Defence Infrastructure Organisation

ARMY BASING PROGRAMME, SALISBURY PLAIN

INTEGRATED WATER MANAGEMENT STRATEGY

FEBRUARY 2017

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GLOSSARY

ABBREVIATION	DEFINITION
ABP	Army Basing Programme
ADSL	Aspire Defence Services Limited
AMP	Asset Management Planning
AMR	Automated Meter Reading
BH	Borehole(s)
CfSH	Code for Sustainable Homes
CSF	Catchment-Sensitive Farming
DIO	Defence Infrastructure Organisation
DO	Deployable Output
DMA	District Metering Area
DWF	Dry Weather Flow
DWI	Drinking Water Inspectorate
EA	Environment Agency
EFI	Environmental Flow Indicator
GAC	Granular Activated Carbon
HE	Historic England
HRA	Habitats Regulations Assessment
IWMS	Integrated Water Management Strategy
JNCC	Joint Nature Conservation Committee
KUR	Key User Requirements
KWSD	Kelda Water Services Defence
MNF	Minimum Night Flow
MOD	Ministry of Defence
MUJV	Multi Utility Joint Venture
NE	Natural England
NMP	Nutrient Management Plan
OFWAT	UK Water Services Regulation Authority
PFI	Private Finance Initiative
RoC	Review of Consents
SAC	Special Area of Conservation
SFA	Service Family Accommodation
SLA	Single Living Accommodation
SPTA	Salisbury Plain Training Area
SRO	Source Reliable Output
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works
SUDS	Sustainable Urban Drainage System
SVR	Service Reservoir
VWP	Veolia Water Projects
WBM	Wessex Basin Groundwater Model
Wilts C	Wiltshire Council
WFD	Water Framework Directive
WHS	World Heritage Site
WRZ	Water Resource Zone
WW	Wessex Water
WYG	White Young Green (consultancy)

1 EXECUTIVE SUMMARY

1.1 The Army Basing Programme (ABP), which originates from the 2010 Strategic Defence and Security Review and 'Army 2020' Plan, will see around 6,250 extra people (approximately 3,960 additional service personnel plus families) living around Salisbury Plain by 2020, placing additional pressure on water resources and sewage treatment capacity.

1.2 This Integrated Water Management Strategy (IWMS) covers the part of Salisbury Plain which will be impacted by ABP development – namely Tidworth, Perham Down, Ludgershall, Bulford, Upavon and Larkhill. It has been prepared on behalf of the Ministry of Defence (MOD) by the Defence Infrastructure Organisation (DIO), Kelda Water Services Defence and WSP Parsons Brinckerhoff, to meet Environmental Commitments agreed between the DIO and Regulatory bodies and to address Planning requirements for the ABP developments.

1.3 The aims of the IWMS are as follows:-

- To assess the current capacity of MOD's water supply and waste water systems on Salisbury Plain;
- To assess their capacity to accommodate the expected ABP uplift;
- To consider the potential impacts associated with flood risk and climate change on MOD's groundwater abstraction boreholes and associated infrastructure;
- To assess the environmental effects of both existing and ABP-related abstractions and discharges;
- To detail how MOD intends to manage the environmental impacts identified.

In doing so, the IWMS will help MOD to prepare for forthcoming abstraction reform, whereby all MOD abstractions are expected to fall under licensed control by 2020.

1.4 The assessment takes into account the principles laid out in the Environment Agency's Water Resources Planning Guideline Navigation Tool for Smaller Water Companies (*Ref 7*). Some of the guidance is not directly applicable, since MOD is the sole/majority customer in most of the four identified Water Resource Zones of Tidworth, Larkhill, Bulford and Upavon.

1.5 For historical reasons, the water supply and waste water arrangements across the MOD estate on Salisbury Plain are relatively complex. The approach to developing the IWMS was therefore agreed at the outset with Wiltshire Council, the Regulators (Environment Agency and Natural England) and the following stakeholders:

- Defence Infrastructure Organisation, which manages the Defence Estate.
- Kelda Water Services Defence, which abstracts water and supplies it to the boundary of Larkhill and Bulford camps. Kelda also manages waste water from Larkhill; it also abstracts and supplies water within the garrison boundary at Upavon and manages waste water.
- Veolia Water, which abstracts and supplies water to the boundary of Tidworth, Perham Down and Ludgershall camps. Veolia also supplies both Service Families Accommodation (SFA) and civilian customers in this area as the incumbent Statutory Undertaker, and manages all waste water treatment in the area.
- Aspire Defence & its subcontractor MUJV, which are responsible for managing water and waste water within the boundary of all garrisons except Upavon.
- Wessex Water, which abstracts water across Salisbury Plain for Public Water Supplies. Wessex supplies some existing SFA as a Statutory Undertaker, and manages waste water from Bulford Camp.

1.6 Public consultation was not undertaken on the IWMS, given the lack of public interest in the draft Veolia Water Resources Management Plan (WRMP) and the proportion of the supply that is used by the MOD.

1.7 The water and waste water requirements for the new SFA developments will be delivered by Wessex Water and Veolia Water as Statutory Undertakers. These companies' abstractions are already licensed by the Environment Agency, and the water is already accounted for in the current Wessex/ Veolia WRMPs in terms of growth, development and headroom assessment.

1.8 Similarly, the Veolia abstractions serving Tidworth garrison, Perham Down and Ludgershall are licensed. Increases in water demand/ waste water volumes associated with ABP will be met from within Veolia's licenced headroom, in accordance with its licence conditions. The additional supply will be used within the Tidworth Inset area and will be discharged back into the catchment via Tidworth STW.

1.9 By contrast, the MOD abstractions at Bulford, Upavon and Larkhill (managed on MOD's behalf by Kelda) are not licensed. Kelda can therefore currently abstract from these sources up to the Deployable Output (DO) limit, if required.

1.10 The assessment of current and future water demand and DO for the Kelda-managed areas at Larkhill, Bulford and Upavon is based upon recent actual data. It concludes that sufficient water is available to meet current demand, with an appropriate margin of available headroom. A similar conclusion is reached for the Veolia in its WRMP, assuming that recommended supply infrastructure improvements are implemented.

1.11 The future water demands associated with ABP have been assessed and considered in light of the leakage reduction and water efficiency measures that have been implemented over the assessment period, including a leakage reduction programme at Bulford and Larkhill camps which has delivered reductions of around 1,700 m^3/d. Net demand in all WRZs is expected to increase slightly with ABP; the exception is Bulford, where abstraction rates have already been reduced from 1.40 to 1.38 ML/day. This improvement should be sufficient to offset the expected ABP uplift.

1.12 The outage assessment indicates that all WRZ's have sufficient infrastructure in place to deal effectively with any failure-related outages.

1.13 The vulnerability assessment identifies that further work is required to minimise the risk of surface water flooding which could impact on the boreholes and associated infrastructure serving Larkhill, Bulford and Tidworth. Further assessment is also required to reduce the operational risks from climate change-related groundwater reduction at Round 'O' and Upavon boreholes.

1.14 Existing abstraction from MOD, PWS and other private sources is known to be adversely affecting low flows within the River Avon Special Area of Conservation (SAC). As a result, the impacts of ABP on the water environment have been extensively assessed. The hydrological impacts have been quantified using the Wessex Basin Groundwater Model (WBM), developed for the Environment Agency and Wessex Water.

1.15 The model shows that ABP uplift does not adversely affect existing river flows in the Avon at Upavon or in the Bourne at Tidworth. However, the abstraction increases at Larkhill, coupled with the planned closure of the Larkhill STW soakaway, will adversely affect existing river flows in the Avon, Till and Nine-Mile River if not mitigated. However, these impacts are shown to be removed (and existing flows improved) if potable abstraction from Larkhill is reduced from 1.4 to 0.8ML/ day and the Round 'O' abstractions are reduced from 1.1 to 0.7ML/ day, with the shortfall drawn from the existing Wessex supply to Larkhill Camp.

1.16 At Bulford, ABP uplift will not lead to any net increase in MOD abstraction. Nevertheless, the groundwater model concludes that reducing *existing* abstractions from the MOD Bulford boreholes and increasing the discharge to Ratfyn STW will have a net positive impact on groundwater levels and on existing river flows in the Avon and the Nine-Mile River, although low flows in the Nine-Mile River would not recover entirely, even if MOD's Bulford abstractions

were switched off. This issue will be explored further over the next 2-3 years in preparation for abstraction licensing.

1.17 To mitigate for the effects of ABP uplift and to increase the sites' long term operational resilience, Wessex Water will install a new potable supply into Bulford camp, and Kelda will increase the use of the existing Wessex supply into Larkhill. These supplies, which are expected to be operational by 2018, will be capable of providing over 90% of the expected potable demand at both sites, to be supplied on a 'best endeavours' basis. This will allow the local MOD abstractions to be reduced if required, without affecting supply to either site.

1.18 The actual amount of water transferred will be subject to further assessment and a commercial agreement with Wessex Water. In practice, MOD is expected to take a fixed volume of around 0.20 ML/day at Bulford and a variable volume up to around 0.54 ML/day at Larkhill throughout the year, although it is reasonably foreseeable that MOD will take higher volumes as required during very dry periods. This volume is more than the amount needed to deal with the impacts of ABP, and the resulting net reduction in abstraction from MOD's Larkhill, Round 'O' and Bulford boreholes is modelled to reduce existing impacts on river flows. Further groundwater modelling will be undertaken to assess the hydrological impact of the abstraction changes and to support Statutory abstraction licencing negotiations, once the contracted volumes have been agreed. To protect river flows in the interim, the Larkhill STW soakaway will not be turned off and MOD will not abstract water above current monthly peak volumes from the Larkhill, Bulford or Round 'O' boreholes, until the Wessex Water secondary supplies are secured and operational.

1.19 For waste water, the ABP developments at Tidworth, Perham and Ludgershall could not be wholly accommodated by Veolia within its current discharge consent; to accommodate the long-term population increases in the area, Tidworth STW is being/ will continue to be upgraded to meet new water quality discharge standards and to increase its capacity. Kelda's Upavon STW will need to be upgraded to handle the ABP uplift, and uplift at Bulford will be handled at Wessex Water's Ratfyn STW, as currently. However, MOD's Larkhill STW (which discharges to a surface soakaway) is unable to handle the ABP uplift and cannot be upgraded due to its location within Stonehenge World Heritage Site. Flows will therefore be diverted to Ratfyn STW via a new sewer and rising main, and Larkhill STW will be closed and demolished.

1.20 The additional discharge from Ratfyn STW will increase the phosphorus loading into the River Avon. This has implications for delivery of the River Avon Nutrient Management Plan, which aims to reduce phosphorus levels to achieve SAC conservation objectives. MOD has therefore agreed to implement a five-year phosphorus action plan in conjunction with Natural England to offset this additional loading. The plan involves the use of catchment-sensitive farming techniques to reduce diffuse agricultural pollution into the river, and if necessary investigating unsewered, MOD-owned properties and reviewing the use of MOD land along the Avon.

1.21 The IWMS will provide the basis for annual review and reporting to the Regulatory Salisbury Plain Hydrology Steering Group, with a formal update every five years across its 25 year life to ensure any changes within the water requirements and environment can be addressed.

2 INTRODUCTION

2.1 BACKGROUND

2.1.1 This Integrated Water Management Strategy (IWMS) has been prepared for the MOD by the Defence Infrastructure Organisation (DIO), Kelda Water Services Defence (KWSD) and WSP Parsons Brinckerhoff. It covers a 25 year period, and details firstly how MOD water resources are currently managed and secondly how the increase in military personnel and service families based around Salisbury Plain through the MOD's Army Basing Programme (ABP) will be accommodated.

2.1.2 The Army Basing Programme originates from the 2010 Strategic Defence and Security Review and 'Army 2020' Plan (*Ref 1*), which recommended the return of personnel from Germany and a reconfiguration of the Army into five regionally-based multi-role brigades. In March 2013, it was confirmed that Salisbury Plain would be the major focus of the Army's Reaction Force. At that time it was expected that in total, around 7,700 extra people (4,300 additional service personnel plus families) would be living around Salisbury Plain by 2020, placing additional pressure on water resources and sewage treatment capacity.

2.1.3 This figure of 7,700 additional people, published in the 2013 ABP Salisbury Plain Masterplan (*Ref 2*) has since been refined. ABP will now see an additional 3,958 military personnel and 2,293 dependents (representing a total uplift of 6,251 people). The scope of the proposed infrastructure change on Salisbury Plain resulting from ABP is as follows:-

- 443 new family homes for Service Families at Larkhill; 227 at Bulford and 247 at Ludgershall (a total of 917 new properties). A further 322 SFA at Tidworth[1] are currently being built.
- Over 2,500 new and refurbished single-living bed spaces for single soldiers at Larkhill, Bulford, Tidworth, Perham Down and Upavon.
- Refurbishment and construction of new technical infrastructure (such as garaging, hard-standing, workshops and offices) at all of the above sites.
- Closure of MOD's Larkhill Sewage Treatment Works and diversion of existing flows to Wessex Water's Ratfyn STW at Amesbury.
- The new training infrastructure on Salisbury Plain Training Area proposed in the 2014 Masterplan has now largely been removed from the proposals, with the exception of a tracked vehicle access road and associated vehicle washdown between Bulford and Salisbury Plain Training Area across the Nine-Mile River valley.

2.1.4 This IWMS is one of a series of documents been prepared by DIO to assess the impacts of ABP uplift on the conservation status of Salisbury Plain SPA/ SAC/ SSSI and the River Avon System SAC/ SSSI. This IWMS also details the impacts of existing MOD abstractions and discharges from those sites on the water environment, which is particularly important because MOD's own water abstractions on Salisbury Plain are not yet statutorily controlled and have been shown (through groundwater modelling) to be contributing to an adverse effect on river flows in the SAC.

2.1.5 DIO initially agreed a range of Environmental Commitments with Wiltshire Council in September 2014, enabling an initial Plan-level Masterplan Habitats Regulations Assessment (HRA) to be positively determined and the Salisbury Plain Masterplan (*Ref 2*) to be formally recognised by Wiltshire Council. The Commitments included the following measures to protect the water environment:

[1] The Tidworth SFA development (known as 'Area 19' or the 'Ashdown Estate') is not part of the ABP programme; however it will enable the Army to achieve its 2020 force laydown in the area.

- DIO will continue to work with the Environment Agency (EA), Natural England (NE) and Wiltshire Council to address the issues regarding additional water abstraction from Army Basing and support forthcoming planning applications for Salisbury Plain infrastructure (the first of which are planned for the last Quarter of 2014).
- DIO (in agreement with EA and NE) has re-run the regional groundwater model with Wessex Water sustainability reductions in place to reassess the in-combination impacts on natural flows and groundwater levels.
- In due course and as a separate exercise, DIO will also assess the implications of the JNCC flow targets and methodology with NE and EA. It will also identify and agree any additional long-term mitigation measures that may be required to meet the conservation objectives of the River Avon SAC.
- DIO will mitigate the abstraction impacts of supplying both the existing network and the proposed developments through a combination of water efficiency improvements, demand management (including implementation of a comprehensive water infrastructure management programme to significantly reduce leakage) and providing a secondary supply from Wessex Water and/or other sources. The mitigation options and implementation timelines will be agreed with NE and EA as soon as possible to support planning applications for Salisbury Plain infrastructure.
- DIO is assessing the provision of additional sewerage treatment capacity, and will include options for phosphate and nitrate removal in the design of its STW effluent systems for when policy has been confirmed by NE and the EA. The location of any new STW infrastructure at Larkhill *will be agreed with Wilts C and Historic England.*

2.1.6 The subsequent Planning permissions required that a Water Management Strategy be submitted and approved by Wiltshire Council before ABP developments are occupied. This Planning condition (detailed below) gives effect to the Masterplan Environmental Commitments:

> *"The development hereby permitted shall not be occupied until such time as a Water Management Strategy that includes the following components has been submitted to, and approved in writing by, the local planning authority. Where necessary, the Strategy shall make reference to, and be an integral part of, the wider Army Basing Programme developments and the existing MOD water network. Development shall be carried out in complete accordance with the Strategy approved as part of this condition to include:*
>
> *a) Details of water abstraction volumes, specific abstraction sources, where water will be discharged and leakage rates. This should include detailing any abstraction conditions and how these conditions will be met, also identifying the link between abstractions and discharge to meet licence and permit conditions.*
>
> *b) Where possible, an overall assessment of individual and combined environmental impacts relating to water resources and how any impacts will be mitigated.*
>
> *c) Details of any required mitigation or infrastructure improvements to the water abstraction/ supply or foul drainage network that have been identified in the overall assessment carried out as part of this Water Management Strategy, or that have been identified by other relevant studies.*
>
> *d) Any specific water management requirements/ mitigation for the developments hereby permitted."*

2.1.7 A Water Management Strategy in the form of a Water Resources Management Plan (WRMP) is normally undertaken by individual Water Companies to cover impacts within their supply area. This is as part of the industry asset management, funding and delivery agreements, undertaken for each Asset Management Planning (AMP) cycle in negotiation with OFWAT. However, across Salisbury Plain, the MOD effectively manages its own potable and foul water systems from abstraction to effluent discharge, with only a very small number of other customers (largely tenant farmers). In conjunction with the current exemption from abstraction licensing, there has until now been no driver for a WRMP covering Salisbury Plain to be prepared. Some aspects have been covered in other standalone documents where these relate to the MOD services that are dependent upon and interlinked with other services/suppliers which fall within the statutory framework.

2.1.8 Industry-standard WRMPs do not usually cover waste water issues – however due to the considerable environmental constraints affecting the Salisbury Plain area, this IWMS does cover both water abstraction and discharge, including the effects of both on ground and surface water hydrology and on water quality.

2.1.9 For historical reasons, the MOD water resource arrangements on Salisbury Plain are relatively complex, with different sites being serviced by a number of water undertakers:

Table 1 – MOD's current Supply Chain partners for water and sewerage across Salisbury Plain

Services supplier	Area(s) of responsibility
Kelda Water Services Defence (KWSD)	MOD potable abstractions at Larkhill, Bulford, Round 'O' (Tilshead) and Upavon Water supply to the boundary of Larkhill, Bulford and Upavon camps Water distribution within the boundary of Upavon camp. Management of foul flows from the boundary of Larkhill, Bulford and Upavon camps Operation of STWs and associated surface-water soakaways at Larkhill and Upavon Responsibility for water supply and management of foul flows from some (but not all) existing SFA at Larkhill, Bulford and Upavon.
Project Allenby-Connaught PFI: Aspire Defence and Multi Utility Joint Venture (MUJV)	Water distribution within the boundary of Larkhill, Bulford, Tidworth, Ludgershall and Perham Down camps. Management of foul flows within the boundary of the above sites.
Tidworth Inset PFI - Veolia Water	Water supply to the boundary of Tidworth, Perham Down and Ludgershall camps and associated SFA Management of foul flows and sewage treatment from the above sites. Veolia also supplies civilian properties within the Tidworth Inset area as the incumbent Statutory Undertaker. Veolia will also supply the new SFA at Corunna Barracks, Ludgershall, as Statutory Undertaker.
Wessex Water	Water supply to some SFA as Statutory Undertaker (principally the Canadian Estate at Bulford). Treatment of sewage from Bulford garrison and associated SFA. Wessex will also supply water to, and manage the treatment of sewage from, the new SFA at Larkhill and Bulford as Statutory Undertaker. With closure of Larkhill STW, Wessex will also manage the foul flows from Larkhill camp and existing SFA.

2.1.10 Given the complexity of the water supply and treatment arrangements across Salisbury Plain, this IWMS has been developed and prepared in close consultation with Wiltshire Council, the Environment Agency and Natural England through MOD's ABP Masterplan Hydrology Sub-Group. Historic England has also been consulted, due to the presence of water infrastructure within the boundary of the Stonehenge World Heritage Site. Due consideration has been given to the shared natural chalk catchments that provide the basis for water abstraction and discharge for both Veolia and Wessex Water; both organisations are considered key stakeholders and have also been consulted throughout.

2.1.11 It is intended that the document will assist MOD to agree a way forward for managing water resources on Salisbury Plain with DEFRA as part of forthcoming abstraction reform negotiations.

2.2 STUDY AREA

2.2.1 This IWMS only covers that part of Salisbury Plain which will be impacted by ABP development, as shown in Figure 1 and Table 2 below. This includes the Tidworth supply area (covering Tidworth, Perham Down and Ludgershall) for which Veolia has already published a Statutory WRMP (*Ref 3*).

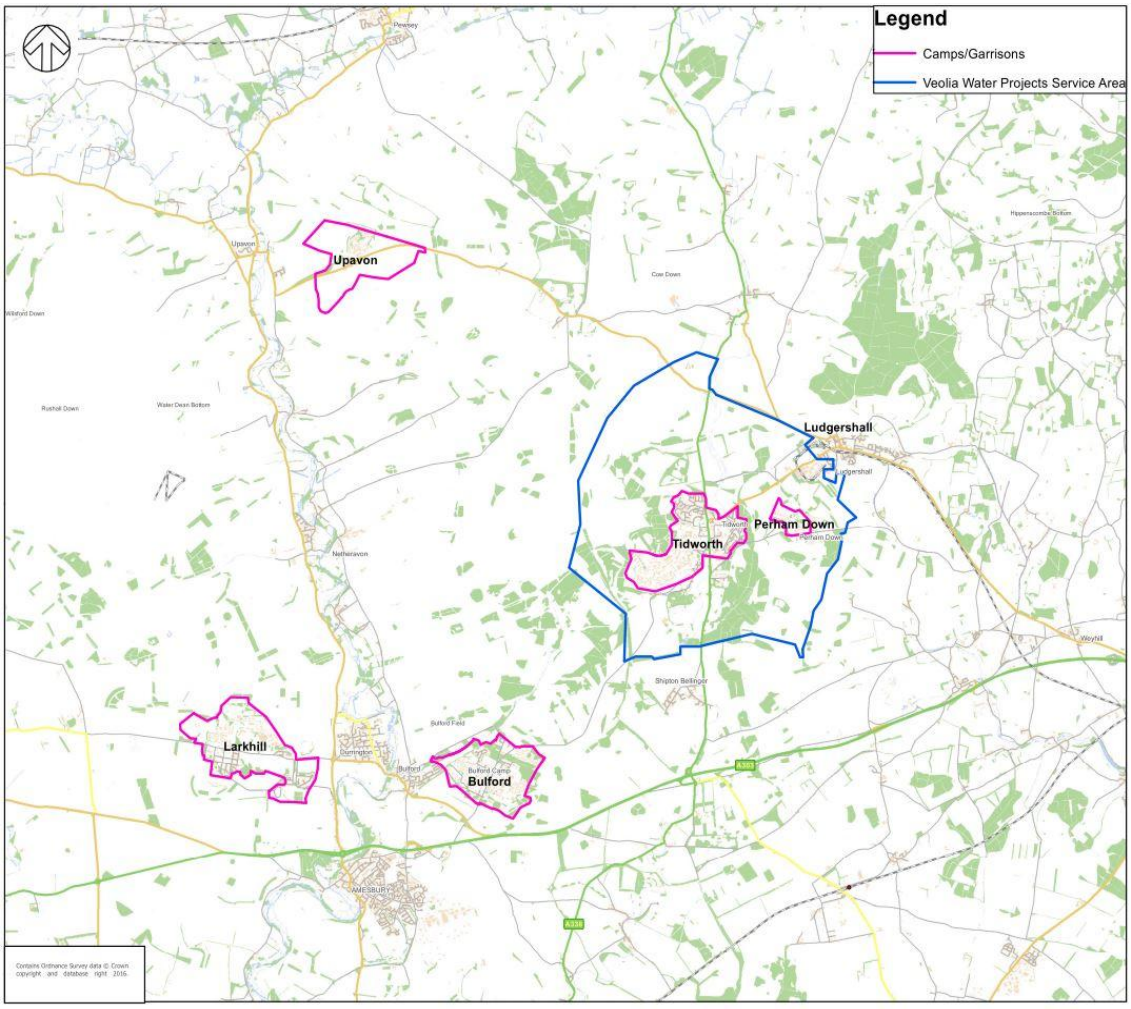

Figure 1 - IWMS Study Area

2.2.2 Tidworth and Perham Down garrisons and the associated SFA at Ludgershall lie to the east of the study area. The only surface watercourse in this area is the River Bourne, a winterbourne stream which flows ephemerally through the eastern section of Tidworth garrison. These sites fall within the Veolia inset area.

2.2.3 Upavon camp is situated in the north of the study area, on a hill top approximately 2km east of Upavon village. The River Avon flows through the village but not the camp.

2.2.4 The Larkhill and Bulford camps are located in the south of the study area to the west and east of the A345/River Avon, respectively. Bulford lies immediately south-east of the Nine-Mile River, which flows into the River Avon downstream in Bulford village.

Table 2 –Army Basing Programme developments on Salisbury Plain

Location	Proposals
Larkhill camp	- New and refurbished technical accommodation - New and refurbished Single Living Accommodation (SLA) * - 443 new Service Families Accommodation (SFA) on greenfield land east of the camp - Closure of the MOD Larkhill STW and diversion of all new and existing flows to Wessex Water's Ratfyn STW - Upgrade of the existing Wessex Water supply to camp
Bulford camp	- New and refurbished technical accommodation - New and refurbished SLA * - 227 new SFA on greenfield land south-west of the camp - New tracked vehicle access onto SPTA plus associated vehicle washdown facility - New supplementary/ back-up water supply to camp from Wessex Water
Tidworth garrison	- New and refurbished technical accommodation - New and refurbished SLA * - 322 new SFA on greenfield land south of the Garrison (not within the scope of the Masterplan, but for ease are being delivered through ABP).
Perham Down garrison	- New and refurbished technical accommodation - New and refurbished SLA *
Ludgershall camp	- Demolition of existing military site - 227 new SFA on brownfield land within the existing site
Upavon camp	- New and refurbished technical accommodation - Upgrade or replacement of STW; upgrade of soakaway - Approx. 180 new and refurbished SLA

* Just over 2,500 new SLA are planned across the Aspire estate, which encompasses Larkhill, Bulford, Tidworth and Perham.

2.3 LIMITATIONS

2.3.1 It should be noted that for historical reasons there are low levels of data in some instances, particularly for historical water use and leakage rates. A programme for addressing these uncertainties has been on-going for the last couple of years. As a result, the figures and approaches used within this document have been based upon the best available information at the time of preparation, including the last three years of Recent Actual water consumption. This approach has been reviewed and agreed by the Environment Agency.

