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# Abstraction Incentive Mechanism

## Methodology and Abstraction in 2017-2018

August 2018

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# Asset Management document control sheet

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# Executive Summary

The Abstraction Incentive Mechanism (AIM) has been proposed by Ofwat with the objective to encourage water companies to reduce the environmental impact of abstracting water at environmentally sensitive sites during low flow periods (i.e. droughts). The purpose of this document is to set out the methodology and assumptions used to calculate the AIM triggers and baseline abstraction values. Actual abstraction data from the AIM sources for the financial year 2017-18 are shown in this report, in order to track performance and validate the AIM triggers selected.

A total of 23 groundwater sources have been identified as sensitive by Affinity Water, some of which will have sustainability reductions implemented in AMP6 and AMP7. The remaining ten sources have an operating agreement, other licence condition or are currently under National Environment Programme investigation. The AIM taskforce guidelines as proposed by Ofwat were followed to calculate the triggers and abstraction baseline figures. The AIM triggers selected were based on the Environment Agency's Restoring Sustainable Abstraction assessments, NEP investigations or other Environmental Impact Assessment work. Where current investigations were in place, the preferred trigger points on river flows were adopted, based on Environmental Flow Indicators in consultation with the Environment Agency. In the absence of these, Q95 flows were adopted as best indication of low flow conditions for the AIM triggers. Baseline abstraction values were calculated based on the 20-year period of 1st April 1995 - 31st March 2015 as this period is considered representative enough to include a number of droughts with and without demand restrictions.

The 23 sites selected under AIM were submitted to Ofwat in September 2015. Since then a number of sources have had sustainability reductions implemented. It was initially proposed to assess these sources for AIM until the timing of the reduction however there may be merit in continuing to operate AIM, where the deployable output has not been reduced to 0 Ml/d, to mitigate any residual abstraction impact. Also, for sources that have augmentation schemes, the volume into supply will only be calculated under AIM, not the river support volume, since the latter is benefiting the environment.

Following the Ofwat guidance, two equations were used to calculate the AIM performance and the normalised AIM performance. For the 19 AIM sources at which the trigger was breached during 2017-18, the combined AIM performance was -3096.95 Ml and the normalised AIM performance was -2.56. The negative figures signify an improved performance as average abstraction was lower than the baseline at the global scale. This suggests that the company met and exceeded the AIM baseline figures for the financial year 2017-18 which is mainly linked to the overall low demand and planned outages at some of the AIM sites.

Following the annual review of the AIM triggers and baseline abstractions, it appears that they are robust and representative of the catchment status. The validity of the triggers and baseline abstraction is constantly monitored and the next AIM performance review will take place in June 2018 for Q1 of 2018-19.

# 1 Purpose

The Abstraction Incentive Mechanism (AIM) has the objective of encouraging water companies to reduce the environmental impact of abstracting water at environmentally sensitive sites in low flow periods (i.e. droughts). The purpose of this document is to set out the methodology and assumptions used to calculate the AIM triggers and baseline abstraction values. Furthermore, actual abstraction data from the AIM sources for the financial year 2017-18 are shown in this report, in order to track performance and validate the AIM triggers selected. Affinity Water have put forward a total of 23 groundwater sources to be included in AIM, which have been deemed as potentially environmentally sensitive by previous studies. AIM has come in force in reputational form since the 1st April 2016. Four sources have been subject to sustainability reductions since 2016 and these abstractions have been omitted from the assessment, leaving a total of 19 sources that have been assessed for AIM in this report.

# 2 Methodology

A total of 23 sites put forward by Affinity Water have been assessed as potentially having an impact on a surface water body hence included in the AIM list. Four sources have been subject to sustainability reductions before the start of the 2017-18 assessment period. A further three abstraction changes were implemented on 1 April 2018. Sustainability reductions may be considered at six additional sources in AMP7. The remaining ten sources have either an operating agreement in place (i.e. augmentation scheme) or other licence condition or are currently under National Environment Programme (NEP) investigation.

In order to calculate the trigger and abstraction baseline, the AIM Taskforce guidelines have been followed. Based on these, the AIM trigger is set based on a specific environmental trigger, identified through the Environment Agency's (EA) Restoring Sustainable Abstraction (RSA) assessments, NEP investigations or other Environmental Impact Assessment (EIA) work. In cases where our sources are situated in catchments under previous or currently ongoing NEP investigations, we have adopted the preferred trigger points on river flows (Environmental Flow Indicators) as set out by the EA. For sites that have not been under investigation or this is currently underway with no triggers yet agreed, the Q95 flows have been adopted as the best indicator of low flow conditions below which AIM should operate. In the majority of cases, the potential impact on the surface water body is the river, so the trigger is set in the downstream gauging station that is considered to be representative of the groundwater catchment. There are exceptions to this, where a groundwater level trigger has been used instead, due to better representation of the aquifer baseline conditions or the absence of a gauging station.

