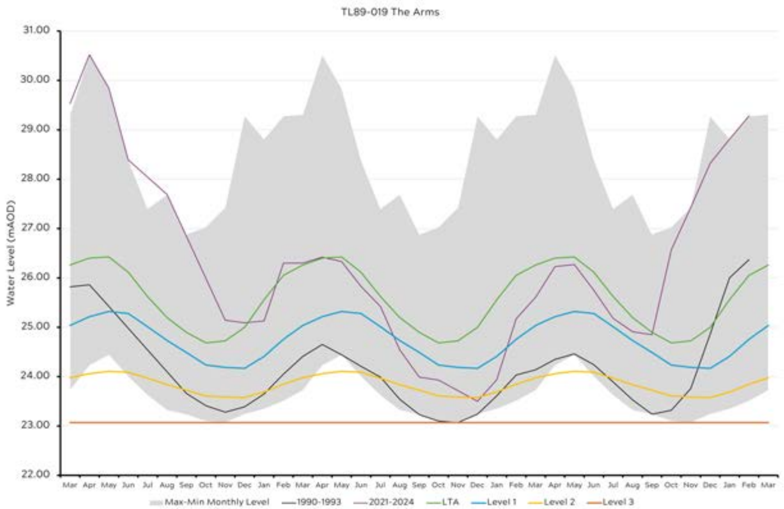


Table 4.5 Drought vulnerable sources

Source	Aquifer	WRZ	Drought Plan 2027 Tier	Drought vulnerability tier comment
Risby	East Anglia Chalk	Bury Haverhill	1	No change. Risk to supply in drought.
Welton	Lincolnshire Limestone	Central Lincs	1	No change. Risk to supply in drought.
Candlesby	Spilsby Sandstone	East Lincs	1	Not previously considered drought vulnerable. Average demand drought yield of 1.6 M/d. DAPWL constraining this is set to be the top of the Spilsby Sandstone.
Fordington	Spilsby Sandstone	East Lincs	1	Upgraded from T3. Drought yields revised in WRMP24 and limit ability to achieve annual and daily licence.
Welton le Marsh	Spilsby Sandstone	East Lincs	1	upgraded from T3. Drought yields revised in WRMP24 and limit ability to achieve annual and daily licence.
Belstead	East Anglia Chalk	East Suffolk	1	No change. Risk to supply in drought.
Westerfield	East Anglia Chalk	East Suffolk	1	No change. Risk to supply in drought.
Southfields	East Anglia Chalk	Newmarket	1	No change. Risk to supply in drought.
West Bradenham	East Anglia Chalk	Norfolk Rural North	1	Not previously considered drought vulnerable, but this is supported by the SRO diagram.
Matlaske	East Anglia Chalk	North Norfolk Coast	1	upgraded from T2. Drought yields limit ability to achieve annual and daily licence.
North Walsham	East Anglia Chalk	North Norfolk Coast	1	No change. Risk to supply in drought.
Sheringham (Bodham)	East Anglia Chalk	North Norfolk Coast	1	Not previously considered drought vulnerable. Risk to supply identified in WRMP24. Shared annual licence, however, drought yield is below recent utilisation.
Wood Norton / Foulsham	East Anglia Chalk	North Norfolk Coast	1	Not previously considered drought vulnerable. Risk to supply identified in WRMP24, with the drought yield less than the annual licence.
Birchmoor	Lower Greensand	RHF South	1	upgraded from T2. Drought yields revised in WRMP24 and limit ability to achieve annual and daily licence.
Marham	East Anglia Chalk	South Fenland	1	No change. Drought expected to impact ability to meet recent utilisation of the source.
Goxhill 2	East Anglia Chalk	Central Lincs	2	Previously T1. Drought may impact ability to meet daily licenced quantity only.
Grove	Sherwood Sandstone	Central Lincs	2	Not previously drought vulnerable. Inability to meet daily licence in drought.
Ulceby	Lincs Chalk	Central Lincs	2	Upgraded from T3. Drought expected to limit ability to meet daily licence.
Waddingham	Lincolnshire Limestone	Central Lincs	2	Upgraded from T3 due to lower drought potential yield identified in WRMP24. Drought impact on ability daily licence only.
Winterton Holmes	Lincolnshire Limestone	Central Lincs	2	Previously T1. Drought expected to impact ability to fully abstract licenced quantity, but downgraded to T2 based on no expected impact relative to current utilisation of the source.
Waneham Bridge (Dunston)	Lincolnshire Limestone	Central Lincs	2	No change. Drought impact on ability to meet daily licence only.
Winterton Carrs	Lincolnshire Limestone	Central Lincs	2	Upgraded from T3 due to lower drought potential yield identified in WRMP24. Drought impact on ability to meet both annual and daily licence, but not T1 due to current utilisation.
Lower Links	East Anglia Chalk	Cheveley	2	Previously T1. Drought expected to impact ability to meet daily licenced quantity only.
Driby	Spilsby Sandstone	East Lincs	2	Not previously drought vulnerable. Inability to meet daily licence in drought.
Little London	Lincs Chalk	East Lincs	2	Not previously drought vulnerable. Inability to meet daily licence in drought.
Raithby	Spilsby Sandstone	East Lincs	2	Not previously drought vulnerable. Inability to meet annual and daily licence in drought, but not T1 due to current utilisation.
Whitton	East Anglia Chalk	East Suffolk	2	Previously T1. Drought expected to impact ability to fully abstract annual licenced quantity but downgraded to T2 based on no expected impact relative to current utilisation of the source. Group licence condition means that full utilisation of the source is unlikely.
Eriswell 1	East Anglia Chalk	Ely	2	No change. Drought impact on ability to meet both annual and daily licence. Not T1 due to current utilisation.
Red barns	Magnesian Limestone	Hartlepool	2	Not previously drought vulnerable. Inability to meet annual licence in drought, but not T1 due to current utilisation.