2.3.2 It should also be noted that there is an inherent degree of uncertainty in the data, where it has been estimated or calculated. This is particularly important to note when considering the groundwater modelling results, which are based on the best information available.

2.3.3 It has not been possible at this time for the IWMS to cover other military sites on SPTA not affected by ABP (such as Porton Down or Warminster), due to funding constraints and delivery timescales. However, the IWMS will be kept under review through the ABP Hydrology Steering Group and its scope amended in future, if required.

3 POLICY

3.1 REGULATORY REQUIREMENTS AND GUIDELINES

3.1.1 According to the Environment Agency's 'Water Resources Planning Guideline – Guiding Principles' (*Ref 4*) the key policy priorities the Government expects Water Resources Management Plans to include are:

- A long term perspective.
- Water scarcity and environmental damage.
- Water trading, cross boundary solutions and third party solutions.
- Reducing demand for water.

3.1.2 Water undertakers must prepare and maintain a 25 year WRMP in accordance with the Water Resources Management Plan Direction 2012. This legislation requires that the WRMP meets the requirements set out in Sections 37A-D of the Water Industry Act 1991 (as amended by Section 62 of the Water Act 2003). Section 3 of the Direction details matters to be addressed in a WRMP.

3.1.3 The Water Industry Act 1991 states that the plan must detail how the water undertaker will manage and develop water resources so as to be able to, and continue to be able to, meet its obligations. Under Section 37A, the plan should address the quantities of water required to meet its obligations; the measures the water undertaker intends to take or continue; the likely timing and sequence of such measures; and any other measures that the Secretary of State may specify. The Act also requires that before the preparation of the management plan, the water undertaker consults the Environment Agency, the Authority, the Secretary of State and any licensed supplier which supplies water to premises in the undertaker's area via the undertaker's supply system.

3.1.4 The Water Resources Management Plan Regulations 2007 provide further guidance on the production of a WRMP and has been referred to in the development of this IWMS.

3.2 LEGISLATION

3.2.1 There is a range of legislation covering environmental protection which MOD must comply with, and in some cases, has special duties to discharge. Those important for this Strategy are outlined below.

3.2.2 The European Habitats Directive (92/43/EEC) and transposing UK Regulations (the Conservation of Habitats and Species Regulations 2010) aim to achieve, protect and enhance Favourable conservation status of Natura 2000 sites. Both Salisbury Plain and the River Avon (including specific stretches of the Bourne, the Wylye and Till and wetland features alongside the Avon) are designated as Special Areas of Conservation (SACs) under the UK Habitats Regulations. Competent Authorities (in this case MOD and Wiltshire Council) are required to undertake an 'appropriate assessment' of any plans or projects that are likely to have a significant effect on the Conservation status of the SAC.

3.2.3 The last SSSI condition assessment, undertaken in ca. 2009, (from which SAC Conservation status is derived) identified the River Avon System SSSI as being 3.5% favourable, 37% unfavourable recovering, 57% unfavourable no change and 2.5% unfavourable declining. A series of plan-level Habitats Regulations Assessments (HRAs) have been undertaken by DIO to inform the ABP Salisbury Plain Masterplan *(Ref 2)* and by Wiltshire Council to inform individual development proposals. The latest (March 2016) Masterplan HRA can be found at Appendix H. Subject to implementation of the mitigation and enhancement measures laid out in this IWMS, no deleterious impacts on the SAC are expected from ABP, and the project-level HRAs for individual ABP have now been positively determined by Wiltshire Council. Further HRA assessment will however be needed to support forthcoming abstraction licensing negotiations.

3.2.4 The EU Water Framework Directive (2000/60/EC) and transposing UK Regulations (the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, as amended) establishes a framework for the protection of inland surface waters, estuaries, coastal waters and groundwater. Under Article 4 of the Directive, most water bodies are required to achieve good groundwater status and good surface water status (incorporating ecological and chemical status) by December 2015. This includes a requirement for no deterioration of elemental status with respect to pollutants, including phosphorus.

3.2.5 Within the scope of this Strategy, there is one groundwater body (the chalk aquifer) and four surface water bodies (Rivers Avon, Till, Nine-Mile and Bourne). It should be noted that the River Avon catchment is classified as a Protected Area under the Directive; however those watercourses within the SAC (the Avon, the Till and most of the perennial Bourne) are subject to the more stringent SAC standards for achieving and maintaining favourable Conservation status. As of 2015, EA data showed the Nine-Mile River (which is not in the SAC) having moderate ecological quality and good chemical quality. For groundwater, the aquifer is classified as poor for both quantity (due to over-abstraction) and for quality (due to diffuse, mainly agricultural, pollution).

3.2.6 The Wildlife and Countryside Act 1981 (as amended most recently by the Countryside and Rights of Way Act 2000 and the Natural Environment and Rural Communities Act 2006) gives protection to wildlife, controls invasive species, enhances the protection of SSSI's and enhances public access to the countryside. Within the the scope of this Strategy, there are two SSSI's – the River Avon SSSI, which covers a larger footprint than the River Avon SAC, and Salisbury Plain SSSI, which includes the upper (ephemeral) reaches of the Nine-Mile River and adjacent ponds which support populations of the European-protected Great-Crested Newt. ABP development must therefore not adversely affect either SSSI – in particular, flows in the Nine-Mile River and water levels in the hydrologically-connected ponds.

3.2.7 The Environmental Permitting (England and Wales) Regulations 2010 replaced the Water Resources Act 1991 as the key legislation for minimising water pollution in the UK. Under the Environmental Permitting Regulations it is an offence to cause or knowingly permit a water discharge activity, including the discharge of polluting materials to freshwater, coastal waters, relevant territorial waters or groundwater, unless complying with an environmental permit or exemption. All the STWs within the scope of this Strategy operate under statutory environmental permits. However it should be noted that a number of private and MOD-owned properties around Salisbury Plain are not sewered but no not require an environmental permit to discharge effluent to ground.

3.3 GUIDANCE

3.3.1 This IWMS takes full account of the 2015 River Avon SAC Nutrient Management Plan for Phosphorus (*Ref 5*). This identifies measures to reduce phosphorus discharges into the SAC from point and diffuse sources to achieve SAC conservation objectives and Good WFD status by 2027 through the delivery of 'protected area' standards. Implicit in this guidance (which has been adopted within the Wiltshire Core Strategy (*Ref 6*)) is that any new phosphorus discharges are only permitted where they either do not adversely affect the deliverability of the Plan, or are otherwise offset, to ensure that the overall level of reactive phosphorus in the river does not increase.

3.3.2 This IWMS has also been produced with reference to the Environment Agency's 2012 Water Resources Planning Guideline (*Ref 4*) and the Water Resources Planning Guideline – Navigation tool for smaller water companies (*Ref 7*). Some variations on the approach have been required due to the unusual nature of water supply arrangements on Salisbury Plain.

3.4 NATIONAL SECURITY CONSIDERATIONS

3.4.1 The information contained within this plan is considered to be at the appropriate level for a WRMP. However, some detailed information has been removed from this (publicly available) document for reasons of national security. All relevant information has however been made available to the Regulators. The document has been reviewed by Kelda and has been adjudged not to contain any information that would compromise national security.

4 METHODOLOGY

This section details the general approach and methodology used, and the key constraints for the IWMS. Where specific approaches are required for individual sections, they are detailed in that section.

4.1 SALISBURY PLAIN WATER RESOURCE ZONES

4.1.1 At the highest level a Water Resource Zone (WRZ) describes an area within which the management of supply and demand is largely self-contained (apart from agreed bulk transfers of water). A WRZ is defined by UK Water Industry Research and the Environment Agency as:

"The largest possible zone in which all resources, including external transfers, can be shared and, hence, the zone in which all customers will experience the same risk of supply failure from a resource shortfall."

Within this IWMS, four Water Resource Zones (WRZs) have been identified across the study area; these are Tidworth, Bulford, Upavon and Larkhill.

4.1.2 Given the rural nature of Salisbury Plain, the WRZs are largely limited to individual camps, with associated SFA and areas of SPTA in their immediate vicinity. The exception to this is the Tidworth WRZ, which also covers both Perham Down and Ludgershall. Figure 1 shows the location of the WRZ's, with further detail in Appendix A.

4.1.3 All the WRZ's have individual abstractions and service reservoirs to ensure continuity of supply. Downstream, the supply network in each WRZ is tightly integrated and is without outside connections, so the risk of supply failure is similar for each. The exception to this is Larkhill, which has a connection to the Round 'O' abstraction borehole at Tilshead. Since Round 'O' serves several other Camps and locations across SPTA which are outside the scope of ABP, the WRZ is limited to Larkhill, although the import of water to Larkhill from Round 'O' is accounted for.

4.2 COMPLEMENTARY DOCUMENTS

4.2.1 Veolia (VWP) supplies MOD properties at Tidworth, Perham Down and Ludgershall under an Inset agreement, and also supplies civilian population in the same area. As the Statutory Undertaker, Veolia has produced and published a WRMP for this area (*Ref 3*). Veolia's three groundwater abstractions are licenced, and its principal STW at Tidworth permitted by the Environment Agency. The environmental impacts of fully-licensed abstraction and effluent discharge will have been assessed and deemed acceptable to the licensing Authority, as part of the approval process. As a result, no further assessment is needed of the environmental impact from Veolia's existing operations within this IWMS. Nevertheless, key parts of the Veolia WRMP are referenced in relevant sections. The WRMP can be found at Appendix B.

4.2.2 As part of the consultation process for this report, Veolia confirmed that no changes to its WRMP are currently required and that the ABP uplift will be used within the Inset area and discharged back to the catchment via Tidworth STW. However, the company is in discussion with the Environment Agency to vary its licence conditions between its three abstraction points and to finalise a new environmental permit for Tidworth STW, to ensure that it can meet future demand. Given the current and forecast headroom, this would not require any variation to the existing combined maximum abstraction requirement.

4.2.3 Wessex Water has produced its own WRMP (*Ref 8*), which covers its abstractions across the river Avon catchment. Of particular relevance are the Durrington and Shrewton Public Water Supply abstractions which, in combination with MOD abstractions, have been shown by the groundwater model to affect flows in the Avon and the Nine-Mile River. As with Veolia, Wessex Water's abstractions and STWs are all licenced/ permitted, respectively, by the Environment Agency. The environmental impacts of fully-licensed abstraction and effluent discharge will have been assessed and deemed acceptable to the licensing Authority. As a result, no further assessment is needed of the environmental impact from Wessex Water's existing operations within this IWMS.

4.3 BASELINE DATA

4.3.1 The dynamic and transient nature of the military population across Salisbury Plain (coupled with a relative lack of accurate historical data) means that forecasting the water demand accurately for any given period is far more complex than for most statutory undertakers. The assessment of current and future water requirements in this IWMS is therefore based on recent water use data (April 2012 – April 2015 inclusive). This period coincides with the return of troops from active deployment and the initial return of units to Bulford from Germany.

4.4 SUPPLY-DEMAND TABLES

4.4.1 Information from the EA indicates that Supply-Demand Tables are currently being updated following the statutory undertakers' submissions of their WRMP's, and are unlikely to be finalised until mid-2016. These tables are primarily designed for statutory undertakers with many customers and with the consequent need to demonstrate a range of elements such as abstraction sources, deployable output, performance, measures to reduce demand, metering and cost effectiveness. It is considered that completing these tables will not add value, especially since the Regulators and MOD have been involved in the preparation of this study. Further information can be provided if required once the updated tables have been received.

4.5 WESSEX BASIN GROUNDWATER MODEL

4.5.1 The assessment of ABP's likely impact on groundwater and river flow has been undertaken using the Wessex Basin Groundwater Model (WBM). This model was developed for the EA by Amec Foster Wheeler and has been used to help set abstraction licences across the area. The baseline data has been updated to include the most up-to-date information on MOD abstraction and discharge rates and to take account of the recently-agreed Wessex Water sustainability reductions, which have and will reduce abstractions shown to be having an impact on flows in the River Bourne. The most recent technical reports are provided in Appendix C.

4.5.2 MOD's water abstractions are not licensed, although they will be once forthcoming DEFRA abstraction reforms come into force. As a result, there is as yet no fully-licensed ('FL') volume figure available to use in the model. Before modelling was undertaken, MOD agreed with the EA that the maximum monthly peak recent actual abstraction figure should be used as a 'proxy' for the 'FL' amount. This value was deemed the best figure to use, given the transient nature of the military population and associated significant uncertainties in monthly demand.

4.5.3 The treated effluent discharges from relevant STWs are also included in the model, since they directly support river flow and groundwater levels. The discharge volumes are based on the following calculation:

STW Discharge + Site Losses = (Abstraction +SU Supplies ± Transfers) *0.95

4.5.4 Note that the modelling is based upon a conservative 'worst case' scenario, as it assumes that flows in the River Avon SAC would be at their lowest, whilst MOD, Wessex and Veolia would simultaneously all be abstracting and discharging at 'FL' volumes. In practice, this situation would be very unlikely to occur.

4.5.5 As recent leakage management successes at the Garrisons (managed by Aspire) are currently being confirmed and long-term plans for leakage reduction are currently being agreed by the MOD and its partners, no additional allowance has been made for the reduction of leakage from the MOD network, other than those reductions already captured within the Recent Actual figures. Given the relatively small distribution systems and the model's assumption that any water leakage largely returns to the aquifer from which it was abstracted, it was deemed that changes in leakage rates would not have a significant impact on the model results. This departs from standard practice for modelling assessments undertaken for statutory undertakers, whose distribution systems are much larger and routinely transfer water between catchments.

4.5.6 All of the above assumptions and methods were agreed with the Statutory Consultees prior to modelling being undertaken.

4.6 GROUNDWATER MODELLING SCENARIOS

4.6.1 The abstraction scenarios that have been assessed are outlined below. Note that these model 'runs' follow on those undertaken previously by the Environment Agency and Wessex Water for their own purposes.

- Run 251 – The 'natural' scenario (e.g. no abstractions) against which all other runs are compared.
- Run 295 – updated 'Recent Actual' abstraction volumes (without ABP).
- Run 296 – updated 'Full Licence' abstraction volumes (without ABP).
- Run 297 – updated 'Full Licence' plus ABP – i.e. maximum future demand.
- Run 298 – as per Run 297 but with MOD's Bulford abstraction turned off, to simulate Bulford camp switching to a Licensed Wessex supply.
- Run 299 – as per Run 297 but with MOD's Larkhill abstraction turned off and the Round 'O' abstraction reduced by 50%, to simulate Larkhill switching to a Wessex supply.
- Run 300 – as per Run 297, but with both Bulford and Larkhill abstractions turned off, and Round 'O' reduced by 50%, to simulate both camps switching to a Wessex supply.
- Run 301 – as per Run 297, but with Bulford and Larkhill abstractions reduced by 50% and Round 'O' reduced 25%, to simulate a 50% switch across both sites to a Wessex supply.

4.6.2 Appendix C details the water volumes used for each model run. Note that Runs 296 and beyond have incorporated the forthcoming Wessex Water sustainability reductions; however Run 295 is based on recorded Recent Actual abstractions, *not* the new RA abstraction rates that will become the norm once the sustainability reductions come into force. Once these reductions are in place, the new 'FL' volumes will actually be lower than 'RA' volumes. As a result, these figures are not directly comparable.

4.6.3 The model uses flow duration statistics based upon the period 1970-2012. This is considered to be a relatively long record and would in theory include several dry years, given that these are expected every 5 to 10 years on average. In practice, significant droughts occurred in England in 1975-76, 1995, 2006 and 2010-12. The impacts of droughts on the study area are therefore considered to have been assessed within the modelled period and this plan.

4.6.4 The findings of the groundwater modelling are detailed in Appendix C, and their wider implications on and water environment are discussed in Section 8.

4.7 ASSESSMENT OF PHOSPHORUS LOADING FROM ABP

4.7.1 Unlike statutory WRMPs, this IWMS also covers waste water. During the preparation of the revised Wiltshire Core Strategy *(Ref 6)* in 2012, an assessment of the additional nutrient loading into the River Avon SAC from consented discharges was undertaken. The findings were used to inform the development of the River Avon Nutrient Management Plan *(Ref 5)* and the Review of Consents (RoC) process, whereby the discharge consents of the Wessex STW's were reviewed and updated. However, ABP was not announced until March 2013, so the associated uplift in sewage volumes from ABP was not included in the Plan.

4.7.2 Given that MOD intends to close Larkhill STW (as described further in Section 8), all existing sewage from Larkhill plus the ABP uplift at Bulford and Larkhill will be transferred to and treated at Wessex Water's Ratfyn STW. As a result, the estimated additional phosphorus discharge into the River Avon must be calculated. The calculation methodology is detailed in Appendix F.

4.8 LIVING DOCUMENT

4.8.1 As MOD's water resources planning matures and ABP-related changes take place, the technical data is likely to evolve. As a result, the information in the Tables may fall slightly out of date over time. This IWMS intended to provide the basis for annual review and reporting, with a formal update every five years across its 25 year life to ensure any changes within the water requirements and environment can be addressed.

4.8.2 The ABP Hydrology Steering Group (which will include the Regulatory community) will monitor annual performance and ensure delivery of associated mitigation measures, ahead of statutory abstraction licensing coming into force.

5 WATER SUPPLY

5.1 CURRENT WATER SUPPLY SITUATION

5.1.1 MOD abstracts water from a number of abstraction locations across Salisbury Plain. Within the scope of the IWMS, water is abstracted from 11 boreholes, some of which supply other military sites outside the WRZs. These abstractions are detailed in Table 3 below.

Table 3 - Abstraction Boreholes Supplying ABP Affected Sites (*Licensed abstractions bold*)

RESOURCE ZONE	REFERENCE	AQUIFER TYPE	OPERATOR	IN USE
Upavon	BH1	Chalk	Kelda Water	
	BH2	Chalk	Kelda Water	Not currently Used
	BH3	Chalk	Kelda Water	
Larkhill	BH01	Chalk	Kelda Water	
	BH02	Chalk	Kelda Water	
Round 'O'	BH10	Chalk	Kelda Water	
	BH11	Chalk	Kelda Water	
Bulford	BH1	Chalk	Kelda Water	
	BH2	Chalk	Kelda Water	
	BH3	Chalk	Kelda Water	Not currently Used
Tidworth	**BH1**	Chalk	Veolia Water	Disused
	BH2	Chalk	Veolia Water	
	BH3	Chalk	Veolia Water	
	CP	Chalk	Veolia Water	

5.1.2 The abstraction, treatment, storage and distribution arrangements in each WRZ are outlined below, with supporting diagrams in Appendix A.

LARKHILL WRZ

5.1.3 Larkhill WRZ includes Larkhill camp and associated SFA. The new SFA to be built for ABP is not included in the WRZ, since water will be supplied by Wessex Water.

5.1.4 Water to supply the Larkhill WRZ comes from two locations; the primary source is the two MOD Larkhill boreholes (BH01 and BH02), although when necessary further water is drawn from the Round 'O' boreholes at Tilshead via a trunk main. A further pipeline connects Larkhill camp to the Wessex Water supply; approximately 0.053 ML/d is drawn from Wessex to maintain the quality of water in the pipe. This infrastructure ensures that a back-up supply is available immediately when needed.

5.1.5 Water abstracted from BH01 and BH02 is treated and metered before passing into a two-compartment service reservoir. From there, water gravitates to distribution at Larkhill Camp. A small amount (approximately 0.095m^3/d RA) is transferred to the small satellite Avon West camp, north of Larkhill. Water is also extracted from boreholes at Round 'O' (BH10 and BH11) and is treated at a WTW before passing through the trunk main and transfer meter to the Larkhill service reservoir, as required. The Round 'O' boreholes also supply three other camps/ depots on SPTA which are outside of the Larkhill WRZ.

5.1.6 Table 4 below outlines the abstractions for this WRZ in annual average, monthly peak and daily peak terms. The daily peak figure has been provided to enable a direct comparison with the Tidworth WRMP, although as a calculated estimate, it should not be used for planning purposes. Note that the maximum monthly flows (FL 'proxy' figures) are derived from site level use rather than by borehole. At Larkhill, the two boreholes run as duty/duty, therefore peak monthly values are unlikely to coincide. However Bulford and Upavon operate duty/standby, which explains the apparent difference between the sites.

Table 4 - Larkhill WRZ Outputs (ML/ day)

Abstraction volumes (ML/ day)	**BH01**	**BH02**	**NET TRANSFER FROM ROUND 'O'***
Recent actual annual average	0.302	0.714	0.093
Peak monthly value (April 2012 to March 2015)	0.389	0.967	0.215
Daily peak	0.549	0.997	0.711

* Transfer from Round 'O' Boreholes to Larkhill Knighton Down Service Reservoirs minus transfer to Avon West Camp

BULFORD WRZ

5.1.7 Bulford WRZ includes Bulford Camp and some existing SFA. Neither the Canadian Estate nor the new ABP SFA developments are included in the WRZ, since water for these is/ will be supplied by Wessex Water as statutory undertaker.

5.1.8 Within the Bulford WRZ, water can be abstracted from the Bulford boreholes BH1, BH2 and BH3. Bulford boreholes BH1 and BH2 are metered at source via a System/ DMA Meter; BH3 is not currently in use. From the two operational sources, water is treated prior to transfer to a service reservoir. A distribution pump then pumps the water via another System/ DMA Meter to a second service reservoir and a further metering point and into Bulford Camp. Table 5 outlines the abstractions for this WRZ, in annual average, monthly peak and daily peak terms (as above, the daily peak figure has been provided to enable a direct comparison with the Tidworth WRMP). There is currently no intention of using Bulford BH3, although this may be reviewed as part of future licencing discussions.

Table 5 - Bulford WRZ Outputs (ML/ day)

ABSTRACTION VOLUMES (ML/D)	BH1	BH2	BH3
Recent actual annual average	0.630	0.477	0
Peak monthly value (April 2012 to March 2015)	1.398 (all boreholes)		
Daily peak	1.638 (all boreholes)		

UPAVON WRZ

5.1.9 Upavon WRZ includes Upavon camp and existing SFA. In this WRZ, water is extracted from two boreholes (BH1 and BH3), with a third (BH2) currently unused. The supply passes through WIS Meters before passing into two service reservoirs. From the reservoirs, the water is pumped via distribution pumps to Upavon camp via a further System/ DMA Meter. Table 6 outlines the abstractions for this WRZ, in annual average, monthly peak and daily peak terms (the daily peak figure has been provided for comparison with the Tidworth WRMP). There is currently no intention of using Upavon BH2, although this may be reviewed as part of future licencing discussions.

Table 6 - Upavon WRZ Outputs (ML/ day)

ABSTRACTION VOLUMES (ML/D)	BH1	BH3	BH2
Recent Actual Annual Average	0.124	0.127	Not currently in use
Peak monthly value (April 2012 to March 2015)	0.308 (for both boreholes)		
Daily peak	0.330 (for all boreholes)		

TIDWORTH WRZ

5.1.10 Tidworth WRZ includes Tidworth Garrison, Perham Down and Ludgershall camps and associated SFA. Unlike the other WRZ's, the abstractions within the Tidworth WRZ are licenced. Water is abstracted from three separate boreholes (BH1, BH3 and CP) under licence conditions. The water is treated at two sites (BH2 and BH3 are treated at the same site), via Granular Activated Carbon (GAC) filtration at one site and marginal chlorination at the other, with an interposed contact tank/ main at both sites. The treated water is pumped from the treatment sites to a strategic reservoir and from the other source to a small distribution reservoir under borehole pressure, from which point the network is almost entirely gravity fed.

5.1.11 The source volume outputs for 2011-2012 are shown in Table 7. This shows that this WRZ operates at an annual average of 5.52ML/ day, but peak volume can be up to 7.05ML/ day. Sources BH2 and BH3 together provide 78% of the total distribution input.

Table 7 - Source Volume Outputs for 2011-12 (ML/ day) (adapted from VWP WRMP, 2014)

ABSTRACTION VOLUMES (ML/D)	BH1	BH2	BH3	CP	GROUP TOTAL
Recent Actual Annual Average (2011-2012)	0.00	2.22	2.10	1.20	5.52
Average Peak	0.00	2.47	2.35	2.23	7.05
Annual Total (ML)	0	809	766	435	2,010

5.1.12 BH2 and BH3 run close to peak capacity, however CP is relied upon in times of peak demand, with abstraction increasing by around 86% from average to peak.

ABSTRACTION SUMMARY

5.1.13 The abstraction profiles for all four WRZ's reflect the transient nature of military occupation across the garrisons/ camps throughout the year, with demand tending to drop during the summer months in line with lower training requirements. This is an unusual trend compared to most water companies whose demands traditionally peak during this period as a result of higher domestic use. Figure 2 shows the three year average monthly abstraction volumes for the Kelda-operated Larkhill, Upavon and Bulford WRZs.

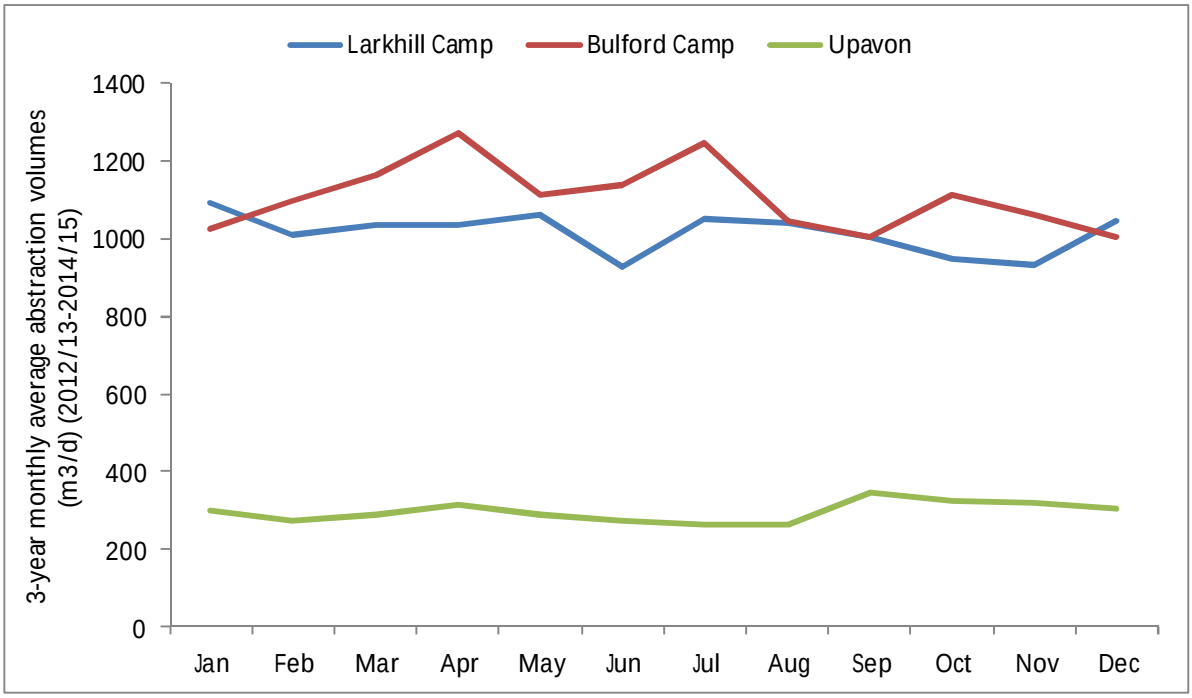

Figure 2 - Average abstraction volumes for Larkhill, Bulford and Upavon WRZs (three year average 2012/13-2014/15)

5.1.14 The available data is currently not at a suitable resolution to assess water demand on a sub-monthly level for a variety of reasons including significant population changes at weekends (actual numbers are unavailable). The VWP WRMP (*Ref 3*) states:

"There are times when there will be significant variations in consumption as a result of the transient nature of MOD planning. There is no reliable advanced warning of these activities for obvious reasons of security and their effect may be to reduce the behind the wire soldiery to a very small percentage of the total established levels for several months at a time. The corollary of this situation maybe that an influx of Units consisting many hundreds of troops deploy to Tidworth and its environs on Salisbury Plain thus inflating consumption of services. This scenario often occurs several times per annum and can last for 2-3 weeks at any one time."