The length of the record for each gauging station or groundwater level monitoring point is defined by the data availability and data quality in order to better calculate the AIM trigger. Where the Q95 or Q70 values have been used, these were adopted from the Centre of Ecology and Hydrology as published in their website[1] in July 2016.

Once the AIM triggers were identified, the baseline abstraction values were calculated based on the average abstraction during the historic period when river flows or groundwater levels were at or below the trigger. The duration of the abstraction record was chosen as the period between the 1st April 1995 and the 31st March 2015. This 20-year period was chosen as the most representative of current and future abstraction patterns, as the distribution network constantly evolves and pressure on sources may fluctuate accordingly. Also, if this were to extend further back, the uncertainty on data quality would increase as flow meters were not always available, with abstraction being calculated based on pump hours. Following the AIM guidance stating that "the past needs to be representative of the future", the period from 1995 – 2015 is thought to best represent the future. Furthermore, this 20 year period includes a number of low flow periods

(1997, 2003, 2005, 2006 and 2012) with some of them having demand restrictions and others being unrestricted. As such, this record is considered as being long enough to incorporate different types of droughts and also smooth out abstraction values that may be very low due to site outages. In cases where outliers were found that are deemed as not representative of the future use of the sources, these were highlighted and addressed appropriately as explained in the next sections.

# 3 Triggers and Abstraction Baseline

Table 1 below presents the sources that were submitted to Ofwat in September 2015 for inclusion in the AIM list.

### Table 1. Sources Operated Under AIM from 1st April 2016

| | Source | Group | Licence Number | Avg. Ann. Licence | Max Daily Licence | 2015 DO | | AMP6 SR | AMP7 SR | Environmental Benefit |
|---|---|---|---|---|---|---|---|---|---|---|
| NEP further sites | NETH | CLAY | 28/39/28/336 | | 40.91 | 28.00 | 30.00 | No | No | Yes |
| | BRIC | CLAY | 28/39/28/336 | | 27.28 | 14.00 | 15.00 | No | No | Yes |
| | CHES | Individual | 28/39/28/104 | 5.22 | 7.09 | 5.22 | 6.00 | No | No | Yes |
| AMP5 sustainability operating agreements | OUGH | Individual | 28/39/28/339 | 4.55 | 6.55 | 4.10 | 5.22 | No | No | Yes |
| | SLIP | Individual | 06/33/14/36 | 5.46 | 6.82 | 0.00 | 0.00 | No | No | Yes |
| | WELL | Individual | 06/33/13/10 | 2.27 | 2.27 | 1.15 | 1.15 | No | No | Yes |
| | OFFS | Individual | 06/33/13/09 | 1.14 | 1.14 | 0.00 | 0.00 | No | No | Yes |
| | PRIM | Individual | 9/40/4/497/G | 3.00 | 4.00 | 3.00 | 3.00 | No | No | Yes |
| | BUCM | Individual | 14/033 | 4.00 | 4.00 | 4.00 | 4.00 | No | No | Yes |
| | DENG Gravels | DENG | 9/40/5/71/G | 9.04 | 15.00 | 4.65 | 9.04 | No | No | Yes |
| AMP6 Sustainability reduction sites | BOWB | KENS | 28/39/28/130 | 6.82 | 11.37 | 5.82 | 5.82 | Yes | N/A | Yes |
| | AMER | GREM | 28/39/28/334 | 7 | 18.18 | 7.00 | 12.00 | Yes | N/A | Yes |
| | WHIH | WHIH | 29/38/03/42 | 22.73 | 30.46 | 15.00 | 28.00 | Yes | N/A | Yes |
| | FULL | DIGS | 29/38/02/46 | 9.09 | 9.09 | 5.60 | 9.09 | Yes | N/A | Yes |
| | MARL | LITT | 28/39/28/335 | | 20.47 | 4.74 | 4.74 | Yes | N/A | Yes |
| | PICC | LITT | 28/39/28/335 | | | 15.72 | 15.72 | Yes | N/A | Yes |
| | HUGH | Individual | 28/39/25/47 | 2.28 | 2.27 | 1.60 | 1.75 | Yes | N/A | Yes |
| AMP7 potential Sustainability reduction sites | DIGS | DIGS | 29/38/02/46 | 11.37 | 11.37 | 7.88 | 7.88 | No | Yes | Yes |
| | CHAL | GREM | 28/39/28/334 | 4 | 4.55 | 4.00 | 4.50 | No | Yes | Yes |
| | HOLY | STAL | 28/39/28/337 | | 9.09 | 8.20 | 9.09 | No | Yes | Yes |
| | MUDL | STAL | 28/39/28/337 | | 11.37 | 10.03 | 11.37 | No | Yes | Yes |
| | PERI | Individual | 28/39/28/401 | 4.99 | 5 | 4.19 | 4.19 | No | Yes | Yes |
| | RUNL (Chalk) | Individual | 29/38/01/09 | 9.55 | 9.55 | 6.30 | 6.30 | No | Yes | Yes |

