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Member of the SNC-Lavalin Group

Proposal to address GARD concerns over Abingdon resilience assessment

Overview

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- Summarise the positions to date (not a point by point rebuttal)
- Address the need and rationale for further analysis
- Explain our proposed way forward and try to reach agreement

Is there a resilience risk?

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- Of course there is
  - There is with *any* resource development or demand management proposal
  - The operation of Abingdon is low tech so the risk is generally limited to drought conditions
- If a drought that is severe enough to test the existing London system and long enough to prevent refill for 2 years occurs then the benefit from Abingdon to the combined system can drop significantly
- Similar issues exist with other options – e.g. shorter droughts can severely limit the benefits from the Severn-Thames transfer

Is there a resilience risk?

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- The key questions are:
  - How likely is it for such conditions to occur?
  - How does that affect the supply/demand *benefits* of Abingdon in comparison to other options?
- The second point is key. All options need to be compared on a *like for like* basis.
  - This has been a fundamental part of water resource planning since the 1996 drought.

Findings to Date

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Aspect	Thames	GARD
Method	Random sample of 30 droughts likely to be 1 in 100* or worse run through WARMS2 and the net yield of Abingdon under each drought evaluated.	Evaluation of circa 2,000 years of the weather generated record, with evaluation of DO with and without Abingdon for 4 selected droughts
Findings	10% of the droughts resulted in a yield significantly below expectations, and there was a typical distribution of +/-25%, but the *average* yield was within 5Ml/d of the expected 283Ml/d. No particular trend with increasing drought severity.	Two highly extreme droughts (worse than 1 in 1,000 years) found with very poor Abingdon resilience. Two or three* droughts with a severity that falls within the range that might be considered for resilience testing found with poor Abingdon resilience
Conclusions	DO performs as expected on average across design type events; risk of encountering a problematic event is too small (less than 0.2% per annum) to plan for	Droughts can occur that test the resilience of the Abingdon scheme and the net benefit can be very small under such events.

Very similar findings, very different conclusions!

*Criticised by GARD as some events were not at or worse than worst historic event when they were run through WARMS2. This was because severity was initially calculated through IRAS – see later

**GARD also highlight run 151 @ 239Ml/d yield and run 104@224Ml/d; these form part of the general probability distribution that you would expect for any yield analysis. Obviously GARD did not look for droughts where Abingdon does better than expected

Is further analysis needed?

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Technically, I would still say not:

- The sampling used in the previous Thames analysis was random and not intentionally biased
- Studies across the country show that drought severity is proportionally worse for 12-24 month events that it is for longer events (EA Drought Vulnerability Framework)
- Both Thames and GARD studies showed that droughts that test the conjunctive system and result in poor yield in Abingdon are rare. Certainly much rarer than events that test the Severn Thames transfer.
- The use of an ‘average yield’ to determine benefit is consistent across the resource options that have been tested and is effectively exactly what GARD has requested, just in a different format

However, for the sake of stakeholder consultation, **definitely yes**:

- Arguments are highly technical and as the conflict is over the conclusions, risks becoming a case of one expert versus another
- GARD have expressed concerns over sampling methods, yield assessment techniques, use of average yield as an appropriate metric, and these need to be taken seriously and addressed
- We ned to agree a method that is understandable to stakeholders, where the way that conclusions are reached is transparent and agreed by all
- Although Thames has shared all data, there has been a lot of confusion about the differences between IRAS and WARMS2 and the management of those differences; that is a distraction and needs addressing

What tools are available?

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There is one large, artificially generated drought data set that can be used to test resilience, consisting of spatially coherent rainfall and evaporation timeseries

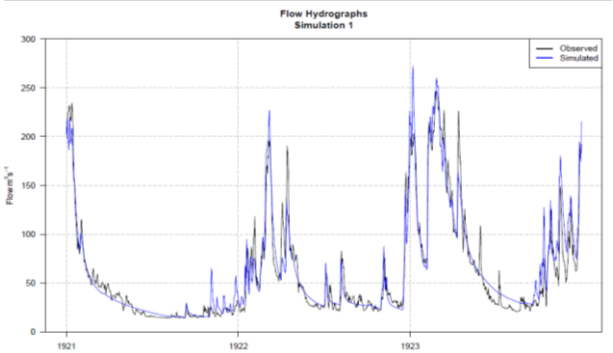
There are two different tools that can evaluate yield and option benefit