5.2 LEVEL OF SERVICE AGREEMENTS

LARKHILL, BULFORD & UPAVON WRZS

5.2.1 The level of service agreement that covers the water supply to the camps within the Larkhill, Bulford and Upavon WRZs is covered by the AQUATRINE contract. AQUATRINE is the MOD Private Finance Initiative (PFI) which brings industry expertise to the management of water and waste water infrastructure and assets on the majority of MOD sites in Great Britain. It operates three separate contracts, known as Packages, which each run for 25 years until 2028. Kelda Water Services Defence (KWSD) holds the contract for South-West England, which includes Salisbury Plain.

5.2.2 The Key User Requirements within the contract are to:

- Provide an uninterrupted supply of potable water for drinking;
- Provide a supply of water for fire fighting purposes in accordance with Crown Fire Standards (CFS);

- Collect and dispose of sewage and surface water;
- Operate a dedicated 24 hour help line for all Service users;
- Ensure there is no flooding from surface water or foul systems caused by a failure to provide the services.

TIDWORTH WRZ

5.2.3 Veolia (VWP) acquired the water supply and sewerage contract for the Tidworth WRZ from Thames Water under an Inset Appointment in 2007, and now provides clean and waste water services for over 800 civilian and over 90 commercial properties in Tidworth and the surrounding areas. An additional PFI agreement is in place with the MOD to serve Tidworth, Perham Down and Ludgershall camps, together with approximately 1,300 SFA. This contract will be in force until February 2018.

5.3 IMPORTS AND EXPORTS INTO EACH WRZ

IMPORTS

5.3.1 The imports into the WRZ's are:

- Contribution from Round 'O' boreholes into Larkhill WRZ;
- The secondary Wessex connection into Larkhill WRZ (any volumes from which are accounted for in the groundwater model as part of the Wessex 'FL' abstraction figure);
- The Wessex supply to the existing Canadian Estate SFA at Bulford WRZ (volumes from which are accounted for in the groundwater model through the Wessex 'FL' figure).

There are currently no other imports into any of the other WRZ's.

5.3.2 As the ABP SFA developments at Larkhill and Bulford will be supplied by Wessex as the statutory undertaker, these will be classed as imports into the Larkhill and Bulford WRZs, respectively.

EXPORTS

5.3.3 There is only one main export across the study area. The Leckford Bridge Agreement within the Tidworth WRZ is a bulk supply agreement between Veolia and Wessex Water, whereby Wessex Water takes up to 3 ML/ day from Veolia, with a maximum instantaneous flow equivalent to 36.5 litres per second and a maximum take of no more than 1,000ML/ year. In practice, Wessex takes an average of 2.74ML/ day. If Veolia's peak daily demand exceeds a critical threshold figure of 5.4ML/ day, Veolia can reduce the volume of their transfer to Wessex on a litre by litre basis. To date, Wessex Water has not taken its full entitlement in accordance with this agreement. This agreement is due to terminate in 2022. However, the high nitrate levels that are affecting local Wessex Water abstractions are not reducing significantly; it should therefore be assumed that this agreement will continue throughout the period of the Veolia WRMP to 2040. As this export is covered by existing abstraction licences it is accounted for within the groundwater model through the Veolia 'FL' figure.

5.3.4 The water supply to Avon West Camp (which will not be affected by ABP) is considered to be a small export from the study area, as it is supplied by the service reservoirs and abstractions within the Larkhill WRZ.

5.3.5 All other exports are non-typical bulk supplies, consisting of three separate Wessex Water enclaves within the Veolia supply boundary and operated in accordance with their own licence by Wessex Water. These enclaves contain approximately 350 Wessex Water customers.

5.4 DEPLOYABLE OUTPUT

5.4.1 It is necessary to assess Deployable Outputs ('DO') to ensure that the risks to both supplies and the environment are considered in conjunction with the supply system. This assessment needs to be proportionate in its approach, taking into account the available data and the use of the Wessex Basin Groundwater Model to assess the wider environmental implications.

5.4.2 For the purposes of this IWMS, Deployable Output (DO) is based on the maximum peak monthly abstraction over the monitoring period (April 2012 to April 2015) for Larkhill, Bulford and Upavon WRZ's. This data has been determined by establishing the maximum abstraction recorded for each borehole in any given month over the three-year period. Daily figures have been derived on the basis of each month being 30 days long.

5.4.3 The Deployable Output for each site (Table 8) has been assessed upon the available data (April 2012 to April 2015 for Larkhill, Bulford and Upavon WRZ's). This data is currently being revised and refined in light of abstraction reform. The data used for these WRZ's is Recent Actual (for the average annual use) and the 'Full Licence' (for the maximum Daily Licence at Tidworth and estimated MOD equivalent at Bulford and Larkhill). The abstraction pumps at Larkhill run as Duty – Duty, whereas they run as Duty - Standby at Bulford and Upavon, so the totals can be combined. Further information on the assessment of the Tidworth WRZ is detailed in the Veolia WRMP at Appendix B.

5.4.4 Although there is some uncertainty regarding the groundwater level at which the Deployable Output may be impacted, the values used in this assessment are considered to be conservative, as the maximum monthly peak value for each individual abstraction point within each group has been adopted. This figure is the maximum volume of water which could theoretically be abstracted; however in practice it is unlikely to exceed this amount and further increases could be secured through alteration to the infrastructure, should the environmental constraints permit.

Table 8 - Deployable Output

Group	Source	Average Annual Licence (ML/d)	RA Average (ML/d)	Peak Daily licence / FL proxy (ML/d)	Average DO (ML/d)	Peak DO (ML/d)
Tidworth	BH1*	0.00		0.00	0.00	0.00
	BH2	3.68		4.32	2.22	2.22
	BH3	3.68		4.32	2.10	2.10
	CP	3.68		4.69	2.00	2.50
Larkhill	BH01		0.30	0.39	0.30	0.39
	BH02		0.71	0.97	0.71	0.97
Bulford	BH01		0.63	1.40	1.11	1.40
	BH02		0.48		1.11	1.40
	BH03*		0.00		0.00	0.00
Upavon	BH01		0.12	0.31	0.25	0.31
	BH02		0.13		0.25	0.31
	BH03*		0.00		0.00	0.00
Round O	BH01		0.65	0.98	0.65	0.98
Total		**14.07**		**17.37**	**10.71**	**12.57**

*Not currently in use

5.4.5 Note that for the Tidworth WRZ the figures are licenced. For the other WRZ's which are unlicensed, the peak month recent actuals have been used as the best available proxy for the full licence figure.

5.4.6 There are two boreholes within the Larkhill WRZ; the DO calculation assumes that the boreholes are run continuously on a Duty-Duty arrangement. DO values are equal to the historical abstraction rates as the pumps at Larkhill operate continuously at their full capacity, with negligible additional headroom available. By contrast, at Bulford and Upavon WRZ's DO is likely to be higher than indicated in the table, given that under the current operating protocol only one borehole is operated at any given time. This means that should the need arise to run both boreholes at the same time to meet demand, a higher DO could be achieved. The DO is derived from peak monthly values for the KWSD WRZ's, i.e. it is based upon maximum actual requirements for the last three years.

5.4.7 At Tidworth WRZ, there is no DO associated with BH1 as it has been abandoned and removed from the licence due to Atrazine contamination. BH2 and BH3 are linked in that they are located in a similar position in the aquifer and share their treatment process and license constraints. It is understood that works are currently scheduled over the next three years to increase DO within the Tidworth WRZ to bring it closer to the licence levels in order to meet future water demand in the area, including those associated with ABP.

5.4.8 Kelda borehole water level data largely covers the period from April 2012, when hosepipe bans were in force by Anglian Water, Southern Water and Thames Water. Reliable data prior to this is not available. This timeframe also covers a period of record rainfall across the UK. However, as the abstractions are from groundwater, the rainfall response will be delayed. As a result, the observed groundwater levels (as shown in Appendix E) could be used as an indicator of DO sensitivity to adverse groundwater levels, for which they do not show a constraint to abstraction.

5.5 OUTAGE ASSESSMENT

5.5.1 A detailed risk assessment of the potential implications supply outage conditions at the camps has been undertaken. Note that some details have been omitted from this document for security reasons.

- Larkhill WRZ – Secondary supply infrastructure from Wessex Water is currently in place to provide up to 1.162 ML/day. This backup supply would be fed into the existing significantly sized service reservoirs.
- Bulford WRZ – Secondary supply infrastructure from Wessex Water is currently being designed to provide up to 1 ML/day. This would be fed into the existing significantly sized service reservoirs.
- Upavon WRZ – There is a significantly sized service reservoir available to manage outages.

5.5.2 In all cases, the significant size of the existing service reservoirs is such that the operators have sufficient time to address the issue or arrange an alternative water supply as necessary. At Upavon, a back-up diesel generator is in place to manage any power outages affecting the water supply around the camp. At Larkhill and Bulford, generators could be supplied at short notice through existing framework agreements.

5.5.3 For Tidworth WRZ, Veolia's WRMP (*Ref 3*) states that Tidworth does not have any 'economies of scale' as it is a small operation with only three raw water sources. Any small outage would therefore result in a significant percentage of the DO being affected, so the outage assessment would show a less secure source reliable output (SRO) than that with which Veolia actually operates. However, in a similar fashion to the other WRZs, there is large reservoir storage in comparison to demand and only peak demand would see this significantly depleted.

5.5.4 The Wessex Water WRMP (*Ref 8*) states that its supply system is of a sufficient size and complexity to withstand all reasonable outages.

6 FUTURE WATER DEMAND

6.1 LARKHILL, BULFORD AND UPAVON

6.1.1 Future water demand for the Larkhill, Bulford and Upavon WRZ's has been assessed together rather than considering each as individual areas, due to the confined nature of the study area and because the mitigation measures, leakage reduction and other initiatives are interlinked and are being mobilised across all sites concurrently. Within these WRZ's there are no known future demand changes beyond ABP.

6.1.2 Table 9 below summarises the estimated *current* water demand and available headroom across the above sites.

Table 9 - Baseline (Recent Actual) water demand (ML/ day)

ML/day	Larkhill	Bulford	Upavon
Leakage	0.462	0.376	0.140
Consumption	0.700	0.731	0.111
Average Demand	**1.162**	**1.107**	**0.251**
Available Abstraction (average DO)	1.016	2.215	0.502
Available Transfers	0.093	0.000	0.000
Available Wessex Water Supplies	1.162	0.000	0.000
Available Water Into Supply	**2.271**	**2.215**	**0.502**
Headroom	1.109	1.108	0.251
Headroom %	49%	50%	50%

6.1.3 The past and predicted water demand at each site is shown in Table 10 below. The predicted demand is based on Recent Actual demand (including leakage) between April and December 2014, plus the anticipated ABP demand. The net uplift is presented as 'Future demand including ABP.'

Table 10 - Past and predicted Recent Actual (average) potable demand (ML/ day)

	Larkhill			Bulford	Upavon
	Net Transfer from Round O	Wessex Water Supply	Larkhill Boreholes		
2012/13	0.120	0.069	1.089	1.261	0.387
2013/14	0.125	0.047	0.983	1.053	0.315
2014/15	0.035	0.042	0.976	1.009	0.188
Recent Actual	**0.093**	**0.053**	**1.016**	**1.107**	**0.251**
Average future demand, including ABP	1.256			1.085	0.270
Net ABP Impact	**+0.094**			**-0.022**	**+0.019**

6.1.4 This shows that whilst demand at Larkhill and Upavon is expected to increase slightly, the ABP impact at Bulford is very slightly negative compared to Recent Actual. This is due principally to significant leakage reductions that have taken place since 2014/15, which have broadly cancelled out the expected ABP uplift.

6.1.5 Whilst the increased demand at Upavon will be met from the existing on-site boreholes, environmental considerations (detailed in Section 8) dictate that future demand at Larkhill and Bulford must be met, in part, by supplementary licensed supplies from Wessex Water. Larkhill has an existing backup supply in place from the Wessex network, which currently only draws minimum flows, so this will be upgraded. A new connection from the Wessex network will be installed into Bulford camp to provide additional resilience and mitigate the environmental impact of existing abstractions. Further details are provided in Section 8.2.

6.1.6 The estimated average future demand and headroom, taking the Wessex Water supplies into account, is shown in Table 10 below. Demand from the new SFA developments is not included, as this water will be provided by Wessex Water and Veolia, and therefore included as future demands within *their* respective WRMPs.

Table 11 - Future water demand* (ML/ day)

ML/day	Larkhill	Bulford	Upavon
Leakage	0.462[S]	0.376[S]	0.140[S]
Consumption	0.794	0.708	0.129
Average Demand	**1.256**	**1.084**	**0.269**
Available Abstraction (average DO)	0.777	2.215	0.502
Available Transfers	0.000	0.000	0.000
Available Wessex Water Supplies	1.162	1.005	0.000
Available Water Into Supply	**1.939**	**3.220[+]**	**0.502**
Headroom	0.683	2.136	0.233
Headroom %	35%	66%	46%

*Figures are estimated based on Recent Actual demand and current water availability
sAssumes worst case scenario; i.e. no further leakage or water efficiency improvements
+This figure does not include for any environmental reductions on MOD abstractions

6.1.7 It must be noted that it is inherently difficult to estimate future demand on the MOD estate, due to the uncertain nature of MOD's planning focus, future commitments of the UK Armed Forces overseas and likely future changes to the size of the estate. It is also expected (although not completely certain) that potable demand for future military developments will be met by licensed Wessex Water and/or Veolia sources rather than from MOD abstractions - not least because abstraction limits are likely to apply to MOD abstractions before 2020.

6.2 FUTURE WATER DEMAND AT TIDWORTH

6.2.1 Veolia's WRMP states that within its supply area, the vast majority of supplied premises are military, with only 762 non-military dwellings serviced. Of these, 455 are metered and it is expected that this number will increase over time. The average demand within the inset area between March 2011 and February 2012 was 5.52ML/d, with a peak demand increase of over 1.5ML/d.

6.2.2 In a similar manner to the other WRZ's, Tidworth does not experience a summer peak due to the non-typical nature of MOD demand; a low demand is typically experienced in August and December, due to large numbers of personnel living on site or in SFA taking leave. There are also occasions when large military exercises exceed the normal customer consumption 'footprint', together making the daily peak demand difficult to predict. Notwithstanding this, Veolia aims to be in a position to meet any daily peak throughout the year.

6.2.3 The baseline forecast was prepared by using data from 2011/12; this has been used to show how demands will change in a dry year assuming existing management and water efficiency policies. The overall water balance for 2012 shows that demand was greater than supply by a water balance net error of 1.3%. Under inspection, it became apparent that approximately 0.5Ml/day was being lost through one of the reservoir cell walls. This has since been repaired.

6.2.4 A demand forecast has been provided for the next 25 years. It is anticipated that in addition to ABP, new private-sector housing developments will impact the demand going forward; at the time of preparation in 2014, three developments (Persimmon, Hitchin Homes and Zog) were forecast to increase domestic housing by 1,449 properties within seven years. With consumption conditions applied at a national average occupancy of three people per home, a total of 0.67Ml/d in additional baseline demand is expected.

6.2.5 In October 2009, Wiltshire Council released figures indicating some 1,900 domestic properties will be needed by 2026 in Tidworth and the surrounding area. Assuming that the Zog site is developed before the 2026 deadline, it is not unrealistic to suggest that the Tidworth WRZ will account for a significant proportion of this aspiration.

6.3 LEAKAGE, WATER EFFICIENCY AND METERING

6.3.1 The nature of the water supply arrangements across Salisbury Plain means that the definition of leakage within this IWMS is broader than typically used for main distribution networks. This is because the MOD as the main/only customer also has responsibility for leakage reduction/water efficiency from source to tap.

6.3.2 Other aspects which need to be taken into account when assessing the implications of leakage, water efficiency and metering on Salisbury Plain are as follows:

- Salisbury Plain is located on a highly permeable chalk catchment, which means that, unlike most geological formations, any water leaking from the supply system has the ability to quickly percolate back down into the aquifer. In most instances, water is abstracted by MOD close to where it will be used, and leakage is therefore assumed to return directly to the same aquifer - the known leakage rates have been incorporated into the groundwater model accordingly. In most cases, this leakage is considered to have a negligible net hydrological impact; however if leakage occurs close to a watercourse, it may support base flows and reduce the impacts on the river from deeper up-gradient abstraction. In these cases, leakage could be considered beneficial in hydrological terms.
- The supply and distribution network is managed through several different long term contracts, each with individual targets and reporting requirements; this makes effective management of leakage and efficiency across the WRZs particularly challenging. Instead, rates are set across the wider contract framework, with funding for leakage and water efficiency measures being secured through individual contracts and/or from MOD itself.
- Uniquely, MOD is both a water undertaker and a majority customer. The unit cost of water to MOD from its own sources under the AQUATRINE contract is very low, and there is no direct income from water bills or cost implications to be considered for multiple customers. As a result, leakage reduction and water efficiency measures (particularly retro-fit measures on existing buildings) do not result in cost savings, as would normally be assessed within an IWMS.

6.3.3 Consequently, long term leakage reduction has not been one of the more critical areas for improvement identified during the development of the IWMS, The regulators are more concerned about water efficiently and consumption in the WRZ's where water is treated and discharged at a distance from the abstraction point (for example water transferred from Round 'O' to Larkhill camp). Water efficiency measures in these instances could reduce the environmental implications associated with the ABP uplift.

6.3.4 Notwithstanding the above, the proposed use of secondary supplies from Wessex Water will naturally act to drive leakage reduction and water efficiency on the MOD network due to cost, as well as for contractual reasons associated with Wessex Water's wider Sustainable Development policies.

6.3.5 A variety of schemes are currently being implemented or being developed to reduce leakage and/or cost-effectively increase water efficiency in MOD buildings, which in turn will help define long term sustainable leakage levels. These are discussed in greater detail below. It is expected that the recommendations of these studies will feed into the upcoming abstraction reform discussions.

LEAKAGE REDUCTION PROGRAMMES

6.3.6 The leakage reduction programme that has been implemented between 2007 and 2015 has delivered reductions in the order of 1,700 m^3/ day. This figure is interpreted from standard water industry methodologies which have been applied to collective water use on the camps, SFA and in third party properties, therefore bringing together all network and consumption-related data. The MOD domestic and industrial night use within the camps/ garrisons is estimated using a consumption model developed for use across the four PAC establishments. This information has increased understanding of specific patterns of water use and loss.

6.3.7 The reduction in leakage in the Larkhill, Bulford and Upavon WRZ's since 2012 is shown in Figure 3.

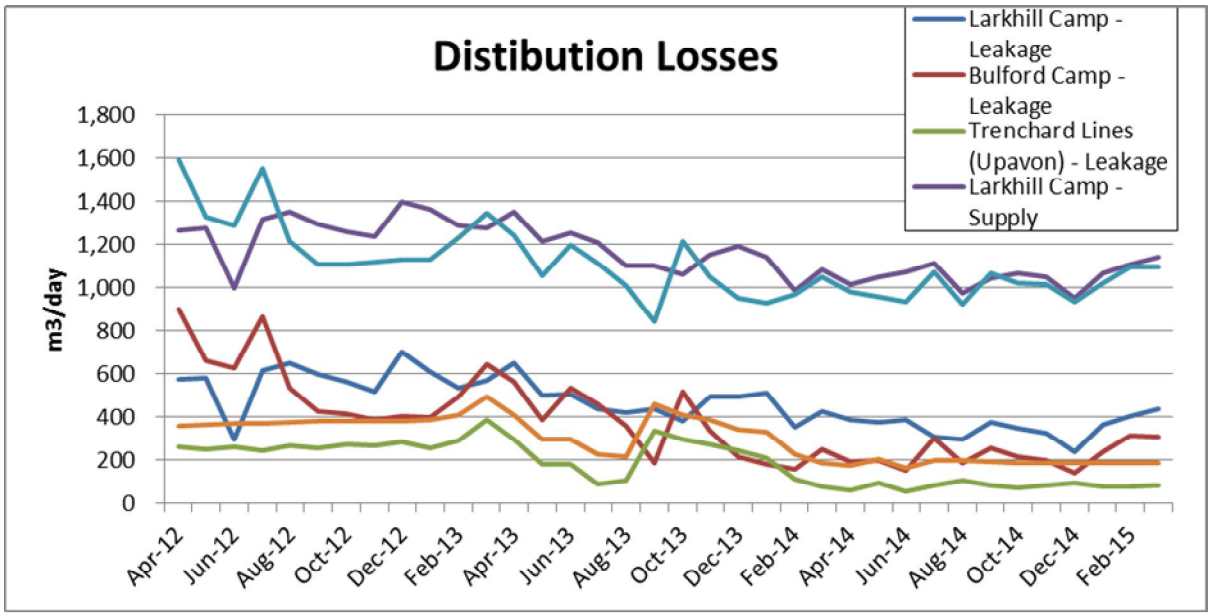

Figure 3 - Leakage/Distribution Losses

6.3.8 Across parts of the estate, consideration has been given to wholesale network replacement. However, replacing extensive lengths of functioning pipework has been deemed to be uneconomic and difficult to deliver without impacting a large area of the rural estate.

6.3.9 The following options to build on the reductions achieved to date have been investigated:

- Additional Network Strategic and DMA Metering;
- Smart Automatic Meter Reading (AMR);
- Noise Logging;
- High MNF mains and services repair/ replacement.

6.3.10 A phased programme is now being implemented to obtain a greater understanding of water use. The first phase will replace the existing zonal meters at Larkhill and Bulford with a more reliable telemetry system, the results of which will inform recommendations for further efficiency/ leakage reduction measures between 2017 and 2019.

6.3.11 Going forward, the leakage rate on the transfer pipeline from Round 'O' towards Larkhill will be assessed, given the proximity of the abstraction to the River Till and the additional pressure that moving water out of the sub-catchment could impose on the winterbourne. Subject to the results, cost-effective measures to reduce water loss will be investigated and discussed with the Hydrology Steering group.

6.3.12 As the preferred solution(s) and associated benefits have yet to be finalised, it has been necessary to adopt a conservative approach for the preparation of this IWMS, and assume that further leakage reduction measures would not have a significant impact on demand. This means that the groundwater model results show the maximum potential environmental impact.

WATER EFFICIENCY MEASURES

6.3.13 Various water efficiency options have been considered by the MOD and its supply chain partners to reduce existing water consumption. The following initiatives have so far been undertaken:

- In 2015, Aspire Defence undertook a scheme called 'The Water Project' to drive water efficiency across the PAC Estate. 495 existing buildings were surveyed, with failing equipment being fixed or replaced. This initiative reduced water use by around190 m^3/day. Further details are provided in Appendix G.
- MOD is currently developing further water efficiency schemes for Larkhill and Bulford WRZ's. Initially, additional flow monitoring is being installed by MUJV to ascertain water balances and to establish where high water use is occurring, with a view to determining where additional funding would be most cost effective (see 6.4.11 below).
- All new and refurbished buildings will meet MOD Sustainable Development standards for water efficiency, as shown in Table 12 below.

Table 10 - Current and ABP Water Efficiency Assumptions for ABP

	Current estimated use	ABP standard	Notes
Single-Living Accommodation (SLA)	80l/ bed space/ day	80l/ bed space/ day	Both existing and new Aspire buildings comply with BREEAM 'Excellent' standard.
Service Families Accommodation (SFA)	150l/ person/ day	105l/ person /day	New SFA will comply with CfSH Code 4 or equivalent, in line with Wiltshire Core Strategy requirements.
Technical buildings	6m^3/ FTE/ year 27l/ person/ day.	4 m^3/ FTE/ year 18l/ person/ day.	

METERING OPTIONS

6.3.14 The benefits of implementing a metering strategy are normally assessed against water efficiency, with a typical customer driver being consumption reduction to reduce cost. However, this does not apply on MOD sites, since the occupiers of individual buildings are unaffected by the various billing mechanisms. Universal metering combined with consumption targets has been considered but excluded as an option, as it is not cost-effective. However as detailed in the leakage section above, additional network metering is being undertaken by MUJV to establish the sections of the network which have the highest leakage rates. This will facilitate a prioritised and targeted pipe replacement programme.

6.4 HEADROOM ASSESSMENT

6.4.1 Target headroom is defined as the minimum buffer introduced into the annual supply-demand balance to ensure that the chosen level of service can be achieved. Available headroom is the actual difference between demand and water available for use. Levels of service for water resources cannot be met when the available headroom falls below target headroom.

LARKHILL, BULFORD AND UPAVON WRZS

6.4.2 The headroom assessment for these sites is based upon the same assumptions as in the DO section above; firstly, that the two boreholes in the Bulford and Upavon WRZ's can both be run concurrently, secondly that Wessex Water has water available to supply the Larkhill and Bulford WRZs and finally assuming that no further demand is expected within the planning horizon.

6.4.3 Taking the above into account, it has been assessed that there is sufficient headroom available at the three sites both currently (*see Table 9*) and in the post-ABP uplift scenario (*Table 11*) to provide water security. Wessex Water has confirmed resource availability to MOD for Larkhill and Bulford.