Some of these sources have individual licences whilst others are part of a group licence. The licence and deployable output (DO) values reflect the situation in September 2015 as since then, sustainability reductions have already been implemented (BOWB reduced to zero as of 1st April 2016, FULL and HUGH reduced to zero as of 1st April 2017 and WHIH reduced to an annual average of 2 Ml/d), hence the licence and DO values have been adjusted accordingly. Where DO has been reduced to 0 Ml/d, it is proposed that AIM no longer applies to these sources as the impact of abstraction has been mitigated. Where DO has not been reduced to 0 Ml/d, there remains the potential for a residual abstraction influence and so there may be benefit in continuing to assess AIM against a lower AIM baseline. For this assessment period, WHIH has not been assessed for AIM as it was the original intention to exclude sources which had suffered a sustainability reduction.

Some of the sources assessed for AIM are located in the same catchment, and have been grouped in, Table 3 and Table 4. The groupings have been used as the baseline was calculated based on the performance of AIM sources under historic droughts, and this does not necessarily reflect the current operational regime. An example is the BRIC and NETH sources. These now both form baseload sources of the CLAY group and usually abstract at a higher rate than the AIM baseline. In the event of an operational outage at either of the sources, there is a need for the flexibility to increase abstraction at the other, to compensate the lost output. Without the grouping, we would not be able to recoup the lost volume if an outage occurred during a low flow period.

This is also important when calculating the normalised AIM score. The relative size of different abstractions means that if output from one source was increased in response to an outage at a baseload source during a low flow period, without the grouping, the normalised AIM score of the two sources would not balance and the AIM assessment would be inaccurate. Where sources are grouped, the same trigger point is used. This is downstream of both sources in the grouping, such that the benefit of their combined operation can be realised.

Based on the methodology explained in section 2, the calculated or adopted AIM triggers are presented in Table 2.

## Table 2. AIM Triggers for Affinity Water Groundwater Sources

| Source | Trigger Location | Monitoring Record | Q95 or bespoke trigger (Ml/d) | Comments |
|---|---|---|---|---|
| BRIC | R. Colne at Berrygrove GS | April 1995 – March 2015 | 13.00 | Bespoke trigger based on minimum flows derived from AMP5 Options Appraisal Work |
| NETH | | | | |
| WELL | R. Hiz at Hitchin GS | August 1980 – to date | 0.26 | Trigger based on Q95 adopted from CEH[1] |
| OUGH | | | | |
| OFFS | | | | |
| DIGS | R. Mimram at Panshanger GS | December 1952 – to date | 18.66 | Trigger based on Q95 adopted from CEH[1] |
| FULL | | | | AIM not applicable due to SRs in April 2017 |
| BOWB | R. Ver at Colney Street GS | April 1995 – March 2015 | 7.44 | AIM not applicable due to SRs in April 2016 |
| HOLY | | | | Trigger based on Q95 adopted from CEH[1] |
| MUDL | | | | |
| MARL | R. Gade at Croxley Green GS | October 1970 – to date | 32.00 | Trigger based on Hunton Bridge Licence condition for flows at Croxley Green |
| PICC | | | | |
| AMER | R. Misbourne at Denham Lodge GS | July 1984 – to date | 5.53 | Trigger based on Q95 adopted from CEH[1] |
| CHAL | | | | |
| WHIH | R. Beane at Hartham Park GS | August 1979 – to date | 15.47 | AIM not applicable due to SRs in April 2017 |
| CHES | R. Chess at Rickmansworth GS | July 1974 – to date | 15.38 | Trigger based on Q95 adopted from CEH[1] |
| HUGH | Hughenden Stream at High Wycombe GS | July 1997 – to date | 1.90 | Trigger based on Q70 from flow duration curve between 1997 to 2015 |
| PERI | R. Lee at Luton Hoo/East Hyde GS | October 1959 – to date | 7.34 | Trigger based on Q70 adopted from CEH[1] |
| RUNL Chalk | | | | |
| SLIP | R. Rhee at Ashwell GS | November 1965 – to date | 2.55 | Trigger based on Operating Agreement for Ashwell BH Augmentation |
| PRIM | R. Dour at Crabble Mill GS | August 1966 – to date | 18.06 | Trigger based on minimum flows at Crabble Mill as per BUCM Licence condition |
| BUCM | | | | |
| DENG Gravels | DENG Tubewell 19 | October 2000 – March 2015 | 1.78mAOD | Bespoke trigger based on minimum levels for the nearby wetlands (at 1.35mAOD in TW33) |

The abstraction baseline values have been calculated as the average historic abstraction, based on the period April 1995 to March 2015 when the AIM trigger would have been reached as set out in Table 2. The results are shown in Table 3 below and have been adopted by Affinity Water as the AIM baseline daily abstraction values.

NETH and BRIC sources will operate under AIM at a combined daily abstraction of 37.16 Ml/d. The 5 Ml/d deficit from the current target will be met by the introduction of TOLP and/or the slight increase of EAST.