Source	Aquifer	WRZ	Drought Plan 2027 Tier	Drought vulnerability tier comment
Long Hill	East Anglia Chalk	Newmarket	2	Previously T1. Drought may impact ability to meet daily licenced quantity only.
Moulton	East Anglia Chalk	Newmarket	2	Previously T1. Drought may impact ability to meet daily licenced quantity only.
Newmarket AR	East Anglia Chalk	Newmarket	2	Previously T1. Drought expected to impact ability to fully abstract licenced quantity, but downgraded to T2 based on no expected impact relative to current utilisation of the source.
Didlington	East Anglia Chalk	Norfolk Rural North	2	No change. Drought impact on ability to meet both annual and daily licence. Not T1 due to current utilisation.
Rushall	East Anglia Chalk	Norfolk Rural South	2	Not previously drought vulnerable. Inability to meet annual and daily licence in drought, but not T1 due to current utilisation.
Square Plantation	East Anglia Chalk	Norfolk Rural South	2	Not previously drought vulnerable. Inability to meet daily licence in drought.
Gayton	East Anglia Chalk	North Fenland	2	Previously T1. Drought expected to impact ability to fully abstract licenced quantity, but downgraded to T2 based on no expected impact relative to current utilisation of the source.
Hillington Patch	Sandringham Sands	North Fenland	2	Not previously drought vulnerable. Loss of output relative to annual available abstraction and daily licence expected in drought.
Sedgeford	East Anglia Chalk	North Fenland	2	No change. Drought impact on ability to meet daily licence only.
Metton	East Anglia Chalk	North Norfolk Coast	2	Previously T1. Drought may impact ability to meet daily licenced quantity only.
Marlingford	East Anglia Chalk	Norwich and the Broads	2	Not previously drought vulnerable. Reduced drought potential yield identified in WRMP24. Impacts ability to meet annual and daily licences, but not T1 due to current utilisation.
Sparham Hill	East Anglia Chalk	Norwich and the Broads	2	Not previously drought vulnerable. 0.1 Ml/d loss against daily licence in drought.
Thorpe St Andrew	East Anglia Chalk	Norwich and the Broads	2	Not previously drought vulnerable. Inability to meet annual and daily licence in drought, but not T1 due to current utilisation.
Gainsborough LR	Sherwood Sandstone	Nottinghamshire	2	Not previously drought vulnerable. Inability to meet annual and potentially daily licence in drought, but not T1 due to current utilisation.
Newspring	Lower Greensand	RHF South	2	Not previously drought vulnerable. Inability to meet daily licence in drought.
Great Bardfield	East Anglia Chalk	South Essex	2	Not previously drought vulnerable. Inability to meet annual and daily licence in drought, but not T1 due to current utilisation.
Etton	Lincolnshire Limestone	Bourne	3	No change. Severe drought yield < annual licence.
Pilsgate	Lincolnshire Limestone	Bourne	3	No change. Severe drought yield < annual licence.
Wilsthorpe	Lincolnshire Limestone	Bourne	3	No change. Severe drought yield < annual licence.
Barrow	Lincs Chalk	Central Lincs	3	No change. Severe drought yield < annual licence.
Winterton Carrs	Lincolnshire Limestone	Central Lincs	3	No change. Severe drought yield < annual licence.
Tetney	Lincs Chalk	East Lincs	3	Yield is 0 in 1 in 500-year drought in WRMP24.
Isleham	East Anglia Chalk	Ely	3	Previously T2, but no impact expected on ability to meet annual or daily licence in drought. Severe drought impact only.
Hope House	Magnesian Limestone	Hartlepool	3	Not previously considered drought vulnerable, but severe drought impact on yield identified in WRMP24. Severe drought yield is < annual licence.
Hopper House	Magnesian Limestone	Hartlepool	3	Not previously considered drought vulnerable but severe drought impact on yield identified in WRMP24. Severe drought yield is < annual licence.
Hillington (Chalk)	East Anglia Chalk	North Fenland	3	Previously T2, but no impact expected on ability to meet annual or daily licence in drought. Severe drought impact only.
Congham	Esat Anglia Chalk	North Fenland	3	Previously T1. Yield reduces below annual licence in severe drought due to water quality limitation. Drought related licence condition reduces daily abstraction to annual average.