TIDWORTH WRZ

6.4.4 The Veolia WRMP (*Ref 3*) headroom assessment has assumed a best demand estimate of 0.4ML/ day given the uncertainty of garrison population. Uncertainty around this increase has been accounted for within headroom estimates between 2017 and 2020.

6.4.5 The headroom estimates range between 4 and 9.5%. Considering the size of Veolia's Inset area, the uncertainty in military population and the level of DO combined with the flexible distribution network, headroom of 9.5% was adopted as a reasonable figure.

6.4.6 The Veolia WRMP identified that there was insufficient headroom to meet the current peak demand if Wessex Water were to take their full entitlement through the Leckford Bridge Agreement. The deficit has been addressed through revisions to the abstraction licence, and infrastructure improvements which are underway/ scheduled to be completed within the next three years. These will deliver the necessary headroom.

7 VULNERABILITY ASSESSMENT

This Section describes the potential threats to Deployable Output across the ABP WRZ's from climatic factors.

7.1 BELOW AVERAGE RAINFALL AND DROUGHT

7.1.1 The areas covered by this IWMS are 100% reliant on groundwater sources for raw water supply. Climate change is predicted to cause changing rainfall patterns which may reduce the recharge of underground water sources.

7.1.2 At present, Kelda does not have a drought plan in place for the Larkhill, Bulford or Upavon WRZ's. This will be prepared over the next few years as part of future licence negotiations. It is nevertheless considered that Kelda abstractions are subject to the same factors as those assessed for the Tidworth WRZ by Veolia, given the proximity and similarity between the catchments.

7.1.3 Veolia's Drought Management Plan for the Tidworth WRZ (*Ref 9*) shows that Veolia can operate effectively with two consecutive poor recharge years (80-100% long term average rainfall) without altering its level of service. In the absence of any contrary evidence, it is assumed that the Larkhill, Bulford and Upavon WRZ's would perform similarly.

7.1.4 The Veolia WRMP (*Ref 3*) also assessed the potential impact of climate change on groundwater levels and DO from its boreholes, using the British Geological Survey's Future Flows and Groundwater Levels Project, which has produced projections of groundwater levels at observation boreholes using catchment groundwater models. The nearest observation borehole to the study area is at Clanville Lodge Gate, approximately 14km east of Tidworth. As it is the nearest observation borehole and is also associated with a chalk aquifer, projections at this borehole are considered to be the best estimate of changing groundwater levels on Salisbury Plain.

7.1.5 The Clanville Lodge Gate climate change graphs suggest a maximum decrease of 1.5m in groundwater level between two thirty year periods (1961-1990 and 2041-2070). A decrease in groundwater level of up to 1.5m has accordingly been adopted for use in this IWMS.

7.1.6 For Tidworth WRZ, the Veolia WRMP confirms that all three operating boreholes have large depths between drought peak DO pumping water levels and pump intakes. Consequently, maximum decreases in groundwater levels of 1.5 m due to climate change are highly unlikely to affect DO.

7.1.7 For Larkhill, Bulford and Upavon WRZ's, the available information indicates that groundwater levels would still be well above the base of most of the boreholes and future DO is unlikely to be affected. This however requires further investigation at the Round 'O' boreholes, as a 1.5m reduction would the water level to drop to 1m above the lower cut off point in BH10). This could lead to a reduction in DO. Further investigations are also required at Upavon BH03, as insufficient data is available to confirm the risks. However, there is significant clearance at BH01 and both boreholes are in close proximity to each other. Appendix E shows the groundwater level fluctuations in the monitored boreholes.

7.1.8 The Wessex Water drought plan (*Ref 10*) states that restrictions or temporary use bans have not been imposed on its customers since 1976, and that its supply system is designed to ensure that it can meet unrestricted demands in the event of a similar drought. Based on a review of the hydrological record over the last 100 years, Wessex Water does not expect to ever require an Emergency Drought Order.

7.2 FLOOD RISK

7.2.1 The flood risk to the potable water supply infrastructure is assessed in terms of risk from rivers, ground water, surface water and reservoir sources. Given that Salisbury Plain is a chalk catchment with historical records of groundwater flooding, this is considered to be the most significant risk. In all cases, flood risk is considered in terms of its ability to cause an infrastructure failure (as a result of inundation) or to cause groundwater contamination (as a result of contaminated flood water entering the borehole). Environment Agency flood risk maps for each site are provided at Appendix D.

GROUNDWATER FLOOD RISK

7.2.2 The British Geological Survey records the bedrock geology underlying most of the Salisbury Plain Training Area to be Chalk (Seaford and Newhaven formations). The 2013 Wiltshire Strategic Flood Risk Assessment (*Ref 11*) records the groundwater flooding potential of chalk as possible, noting 'most recorded groundwater flooding events in chalk.'

7.2.3 According to the Environment Agency's groundwater map, the chalk underlying Salisbury Plain is classified as a principal aquifer, providing a high level of water storage. The area falls within the Environment Agency's groundwater flood warning area due to the potential for groundwater emergence.

7.2.4 According to the Wiltshire Strategic Flood Risk Assessment, Larkhill and Upavon Camps are outside, but in proximity to, 'areas susceptible to groundwater flooding.' However, Bulford Camp spans 'areas susceptible to groundwater flooding' and some parts of Tidworth garrison are defined as 'places above flood risk thresholds'.

7.2.5 Any groundwater emergence is likely to follow overland flow paths, the larger ones being represented in the surface water flooding map. As the abstractions are all from groundwater, a risk remains of localised ponding and overland flows, which could potentially contaminate water in the boreholes.

TIDWORTH WRZ FLOOD RISK

7.2.6 According to the Veolia WRMP, the Environment Agency's flood maps confirm that the potable above ground assets at Tidworth are at low risk from flooding from either surface or groundwater sources. The majority of the garrison is in Flood Zone 1, meaning an annual probability of fluvial/ groundwater flooding of less than 1 in 1000 (<0.1%). Limited parts of Tidworth (largely open space) are in Flood Zone 2, meaning a 1 in 100 (1%) to a 1 in 1000 (0.1%) annual probability of flooding. A small part of north Tidworth is in Flood Zone 3, meaning a greater than 1 in 100 (>1%) annual probability of flooding. There is a negligible risk to the garrison from reservoir flooding.

7.2.7 Although the potable supply is at low risk from flooding, several waste water assets are at greater risk; two sewage pumping stations are located within the 1 in 100 year flood event outline, and Veolia suggests actions could be taken to minimise their use and make alternative arrangements. Tidworth STW (which discharges to a surface soakaway) is also at higher risk, as it is located within Flood Zone 3 (within the 1 in 75 year flood event outline). The Veolia WRMP confirms that mitigation may need to be employed to protect the long-term operational capability of the STW.

7.2.8 By contrast, the water assets at Perham Down and Ludgershall are at low risk of flooding from any source, the whole area being located in Flood Zone 1 (<0.1% annual probability).

UPAVON FLOOD RISK

7.2.9 The Environment Agency's flood maps confirm that the whole of the camp and asset locations at Upavon are at low risk of flooding from any source, being located in Flood Zone 1 (<0.1% annual probability). There is negligible risk of flooding from reservoirs.

LARKHILL FLOOD RISK

7.2.10 The Environment Agency's flood maps confirm that the water assets at Larkhill garrison are at very low risk of fluvial or groundwater flooding, the camp and asset locations being located in Flood Zone 1. Larkhill STW is shown to be located along a surface water flow path; however this flow path is only predicted in a low probability event (between 1 in 1000 and 1 in 100, or 0.1-1%). The risk of surface water flooding to the STW is therefore low, compared to a very low (<0.1%) risk to all other assets. There is a negligible risk of flooding from reservoirs to Larkhill Camp.

7.2.11 The Round 'O' Boreholes and Westdown North service reservoirs are also located in Flood Zone 1 and so are very low risk of fluvial or groundwater flooding.

BULFORD FLOOD RISK

7.2.12 The majority of the Bulford garrison is located in Flood Zone 1. The northwest boundary of the site follows the Nine Mile River and a small part of the north-western boundary is located in Flood Zone 3 (>1% annual probability). However, all boreholes and service reservoirs are located in Flood Zone 1 and are therefore at low risk of fluvial/ groundwater flooding. There is a negligible risk of flooding from reservoirs to Bulford Camp.

7.2.13 The risk of surface water flooding to the majority of the Bulford Camp is low, with less than a 0.1% annual probability of flooding. However, Bulford boreholes BH01, BH02 and their associated treatment works are located in an area shown to be at medium to high risk of surface water ponding. Borehole BH03 is also in proximity to an area of medium to high risk of surface water ponding. Medium risk means an annual probability of flooding of between 1 in 100 and 1 in 30 (1-3.3%) and high risk equates to an annual probability of flooding of greater than 1 in 30 (>3.3%).

7.2.14 Bulford service reservoirs SVR05 and SVR06 are located in proximity to a surface water flow path with low probability, meaning an annual probability of flooding of between 1 in 1000 and 1 in 100 (0.1-1%).

7.2.15 Based on the above, there is some risk of surface water flooding to all Bulford assets; this is medium to high for the three abstraction boreholes and their associated treatment works. Mitigation measures will be considered further to prevent the flooding of these assets from surface water.

7.3 CONCLUSIONS

7.3.1 To ensure that sufficient DO can be achieved during times of drought, further studies are required at the Round 'O' and Upavon BH03 abstractions. A drought plan will be prepared to accompany this IWMS as part of the preparations for abstraction licensing.

7.3.2 Further assessment is recommended for Tidworth WRZ to ensure that the risks of flooding on the foul water system is fully understood and appropriate mitigation measures can be implemented. Assessment is also needed at Bulford to understand the risks of surface water ponding on the potable abstractions. The low risk of surface water flooding at Larkhill STW does not require further assessment as the STW is planned to be closed by 2019.

8 ENVIRONMENTAL ASSESSMENT

8.1 THE NEED FOR ASSESSMENT

8.1.1 Both MOD and Public Water Supplies (PWS) across Salisbury Plain are abstracted from groundwater sources within the catchment of the River Avon. The Avon is an internationally-important chalk-stream habitat, and is designated a Special Area of Conservation (SAC) under the EU Habitats Directive and UK Habitats Regulations. It is also protected as a SSSI, and is subject to various conservation objectives designed to protect and enhance habitat quality; protection of both river flow and water quality are essential to meeting these objectives. Any development proposal must prove through a Habitats Regulations Assessment (HRA) that it will not adversely affect the ecological features for which the river is designated, before planning consent can be granted.

8.1.2 The new SFA at Larkhill and Bulford will be supplied from licensed sources by Wessex Water, and current and future demand across Tidworth WRZ will be served by licensed Veolia sources. As these abstractions are already statutorily controlled, they have been subject to HRAs in their own right. However, the camps and some existing SFA within the Larkhill, Bulford and Upavon WRZs are supplied by MOD abstractions, which are not (and never have been) subject to licence control. As a result, the impact of the current or future water demand in these WRZs on the integrity of the SAC has not previously been established. As a result, no action plan has been developed to mitigate the potential impacts. This IWMS provides that assessment and action plan.

8.1.3 ABP is expected to cause a net increase in potable demand of approximately 94m^3 (0.094 ML) per day to Larkhill WRZ from MOD sources. At Bulford WRZ, on-going leakage reduction work means that demand is estimated to fall by approximately 23m^3/day, when compared to the 2012-15 baseline. At Upavon WRZ, ABP is expected to lead to a net increase in potable demand of approximately 18m^3 (0.018 ML) per day from the MOD sources.

8.1.4 At the same time, MOD's Larkhill STW, which cannot manage the increased flows resulting from ABP uplift, will be closed. Diversion of the final effluent to Wessex Water's Ratfyn STW at Amesbury (discussed in Section 8.3 below) will result in *up to* 934 m^3 water per day not being discharged back into the aquifer from the Larkhill soakaway, but instead being discharged directly into the River Avon.

8.1.5 The environmental assessments supporting development of the ABP Salisbury Plain Masterplan included an Overarching Environmental Appraisal (*Ref 12*) and HRA. These identified that existing water demand and waste water discharge have the potential to adversely affect river flow and water quality in the River Avon SAC and the Nine-Mile River (which forms part of Salisbury Plain SSSI), when considered in combination with other local PWS and private abstractions and discharges. These effects are exacerbated when ABP uplift is considered. This section details the nature of these potential hydrological and water quality impacts associated with ABP development, and considers appropriate mitigation responses.

8.2 HYDROLOGICAL IMPACTS

WESSEX BASIN GROUNDWATER MODEL

8.2.1 The Wessex Basin Groundwater Model (WBM) was originally developed for the River Avon catchment on behalf of the Environment Agency by Amec Foster Wheeler, to inform abstraction licence discussions between Wessex Water and the Environment Agency. It was also used to inform Wessex Water's subsequent WRMP.

8.2.2 To assess the effects of current and future MOD abstractions and discharges on the hydrology of the SAC, MOD commissioned Amec to undertake the following groundwater modelling runs using the WBM:

- The first model run, undertaken in May 2014, assessed the impacts of expected abstraction increases in combination with the existing impacts of MOD and PWS abstractions. The results were used to inform the OEA and HRA of the Salisbury Plain Masterplan. This was updated in September 2014 to consider the implications of using the JNCC methodology and to incorporate the proposed Wessex Water sustainability reductions following the Habitats Directive Review of Consents investigations for the SAC.
- The second model run, undertaken in March 2015, assessed the stand-alone and in-combination impacts of various options associated with closing or reducing the use of the Larkhill STW soakaway.
- A third run in January 2016 refined the STW options data and assessed the effects of bringing in supplementary Wessex Water supplies to Larkhill and Bulford garrisons.
- Following further discussions with Natural England and the Environment Agency, the fourth model run in March 2016 assessed the stand-alone impacts of ABP with the Larkhill soakaway closed and with the various suggested mitigation options in place, to support the updated Masterplan HRA and this IWMS.

The significance of the flow impact on the Avon, Till and Bourne was assessed against the local SAC flow targets (*Ref 15*), whilst those on the Nine-Mile River were assessed against WFD standards for non-protected areas[2] The two most recent groundwater modelling technical reports can be found in Appendix C.

8.2.3 When reviewing the results from the WBM, it needs to be remembered that, as with any model, it is driven by the accuracy of the input data and assumptions made in its development. The key assumptions made in modelling the hydrological impacts of abstraction are:-

- That all licenced abstractions are operating at their maximum licenced consent volume, and that unlicensed MOD abstractions are operating at their recent peak amount (which acts as a 'proxy' for fully-licensed volume). As a result, the modelled impacts represent a 'worst case' scenario; this addresses the need to adopt a precautionary approach required by the Habitats Regulations. In reality, these maximum volumes are only rarely taken, so the day-to-day impacts of abstraction are likely to be far smaller, at least in the short to medium term.
- That the additional water from Wessex is sourced from within its existing licensed abstraction volumes. These have already been accounted for in the 'FL' figures.

8.2.4 It should also be noted that forthcoming abstraction reforms will see MOD supplies licensed for the first time. Licensed volumes will be subject to negotiation with the Environment Agency and Natural England, and further groundwater assessments will be required to inform the process.

GROUNDWATER MODEL FINDINGS

LARKHILL WRZ

8.2.5 The model found that low flows[3] in both the Till and the middle Avon above and below Amesbury are significantly (>10%) impacted by existing abstraction. The SAC targets are currently for natural flows in the River Avon System SAC to be impacted by ≤10% at Q_{95} (5% for the River Till headwaters).

8.2.6 To fulfil the additional ABP demand at Larkhill camp, the Larkhill boreholes would continue to abstract 1.357 ML/ day, whilst abstraction from the Round 'O' boreholes would increase from 0.977 ML/ day to 1.071 ML/ day. However, the model did not identify any significant impact on low flows in either the Avon or the Till from the abstraction increase.

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2 Water-dependant Natura 2000 sites such as the River Avon system SAC are defined as 'protected areas' under the Water Framework Directive, whilst non-Natura sites are classified as 'non-protected.' Flow targets are generally less stringent for non-protected water bodies.

3 'Low flow' is generally accepted to mean the Q_{95} value, where river flow is exceeded 95% of the time.

8.2.7 The model did, however, establish the extent to which water from the Larkhill STW soakaway can support groundwater levels in both rivers. The relocation of the discharge to Ratfyn and the resulting conversion of a soakaway to a surface water discharge reduce low flows on the perennial stretch of the River Till by up to 0.2 ML/ day. On the River Avon upstream of Ratfyn STW, Q_{95} flows reduce by approximately 0.4 ML/ day, potentially affecting wetland habitat with recorded presence of the Desmoulins Whorl Snail, a key SAC species. A small groundwater impact downstream of the STW is, however, eclipsed by the increased surface water input. The March 2016 model confirmed that reduced flows are also apparent at these locations at higher flow states (Q_{30}, Q_{50} and Q_{70}).

8.2.8 The January 2016 model also demonstrated that reducing peak abstractions from Larkhill and Round 'O' by 0.93 ML/ day in total, and making up the shortfall at Larkhill camp from the licensed Wessex supply, will effectively eliminate the effects of losing the same volume from the soakaway. The March 2016 update further assessed that, by reducing abstraction at Round 'O' from 1.1 ML/ day (FL) to 0.7 ML/ day, stopping the transfer from Round 'O' to Larkhill and reducing the Larkhill abstraction from 1.4 to 0.8 ML/ day, it is possible to maintain (and at higher flow states even improve) flows on both the Till and the middle Avon whilst still closing Larkhill STW.

BULFORD WRZ

8.2.9 The groundwater model found that natural flow in the 500-metre perennial section of the Nine Mile River in the Bulford WRZ is significantly (>15%) impacted by existing abstraction. This stream is not part of the SAC, but the impacts still exceed the Water Framework Directive targets for non-protected areas. The model showed that completely stopping MOD's Bulford abstraction would not lead to flows in the perennial stretch being returned to within 10% of daily naturalised flows at or below Q_{90}, indicating that other abstractions are also having a significant effect on low flows in the stream.

8.2.10 The impacts of ABP on river flows in Bulford WRZ were found to be neutral, since pre-ABP 'FL' abstraction rates have reduced from around 1.40 ML/ to 1.38 ML/ day as a result of leakage reductions and water efficiency measures. This improvement should be sufficient to offset the expected ABP uplift in environmental terms.

8.2.11 There are a number of ponds along the length of the Nine-Mile river, most of which are within the SSSI and/or support populations of the protected Great Crested Newt. The WBM identified that groundwater levels in Old Marlborough Road Marsh Pond nearest to the MOD boreholes are slightly affected by existing abstraction. The model indicated that abstraction has caused the pond to fail the water level criteria (water level >10cm above the pond bottom between March and September) in 4 years out of 43, compared with 13 years out of 43 due to natural variation. It also noted that existing abstraction causes the pond to 'fail' for slightly longer each year (equating to an extra one or two ~10 day stress periods in a given year). However, this impact is only recorded at the bottom of the hydrograph when the pond is dry, indicating that abstraction makes the lowest groundwater levels lower rather than significantly impacting on the timing or duration at which the groundwater levels are above the base of the pond. It is therefore concluded that the overall proportion of critical water level 'fails' associated with abstraction is low over the long term, and that the overwhelming influence on water levels in the pond is natural climatic variation and rainfall.

8.2.12 Notwithstanding this, the pattern of fails is also relevant, as repeated failure over several years can cause far greater harm to the newt populations than widely spaced, single-year failures. The modelling suggests failures of the water level criteria due to abstraction tend to cluster with periods of natural failure. In addition, abstraction appears to increase the length of the failure period compared to natural variation. The modelling also demonstrated that switching off the MOD Bulford abstraction does remove this impact.

8.2.13 Since net abstraction in Bulford WRZ is not expected to increase with ABP, the current situation in the Nine-Mile ponds is unlikely to deteriorate. The supplementary supply from Wessex Water will allow MOD's abstractions at Bulford to be reduced, which is likely to reduce this impact to an extent. In order to provide a more complete picture of the hydrology of the SSSI pond system, a groundwater and pond level monitoring programme has now been implemented along the Nine-Mile River. This will provide additional evidence about the hydrology of the river and ponds, and inform forthcoming abstraction licensing discussions with the Environment Agency.

UPAVON WRZ

8.2.14 At Upavon WRZ, the model found that existing abstractions do not impact adversely on low flow in the River Avon. Increased ABP abstraction lowers the groundwater level slightly at the borehole and increases it at the adjacent STW soakaway. However, the River Avon is not adversely impacted at any flow state. As a result, no mitigation measures are required.

TIDWORTH WRZ

8.2.15 The impacts of existing abstraction on the perennial stretch of the River Bourne in Tidworth WRZ will be reduced to within WFD limits (<10% impact) as a result of the Wessex Water sustainability reductions that are being put in place.

8.2.16 The additional ABP demand will be provided by Veolia within its current abstraction licence. As this has already been accounted for in 'FL' figures in the groundwater model, ABP is not considered to have any additional impacts on low flows in the perennial stretch of the Bourne.

SUMMARY

8.2.17 In summary, when FL volumes are taken, *existing* MOD abstractions (in combination with licensed Public Water Supply and other unlicensed abstractions) are significantly affecting low flows in the Nine Mile River, the River Till and some parts of the middle Avon, such that environmental flow limits are being breached. Forthcoming sustainability reductions on the Bourne, however, appear to resolve the issues there.

8.2.18 When ABP changes are considered, the situation on the Nine-Mile River is unaffected, but the increased abstractions at Larkhill and Round 'O', coupled with the closure of Larkhill STW soakaway, cause additional impacts on low flows in the Till and middle Avon. The increased surface discharge to the Avon at Ratfyn does however increase flow downstream of the STW.

8.2.19 The impacts of closing the STW on flows in the Avon and Till can be removed completely (and at higher flow states even improved) if the Larkhill and Round 'O' abstractions are reduced by an equivalent volume and the shortfall made up from Wessex Water supplies. The impacts of existing abstraction on the Nine-Mile River can be reduced by taking less water from the MOD Bulford boreholes and drawing the balance from Wessex Water. This will also increase the operational resilience of the camp as it would no longer be relying on just the MOD abstractions.

8.2.20 The groundwater modelling therefore shows that the hydrological impacts of ABP uplift on the River Avon System SAC can be effectively mitigated by reducing MOD abstraction and using potable supplies from Wessex Water.

8.2.21 The groundwater modelling also demonstrates that, irrespective of ABP impact, existing PWS, MOD and private abstractions in the area are adversely affecting flows in the SAC. Further groundwater modelling will therefore be required to quantify future levels of MOD abstraction as part of the forthcoming abstraction licensing programme.

8.2.22 When interpreting the model findings, it must be borne in mind that the impacts are assessed assuming all abstractions are operating at their full license (or equivalent) volume. Actual abstractions are significantly lower than this; for example, Wessex Water's Recent Actual abstraction at Durrington PWS is 2.25 ML/ day against a licensed limit of 5 ML/day. In practice, this means that in the short to medium term, the impacts of existing and ABP-related activity modelled on flows in the Avon, Till and Nine-Mile River may not be apparent in actual measured flows.

8.3 WATER QUALITY IMPACTS

8.3.1 The Army Basing Project will result in around 6,250 extra people (3,958 additional service personnel plus families) living around Salisbury Plain by 2020. These additional personnel will increase pressure on the existing waste water treatment and transfer systems. This section considers the ability of each WRZ to manage the increased foul flows, assesses the environmental impacts of those increased flows and proposes a number of mitigation measures.

LARKHILL AND BULFORD WRZ

CURRENT SITUATION

8.3.2 Waste water from Bulford camp and the existing SFA is treated by Wessex Water at Ratfyn Sewage Treatment Works and discharged directly to the River Avon. ABP will bring approximately 1,200 additional people to Bulford; the uplift in flows will be managed within Wessex Water's existing licensed discharge consent at Ratfyn. This uplift has implications, however, for water quality in the River Avon SAC, which are discussed further below.

8.3.3 Waste water from Larkhill camp and the existing SFA is treated at MOD's Larkhill STW (operated by Kelda). The final effluent is discharged back to the aquifer via the adjacent soakaway. The STW is situated within the Stonehenge World Heritage Site (WHS), immediately adjacent to the Great Cursus and close to Stonehenge itself.

8.3.4 Larkhill STW operates at its permitted capacity and the facility is close to the end of its functional life. The 'new' soakaway is poorly located uphill of the STW (the first having been originally built across the Cursus), and final effluent can re-enter the treatment system when groundwater levels are high. Removal of all MOD Larkhill STW infrastructure is a stated objective in Historic England's recently updated WHS Management Plan (*Ref 13*), so it would be very difficult to obtain the necessary approvals to replace, refurbish or improve the facility to handle flows from the additional 3,100 people who will be based at Larkhill under ABP. As a result, it was considered that an alternative means of managing the uplift would be required.

LARKHILL STW OPTIONS STUDY

8.3.5 In 2015, DIO commissioned a Kelda Options study (*Ref 14*) to determine how the existing wastewater flows from Larkhill STW and ABP flows from Larkhill and Bulford could be managed. The options had to meet the following objectives:

- Provide an adequate, practical and cost effective waste water service;
- Adhere to and support the programme for Army Basing;
- Meet the environmental commitments for the Salisbury Plain Masterplan and support planning applications.

8.3.6 The study, summarised in Part 1 of Appendix F, included consultation with key stakeholders including DIO, Aspire, MUJV, Veolia, WYG and Wessex Water. Seven options were reviewed in detail; two options (plus a 'do nothing' comparator) were shortlisted for more detailed review in January 2015. These options were:

i. Provide a new (relocated) STW to handle existing and future flows from Larkhill camp and some existing SFA, with flows from the remaining SFA, new SFA development and Bulford camp sent to Wessex Water for treatment at Ratfyn (Option C1).

ii. Send all flows from both sites to Wessex Water for treatment at Ratfyn STW (Option E).

8.3.7 The major options that were rejected during analysis included doing nothing, enhancing the existing Larkhill STW to take additional flow, relocating the secondary treatment facility or replacing it with a reed bed, and keeping the STW in operation at its current level and transferring the Larkhill uplift to Wessex. Appendix F Part 1 details the rationale and results of the options assessment.

8.3.8 The challenges associated with Option C1 (Relocating the STW) included the high capital cost of development and the availability of suitable land outside the WHS on which to site it. Following further evaluation, it was found that the only acceptable site immediately west of Larkhill camp would have significant costs associated with minimising visual impact, odour, and buried archaeology, making road improvements on the Packway and pumping flows up from the existing pumping station.