The Hitchin sources (WELL, OUGH and OFFS) currently have augmentation schemes in place, based on level trigger points at Charlton Mill Pond (for WELL) and Oughton Springs (for both OUGH and OFFS). It is proposed that AIM will only apply to the abstracted water for public water supply and not for augmentation, as augmentation is in place to mitigate the abstraction impacts. The EA also operates an augmentation scheme from Bath Springs borehole to the River Hiz downstream of Charlton Mill Pond and upstream of their gauging station. Despite the low augmentation volumes, if this is considered to skew the gauge readings when in operation, then a groundwater level trigger could apply based on the EA observation borehole at Lilley Bottom. The equivalent trigger for flows at Q95 (0.26 Ml/d) at Hitchin Gauging station, would be set at 92.4 mAOD based on the relationship between the groundwater level hydrograph and the river gauge as shown in Figure 1.

The Mimram source (DIGS) will operate under AIM at the baseline abstraction of 7.53 Ml/d, based on the Q95 trigger flow at Panshanger Gauging Station. FULL previously formed part of this grouping however following the 2017 sustainability reduction, it will not be included in the AIM assessment.

The Ver sources (HOLY and MUDL) will operate under AIM at the combined output of 17.72 Ml/d. Since MUDL is considered operationally as an additional borehole for HOLY and due to their close proximity, it is proposed that the combined AIM baseline will apply instead of the individual baseline values, in order to allow operational flexibility during low flow periods. As discussed earlier, it is proposed that AIM will not apply for BOWB since the source has had its licence revoked due to sustainability reductions as of the 1st April 2016.

The Gade sources (MARL and PICC) will operate under AIM at the combined output of 20.14 Ml/d. It is suggested that for these two sources the combined AIM baseline is used so that there is operational flexibility between the two sources to operate at or below the 20.14 Ml/d aggregate volume during low flows. It may be beneficial to continue to operate AIM in the Gade catchment after the April 2018 sustainability reductions at MARL and PICC to help mitigate any residual abstraction impact. The baseline abstraction for MARL (4.42 Ml/d) was calculated by applying the AIM methodology but taking into account only abstraction values >1 Ml/d due to operational outages during historic low flow periods. This also discounts the very low abstraction values due to flowmeter errors. Conversely, the AIM methodology suggested a higher value (17.3 Ml/d) for PICC, but this was capped at the drought DO of 15.72 Ml/d so that the aggregate volume from this and MARL is lower than the licensed volume of 20.47 Ml/d by 0.33 Ml/d.

The Misbourne sources (AMER and CHAL) will operate under AIM at the combined baseline abstraction of 10.38 Ml/d. Sustainability Reductions will be imposed on AMER on the 1st April 2018 with potentially further reductions in the future at either AMER or CHAL. These will not reduce DO to 0 Ml/d and so there may be merit in continuing to operate AIM following the reductions.

## Table 3. AIM Baseline Abstraction versus Triggers

| Source | Catchment | Combined AIM baseline (Ml/d) | AIM baseline (Ml/d) | Average Deployable Output (Ml/d) | Operational Site Target (Ml/d) |
|---|---|---|---|---|---|
| BRIC | Colne | 37.16 | 18.65 | 14.00 | 15.00 |
| NETH | | | 18.51 | 28.00 | 27.00 |
| WELL | Hiz | 0.84 | 0.84 | 1.15 | 1.70 |
| OUGH | | 5.03 | 4.43 | 4.10 | 4.55 |
| OFFS | | | 0.60 | 0.00 | 1.00 |
| DIGS | Mimram | 7.53 | 7.53 | 7.88 | 8.00 |
| FULL | Mimram | Not assessed due to April 2017 sustainability reduction | | | |
| BOWB | Ver | Not assessed due to April 2016 sustainability reduction | | | |
| HOLY | Ver | 17.72 | 10.29 | 8.20 | 8.00 |
| MUDL | | | 7.43 | 10.03 | 10.00 |
| MARL | Gade | 20.14 | 4.42 | 4.74 | 4.70 |
| PICC | | | 15.72 | 15.72 | 15.00 |
| AMER | Misbourne | 10.38 | 7.51 | 7.00 | 7.00 |
| CHAL | | | 2.87 | 4.00 | 4.00 |
| WHIH | Beane | Not assessed due to April 2017 sustainability reduction | | | |
| CHES | Chess | 4.08 | 4.08 | 5.22 | 5.22 |
| HUGH | HUGH | Not assessed due to April 2017 sustainability reduction | | | |
| PERI | Upper Lee | 9.94 | 3.36 | 4.19 | 4.50 |
| RUNL Chalk | | | 6.58 | 6.30 | 6.30 |
| SLIP | Rhee | 3.62 | 3.62 | 0.00 | 4.50 |
| PRIM | Dour | 6.50 | 2.50 | 3.00 | 2.50 |
| BUCM | | | 4.00 | 4.00 | 3.50 |
| DENG Gravels | DENG | 6.00 | 6.00 | 4.65 | 5.00 |