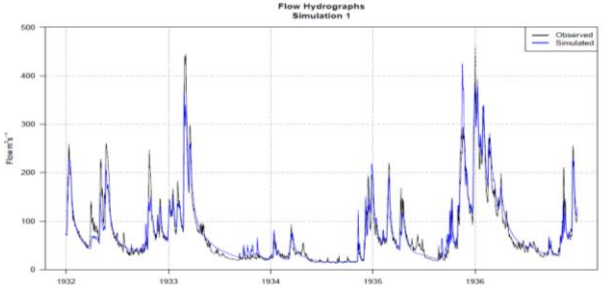
	WARMS2	Catchmod-IRAS
How it works	Rainfall and evaporation are fed directly into the model. It generates flows and then optimises abstraction to calculate yield	Flows are generated separately using a Catchmod lumped parameter catchment model. IRAS then models abstraction and storage
Pros	Distributed catchment model provides a more accurate representation of flows.	Fast to run and can generate yields and options benefits for all the generated droughts
Cons	Slow – cannot realistically carry out yield analysis across the full generated timeseries	Less accurate and the rate of change of yield with drought severity is larger. .

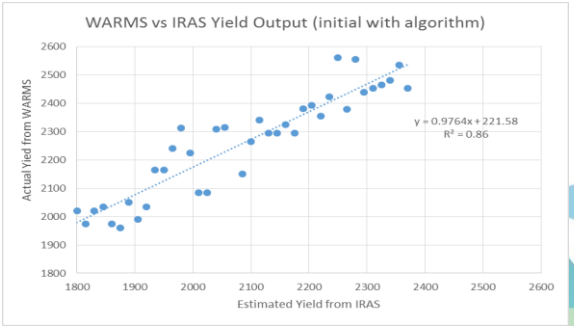
What tools are available?

The difference is almost all down to hydrology:

- flows are very well calibrated between the two, but a lumped model cannot exactly fit recession and recharge timing of a distributed model
- Yields from the two tools are therefore correlated, but there can be substantial differences for individual droughts.
- Typically we would just use IRAS and the correlation to infer the WARMS2 benefit from options.
- In the case of Abingdon, any differences are exacerbated because the same hydrology is being used by both the existing system and the new option.







What do we Propose?

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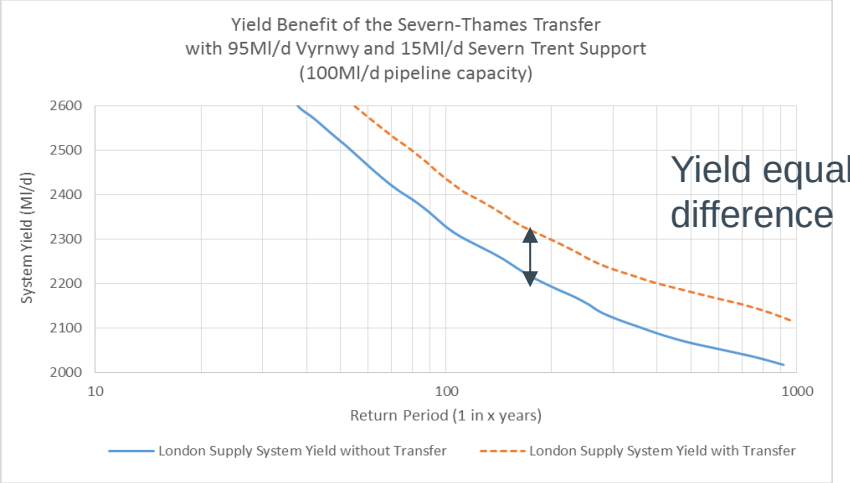
- GARD have previously requested a similar analysis to the Severn Thames transfer
- We agree, but would rather use IRAS to identify a sample of droughts and then run through WARMS2 to ensure better accuracy
  - No problem with doing the analysis in IRAS, it's just a waste of time and I suspect it would tend to favour Abingdon. We would end up having to do the WARMS2 analysis in any case.
- The nature of the result is effectively the same, but avoids the 'double dipping' risk



Yield equal to this difference

What do we propose?

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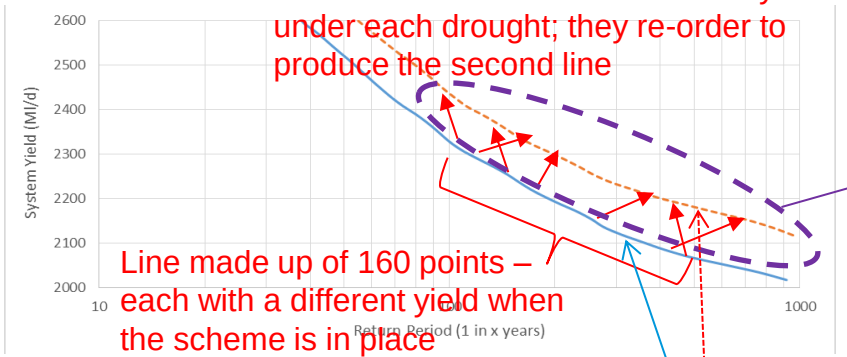
- We use IRAS to identify *all* droughts that are likely to lie in the 1 in 100 to 1 in 500 range
- We run a sample of those through WARMS and calculate the net benefit of Abingdon for each drought
- This shows the range *and likelihood* of yields during major droughts, between a 1 in 100 and 1 in 500 return period.
- The average gives the resilient yield across that range

What do we propose?