8.3.9 For Option E (all flows to Ratfyn STW), Wessex Water confirmed that it would be able to accept the current and predicted flows from both sites within its existing permitted headroom at Ratfyn STW. The challenges associated with this option include the need to pump flows up from lower sections of the system, the need for extensive new pipework (including a new sewer along the Packway and a crossing under the River Avon), the increase in phosphorus entering the River Avon from Ratfyn (despite phosphate stripping already being in place) and the modelled hydrological impacts of closing the Larkhill STW soakaway on the Middle Avon and River Till (Section 8.2 above).

8.3.10 The shortlisted options were further evaluated against the key objectives including an assessment of both capital and whole-life costs over a twenty-five year lifespan. The report recommended that Option E (transfer all flows to Wessex Water) should be developed further as the preferred option. This option provides the best cost-benefit overall against the key objectives, having the most favourable through-life financial profile and the least Planning and delivery risk. A summary diagram of the final proposed route is shown in Appendix A.

IMPLICATIONS OF SEWAGE-DERIVED PHOSPHORUS DISCHARGES TO THE R. AVON

8.3.11 The River Avon is one of the finest chalk streams in Europe, and is protected as a Special Area of Conservation under the EU Habitats Directive. Chalk streams are naturally low in nutrients and are very sensitive to increases in phosphorus levels, which encourage the growth of algae and other aquatic plants which can damage the features for which the river is protected.

8.3.12 The River Avon SAC currently exceeds the phosphorus targets set out in Natural England's supplementary advice to the European Site Conservation objectives, with current reactive phosphate levels of 0.07 - 0.1mg/l (70-98 ppb) against a target level of 0.05mg/l (50 ppb) between the Nine Mile confluence and Salisbury. This failure has prompted development of the River Avon Nutrient Management Plan for Phosphorus (NMP), issued in April 2015 (*Ref 5*). The NMP aims to stop further deterioration of the SAC by reducing both consented (point source) and diffuse phosphate discharges, and restoring it to Favourable condition in line with the statutory requirements of the Habitats and Water Framework Directives.

8.3.13 A key element of the NMP is ensuring that existing consented activities do not adversely affect the integrity of the SAC. As a result, Sewage Treatment Works can only *"accept further connections without the need for an appropriate assessment, where permit headroom remains and where further development will not compromise deliverability of the NMP."*

8.3.14 Whilst the uplift of phosphorus from ABP (originally calculated at 933g Total P/day) would be within Wessex Water's existing permitted discharge limits at Ratfyn, Natural England stated that the additional input would make it harder to deliver the NMP target, and concluded that MOD should *"include measures to reduce or offset the additional P load discharged to the River Avon from MOD growth to reduce uncertainty on whether the project will compromise deliverability of the SAC conservation objectives."*

8.3.15 Although the estimated phosphorus burden from ABP has since been reduced to around 567g Total P/ day (as detailed in Appendix F, Part 2), positive determination of the Masterplan HRA depends on MOD concluding that ABP will **not** have a negative impact on the SAC. Rendering delivery of the NMP more difficult by sending all flows to Ratfyn would make it harder for MOD to conclude this with confidence, especially in light of the currently sub-optimal condition of the SAC.

8.3.16 MOD has therefore developed an ABP Phosphorus Action Plan (Appendix F, Part 3) to manage the increased phosphorus that will be discharged into the River Avon from Spring 2018 onwards, when the connection to Larkhill STW is due to be closed. The aim of the Action Plan is to offset an equivalent amount of diffuse phosphorus discharge into the Avon catchment through the adoption and funding of Catchment-Sensitive Farming techniques. The Plan, which lasts for five years until ABP completes in March 2021, has a number of regulator-approved safeguards to ensure that the phosphorus reductions are met and sustained within the catchment.

8.3.17 Progress with the Action Plan will be monitored by the ABP Hydrology Steering Group; arrangements for securing any on-going offsetting measures required beyond 2021 will be kept under review and included in the five year review of this Strategy.

8.3.18 It should be noted that the UK water industry is currently investigating enhanced phosphate stripping technologies, which could reduce final effluent phosphorus levels to below 0.1ppm in future. If and when such measures are installed at Ratfyn and/ or Salisbury STW (most likely at some point after 2020), they would significantly reduce overall phosphorus discharges into the SAC.

UPAVON WRZ

8.3.19 The sewage generated within this WRZ is treated at Kelda's Upavon STW, which discharges treated effluent to an adjacent soakaway. Although the facility is able to treat current flows, it will not be able to cope with the ABP uplift. The STW will therefore either be upgraded in situ or rebuilt as part of the site development programme. An appropriate environmental permit from the Environment Agency will be applied for in the normal manner; MOD notes that specific nutrient standards may be applied at this point.

TIDWORTH WRZ

8.3.20 Treated effluent from Tidworth STW is currently discharged to ground via an on-site soakaway system. The cumulative population uplift from ABP and civilian developments in and around Tidworth will raise Dry Weather Flows from just over 1.7 ML/ day currently to 2.9 ML/ day by around 2020. The current environmental permit limit is already being reached; Veolia has therefore applied for a new environmental permit to increase the DWF limit and meet new water quality discharge standards required under the water industry's AMP6 Planning cycle.

8.3.21 To achieve the new permit conditions and accommodate the full growth plan, Veolia is upgrading Tidworth STW; this includes improving the on-site infiltration capacity needed to accommodate the increased throughput. The environmental permit for the STW will include a Total Nitrogen standard (incorporating nitrate, nitrite and ammonia) of 8.4 mg/l N, measured as an annual average. This is a reduction of around 50% compared to current effluent nitrate levels. This tightened water quality standard will help ensure that the effluent does not adversely impact on the water environment requirements of Cholderton Safeguard Zone Action Plan.

8.3.22 Veolia will finalise and submit the full permit application demonstrating how it will meet the agreed permit conditions in Q1 2017 and, subject to the outcome of subsequent negotiation with the EA, will ensure that the STW operates within the limits of the new permit by the end of 2017. Further upgrade work is planned in 2018 to accommodate further population increases.

8.4 SUMMARY

8.4.1 The hydrological and water quality assessments have identified that the main impact of ABP in the Larkhill and Bulford WRZs is the closure of Larkhill STW soakaway, which if not mitigated for would increase phosphorus discharges to the River Avon at Amesbury, reduce low flows in the middle Avon and the Till, and affect wetland habitat supporting notified SAC species such as the Desmoulins Whorl Snail. The mitigation plan for these impacts includes reducing groundwater abstractions at Larkhill and Round 'O' and implementing a programme of phosphorus offsetting for the river Avon.

8.4.2 At Upavon WRZ, increased abstraction will not affect flows or water quality in the river Avon. The STW will be upgraded or rebuilt by Kelda as part of the site development programme.

8.4.3 At Tidworth WRZ, the increased ABP potable demand will be met within Veolia's existing abstraction licence. Tidworth STW is not capable of handling the uplift in ABP flow, and to address ABP and civilian population growth in the area, a new environmental permit is being applied for and the STW upgraded accordingly. The new permit will introduce controls on nitrogen for the first time.

9 COMPLIANCE

9.1 INTRODUCTION

9.1.1 One of the key drivers for the preparation of this IWMS is compliance with MOD's Salisbury Plain Masterplan Environmental Commitments and the subsequent Wiltshire Council Planning requirements. This report details how water will be provided to meet ABP demand, the known environmental impacts of existing MOD abstractions and discharges and the likely environmental impacts of the ABP uplift. It then details how these impacts will be mitigated.

9.1.2 Sections 9.2 and 9.3 below list the Masterplan commitments and relevant Planning conditions, respectively, in bold type. The MOD's agreed approach to addressing each point is then detailed. Progress against all issues will be monitored through the ABP Hydrology Steering Group, membership of which will include the Regulators, Wiltshire Council and supply chain partners.

9.2 SALISBURY PLAIN MASTERPLAN - ENVIRONMENTAL COMMITMENTS

9.2.1 ***'DIO will continue to work with the Environment Agency (EA), Natural England (NE) and Wiltshire Council to address the issues regarding additional water abstraction from Army Basing and support forthcoming planning applications for Salisbury Plain infrastructure (the first of which are planned for the last Quarter of 2014).'***

The IWMS identifies the environmental impacts on river flows and groundwater hydrology associated with both existing MOD abstraction and ABP uplift. The following mitigation measures will be implemented to specifically address the impacts of the uplift. Implementation dates will be agreed with the Regulators. Although these mitigation measures may also partially or fully address the existing impacts of abstraction and discharge, further assessment will be required to inform the forthcoming abstraction reform process.

BULFORD WRZ

MOD abstraction at Bulford has reduced from 1.261 ML/day in 2012/13 to a Recent Actual (2014 figure) of 1.108 ML/day, as a result of leakage reductions and water efficiency measures on the camp. The future requirement (including ABP uplift) is expected to be around 1.085 ML/day, which is marginally below the RA figure. As a result, additional potable water is not required from Wessex Water to meet ABP DO requirements and no additional mitigation measures are necessary.

Notwithstanding this, a new supplementary supply will be provided to Bulford camp from the existing Wessex Water network at Allington to strengthen the site's operational resilience into the future and to address the *existing* impacts of water abstraction on the Nine-Mile River. The Wessex supply will be capable of providing up to 1.005 ML/day, approximately 93% of the camp's total requirement, to be supplied on a 'best endeavours' basis. For financial and operational reasons, Wessex will supply a constant baseline volume of around 0.2 ML/ day (subject to commercial agreement), with the balance coming from the MOD abstractions. This supply is expected be in place by mid-2018, prior to the main uplift in demand in 2019. Abstractions from MOD's Bulford boreholes will then be reduced by an equivalent amount.

In the unlikely event that Wessex Water is unable to supply all of the camp's potable requirements during a prolonged drought, the limitations on MOD abstractions would necessitate the use of drought measures (such as closure of washdown facilities, restrictions on water use and if necessary the use of tanker-supplied water to balance consumption with available supply.

Wessex Water will also supply Bulford SFA as statutory undertaker; the company has sufficient headroom within its licenced supply to meet MOD's requirements.

LARKHILL WRZ:

Abstraction from Round 'O' will be reduced from 1.1ML/ day (FL) to 0.7 ML/ day; abstraction from the Larkhill boreholes will reduce from 1.4 to 0.8ML/ day. The additional (variable) potable

water requirement will be sourced from the existing Wessex Water backup connection onto the camp. This will be capable of providing up to 1.162 ML/day, just under 93% of the camp's requirements, which will be supplied on a 'best endeavours' basis. In practice, the backup supply is expected will provide up to 0.537 ML/day (subject to commercial agreement). The supply infrastructure will be upgraded in 2017/18, prior to the main uplift in demand in 2019. In the unlikely event that Wessex Water is unable to supply all of the camp's potable requirements during a prolonged drought, the drought measures described above for Bulford would be implemented.

Wessex will also supply the SFA as statutory undertaker; the company has sufficient headroom within its licenced supply to meet MOD's requirements.

TIDWORTH WRZ:

Veolia has confirmed that it holds sufficient licensed water resources to supply the ABP uplift at Tidworth garrison, Perham Down and Ludgershall SFA. No additional mitigation measures are therefore required. The existing impacts of abstraction on the perennial stretch are modelled to be reduced to within EFI limits by forthcoming Wessex Water sustainability reductions.

UPAVON WRZ:

The expected ABP uplift lowers the groundwater level slightly at the borehole and increases it at the adjacent STW soakaway. However, the river Avon is unaffected at any flow state, and no additional mitigation measures are required.

9.2.2 ***'DIO (in agreement with the EA and NE) has re-run the regional groundwater model with Wessex Water sustainability reductions in place to reassess the in-combination impacts on natural flows and groundwater levels. DIO will update Annex 9A of the OEA with an assessment of the individual and in-combination abstraction impacts of supplying the existing networks and the proposed development against the Review of Consent flow targets and methodology. The update to Annex 9A will also provide a narrative on the merit/ feasibility of doing further work using the JNCC methodology.'***

The IWMS has been informed by four runs of the WBM, over which time the Wessex Water sustainability reductions have been included and improvements have been made to MOD's consumption and leakage data. Annex 9A to the Masterplan OEA was updated in September 2014 by Amec; this considered the implications of using the JNCC methodology as described in 9.2.3 below.

9.2.3 ***'In due course and as a separate exercise, DIO will also assess the implications of the JNCC flow targets and methodology with NE and EA. It will also identify and agree any additional long-term mitigation measures that may be required to meet the conservation objectives of the River Avon SAC.'***

The September 2014 groundwater model update did consider the implications of adopting the JNCC methodology and compared the MOD flow impacts against the JNCC flow targets; however it was not possible to consider the temporal element of the targets and as the targets had not yet been agreed, no further work has been undertaken. Instead, impacts were assessed against the SAC flow targets for the Bourne, Avon and Till; the non-SAC Nine-Mile River was assessed against the more general WFD non-protected area targets.

DIO notes that the flow assessment methodology and targets required as part of the forthcoming consenting process may be amended. Further guidance will be sought from the EA and NE with regards to the appropriate targets to be used at that time with regards to completion of the HRA and any other assessments required.

The IWMS recommends mitigation measures to help meet the long term objectives of the River Avon SAC. These are the abstraction limits outlined above and implementation of the Phosphorus Action Plan (Appendix F) to address the additional phosphorus discharge into the river Avon. The Action Plan will be kept under formal review by the Regulatory Hydrology Steering Group, which will meet twice a year as long as required.

9.2.4 ***'DIO will agree and implement appropriate monitoring measures for the Nine Mile River with the EA and NE as soon as possible to inform forthcoming planning applications. These may include pump testing, pond level and groundwater monitoring. Appropriate mitigation and habitat management measures will then be agreed and taken forward.'***

Water level monitors and groundwater monitoring boreholes were installed at five ponds along the Nine-Mile River at Bulford Ranges in November 2015. Water levels will be recorded until at least November 2017. The results will be shared with the Hydrology steering group and used to agree the best habitat mitigation measures in the Nine-Mile River Habitat Management Plan. The data will also be available for use in further groundwater modelling and/ or abstraction licensing negotiations.

9.2.5 ***'DIO will mitigate the abstraction impacts of supplying both the existing network and the proposed developments through a combination of water efficiency improvements, demand management (including implementation of a comprehensive water infrastructure management programme to significantly reduce leakage) and providing a secondary supply from Wessex Water and/or other sources. The mitigation options and implementation timelines will be agreed with NE and EA as soon as possible to support planning applications for Salisbury Plain infrastructure.'***

As detailed in 9.2.1, MOD will mitigate the hydrological impacts of ABP uplift (and mitigate at least some of the impact from existing abstraction) by increasing its use of the existing secondary Wessex Water supply to Larkhill camp, and installing a new supply to Bulford Camp. These already-licensed supplies will be capable of providing the majority of the maximum potable demand at both Bulford and Larkhill Camps by 2018, to be supplied on a 'best endeavours' basis. The connections will help ensure that the local MOD abstractions can be reduced or turned off as required (subject to future regulator negotiations) without affecting supply to either site. In practice, MOD will take potable supplies from Wessex Water all year round, with increased amounts being taken as required (for example during very dry periods) once MOD abstractions are licensed. MOD and Wessex Water will work together to ensure that sufficient supply is always available; however in the unlikely event that it is unable to supply all of the camps' potable requirements during a prolonged drought, the agreed limitations on MOD abstractions would necessitate the use of drought measures to control consumption.

To protect river flows in the interim, the Larkhill STW soakaway will not be turned off and MOD will not abstract water above current levels (defined as the recent maximum monthly peak volume) from Larkhill, Bulford or Round 'O' boreholes, until the Wessex Water secondary supplies are secured and operational.

In addition to the measures outlined above, water efficiency and leakage reduction measures have delivered consumption reductions in the order of 1,700 m^3/day; further network metering and other options are being considered for future implementation, as detailed in Section 6.3. Wessex Water and Veolia will supply the SFA developments as Statutory Undertaker.

9.2.6 ***'DIO is assessing the provision of additional sewage treatment capacity, and will include options for phosphate and nitrate removal in the design of its STW effluent systems for when policy has been confirmed by NE and the EA. The location of any new STW infrastructure at Larkhill will be agreed with Wilts C and HE.'***

Additional flow from Tidworth WRZ will be treated at Veolia's Tidworth STW, which discharges to a soakaway. Veolia's current environmental permit is being varied to deal with long-term development, increasing the volumetric output whilst reducing the nitrate concentration. Tidworth STW is being upgraded accordingly.

Additional flow from Upavon WRZ will be treated at Kelda's on-site Upavon STW, which discharges final effluent to an adjacent soakaway. The STW will be upgraded or rebuilt as part of the site development programme; a revised environmental permit will be obtained in the normal manner.

Additional flows from Bulford will be treated at Ratfyn STW, as currently. The options assessment for Larkhill STW concluded that the best overall option would be to close the STW and divert flows to Wessex Water's Ratfyn STW. To mitigate the resulting hydrology and phosphorus impacts in the Avon, the following measures will be adopted:

(a) MOD will implement the ABP Phosphorus Action Plan (Appendix F, Part 3). This incorporates funding a Catchment-Sensitive Farming Officer from 2016 to 2021 inclusive to help farms access Stewardship funding; providing additional financial assistance to farmers from 2017 to 2021 for small-scale infrastructure improvements; identifying potential non-agricultural inputs (such as from unsewered properties) and if required, considering changes to how MOD land is used. Progress will be monitored by the Hydrology Steering Group.

(b) Nitrate is not an issue for the SAC conservation objectives; however any measureable reductions in nitrate will be recorded as part of the CSF initiative.

(c) MOD will reduce Larkhill and Round 'O' abstractions as described in 9.2.5 to mitigate the loss of the soakaway volume into the aquifer. Further groundwater modelling will be undertaken as required to provide further evidence about the hydrological impact of closing Larkhill soakaway.

9.2.7 ***'DIO will ensure that WFD assessments for planning applications are updated, as required, once more detailed water resource and water quality modelling/ investigations are completed.'***

WFD assessments have not been necessary for any of the ABP Planning Applications to date. If required for any supporting infrastructure, assessments will be undertaken and shared with the Regulators through the normal Planning process.

9.3 WATER MANAGEMENT STRATEGY - PLANNING CONDITION

9.3.1 ***'The development hereby permitted shall not be occupied until such time as a Water Management Strategy that includes the following components has been submitted to, and approved in writing by, the local planning authority. Where necessary, the Strategy shall make reference to, and be an integral part of, the wider Army Basing Programme developments and the existing MOD water network. Development shall be carried out in complete accordance with the Strategy approved as part of this condition to include:***

9.3.2 ***a) Details of water abstraction volumes, specific abstraction sources, where water will be discharged and leakage rates. This should include detailing any abstraction conditions and how these conditions will be met, also identifying the link between abstractions and discharge to meet licence and permit conditions.'***

This IWMS details:

- The abstraction locations and associated volumes required for each WRZ, both currently and with expected ABP uplift.
- The discharge locations for each WRZ (these will remain the same after ABP for all WRZ's except Larkhill, where sewage will be diverted to the Wessex Water STW at Ratfyn).
- The potable water leakage rates and water efficiency measures that are in place; further schemes under determination are also detailed.
- Limitations on abstraction rates are detailed.
- The link between abstractions and discharge has been made through the use of the Wessex Basin Groundwater Model (WBM) to ensure a whole water cycle approach has been adopted.

9.3.3 ***b) 'Where possible, an overall assessment of individual and combined environmental impacts relating to water resources and how any impacts will be mitigated.'***

The Wessex Basin Groundwater Model has been used to provide an overall assessment of the hydrological impacts associated with both existing abstraction and ABP uplift. It has identified appropriate mitigation measures to deal with the impacts of ABP uplift and provides the basis for further modelling to develop mitigation for existing abstraction impacts in future.

9.3.4 ***c) 'Details of any required mitigation or infrastructure improvements to the water abstraction/ supply or foul drainage network that have been identified in the overall assessment carried out as part of this Water Management Strategy, or that have been identified by other relevant studies.'***

The following mitigation measures in addition to those detailed above will be implemented:

- New SFA potable and foul water treatment requirements will be met by the statutory undertakers;
- MOD's Larkhill STW will be closed and flows diverted to the Wessex Water STW at Ratfyn from Q3 2017;
- MOD will implement the ABP Phosphorus Action Plan, based upon Catchment Sensitive Farming principles;
- Further leakage reduction and water efficiency measures are currently being investigated and will be implemented in agreement with the ABP Hydrology Steering Group;
- Investigations will be undertaken at specific abstraction points to reduce the identified risk associated with surface water flooding;
- The impacts of climate change on future Deployable Output at Round 'O' and Upavon BH03 will be considered further.

9.3.5 ***d) 'Any specific water management requirements/ mitigation for the developments hereby permitted.'***

The following addition mitigation measures will be implemented:

- New builds and major refurbishments will be designed to MOD standards for water efficiency. The following standards for potable use will be adopted:
  - SLA - 80l/ bedspace/ day.
  - SFA – demand will follow the CfSH Code 4 minimum standard of 105l/ person/ day.
  - Non accommodation domestic demand – around 4m^3/FTE/yr (18l/ person/ day).
- All new development will discharge surface water to soakaways, with appropriate levels of SUDS-based treatment to assist groundwater recharge.

9.3.6 ***e) A timetable for implementation of the Water Management Strategy, together with a procedure for reporting progress against the agreed targets at regular intervals. In the event that this reporting identifies a need for additional mitigation to achieve the agreed targets, details of that mitigation, including a timetable for its implementation, shall be submitted to the local planning authority within 3 months for written approval. The additional mitigation shall be carried out in accordance with the approved details.***

A delivery timetable is included in Section 9.4 below. Progress will be monitored by the Regulatory ABP Hydrology Steering Group. The Terms of Reference for the group, which is expected to meet on a six-monthly basis from Spring 2017 onwards, will be finalised and agreed at that point.

9.4 DELIVERY TIMETABLE

The following dates are indicative, based on MOD's current understanding. As this IWMS is a 'living document,' some dates may be subject to change. Where dates are not yet known, they are marked 'TBC.'

Activity	Responsibility	Planned Delivery by
Undertake leakage reduction initiative (phase 1) at Bulford & Larkhill camps	MUJV	Feb 2017
Finalise and approve TORs for the 6-monthly Hydrology Steering group	DIO/ Hydrology Steering Group	Mar 2017
Upgrade foul capacity at Bulford to accommodate SFA	Kelda Water	Autumn 2017

Bulford tracked vehicle washdown facility operational	DIO & Landmarc	Autumn 2017
Undertake hydrological monitoring along the Nine-Mile River	DIO & Landmarc	Nov 15 – Nov 17 (minimum)
5th Bn Rifles move to Bulford	-	Aug 2016
Upgrade Tidworth STW to comply to new environmental permit conditions	Veolia	Dec 2017
Agree abstraction licence requirements for MOD potable sources	DIO, DEFRA & EA	Negotiation / supporting groundwater modelling during 2017
MOD sources licensed	DIO & EA	Licencing expected into force late 2017
Install foul connections from Larkhill camp & SFA to Ratfyn STW	Wessex Water	Construction complete Dec 2017
	Kelda Water	Construction complete Mar 2018
Install supplementary Wessex potable supply to Bulford camp	Wessex Water	Construction to Mar 2018.
Upgrade current Wessex backup supply into Larkhill camp	Kelda Water	Upgrade to Mar 2018.
0.5 Ml/day backup supply from Wessex to Larkhill camp operational	Wessex Water	Apr 2018 (estimated)
1.35 Ml/day supplementary supply from Wessex into Bulford camp	Wessex Water	Apr 2018 (estimated)
Reduce abstractions from MOD boreholes at Larkhill & Round 'O'	Kelda	Concurrent with switch-on of Wessex supply - Apr 2018 (estimated)
Closure of MOD Larkhill STW	Kelda Water	Closure to follow switch-on of Wessex supply – Apr 2018 (estimated)
Demolish MOD Larkhill STW	Kelda Water	Demolition date TBC after Apr 2018.
Undertake leakage reduction initiative (phase 2) at Bulford & Larkhill camps	MUJV	Mar 2018
Undertake initial Catchment-Sensitive Farming initiative (CSFO & Capital funding)	DIO & NE	Aug 2016 – Mar 2021
Formal review of progress with CSF initiative	Hydrology Steering Group	Summer 2018
Undertake leakage reduction initiative (phase 3) at Bulford & Larkhill camps	MUJV	Mar 2019
Main Unit moves into Larkhill, Bulford, Tidworth & Perham Down	-	Aug 2019
Negotiate revised Environmental Permit for Upavon STW	DIO & Kelda	TBC; most likely 2019-20
Agree further CSF measures required beyond Mar 2021	Hydrology Steering Group	2020

Assess impacts of climate change on DO at Round ‘O’ and Upavon BH03	Kelda	Prior to five-year review point in 2022
Further assess and address surface water flood risks for MOD abstractions at Larkhill & Bulford	Kelda	Prior to five-year review point in 2022
Further assess and address surface water flood risk for Veolia abstractions around Tidworth	Veolia	No target date set.

10 CONCLUSIONS

10.1 The following WRZ's across Salisbury Plain will be impacted by ABP development:

- Upavon (managed by Kelda Water)
- Bulford (managed by Kelda Water and Aspire, with Wessex Water as statutory undertaker for some existing and the new SFA)
- Larkhill (managed by Kelda Water and Aspire, with Wessex Water as Statutory undertaker for the new SFA)
- Tidworth (managed by Veolia and Aspire, with Veolia as statutory undertaker for the new Ludgershall SFA).

10.2 For historical reasons, water supply and waste water management across the military establishments on Salisbury Plain is relatively complex. Water is abstracted by Kelda from eleven boreholes and by Veolia from three. Wessex Water also operates a number of PWS boreholes across Salisbury Plain. There is one major import into Larkhill WRZ from Round 'O', which also serves MOD properties outside of the scope of the IWMS. There is one major export from the Tidworth WRZ to Wessex Water (the Leckford Bridge bulk transfer), but apart from this the Veolia supply area is largely self-contained. Other minor transfers include supplies from Round 'O' onto SPTA for agricultural use, and PWS supply from Wessex Water to the Canadian Estate SFA at Bulford.

10.3 Since historical supply data for the non-Veolia WRZs is relatively incomplete, the assessment of Deployable Output has been based upon Recent Actual and peak monthly flow data for April 2012 – April 2015 inclusive. The assessment concludes that sufficient water is available to meet current demand, with an appropriate margin of additional headroom available. A similar conclusion is reached by the Veolia WRMP, assuming that recommended supply infrastructure improvements are implemented.