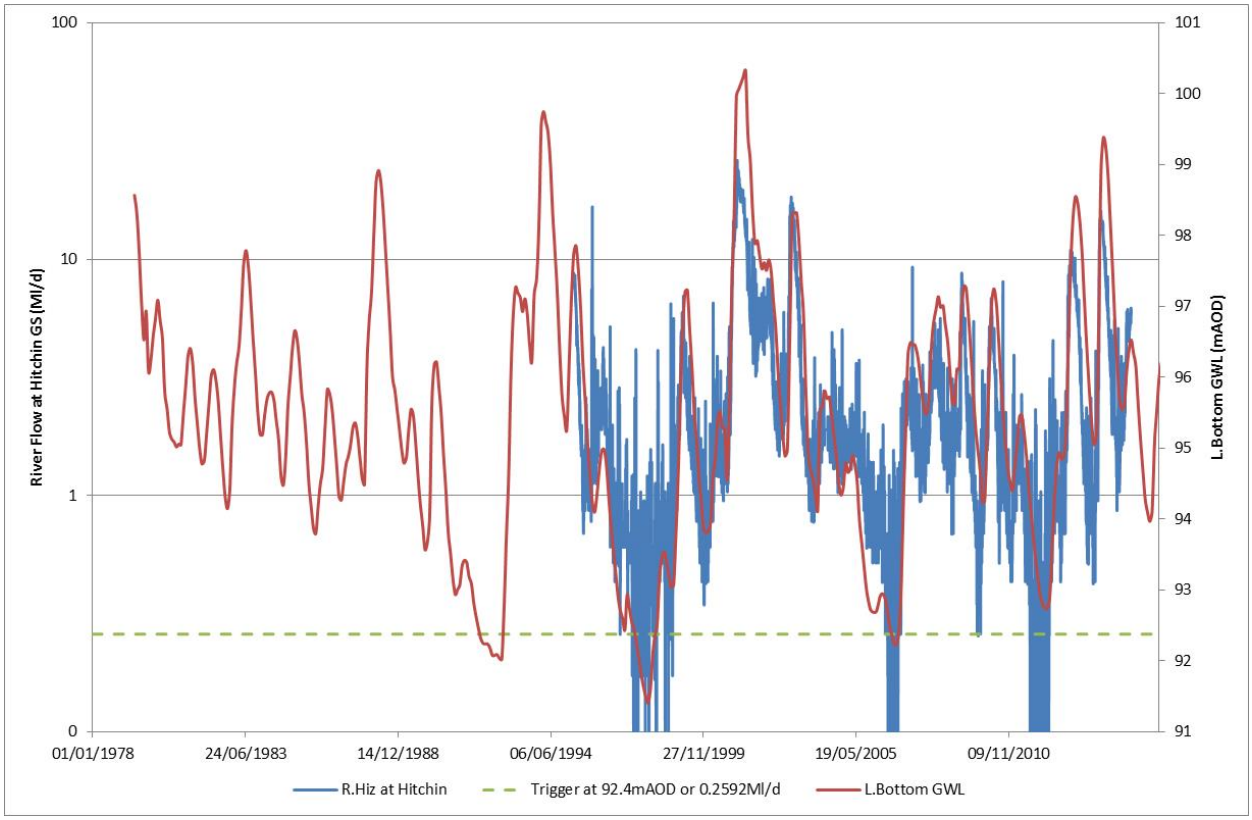


**Figure 1: Relationship between River Flows at Hitchin Gauging Station and Groundwater Levels at Lilley Bottom Observation Borehole**

The WHIH source in the Beane catchment had sustainability reductions imposed on the 1st April 2017. The source was not assessed for AIM in 2017-18 but there may be environmental benefits to re-introduce the operation of AIM for this source next year. The considerable difference between peak and average licensed conditions would serve to severely constrain peak use and limit abstraction during low flow events.

CHES source will operate under AIM at the abstraction baseline of 4.08 Ml/d as calculated by the AIM methodology for flow in the Chess reaching Q95 values at the Rickmansworth gauge. It needs to be noted though that if the CHAR source is out of supply due to high nitrates, the AIM will not apply for CHES as they are both in the same catchment area. In this case, the river would theoretically benefit from CHAR being out of supply (DO of 1.78 Ml/d).

HUGH source has had a sustainability reduction imposed on the 1st April 2017 (full closure). As such, going forward, AIM will cease to apply.

The Upper Lee sources (RUNL Chalk and PERI) are being considered for sustainability reductions in AMP7. It is proposed that the AIM baseline will be 9.94Ml/d as the combined abstraction from the two sources until the reductions are implemented. If the reductions are no longer required based on the monitoring results, the sources could be removed from the AIM list.