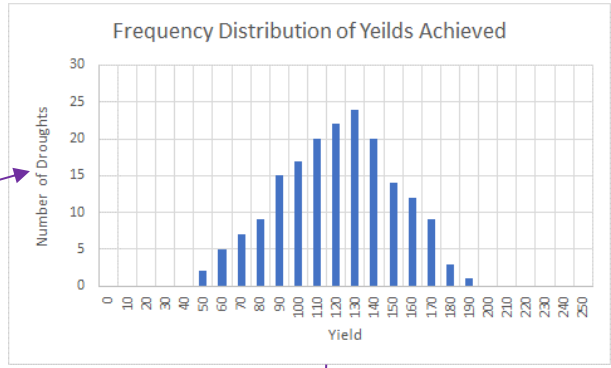
This is actually the same as GARD want, just evaluated in a different format that can be done more accurately using WARMS2



The transfer scheme has different yields under each drought; they re-order to produce the second line

Line made up of 160 points – each with a different yield when the scheme is in place

If you plot all of these, they look like this



We're proposing to do that based on 25% (40) of the points, but more accurately using WARMS2

The beauty of that is that if you take the average of the distribution, it is a more accurate calculation of the average distance between these two lines within the required range…

What do we propose?

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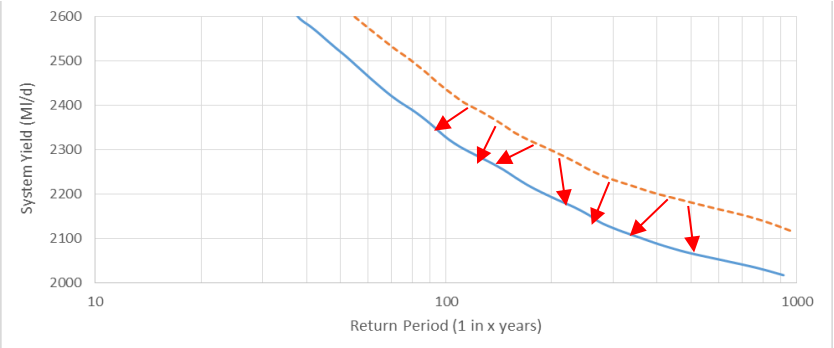
GARD have requested to do it the other way round

Generate this line first then back calculate to the blue line



- Similar principle and similar results
- Not quite sure of the point – isn't the question how much benefit Abingdon provides?
- Additional effort
- Additional uncertainty and potential for bias – any bias from the IRAS hydrology is 'double dipped' before the analysis carried out in WARMS2

Just to clarify – doubling the storage of the system does not 'fundamentally change' the nature of the system drought vulnerability. It is still almost entirely dictated by the probability & duration of the River Thames flows falling below constraint values, which does not change. There is *some* effect under certain drought patterns, but that's why the yield impact assessment is carried out

Sample Size

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- There are approximately 160 droughts in the generated data set that lie between the 1 in 100 and 1 in 500 return period severity
- We propose to sample 40 of those – i.e. 25% of the ‘population’
  - This is the one area where we actually disagree with GARD; taking a sample of 40 events that represents 25% of the whole sample population is more than adequate, and would be confirmed as such by any statistician
  - We can even use standard statistical methods that have been around for hundreds of years to evaluate the uncertainty caused by just taking a sample

Interval

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- Why only use droughts up to 1 in 500 Return Period?
- GARD have suggested 1 in 2,000
  - If Thames try and invest to be resilient to a 1 in 2000 year event then they would need to find over 500Ml/d additional investment
  - Is this affordable, or in line with customer expectations
  - Ironically it would significantly increase the chance that Abingdon gets built!

Transparency

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To ensure the sample is in no way statistically biased, or open to accusations of bias or error we propose to:

- Identify all droughts in the 1 in 100 to 1 in 500 range and list them so GARD can check them against the data set that has been shared
- Simply take every fourth drought from that list. We can start at whatever number (1-4) that GARD want
- Share the WARMS2 generated reservoir volumes for all runs
- Share the spreadsheet analysis used to turn WARMS2 outputs into Abingdon yields for each drought