10.4 The outage assessment confirms that all WRZ's have substantially sized service reservoirs which would provide sufficient time to address the cause of any outages or arrange an alternative water supply. The planned connection from the Wessex Water supply into Bulford WRZ and the enhancement of the existing supply into Larkhill WRZ will guarantee the operational resilience of both sites in the longer term; no further mitigation for outage scenarios is therefore needed.

10.5 The future water demands associated with ABP have been assessed and considered in light of the leakage reduction and water efficiency measures that have been achieved over the assessment period (such as the Aspire/ MUJV leakage reduction programme alone has delivered reductions in the order of 1,700 m^3/day). Net demand at all WRZs except Bulford is expected to increase; however at Bulford, abstraction rates have recently fallen from 1.398 to 1.375 ML/ day, and this improvement appears sufficient to offset the expected ABP uplift.

10.6 The vulnerability assessment identifies that further work is required to minimise the risk of surface water flooding affecting the abstraction points and associated infrastructure in the Larkhill, Bulford and Tidworth WRZs. It also identifies that further work is required to reduce the operational risks of climate change-induced reductions in groundwater levels at the Round 'O' and Upavon BH03 boreholes.

10.7 Existing abstraction is known to be adversely affecting flows within the River Avon SAC; as a result, the likely impacts of ABP on the water environment have been extensively assessed. The hydrological impacts have been assessed using the Wessex Basin Groundwater Model, which has been refined and updated to ensure that it accurately reflects MOD's water use across Salisbury Plain.

10.8 The WBM has shown that ABP demand does not significantly reduce low river flows in the Upavon or Tidworth WRZ's; these WRZ's therefore have no further mitigation requirements. It has however shown that existing MOD abstractions (in combination with PWS and other

unlicensed abstractions) are significantly impacting on low flows in the Nine Mile River, the river Till and the middle river Avon. ABP uplift at Larkhill and Round 'O' and the closure of Larkhill STW soakaway will further reduce flows on the Till and Avon. Leakage from the supply system is not deemed to be a significant issue, as Salisbury Plain is on highly permeable chalk bedrock, and the Regulators assume that most leaked water returns directly to the aquifer.

10.9 The flow impact of ABP uplift and closure of the Larkhill STW soakaway on these rivers can be removed (and in some situations improved) if the peak Larkhill and Round 'O' abstractions are reduced by 0.6 ML/ day and 0.4 ML/ d respectively, and the shortfall made up from the Wessex supply. At Bulford, ABP uplift does not have a discernible effect on river flows, but the impact of existing abstractions can be reduced by limiting abstractions from the MOD Bulford boreholes and installing a supplementary supply from Wessex Water.

10.10 Use of the existing Wessex supply to Larkhill will therefore be increased, and a new supply to Bulford Camp will be installed. These will be installed before the end of 2018 and will be capable of providing at least 93% of the potable demand at both Bulford and Larkhill Camp. Wessex Water will also supply the associated new SFA as statutory undertaker. These connections will ensure that the local MOD abstractions can be reduced or turned off as required, without affecting the potable supply to either site.

10.11 In practice for operational and economic reasons, around 0.2 ML/ day will be sourced from Wessex to supply Bulford Camp all year round, with increased amounts being taken as required (for example during prolonged dry periods). To protect river flows in the interim, Larkhill STW soakaway will not be turned off and MOD will not abstract water above current levels (defined as the recent maximum monthly peak volume) from Larkhill, Bulford or Round 'O' boreholes, until the Wessex Water secondary supplies are secured and operational.

10.12 It must be borne in mind that the potential impacts identified by the WBM are based on a 'worst case' scenario whereby MOD and Wessex PWS abstractions are operating at their Full Licence amounts. As these volumes are substantially higher than recent actual abstractions, mitigation might not result in any observable difference in the short to medium term. Further groundwater modelling will be required to assess the impact of existing MOD abstractions with the new supplementary supplies in place.

10.13 Regarding wastewater, Tidworth STW will be able to handle the uplift in flows from ABP developments at Tidworth, Perham and Ludgershall. Veolia is upgrading the STW to manage MOD and civilian developments in the area and has accordingly agreed a variation to the Environmental Permit with the Environment Agency. The new standards are due to be implemented before the end of December 2017. Flows from ABP developments at Bulford will be handled at the Wessex Water Ratfyn STW, as currently.

10.14 The wastewater requirements for Larkhill have been subject to a detailed options assessment, since the existing STW would be unable to handle the uplift and cannot be upgraded. The recommended option (closure of Larkhill STW and diversion of all flows to Ratfyn STW) will be taken forward, as it provides the best cost-benefit match overall against the key objectives including the most favourable through-life financial profile and least delivery risk. This has been agreed with the relevant Regulators and stakeholders.

10.15 For both Bulford and Larkhill, the additional discharge results in increased phosphorus loading into the River Avon. This has implications for delivery of the River Avon Nutrient Management Plan, which aims to reduce nutrient loading to achieve SAC conservation objectives. MOD has therefore agreed a five-year Phosphorus Action Plan with the Regulators (Appendix F) to offset the additional phosphorus loading. This Plan involves the use of Catchment-Sensitive Farming techniques to reduce diffuse agricultural pollution into the river, and if necessary investigating unsewered MOD-owned properties and reviewing land use.

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12 APPENDICES

APPENDIX A FIGURES

Wessex Water Upavon WWTW

XA068

XA013

WxW Netheravon WWTW

XA679

Wessex Water Tilshead WWTW

XA677

XA050S04

XA050

XA680

XA051

Wessex Water Ratfyn WWTW

FOR DETAILS OF THIS AREA, REFER TO VEOLIA WATER PROJECT'S WATER RESOURCES MANAGEMENT PLAN

NINE MILE RIVER

RIVER BOURNE

RIVER TILL

RIVER AVON

DO NOT SCALE

KEY

- BOREHOLES IN SERVICE
- BOREHOLES NOT IN SERVICE OR SERVING ISOLATED FARMS
- SERVICE RESERVOIRS
- WASTE WATER TREATMENT WORKS
- RAW/POTABLE WATER
- WASTE WATER
- CAMPS/GARRISONS WITHIN SCOPE OF STUDY
- RIVERS/WATERCOURSES
- FUTURE (ESTIMATED 2017–2019) SFA LOCATIONS
- VEOLIA WATER PROJECTS SERVICE AREA
- FOCUS AREA

NOTES:

1. ONLY INFRASTRUCTURE PERTINENT TO THE IWMS IS SHOWN.

REV	DATE	BY	DESCRIPTION	CHK	APD
D	08/07/16	MD	IWMS FINAL ISSUE	AS	CR
C	21/01/16	MD	IWMS FINAL ISSUE	AS	CR
B	18/01/16	MD	IWMS INITIAL ISSUE	AS	CR
A	DEC 2015	MD	INITIAL ISSUE FOR DISCUSSION	AS	CR

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CLIENT: DIO

ARCHITECT:

PROJECT: SALISBURY PLAIN INTEGRATED WATER MANAGEMENT STRATEGY

TITLE: FIGURE 1 - PRINCIPAL FEATURES FOR THE INTEGRATED WATER MANAGEMENT STRATEGY

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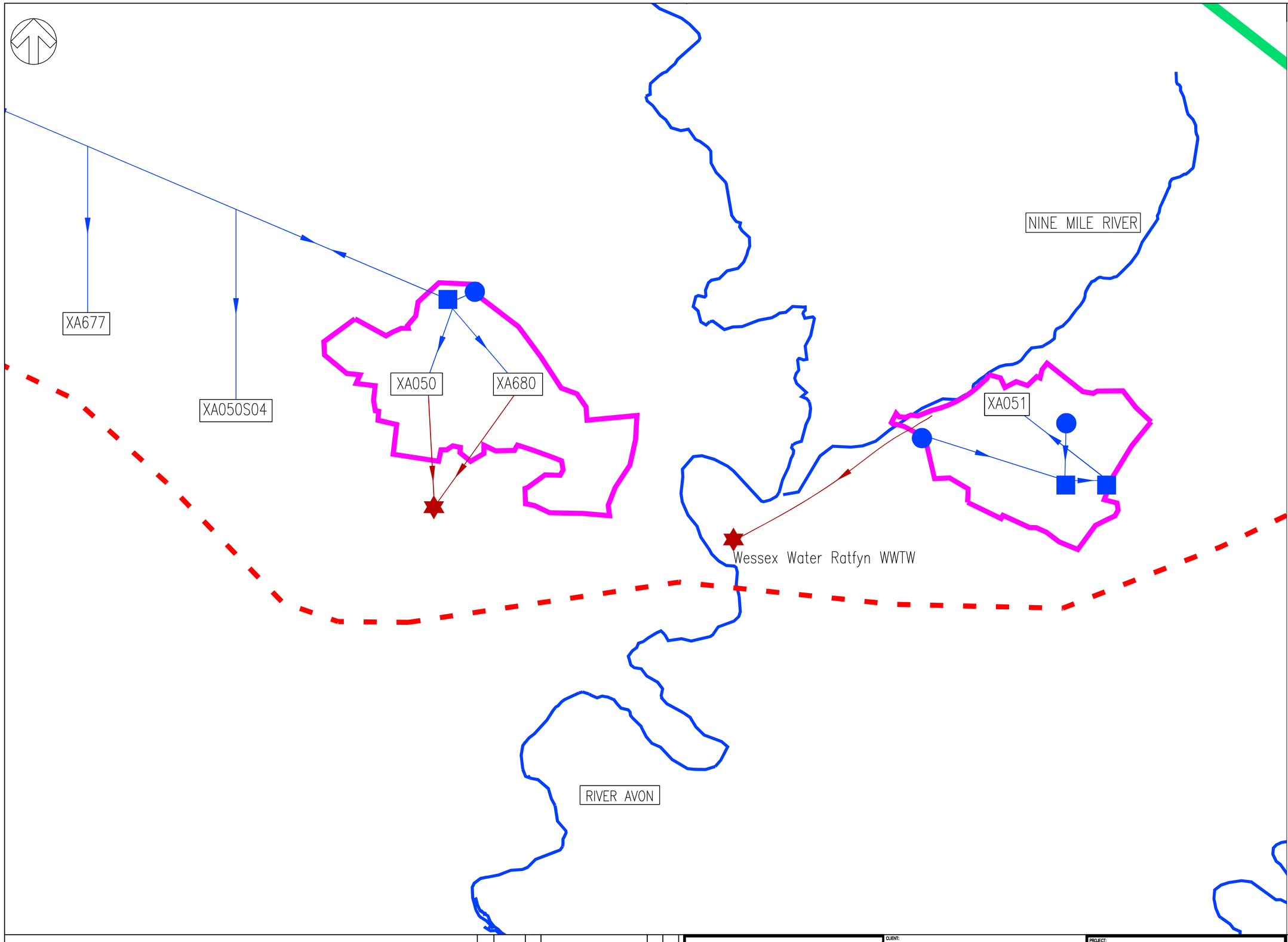

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- WASTE WATER TREATMENT WORKS
- RAW/POTABLE WATER
- WASTE WATER
- CAMPS/GARRISONS WITHIN SCOPE OF STUDY
- RIVERS/WATERCOURSES
- VEOLIA WATER PROJECTS SERVICE AREA
- FOCUS AREA

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B	21/01/16	MD	IWMS FINAL ISSUE	AS	CR
A	21/01/16	MD	IWMS INITIAL ISSUE	AS	CR

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TITLE: FIGURE 2 - PRINCIPAL FEATURES FOR THE INTEGRATED WATER MANAGEMENT STRATEGY

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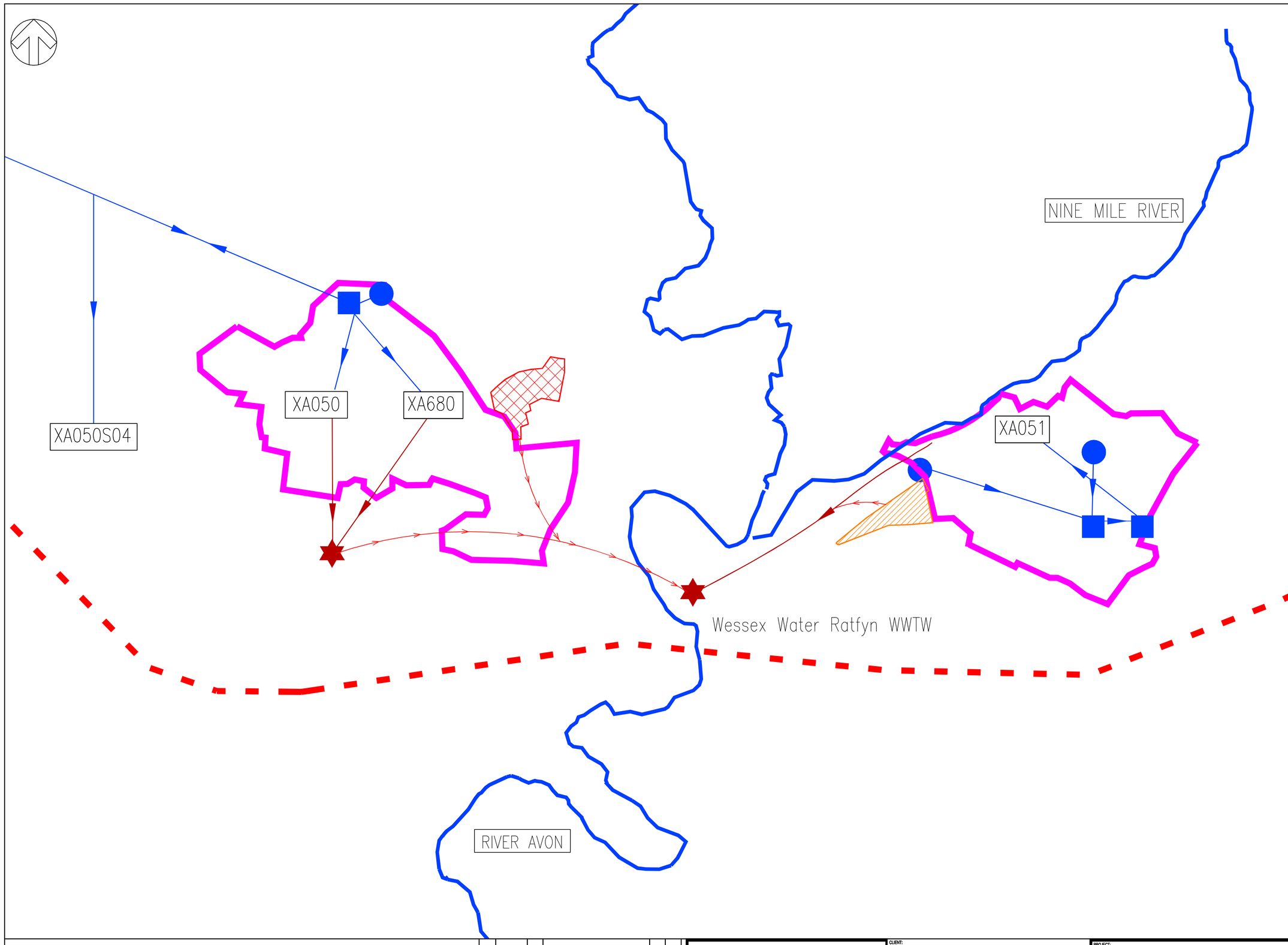

DO NOT SCALE

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- SERVICE RESERVOIRS
- WASTE WATER TREATMENT WORKS
- RAW/POTABLE WATER
- WASTE WATER
- CAMPS/GARRISONS WITHIN SCOPE OF STUDY
- RIVERS/WATERCOURSES
- PROPOSED LARKHILL SFA TREATED AT WESSEX WATER RATFYN WWTW
- PROPOSED BULFORD SFA TREATED AT WESSEX WATER RATFYN WWTW
- VEOLIA WATER PROJECTS SERVICE AREA
- FOCUS AREA

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PROJECT: SALISBURY PLAIN INTEGRATED WATER MANAGEMENT STRATEGY

TITLE: FIGURE 3 - LARKHILL AND BULFORD CAMPS PROPOSED WASTE WATER TRANSFER AND TREATMENT

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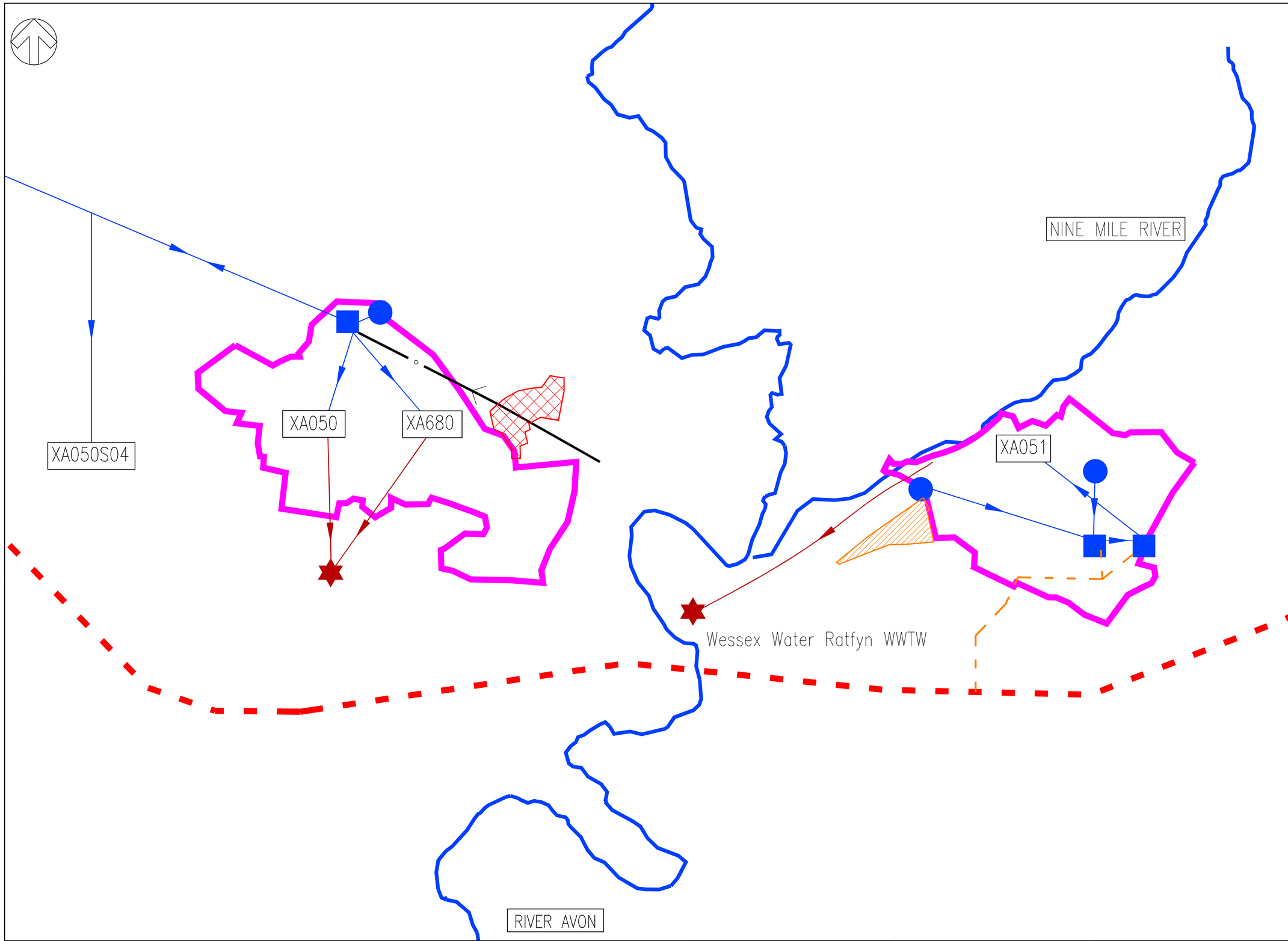

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- SERVICE RESERVOIRS
- WASTE WATER TREATMENT WORKS
- RAW/POTABLE WATER
- WASTE WATER
- CAMPS/GARRISONS WITHIN SCOPE OF STUDY
- RIVERS/WATERCOURSES
- SFA LARKHILL DEVELOPMENT SUPPLIED FROM WESSEX WATER
- SFA BULFORD DEVELOPMENT SUPPLIED FROM WESSEX WATER
- EXISTING WESSEX WATER BACKUP TO LARKHILL CAMP
- NEW WESSEX WATER BACKUP TO BULFORD CAMP
- VEOLIA WATER PROJECTS SERVICE AREA
- FOCUS AREA

NOTES:

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PROJECT: SALISBURY PLAIN INTEGRATED WATER MANAGEMENT STRATEGY

TITLE: FIGURE 4 - LARKHILL AND BULFORD CAMPS PROPOSED SUPPLEMENTARY WATER SUPPLIES

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APPENDIX B VEOLIA WATER PROJECTS WRMP

Veolia Water Projects

Water Resources Management Plan

Final Published Report

VEOLIA WATER

DOCUMENT INITIAL REVIEW AND AUTHORISATION SHEET

Document

PUBLISHED REPORT VERSION 7 [P]

Project or Subject:

Water Resources Management Plan

Job:

Preliminary Check

Originator: M. Ascott *Date* *Signature*	Project Manager *date* *signature*
Comments	

DRAFT

			To see				**Screening Panel**						
Rev		Originator	Proj Man	MT	IK		Proj Dir.	H WQ	H Eng.	H TechS	H Plan	Tec hDir.	MD
	Seen												
	Date												
Comments: Amendments made accordingly *Please return comments by:*													

FINAL DRAFT

			To see				**Screening Panel**						
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3	Seen	JG	JG										
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	Date	250313											
7	Seen	JG/MA	JG										
	Date	281013	301013										
Comments: *Please return comments by:*													

All comments resolved and ready for issue:

Published Report = Version 7[P]	*Report Ref:7 [P]*	*Date 1st June 2014*

Electronic File Reference:

S:\VWOL\Allenby Connaught and Tidworth\DMP

AUTHORISATION FOR ISSUE/USE

Project Manager	*Signature* **Jim Griffiths for Publication.**	1st June 2014	Issue to Use by Ext. Reporter	☐

Executive Summary

Veolia Water Projects [VWP] Tidworth is an Inset Appointment which supplies Regulated Water and Waste Water services to over 800 civilian properties and over 90 commercial properties in and around the Wiltshire town of Tidworth. In addition the overarching PFI agreement with the Ministry of Defence includes services to the Tidworth Military garrison where up to 6,000 personnel can be "behind the wire" at any one time. The Contract also includes the provision of similar services to some 1300 Service Families accommodations [SFA's] in the town and surrounding community. The water supply comes from groundwater, drawn from a supply of robust unconfined chalk aquifer boreholes. Currently these water sources provide sufficient water to meet all the needs of the customers as well as providing neighbouring company Wessex Water with a number of treated bulk supplies.

This final published document replaces the [ex] TWUL Water Resources Management Plan currently in force produced in 2008. The purpose of the Plan is to show how Veolia Water intend to maintain sufficient water supplies to meet the customers' needs until 2040. It is a statutory document which has been subject to public consultation. In order to compose this plan, studies were undertaken to understand how the supply and demand of water will change over the next 25 years, taking into account and making due allowance for any uncertainty associated with MoD developments. A principle driver for the review is the proposal for a number of large new housing developments on land recently sold by the MoD in and around the town together with the latest Army predictions around its basing requirements. These were unforeseen in the previous planning document.

A theoretical deficit of 2.12 Ml/d has been identified in 2012 /13 however this is completely mitigated once the preferred option to install uprated pumps in BH's 2 & 3 has been carried out. There is then no deficit for the remainder of the Plan. In March 2013 a new licence was granted to VWP which increases the licensed abstractions from BH2 and 3 by splitting the licence for BH1 and removing this from the document.

Veolia Water Projects intends to continue working in a sustainable manner, promoting efficient water use and continuing to improve its own assets to reduce water waste. As part of the options appraisal Veolia Water Projects has and will continue to prioritise security of supply, conservation of stressed aquifers, protecting river flows and their ecology while considering the cost of capital which, due to the nature of the Inset Appointment Conditions, cannot be linked to customer's bills through the Periodic Review mechanism in the usual way.

The preferred option is to uprate the pumps at BH2 and BH3 to increase the DO to the new licenced quantities resulting from the split of the former BH1 licence. This will allow VWP the ability to fully utilise both of these licences while restraining use at the CP source, thus participating in the protection of the Nine Mile River from abstraction effects. Environment Agency catchment modelling studies show that the Winter Bourne is only marginally affected by abstraction at BH2 and BH3, potentially affecting its dry season length and reach. However this is offset by the sewage treatment works discharging treated effluent back into the same aquifer via soak away lagoons slightly further down catchment (any leakage will also return the same way). Although this will be at greater capital cost to Veolia Water Projects, it has been assessed as the preferred option providing potential nitrate loading at the sewage treatment works can be taken into account.

Abbreviations

ADSL	Aspire Defence Services Limited
AGA	Above Ground Asset
BGA	Below Ground Asset
CC	County Council
CCW	Consumer Council for Water
CoP	Code of Practice
DAPWL	Deepest Advisable Pumping Water Level
DI	Distribution Input
DMA	Demand Management Area
DEFRA	Department for Environment, Food and Rural Affairs
DMG	Drought Management Group
DMP	Drought Management Plan (Statutory Document)
DO	Deployable Output (from water sources)
DWI	Drinking Water Inspectorate
DZ	Drought Zone
EA	Environment Agency
EMP	Environmental Monitoring Plan
JRSLA	Junior Ranks Single Living Accommodation
LBA	Leckford Bridge Agreement (with Wessex Water)
LoS	Level of Service
LTA	Long Term Average
mAOD	Meters Above Ordnance Datum (Sea Level)
mBHP	Meters Below Head Plate
MoD	Ministry of Defence (Refers to Tidworth Garrison)
OBH	Observation Borehole
Ofwat	Office of Water Services, Industry Regulator
PFI	Private Finance Initiative
Serk	System for control and data capture of operating sites
SFA	Services Family Accommodation
SoS	Secretary of Sate (refers to the Minister for Environment)
SRO	Source Reliable Output
STW	Sewage Treatment Works
TWUL	Thames Water Utilities Limited
The 'wire'	Refers to MoD secure land boundary
UKWIR	Water Industry Research Group
VWP	Veolia Water Projects (Part of Veolia Water UK)
WAFU	Water Available for Use
WaSC	Water and Sewerage Companies
WIA	Water Industry Act, 1991
WR	Water Resources
WRMP	Water Resources Management Plan (Statutory Document)
WRZ	Water Resource Zone
WW	Wessex Water
9MR	Nine Mile River

NOTE.
For security purposes all abstraction locations are referred to by codes.
Namely; CP, BH1, BH2, BH3,
The geographic locations are known to the Environment Agency.