SLIP source has an augmentation scheme in place linked to flow in the River Rhee at Ashwell gauge. It is proposed that AIM will operate at the volume for water into supply and not the augmentation volume as explained earlier for the Hitchin sources. The AIM baseline abstraction as calculated by the methodology is 3.62 Ml/d.

BUCM source has a licence condition that allows augmentation to the River Dour. However, since both this and PRIM are located in the same part of the catchment, it is proposed that when the trigger is reached at Crabble Mill gauge, that both sources will operate under AIM at the combined

abstraction of 6.50 Ml/d. This was adopted based on the anticipated increased demand in this zone due to housing developments. This volume is still lower than the combined DO for the two sources by 0.5 Ml/d. It needs to be noted, that as mentioned above for sources that have river support schemes, the AIM baseline will apply to the volume of water into supply and not the augmentation volume. This will apply to BUCM only as there is no augmentation capability from PRIM.

DENG source will operate at the AIM baseline of 6 Ml/d as per the new average licence implemented on the 1st April 2015. This is a voluntary licence reduction by 3 Ml/d at average (previous licence at 9 Ml/d average), so the AIM baseline is adjusted to reflect the new operational pattern.

It should be noted that the triggers and the AIM abstraction baseline values are subject to consultation and may need to be reviewed following this procedure. At present, they are thought to be robust based on the current knowledge of the catchments and the historic and future use of the sources under low flow conditions. Periodic reviews of the AIM sites will take place in order to validate both the triggers and the abstraction values. The review for the financial year of 2017-18 for the AIM sites is discussed in the next section.

# 4 Abstraction in 2017-2018 versus AIM Baseline

A periodic review of the AIM triggers and baseline abstraction is undertaken on a quarterly and annual basis in order to validate the selected values. Table 4 below shows the actual abstraction figures for the period 2017-18 (1 April to 31 March) against the AIM baseline values.

### Table 4. AIM baseline Abstraction versus Actual Abstraction in 2017-18

Note that sustainability reduction sources have been removed.

| Source | Catchment | Combined AIM baseline (Ml/d) | AIM baseline (Ml/d) | Actual Abstraction (2017-18) (Ml/d) | | AIM Performance (Ml) | Normalised AIM Performance | Number of days flow below the trigger |
|---|---|---|---|---|---|---|---|---|
| BRIC | Colne | 37.16 | 18.65 | 16.03 | 42.72 | +88.35 | +0.13 | 19 |
| NETH | | | 18.51 | 26.69 | | | | |
| WELL | Hiz | 0.84 | 0.84 | 1.32 (excluding augmentation) | | +4.03 | +0.37 | 13 |
| OUGH | | 5.03 | 4.43 | 0.84 | 1.02 | -55.77 | -0.85 | |
| OFFS | | | 0.60 | 0.18 | | | | |
| DIGS | Mimram | 7.53 | 7.53 | 7.94 | | +23.10 | +0.05 | 66 |
| HOLY | Ver | 17.72 | 10.29 | 9.20 | 17.68 | +13.13 | +0.01 | 101 |
| MUDL | | | 7.43 | 8.48 | | | | |
| MARL | Gade | 20.14 | 4.42 | 5.88 | 19.72 | -102.86 | -0.07 | 74 |
| PICC | | | 15.72 | 13.86 | | | | |
| AMER | Misbourne | 10.38 | 7.51 | 5.47 | 9.20 | -172.90 | -0.18 | 95 |
| CHAL | | | 2.87 | 3.73 | | | | |
| CHES | Chess | 4.08 | 4.08 | 2.78 | | -154.86 | -0.43 | 89 |
| PERI | Upper Lee | 9.94 | 3.36 | 3.52 | 3.52 | -1919.12 | -0.65 | 298 |
| RUNL Chalk | | | 6.58 | 0.00 | | | | |
| SLIP | Rhee | 3.62 | 3.62 | 3.86 (excluding augmentation) | | -121.98 | -0.31 | 107 |
| PRIM | Dour | 6.50 | 2.50 | 1.79 | 4.47 | -568.16 | -0.41 | 212 |
| BUCM | | | 4.00 | 2.67 (excluding augmentation) | | | | |
| DENG Gravels | DENG | 6.00 | 6.00 | 5.00 | | -79.91 | -0.22 | 61 |
| | | | | **TOTALS** | | -3046.95 | -2.56 | |

It should be noted that from July 2016 onwards, the background groundwater levels have been below the Long Term Average (LTA) (Figure 2). Groundwater level crossed Drought Zone 1 in August 2016 and dipped below Drought Zone 2 by the end of December 2016, where it remains. The winter recharge of 2016-17 was low, although the summer of 2017 experienced above average rainfall; this subdued the rate of recession. Chalk groundwater levels started to rise in December 2017, the result of high rainfall and snowmelt. The current groundwater level situation was the result of lower than average winter rainfall (2016-17) and higher than average temperature, which combined to cause a recharge deficit. Even with above average rainfall from May to September 2017, groundwater levels continued to decrease. The result was that AIM was active in all of the catchments in which it operates, at some point in 2017-18. Groundwater levels in Q4 of 2017-18 have started to move towards the drought zone 2 curve. This, in combination with surface water runoff, has led to fewer triggers being active compared with earlier in the year.