Source	Aquifer	WRZ	Drought Plan 2027 Tier	Drought vulnerability tier comment
Battlesden	Lower Greensand	RHF South	3	No change. Severe drought yield < annual licence.
Pulloxhill	Lower Greensand	RHF South	3	No change. Severe drought yield < annual licence.
Sleaford DL	Lincolnshire Limestone	South Lincs	3	No change. Drought yield >10 Ml/d (annual licence 11.4 Ml/d). Projection on UKWIR diagram suggests no impact. Severe drought impact on ability to meet annual licenced volume.
Bourne	Lincolnshire Limestone	Bourne	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Northborough	Lincolnshire Limestone	Bourne	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Tallington	Lincolnshire Limestone	Bourne	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Fosters Bridge- Moors Farm	Lincolnshire Limestone	Central Lincs	4	Previously T3. Severe drought reduction to yield but not expected to be realised due to licence constraint.
Spridlington	Lincolnshire Limestone	Central Lincs	4	Previously T3. Severe drought reduction to yield but not expected to be realised due to licence constraint.
Branston Booths	Lincolnshire Limestone	Central Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Glentham	Lincolnshire Limestone	Central Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Hibaldstow Bridge	Lincolnshire Limestone	Central Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Barnoldby	Chalk	East Lincs	4	Previously T3. Severe drought reduction to yield but not expected to be realised due to licence constraint.
Aslackby	Lincolnshire Limestone	East Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Haconby	Lincolnshire Limestone	East Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Pinchbeck (Jockey)	Lincolnshire Limestone	East Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Rippingale	Lincolnshire Limestone	East Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
West Pinchbeck	Lincolnshire Limestone	East Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Playford	Chalk	East Suffolk	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Fring - Osier Carr	Chalk	North Fenland	4	Previously T3. Severe drought reduction to yield but not expected to be realised due to licence constraint.
Aswarby	Lincolnshire Limestone	South Lincs	4	Previously T3. Severe drought reduction to yield but not expected to be realised due to licence constraint.
Billingborough	Lincolnshire Limestone	South Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Kirkby La Thorpe	Lincolnshire Limestone	South Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Kirkby La Thorpe (Bones Farm)	Lincolnshire Limestone	South Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.
Swaton	Lincolnshire Limestone	South Lincs	4	Severe drought reduction to yield but not expected to be realised due to licence constraint.

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