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1. Introduction

Thames Water Utilities Limited (TWUL) operated the water supply and sewerage function of this small water resource zone on the edge of Salisbury Plain in Southern England under an Inset Appointment since 1998. The Inset was acquired by Veolia Water in 2007, who are now responsible for the management of the water resource zone during the 25 year planning period. Veolia Water Projects (VWP) provides water services (clean and waste) for over 800 civilian properties and over 90 commercial properties in Tidworth and the surrounding areas in Wiltshire on the edge of the Salisbury Plain (see Figure 1). The PFI agreement with the Ministry of Defence (MoD) means VWP also services a large garrison that can house up to 6,000 personnel "behind the wire" at any one time together with some 1300 Service Families Accommodation [SFA's] properties in the town and community. All of the supply comes from groundwater, drawn from a supply of robust unconfined chalk aquifer boreholes. Currently, these water sources provide sufficient water to meet all the needs of the customers as well as providing neighbouring company Wessex Water (WW) with a number of bulk supplies (see section 2.3). The previous Water Resources Management Plan (WRMP) 2008, created by TWUL showed the supply and water balance over the 25 year planning period until 2040 (see Figure 3).

According to this Plan no deficit exists for the zone on average based on the initial supply demand balance throughout the period from the year 2006/07 to 2040. As written by TWUL, the zone would remain in surplus for the whole planning horizon.

However in light of MoD land sales to housing developers the civilian population is set to increase significantly over the next 4 to 5 years. There are a number of planned developments proposed, some may not come to fruition but one consisting some 600 houses is at detailed planning and looking certain to begin during 2012/13. This situation is set out in more detail in Section 3.2. Additionally, in March 2013 VWP were granted a revised abstraction licence which removed BH1 from the licence and split this licenced volume between BH2 and BH3. As a consequence the previous and legacy WRMP's and supply/demand forecasts will be made redundant hence the creation of an updated statutory document to completely reassess the WR situation. Using as the prime legislation VWP's statutory duty under new sections of the Water Industry Act (WIA), 1991, brought in by section 62 of the Water Act 2003 and as detailed in the Water Resources Management Plan Regulations, 2007 and the WRMP Direction, 2007. VWP also recognise the advice given in the Environment Agency (EA) 'Water Resources Planning Guideline Navigation Tool' October 2010 designed for small water company's use in the preparation of this Plan.

This document intends to demonstrate VWP has a sound and through understanding of its new demand and supply situation. Additionally it will include a 'risk assessment' approach to any potential future large scale land developments providing a WR planning document until the year 2040.

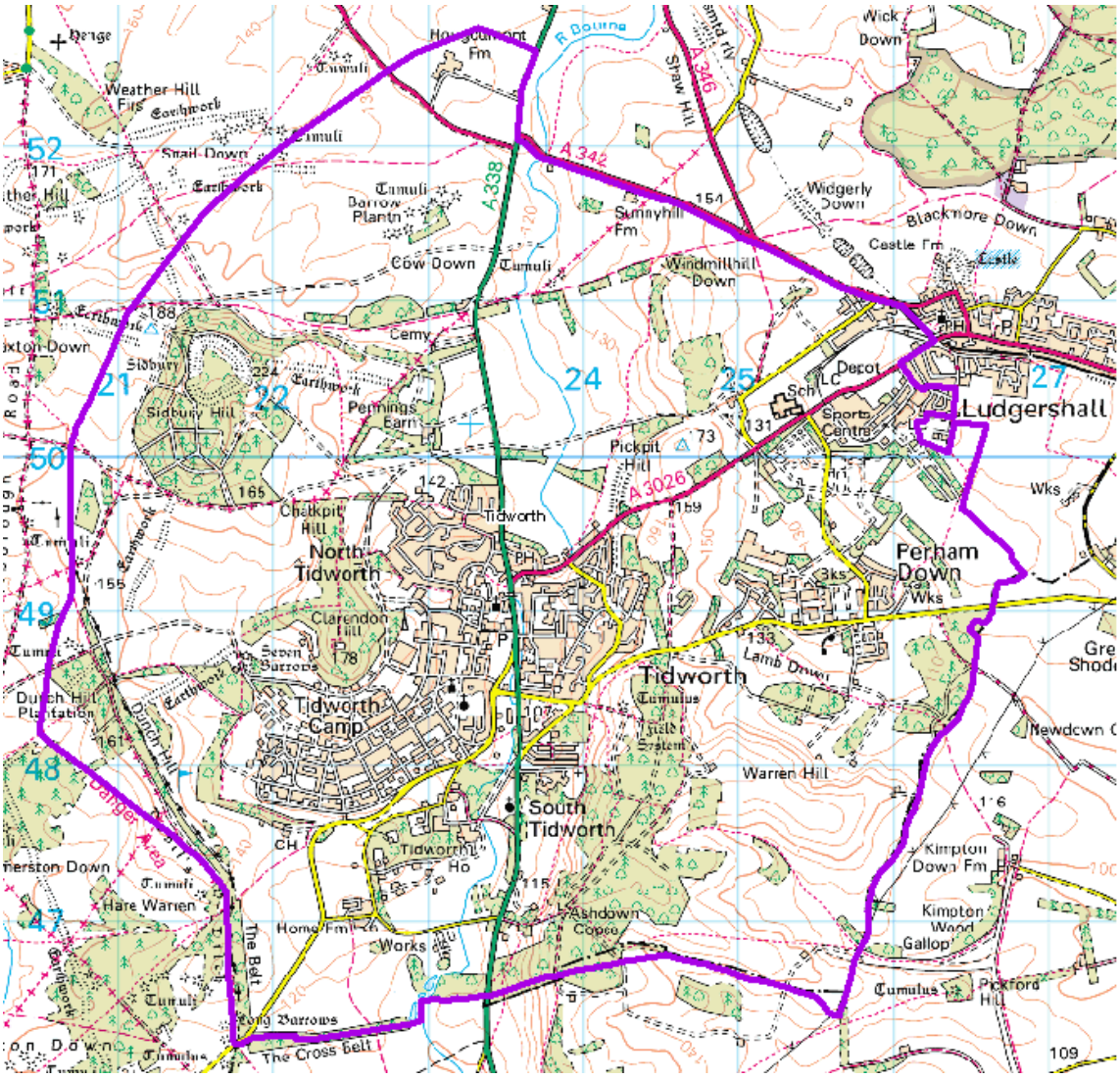


Figure 1: Veolia Water Projects Service Area.

The report has been assembled under the main concepts in the order shown below in Figure 2 below.

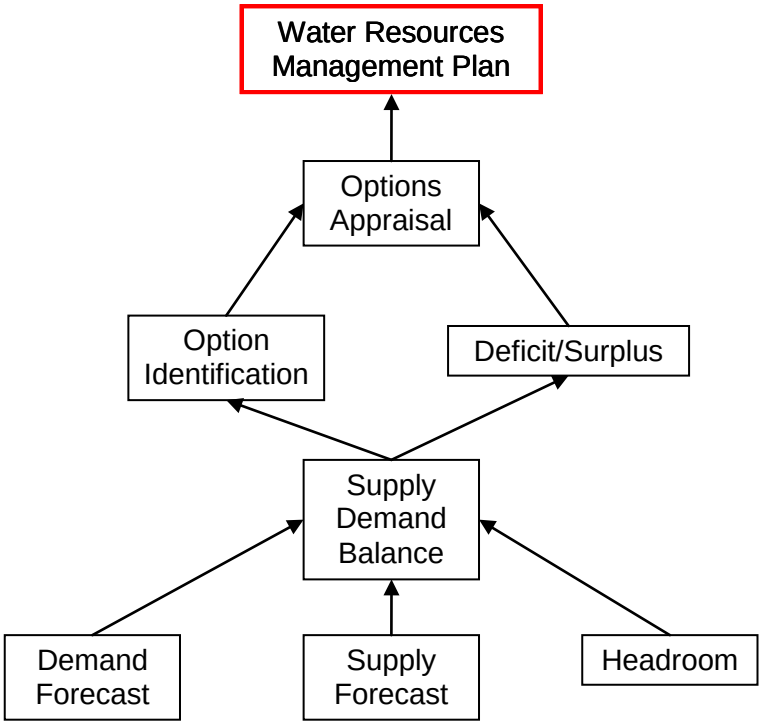


Figure 2 Key Components of a WRMP

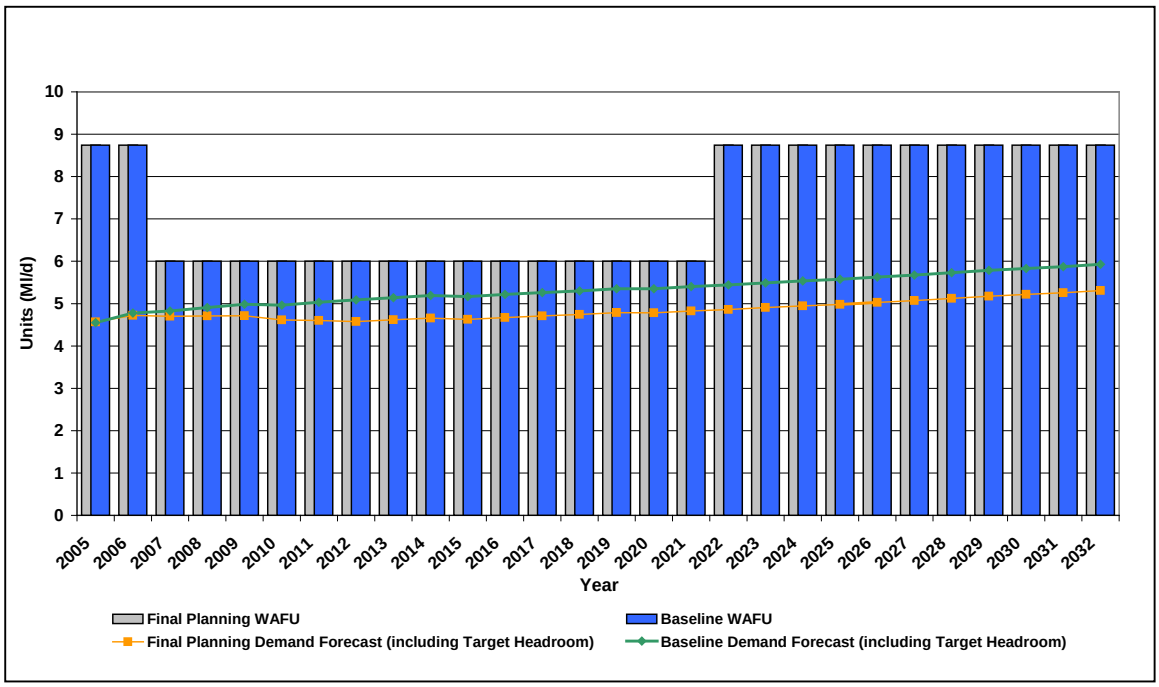


Figure 3 Annual average final planning supply demand balance, Tidworth. (Taken from TWUL WRMP08)

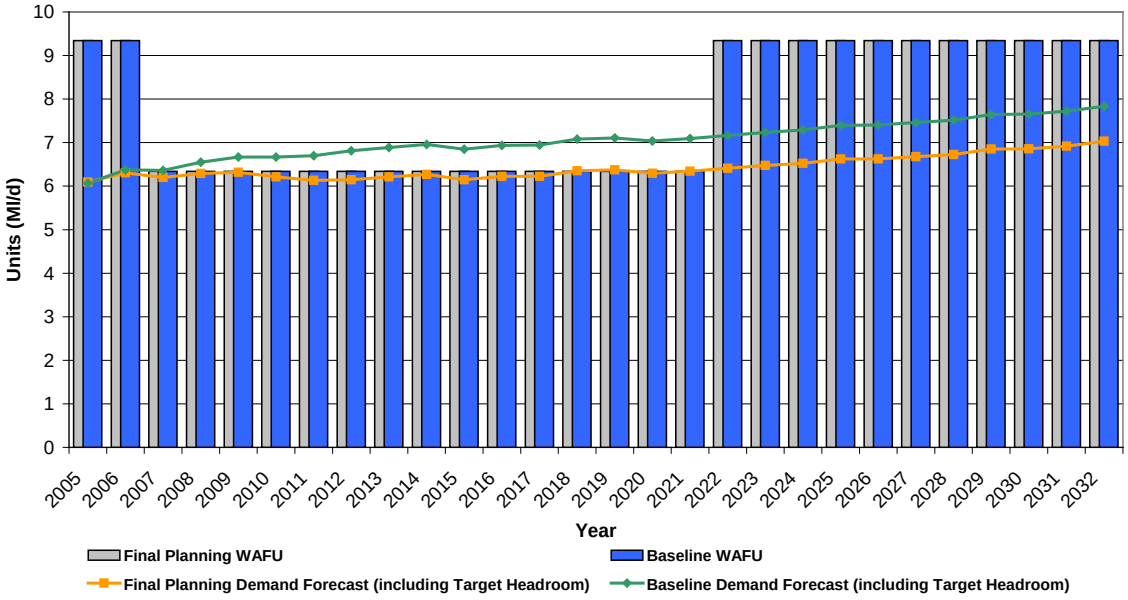


Figure 3A Peak Annual Supply Demand Balance - Tidworth [Taken from TWUL WRMP08]

2. Supply

2.1 Current Water Supply Situation

VWP Tidworth extracts raw water from three separate sources according to licence conditions (see section 2.4 for details). These are treated on two sites via GAC filtration at one site and marginal chlorination with an interposed contact tank/main at both sites. Both treated waters are pumped to one strategic reservoir (CR) and from one source to a small distribution reservoir under borehole pressure. From these positions the network is almost entirely gravity fed. One (BH1) source was abandoned (prior to VWP) due to water quality issues and additional treatment being required at that site. As previously discussed, this source has now been removed from the licence and the volumes split between BH2 and 3. The table below shows a summary for all the source output totals for one year (from the date of this report).

Source Volume Outputs for 2011-12 (YTD, all values average Ml/d)

Average	BH1	BH2	BH3	CP	Group Total
Yearly	0.00	2.22	2.10	1.20	5.52
Peak	0.00	2.47	2.35	2.23	7.05
Annual	0	809	766	435	2,010

From this summary it can be seen that VWP sources operate at an average of 5.52Ml/d throughout the year, but can run at 7.05Ml/d as a peak volume. This is an increase of almost 30% from average to peak. Sources BH2 and BH3 combined provide 78% of the total distribution input (DI). As the raw water from these sources is treated at the same site and are located in a similar position in the aquifer, they should be considered as 'one source' from a water resource (WR) perspective. However in section 2.5 for outage assessments they are separated as operational issues are key. These sources are also assessed to be the most robust in terms of deployable output (DO), however CP cannot be overlooked. BH2 & BH3 essentially run close to peak capacity on a yearly basis whereas CP has an increase of 60% between its average and peak. Therefore this source is relied upon to meet periods of peak demand but otherwise adds minimally in a 'normal' day (other WQ issues associated with this site and usage, see section 2.4).

Viewing the DI from all sources over the year as seen in Figure 4 shows an unusual trend. Unlike the major WASC's, VWP Tidworth does not have a 'traditional peak' during the summer months from the usual domestic activities (e.g. garden watering, paddling pools, hot weather etc). The MoD being such a large customer in relation to the overall Tidworth population means any change in activity will be reflected in the demand and hence DI. Examples being large exercises on Salisbury Plain or extra Military personnel in or out of the garrison e.g. Soldiers block leave, which will negate any increases in civilian increased summer water use.

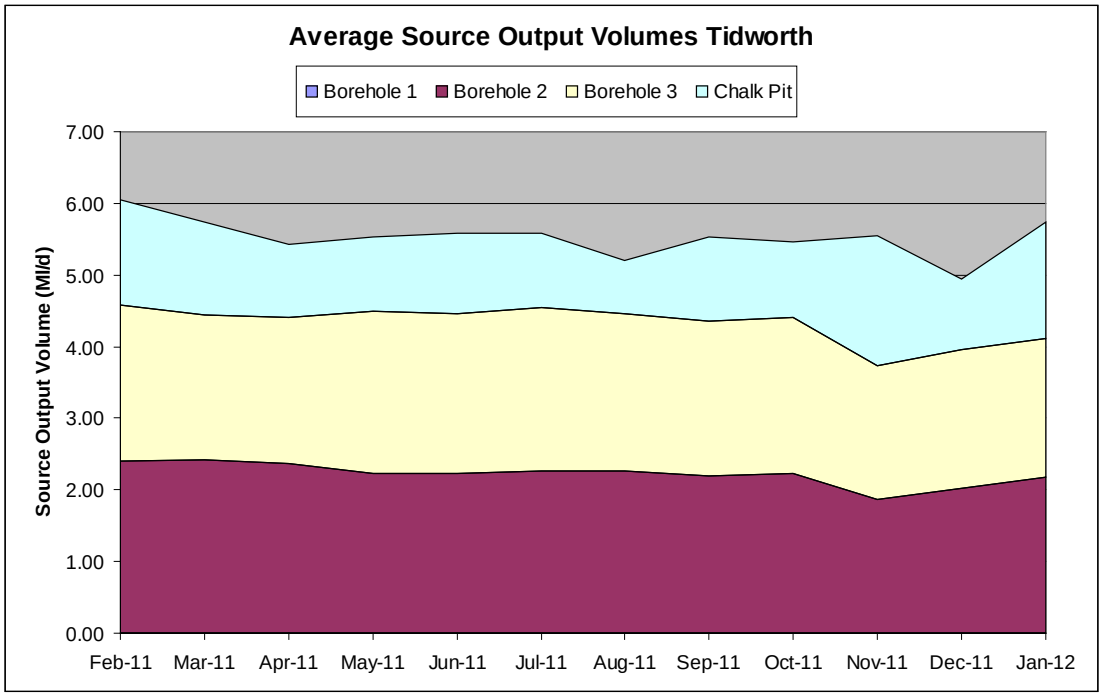


Figure 4: Average Source Output Volumes Tidworth [monthly] (YTD 2011-12)

2.2 Water Resource Zone (WRZ)

A resource zone is the largest possible zone in which all resources, including external transfers can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall. The VWP supply network is highly integrated and the risk of supply failure is shared throughout the Service Area, Therefore all the supply area is one WRZ.

2.3 Imports & Exports

There are no imports into the VWP inset as stated in the introduction. Indeed there is little likelihood of any meaningful import volumes due to the lack of assets belonging to adjacent Water Companies. The water balance shows a robust supply versus demand situation. However there are a few significant exports, all supplied to neighbouring WW.

The Leckford Bridge Agreement [LBA] is the largest of these, it is an operating agreement dated 16th November 2006 between TWUL and WW endorsed by the MOD. It is a bulk supply agreement comprising a maximum volume of 3 Ml per day with a maximum instantaneous flow equivalent to 36.5 litres per second, with a maximum take of no more than 1,000Ml per year, giving an average value of 2.74Ml/d. Changes in this agreement primarily revolve around a 'critical figure' agreed to be 5.4Ml/d (as a daily peak) which VWP needs to be able to provide for its own customers. If the peak daily demand exceeds this figure VWP can reduce the volume of this bulk transfer on a litre by litre basis (the day after WW receives notice of this occurring). This also applies if VWP has its licence reduced to a value below the critical figure. To date, WW has not taken its full entitlement but this will be discussed in the demand section 3. For the purposes of this WRMP VWP should assume that the agreement was expected to terminate in 2022, but as the nitrates affecting the Wessex abstraction at this location are not reducing markedly the Plan will assume the LBA will continue throughout the period of the Plan.

The remaining exports are non-typical bulk supplies, they consist of three separate **Wessex Water 'Enclaves'** within the VWP supply boundary operated soley in accordance with their own Licence by Wessex Water and containing some 350 Wessex Water customers. This arrangement originated before TWUL gained the inset as the MoD were supplying these legacy estates, two of which were predominantly Social Housing from the 1950's, the other being a new build private development in the 1980's. Consequently this agreement was carried over to TWUL and then VWP. Unlike the LBA these supplies are deeply imbedded within VWP distribution network and no such 'critical figure' or mechanism for reduction of supply exists. The enclaves supply points are thought of as part of the Commercially Metered customer base [as 3 individual commercial accounts] in operating terms and will be treated as such from a Water Resource perspective.

2.4 Levels of Service

VWP nor its predecessors have had occasion to resort to any form of restrictions [formal or informal] in over 13 years including through recent drought conditions in 2006/07 when many water companies' sources in Southern England were under extreme pressure. Thus the preferred LoS are supported by historical actual LoS as shown in the table below.
VWP Tidworth is completely supplied by groundwater. Level of Service restrictions on use allow VWP Tidworth to reduce groundwater abstraction in times of drought. This reduction in abstraction allows groundwater storage to be conserved in theoretical terms. However, the groundwater system continues to drain to rivers and downstream catchments when abstraction is reduced. Consequently, reductions in abstraction in reality allow environmental flows to be improved, rather than an increase in quantifiable groundwater storage and Deployable Output of groundwater sources.

LoS offered by VWP to all Regulated Customers – Historical and Future.

Water Restriction	Level of Service
Hosepipe Ban	No restrictions
Drought Order/permit	No restrictions
Rotacuts/standpipes	No restrictions

2.4.1 Customer Engagement

Due to the small scale nature of the Regulated Customer base within the Tidworth Inset Area it was not seen to be cost effective to conduct wide ranging surveys prior to the drafting of this Plan. Given the past LoS [Nil impact historically] and the prediction of zero impact as noted within the Drought Management Plan, such an exercise was not considered necessary and academic in value.

A "surgery", not specifically for the launch of the WRMP, was held by VWP staff in the Spring of 2013 at the only practical focal point in Tidworth, the local supermarket, and this was trailed across the town by means of publicity material consisting Parish Council notices and notice boards. Due to the mix of general public, VWP customers, Wessex Water Customers and Military personnel in the vicinity of the supermarket attendance and interest was very poor.

The Plan, together with the VWPL Formal Response is published on the VWP web site in a section specifically designed for Public Notices along with the draft Drought Management Plan.

2.5 Reductions to Deployable Outputs

A key term used when discussing water supply is Deployable Output (DO). This is the sum of the amount of water each individual source (including both surface and groundwater) can yield which is available to the Company for putting into supply. This takes into account licensed volumes, pump capacity, treatment and distribution constraints. It is calculated for a stress period (drought) and for both average and peak demands during this period. VWP have used 'A methodology for the determination of outputs of groundwater sources' (UKWIR, 1995b) guidance as recommended by the EA.

TWUL submitted to the EA a DO assessment of the Tidworth sources in November 2005. This concluded that the sources were constrained by Licence at 2 & 3 and pumping water levels at CP. The values are shown below:

	Average DO	**Peak DO**
BH1	0.00	0.00
BH2	2.88 Ml/d	2.88 Ml/d
BH3	2.88 Ml/d	2.88 Ml/d
CP	3 Ml/d	3.6 Ml/d
TOTAL	**8.76 Ml/d**	**9.36 Ml/d**

This DO assessment has been re-visited using current outputs and is shown in the following table, where the new licence conditions can also be seen. These are explained below as each source has specific issues.

Current Deployable outputs for all VWP Tidworth sources [no options applied]

	Source	Group	Aquifer Type	Resource Zone	Avg. Ann. Licence (Ml/d)	Max Daily Licence (Ml/d)	Base year values (Ml/d)	
							Average DO	Peak DO
Tidworth Group GW Sources	BH 1	Tidworth	Chalk	WRZ 1	0	0	0	0
	BH 2	Tidworth	Chalk	WRZ 1	3.68	4.32	2.22	2.22
	BH 3	Tidworth	Chalk	WRZ 1	3.68	4.32	2.10	2.10
	CP	Tidworth	Chalk	WRZ 1	3.64	4.69	2.0	2.5
Group Total					**9.02**	**12**	**6.32**	**6.82**

BH1 is abandoned and now removed from the licence due to pesticide contamination (Atrazine). It was not seen as cost effective to implement treatment on site or move raw water to another treatment site.

The DO's for BH2 and BH3 are essentially linked as they share treatment process and licence restraints. Both boreholes are operated on a continuous basis to their maximum capability. As shown in the above table these sources are operating closer to their licensed volumes than CP, but currently cannot deliver Licence/DO due to aging of the pumps and are now only capable of running at 28-30l/s (2.4-2.6) maximum, with the lower flows at lower groundwater levels. To perform at maximum licence the pumps would need to run at around 33 l/s (66.59l/s combined for 24 hours). Additional to pump performance the GAC filters limit flows to 62l/s (5.36Ml/d), however the contact tank can process up to 75l/s (6.48Ml/d).

A further meaningful complication to source usage is the issue of 'high nitrates' extracted at BH2 and BH3. Contemplating Figure 5, BH2 & 3 show much higher and less stable nitrate levels than CP. Although these levels meet the DWI standards they have the potential to cause issues elsewhere. Once blended with CP as shown in the figure the overall Tidworth zone drops to a lower level, which in turn marginally reduces the stress placed on the STW and lowers the nitrate levels it discharges back into the aquifer. The historic EA preference requiring use of boreholes 2 and 3 over CP has a detrimental effect on the nitrate loading at the Waste Water Treatment Works and this contradiction is the subject of on-going negotiations with several EA parties and VWP.

CP site has a number of complex issues affecting its DO. The borehole arrangement has two pumps that individually can deliver flows of 38 (3.3Ml/d) and 35 l/s (3.02Ml/d), Combined, they can deliver peak Licence (4.75Ml/d). However, recent pumping tests have shown this figure cannot be achieved as turbidity spikes have occurred at these higher rates, shutting down the source. Assuming one pump running at full capacity (24 hours) the source would produce 3.0Ml/d DI. However, as stated above, condition 9.4 of the Abstraction Licence states that the abstraction should routinely and preferentially be taken from 2 and 3, before any use is made of CP due to concerns over the Nine Mile River (9MR) as highlighted by an EA investigation, which indicates approximately 1% of the abstraction from CP impacts on the flows to this river.
[Source: River Bourne & Nine Mile River Conceptual Modelling Report, EA South West Region, 2001.]

Due to this restriction, and the quality constraint, the DO of this source can be considered to be lower than the Licence and has been set here as 2Ml/d average and 2.75Ml/d peak. Although in times of emergency or failure of one of the other boreholes it has the capability of producing its full Licensed volumes.