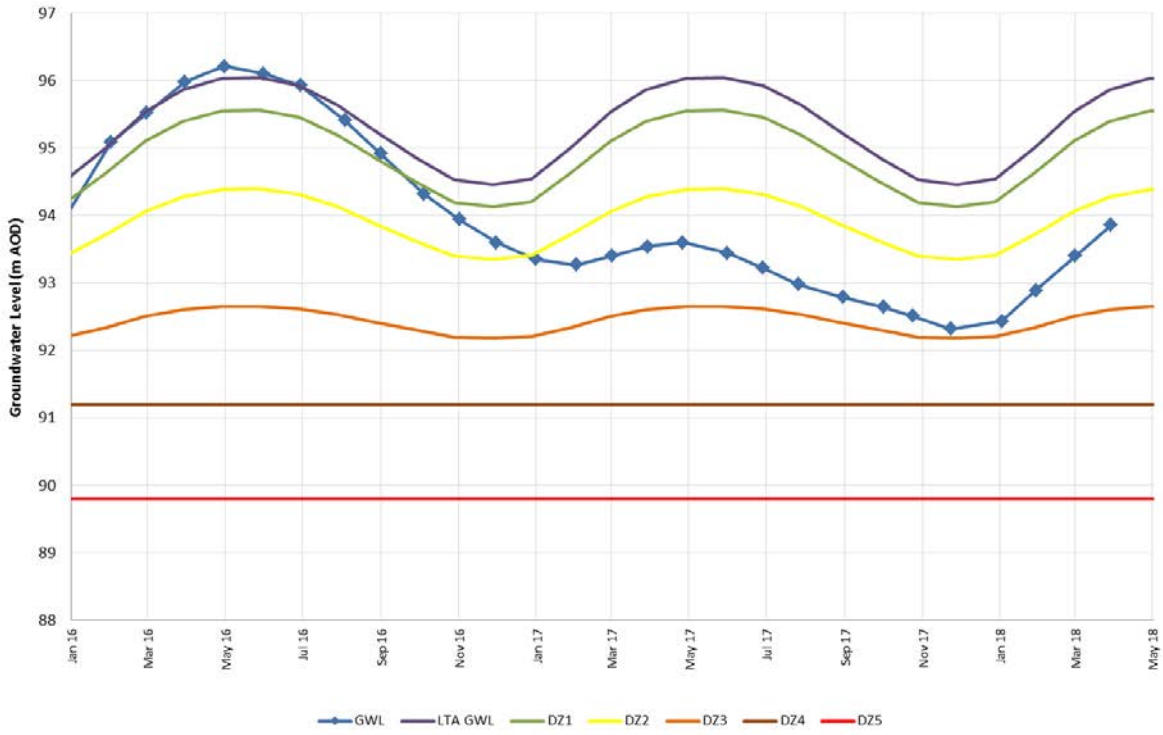


**Figure 2: Background Groundwater Level Fluctuations Measured at the EA Observation Borehole at Lilley Bottom**

All rivers experienced a gradual decline in basefow in line with regional groundwater levels. The peak of the surface water drought generally coincided with that of the groundwater event. The exception to this was the Colne. Here, flows are artificially supported by the treated effluent discharge from Blackbirds Sewage Treatment Works (STW). The low-point in the hydrograph of the Rhee occurred in October 2017. This was followed by step recoveries in the flow regime, which may be linked to changes in abstraction at our SLIP source and the commencement of augmentation in December 2017.

Table 4 states the number of days in 2017-18 that each AIM trigger was active. This can be used to assess how sensitive each trigger is to drought. It can be seen that the Lea trigger was active for the longest period (298 days), followed by the Dour trigger (212 days), Rhee trigger (107 days) and Ver trigger (101). The Colne (19 days) and Hiz (13 days) were least impacted. As previously mentioned, flows in the Colne are artificially maintained by STW discharge and the trigger being breached was coincident with outage. The resilience of the Hiz to drought may be evidence that

the augmentation schemes are effective at mitigating low flows. Crabble Mill gauging station is upstream of the discharge from BUCM and so the mitigating effect of the augmentation scheme cannot be assessed.

Some of the sites (BRIC and NETH, HOLY and MUDL, DIGS and WELL) assessed for AIM had higher abstraction than the AIM baseline during low flow periods in 2017-18. For the MUDL/HOLY pairing (0.13 Ml/d), DIGS abstraction (0.35 Ml/d) and WELL source (0.3 Ml/d), the difference was very small. The discrepancy between the AIM baseline and average abstraction for BRIC/NETH was larger (4.65 Ml/d) however flow in the Colne was maintained by the discharge from Blackbirds STW and the normalised AIM score only resulted in a small penalty. Flow in the Colne was below the trigger for 19 days in 2017-18 (out of 365) and the combined average abstraction from BRIC and NETH during the 19 days was 41.82 Ml/d.

As specified in the AIM guidelines document from Ofwat, the AIM performance is measured based on the difference between the actual and the baseline abstraction, multiplied by the number of days when flows were at or below the trigger threshold (see equation below).

> AIM performance in Ml = (average daily abstraction during period when flows are at or below the trigger threshold - baseline average daily abstraction during period when flows are at or below the trigger threshold) * length of period when flows are at or below the trigger threshold.

In order to allow for comparison of the AIM performance between abstraction sites, either within the company or between water companies, the performance on the AIM is normalised by the baseline average daily abstraction and the length of time for which flows were at or below the trigger threshold. This is because the guidelines suggest that a performance of -1Ml is better if the AIM baseline is smaller or if the period for which flows are at or below the trigger threshold is shorter. The equation for the Normalised AIM performance is given below as proposed by Ofwat.

> Normalised AIM performance = AIM performance / (baseline average daily abstraction * length of period when river flows are at or below the trigger threshold)

As such, when applying the two equations above to measure the AIM performance and the normalised AIM performance for BRIC and NETH for 2017-18, the AIM performance is +88.35 Ml and the normalised performance is +0.13. The positive figures signify a reduced performance as average abstraction was higher than the baseline, over the 19 day that AIM was in effect. As explained above, the flow pattern seen at Berrygrove gauge is linked to the discharge from Blackbirds STW. This discharge is known to be critical for maintaining flows in the Colne, especially in the section between Munden Estate and Berrygrove gauge. As such at times of reduced STW outage, the river suffers from low flows due to the leaky nature of the river bed and the underlying drift deposits. Blackbirds experienced ongoing operational issues towards the end of Q4 of 2016-2017. These have now been resolved and Blackbirds discharged for the majority of 2017-2018, helping to sustain river flow. Instances of flow falling below the trigger at Berrygrove coincide with outages at Blackbirds.

PERI and RUNL Chalk sources are situated in the Upper Lee catchment. The AIM trigger was active for most of 2017-18, 298 days in total. Using the same equations as above, the AIM performance was -1919.12 Ml and the normalised AIM performance was -0.65, since the combined abstraction at both sites was significantly lower than the AIM baseline when the trigger was on at the East Hyde gauge. This is mainly attributed to the outage at RUNL Chalk due to water quality issues.

Flow triggers in the Rivers Mimram (DIGS source), Ver (HOLY and MUDL sources), Gade (PICC and MARL sources) and Misbourne (AMER and CHAL sources) were reached intermittently, at times when the rivers were not responding to runoff from summer rainfall events. For the Gade

and Misbourne sources, abstraction when AIM was in effect was below the AIM baseline, at -102.86 Ml and -172.90 Ml respectively. This gives a normalised AIM score of -0.07 for MARL and PICC and -0.18 for AMER and CHAL. For the Ver and Mimram sources, abstraction when AIM was in effect was above the AIM baseline, at +13.13 Ml and +23.10 Ml respectively. This gives a normalised AIM score of +0.01 for HOLY and MUDL and +0.05 for DIGS.

The Rivers Chess, Dour and Rhee were not as responsive to the summer rainfall as some of the other rivers assessed for AIM, and have experienced a gradual decline in flows. Subsequently, the River Rhee breached the AIM trigger in mid-August and the Chess in mid-September. When flow was below the AIM trigger on the Chess, abstraction from CHES was below the AIM baseline, giving an AIM performance score of -154.86 Ml and a normalised AIM score of -0.43. When AIM was enforced, abstraction from SLIP was below the AIM baseline, partly in response to step reductions in abstraction to comply with the abstraction licence conditions. This gave a score of -121.98 Ml, and a normalised AIM score of -0.31. Water abstracted for the purposes of augmentation was not included in the assessment.

Flow in Dour, as measured at Crabble Mill, was below the AIM trigger for much of 2017-18. Abstraction over this period from BUCM and PRIM was below the AIM baseline, at -568.16 Ml, giving a normalised score of -0.41.

The DENG groundwater levels, as measured in tubewell 19, were maintained by the above average rainfall which we received over the summer. They dipped below the AIM trigger between early October and early December 2017. Abstraction from the DENG aquifer was below the AIM baseline at -79.91 Ml, giving a normalised AIM score of -0.22.

In summary, for the 19 AIM sources that the trigger was reached during 2017-18, the combined AIM performance was -3096.95 Ml and the normalised AIM performance was -2.56. This suggests that the company met and exceeded the AIM baseline figures for this year.

Following the quarterly review of the AIM triggers and baseline abstractions, it appears that they are robust and representative of the catchment status. The validity of the triggers and baseline abstraction is constantly monitored and the next AIM performance review will take place in June 2018 for Q1 of 2018-19.

# References

[1]: http://nrfa.ceh.ac.uk/data/search