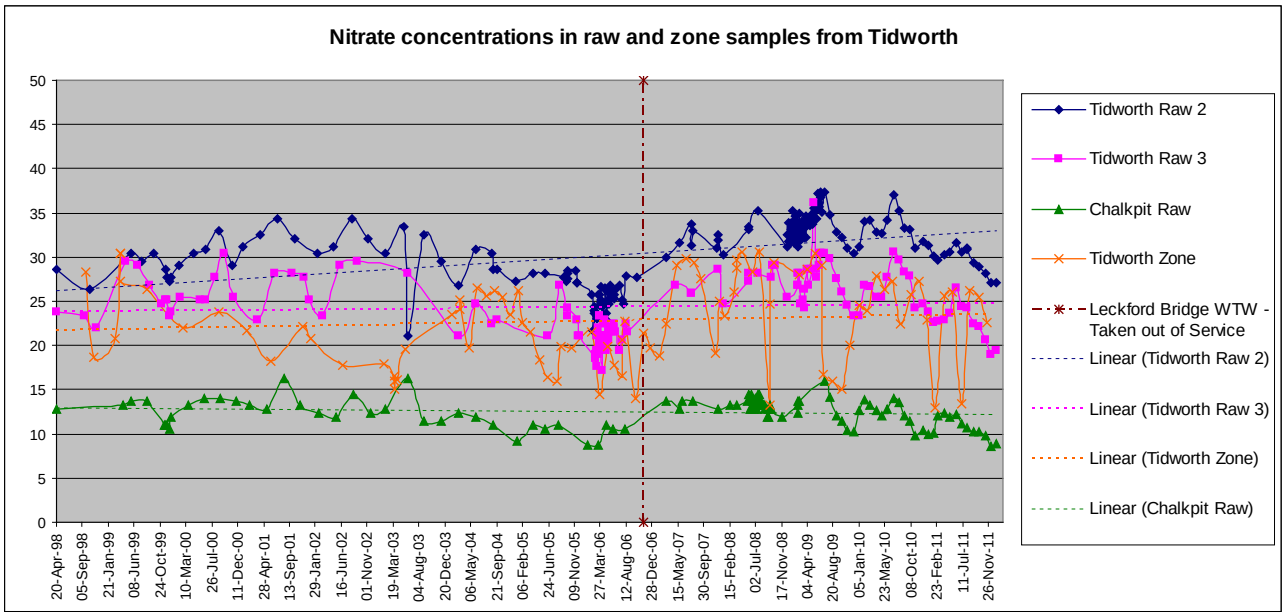


Figure 5: Nitrate concentrations in raw water samples, taken 8 times a year

2.6 Outage Assessments

Outage is also calculated as part of Water Supply, it is defined as a temporary loss (less than 3 months) of Deployable Output and it can be as a result of power loss, pollution events and other reasons. VWP has used, 'Outage allowances for water resources planning' (UKWIR, 1995) as recommended by the EA.

Due to the lack of credible information from MoD, assessments were mainly based on interviews with operational staff and management experiences with each source and historical data was used as an aid to complete the assessment.

The outage information from the above exercise for all groundwater source abstractions were then applied to a Monte-Carlo based statistical model using excel (random number generator), which was created specifically for this outage assessment. A Monte-Carlo model was created for the single resource zone, with source outages and duration being summed to give a total outage value for the resource zone. The results are shown in the following two tables for the average and peak outages (same method adapted for section 4.1 headroom assessment).

Outputs of Monte-Carlo analysis on average DO figures

Average Outage					
Resource Zone	**Average DO**	**Average Outage Ml/d**			
		10%ile	**50%ile**	**90%ile**	**95%ile**
1	5.52	1.38	1.79	2.2	1.80
% of DO		23	30	38	31

Outputs of Monte-Carlo analysis on peak DO figures

Peak Outage					
Resource Zone	**Peak DO**	**Average Outage Ml/d**			
		10%ile	**50%ile**	**90%ile**	**95%ile**
1	7.05	1.7	2.09	2.48	2.03
% of DO		26	32	38	31

This Monte-Carlo analysis used on the data show a 'worse case' than expected as they included 'one off' events that have been mitigated against, e.g. surface water flooding at CP where a small barrier wall has been built to reduce the effect of similar SW flooding occurring in the future. Events such as an E.Coli spike that caused a voluntary outage have been included, even though the robust disinfection process treated the microbiological issue. Concerns over why it had occurred led to the borehole outage as more raw water samples were taken.

These factors added to the fact that VWP Tidworth does not have any 'economies of scale' as it is a small operation with only 3 raw water sources, any small outage will result in a significant percentage of the DI being affected. This will result in any outage assessment showing a less secure source reliable output (SRO) than that with which VWP actually operates.

The Average Outage table uses the average DO against outage events. The most likely situation shows that between 1 in 1 year, or 1 in 2 year outage events of under

2Ml/d will affect VWP. Although this is almost 30% of the companies DO for that day, the network can comfortably deal with this kind of outage as it has large reservoir storage in comparison to demand and only peak demand would see these significantly depleted. This value has been skewed by the turbidity issues (mainly due to minor surface run-off events) at CP. 1 in 10 and 1 in 20 year event show a similar level of outage as 1 in 1 year event, which again demonstrates VWP lack of economies of scale in source outputs. Clearly the less likely event will remove a more secure source, but as there are only 3 in total it will not have a meaningful effect. The fact that a 1 in 20 year event indicates a lower outage than 1 in 10 year indicates the lack of operational data/knowledge at VWP Tidworth (more known events at a 1 in 10 year frequency).

As a result these figures are not reflective of the 'true' effect outage has on VWP. A more useful method of looking at outage is on an event basis as duration of outage events are key to impacts on VWP LoS. The table below shows the total event outage value in Ml, these would be amounts per year. They show the more likely events are very small volumes annually and they do not pose a threat. However the 1 in 10 and 1 in 20 year events do show a significant total outage.

These are again worse case and mainly revolve around pump failure and concerns over getting replacements ordered and delivered. This situation is being addressed as part of VWP new Asset Management Plan (AMP) which will identify greater operational risks and help quantify asset life spans more effectively.

Monte-Carlo assessment of outage per event (in 1 year)

Outage per event (Ml)				
	10%ile	**50%ile**	**90%ile**	**95%ile**
Average DO	2.3	4.6	10.78	13.92
Peak DO	2.8	5.6	11.6	15.9

2.7 Climate Change

2.7.1 Overview

The climate of south-west England is classed as oceanic. Inland areas of higher altitude such as Tidworth (next to Salisbury Plain) which are over 100 metres above sea level receive a much higher annual rainfall average than lowland areas. Current climate work predicts the southwest region to become the hottest in the UK. The wettest time of year tends to be early to mid winter with the driest being early summer, with a total average yearly rainfall of 755mm (91yrs worth of data).

Changing rainfall patterns caused by climate change may reduce the recharge of underground sources and increase demand in the summer months at the same time. *UKCP09* findings showed that annual precipitation will remain relatively unchanged but will be more intensified during the winter meaning there will be drier period during summer (peak demand) months.

The frequency of these low rainfall events in the past is not necessarily a guide to how they will occur in the future, particularly when climate change is considered. The *UKCP09* projections do not show a long term historic decline in overall rainfall patterns, but they do predict more variability. Increased variability could result in more drought condition periods and more flood condition periods.

2.7.2 Vulnerability Assessment

VWP Tidworth is 100% reliant on groundwater sources for raw water supply. Vulnerability to climate change was considered by reviewing SRO diagrams for the 3 groundwater sources and historic work undertaken for the Drought Management Plan.

The Tidworth DMP shows VWP can cope with 2 poor recharge (below 100%LTA but above 80%LTA rainfall) years without altering its level of service. However climate change cannot be discounted as having an impact on the 25 year water resources planning horizon.

SRO diagrams were reviewed to assess how decreases in groundwater levels associated with climate change induced drought may result in decreases in deployable output. Under drought conditions at current peak deployable outputs of 3.24 Ml/day per borehole, there are 18 and 40 m between the pumping water level and the pump intake in boreholes 2 and 3 respectively. This suggests that boreholes 2 and 3 have a low vulnerability to climate change.

At the peak DO of 2 Ml/d at CP, there is 12 m between the pumping water level and pump intake under drought conditions. This suggests that CP has a low vulnerability to climate change.

2.7.3 Impacts of climate change on deployable output of Veolia Water Projects Tidworth Sources

The impact of climate change on DO of boreholes 2, 3 and CP was assessed using Approach 1.4 under the Water Resources Planning Guidelines. This approach uses groundwater level change factors derived from the British Geological Survey's Future Flows and Groundwater Levels Project.

The nearest BGS Future Flows borehole is located at Clanville Gate, near Andover (14 km east of Tidworth). The borehole is cased into the chalk and is considered to be suitable for climate change impact predictions at Tidworth.

Future Flows predictions suggest a maximum decrease in groundwater levels of 1.5 metres at Clanville Gate in the 2050s. As previously discussed, boreholes 2, 3 and chalk pit have large depths between drought peak DO pumping water levels and pump intakes. Consequently maximum decreases in groundwater levels of 1.5 m due to climate change are highly unlikely to affect Deployable Output.

2.8 Flooding

According to the EA regional flood model maps produced for Tidworth, none of the clean water AGA's are at risk from a flooding event. All BGA's are resistant to the effects of flooding (all gravity fed network) with the exception of accessing them in the event of an extreme flood in the areas highlighted in Figure 6. several waste water assets are at risk of flooding. Two pumping stations are very low risk due to their position in the 1 to 100 year (+) zone. Actions could be taken to minimise their use and make alternate arrangements such as tankering of sewage. The STW is a slightly greater risk as it sits in the 1 in 75 year zone (1.3% chance).

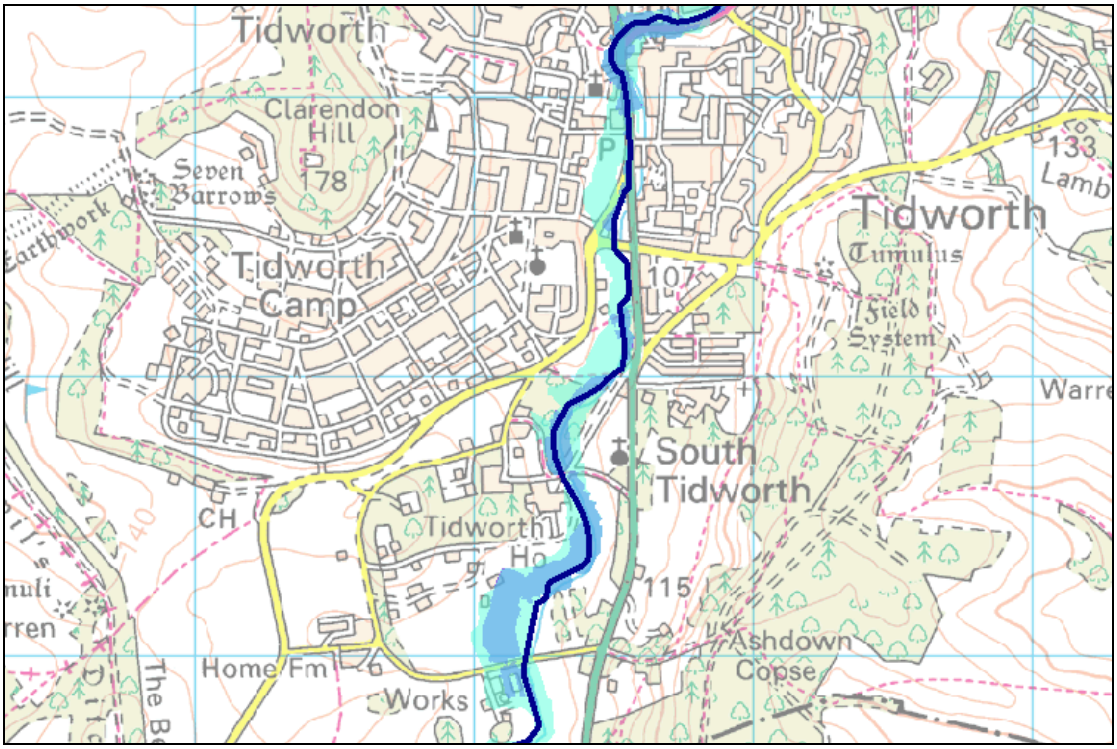


Figure 6: EA flood risk map for Tidworth area

3. Demand

The predicted demand for water is developed using a sequence of elements as described in the section below. VWP has produced robust demand forecasts based on assumptions about how water demands will change over the next 25 years. A model was used to generate long-term forecasts of demand components in average conditions based on assumptions about changes in population, per capita consumption, leakage rates, meter penetration, savings on metering and non-household demand.

All demand forecasts used are based on a best estimate normal year, annual average daily demand, for a single set of population and properties. '*Demand Forecasting Methodology*' UKWIR and NRA, 1995 has been used to construct and advise this section.

3.1 Current Demand

There are only 762 dwellings that do not fall into the category of Tidworth Garrison. 455 of these are metered and it is intended to increase this number going forward.

Total supply over the past 5 years is shown in Figure 7, along with the current average licence value as a red line.

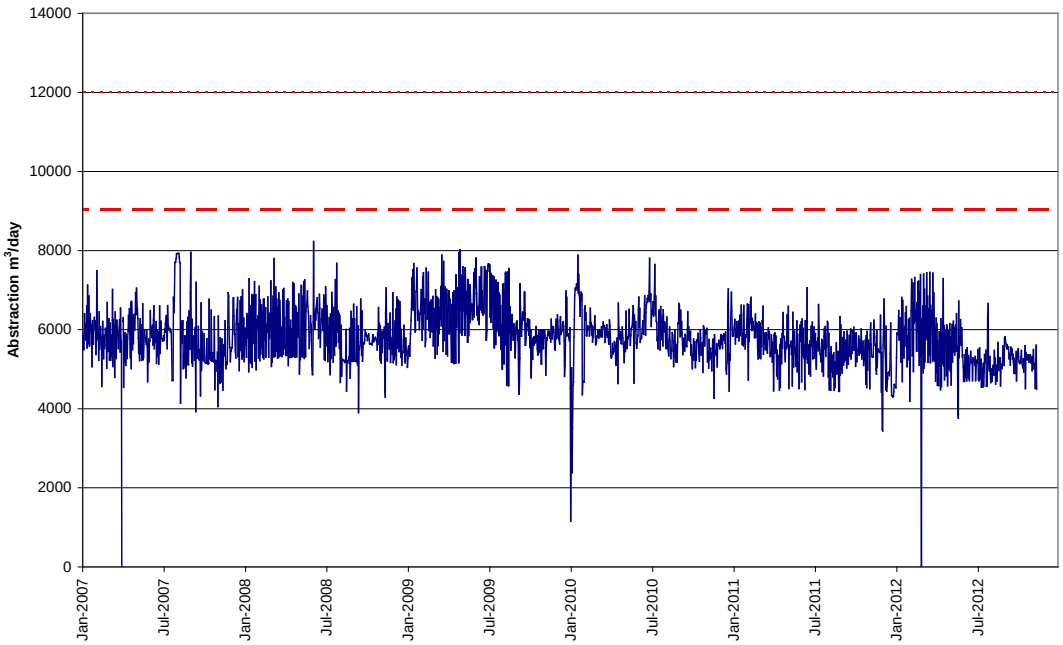


Figure 7 VWP abstraction including WW bulk supply

The average demand over 2011-12 (March – February) was 5.52Ml/d. the peak being over 1.5M/d greater than the average. Examining the source outputs shown in Figure 4 and 7, VWP does not experience a summer peak as explained due to MoD associated activity. Usually a low is seen in August and December, possibly due to large numbers of junior ranks and officers living both on site and in SFA's taking holiday [aka Block Leave]. There are also occasions where large Military Exercises consisting of out of Garrison troops from elsewhere in the UK over write the usual customer consumption 'footprint'. Daily peak demand is therefore very difficult to predict or apportion to particular months, hence VWP aims to meet any daily peak throughout the year. Historically VWP and its predecessors have always been able to

meet demand and have generally been in a comfortable situation. However an estimate of future peak has been made as described below.

A demand forecast is developed by using the values of the various demand drivers; population and household forecast, commercial demand forecast, micro-component forecast (which gives the Per Capita Consumption), minor-components forecasts and leakage forecasts. A value for domestic demand is produced by multiplying the PCC by the population forecast. The total demand forecast is then the sum of the domestic demand, commercial forecast, MoD forecast, leakage forecast and minor component forecast. Minor components include water use associated with Water Taken Unbilled and Distribution Operational use. As per discussions with the Environment Agency and to clarify Tidworth's PCC [originally calculated at some 300lppd relating to the formulae used in the EA Tables], the consumption of SFAs and military operational buildings will be labelled as non-household unmeasured consumption under line 20BL in the Water Resources Planning Tables.

Total Demand = Domestic + Commercial + MoD + Bulk Supply + Leakage + Minor Components

Forecasts

Equation 1: Simplistic bottom up approach to calculate demand (using *Netbase*)

2011/12 has been used to produce the baseline forecast and this is used to show how demands will change in a dry year assuming existing management and water efficiency policies.

Unmeasured Consumption = Distribution Input – Measured Consumption – Leakage

Equation 2: Unmeasured components calculated using *Netbase* data

Below are extracts from the Table 10 document (Table 1 and) for the year 2011. Values are based on VWP billing system *Navision*, post office records, council records and community surveys carried out by VWP. Consumption data is based on meter reads and *Netbase*. (For details of *Netbase* see section 3.4)

Table 1: Known properties in Tidworth, 2011

Billing (No of Properties)	
Households billed unmeasured water	307
Households billed measured water	455
Households billed water	762
Non-households billed unmeasured water	44
Non-households billed measured water	65
Non-households billed water	109
SFA properties (non household unmeasured 20BL)	1,200
Garrison Properties (behind the wire – 20BL)	200
Void Properties (civilian household)	1.6%

Table 2: Water Balance 2012

Distribution Input		2012
Output all sources	Ml/d	5.52
Flow meter error	Ml/d	0
On site ops use	Ml/d	0
Distribution Input	Ml/d	5.52

Water Delivered - Volumes		
Civilian		
Civilian measured household	Ml/d	0.19
Civilian measured non-household	Ml/d	0.17
Civilian measured total	Ml/d	0.36
Civilian unmeasured household	Ml/d	0.14
Civilian unmeasured non-household	Ml/d	0.04
Civilian unmeasured total	Ml/d	0.18
Bulk Supply		
Wessex Enclaves	Ml/d	0.13
Sarcen Bulk Supply	Ml/d	0.068
Leckford Bridge Agreement	Ml/d	1.66
Total	Ml/d	1.858
MoD		
SFA Properties	Ml/d	0.4
Garrison Use	Ml/d	0.99
Total*	Ml/d	1.39
*Note, this volume has been added to unmeasured non-household civilian consumption in Table line 20BL.		

Leakage & Operational Use		
Operational use	Ml/d	0.010
Trunk main losses	Ml/d	0.000
Service Reservoir Leakage	Ml/d	0.000
Network Leakage	Ml/d	1.601
Total Underground Supply Pipe Leakage	Ml/d	0.041
Supply Pipe Leakage (% of total leakage)	%	2.562
Total Leakage (% of distribution input)	%	29.000
Total Leakage	Ml/d	1.642
Distribution Losses	Ml/d	1.652

Water Delivered - Components		
Per capita consumption (unmeasured household-excluding supply pipe leak)	l/h/d	152.01
Per capita consumption (measured household - excluding supply pipe leak)	l/h/d	146.15
Estimated per capita consumption of SFA properties	l/h/d	142.86
Estimated water delivered per unmeasured non-household	l/pr/d	863.64
Estimated water delivered per unmeasured household	l/pr/d	456.03
Total MoD use at Garrison	Ml/d	0.99
Water delivered per measured household	l/pr/d	417.58
Water delivered per measured non-household	l/pr/d	2,615.38
Distribution system operational use	Ml/d	0.010
Total Leakage	Ml/d	1.642
Distribution Losses	Ml/d	1.652
Distribution input	Ml/d	5.520
Bulk supply imports	Ml/d	0.000
Bulk supply exports	Ml/d	1.858

Overall Water Balance		
	Ml/d	0.072
	%	1.30

The overall water balance shows demand is greater than supply by giving a water balance net error of 1.3%. This is a reasonable figure considering leakage produces a large negative error which is offset by the SFA usage large positive error. As well as using annual consumptions compared with average abstraction (DI) figures producing a small error.

It has become apparent under Inspection that there has been a substantial water loss occurring through one of the reservoir cell walls and this loss has been estimated to be in the region of 0.5 Ml/d. The cell in question has recently been isolated on a long term basis and the water loss volumes have decreased by typically the anticipated 0.5 Ml/d.

3.2 Demand Forecast

As previously mentioned it is anticipated that new housing developments will impact the demand going forward. These will alter the demand outlook over the current planning period by a significant amount compared to the annual population increase applied to the previous WRMP. The table below sets out the proposed rates for all 4 known developments at this time.

At the time of preparing this Plan Area 19 in South Tidworth is subject to an MoD Options Appraisal for circa 350 new SFA houses. Zog development on the ex Medical Supplies Agency site in Ludgershall is still at public enquiry level and thus less certain in the next 3 – 5 years but will go ahead in some form in the future. Persimmon Homes is now at Full Planning permission stage and it is anticipated that all 600 houses will be built in the next 5 – 7 years. However as part of prudent planning it has been assumed that the new builds will be finished by 2019.

Future development planned build rates

Future Developments	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Billing Year	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**
Number of Houses							
Persimmon	50	150	150	150	100	0	0
Hitchin Homes	33	33	33	0	0	0	0
Zog [Ex MSA site]	0	0	0	0	150	150	100
Area 19	0	0	0	0	100	100	150
Total (cum)	**83**	**266**	**449**	**599**	**949**	**1199**	**1449**

The total expected domestic housing increase after all three developments have been completed stands at 1,449 properties. The key assumptions are that [i] all properties will be filled instantaneously. In an area of high rented properties and demand for social housing [Persimmon have indicated a meaningful proportion of their site maybe Social Housing] this is not entirely unrealistic and [ii] that consumption conditions have been applied at a national average with occupancy of 3 people per home. This gives a total of 0.67Ml/d in additional baseline demand.

Wiltshire CC strategy/planning department in October 2009 released figures indicating that some 1,900 domestic properties will be needed by 2026 in Tidworth and its surrounding area [some of which geographically falls into other WASCo's areas of supply]. Assuming the Zog / MSA site is developed before the 2026 deadline it is not unreasonable to suggest that Tidworth as it relates to the VWP Service Area will have absorbed a significant but proportionate share of this WCC aspiration. Wiltshire CC has not predicted any significant economic growth or new businesses to enter Tidworth in its current planning horizon.

The MoD as the largest single user of water in the Service Area will have the potential to impact the above assumptions with its future plans / development needs over and above the SFA requirements. Recently upgraded accommodation across all sites in the Garrison for Junior Ranks and Officers has resulted in a net increase in

soldiers on the base but their consumption has been mitigated to a great extent by the refurbishment and installation of contemporary water efficient plumbing fittings which replace early 20th Century fittings.

By way of example VWP is currently awaiting the potential impacts that may accrue to the town and its water networks from the MoD Paper – Transforming the British Army, July 2012 which indicates future growth of an extra 3 Brigades in the Salisbury Plain Area.

Early indications are that such new development behind the wire at Tidworth could amount to at least an extra Battalion with bed spaces potentially for some 680 soldiers in the main garrison and perhaps a similar number in one of the outlying secure locations if another Battalion is also deployed to the Service Area. No information is available at this time relating to the dependants of these troops and whether new Married Quarters [SFA] estates are also envisaged.

The uncertain nature of the MoD planning focus, the Political dimension and the general commitments of the UK Armed Forces overseas all serve to demonstrate the difficulties in assessing the overall water consumption increases in a predominantly garrison town. For the WRMP we have assumed that future garrison growth could increase by some 2000 personnel, including dependants. At an average of 155l/p/d, this equates to an additional demand of 0.31Ml/d. Making a small allowance for increased garrison use too, we consider a value of 0.4 Ml/day should be incorporated in the headroom analyses in section 4.1, in addition to the developments mentioned above.

3.3 Metering and Water Efficiency

Metering currently sits at; 55.08% penetration of domestic homes, this is expected to increase to 79% by 2016 after the completion of the new developments. WW trials showed that metered customers used on average 17% less water than unmetered. Using the water balance and known consumption values, metered customers in Tidworth use over 5% less water than unmetered. This shows water efficiency should slightly improve with the new developments and population increase as all new properties will be metered.

There are only some 762 dwellings that do not fall into the category of the Military portion of Tidworth Garrison. Of these some 455 are currently metered and it is intended to increase this number within the legacy housing stock going forward. All new properties are metered. It is hoped that a further 100 legacy accounts will opt to convert to metered status by 2020 at an NPV overall cost of £17,000. This expenditure by VWPL is not expected to produce measurable water savings over the period but the high profile Industry requirement to encourage optional metering is the driving imperative. Compulsory metering is not being considered at this time.

A major refurbishment programme behind the wire of all accommodation blocks has given VWP the opportunity to advise the MoD on the available water saving devices and applications. Through their Prime Contractor responsible for this re-development water efficient fittings have be installed throughout including the widespread use of Rainwater Harvesting for groups of Junior Ranks barracks. The outcomes, benefits and potential pitfalls of this technology are being closely monitored by VWP as well as the Prime Contractor.

3.4 Leakage

Leakage is primarily calculated using a “bottom up” and “top down” approach employed widely in the Water Industry through a software system known as *Netbase* which is operated by VWP leakage contractor Crowder Consulting. Netbase uses DMAs and several key meter locations to correct the bottom up estimations from each property / DMA. Whilst many Regulated customers are measured and the water volumes used by the remainder are easy to assess using Industry Standard consumptions, the bulk of the more recent work has been conducted in an attempt to quantify the varying MoD garrison uses. Initially this was achieved by surveying MoD buildings and their uses with direct comparisons in the Civilian arena. More recently the MoD Prime Contractor for the garrison has metered all significant buildings for water use and this information has been shared with Crowder who substitute this data for the proxy information derived as described above. The effect has been more to increase the confidence levels of data accuracy than to actually change the consumption values which have proved to be similar to those previously used.

The water balance shown in section 3.1 has a very low error percentage, hence the aspiration to initially reduce leakage from 1.6 Ml/d to 1.2 Ml/d of the total DI is a confident and deliverable value. Until recently, a significant percentage of the reported leakage derived from a storage reservoir cell which had failed. This cell has now been isolated and the leakage has declined significantly.

VWP is mindful that the operation of the basic Tidworth network produces easy to derive leakage levels expressed as a percentage of total DI. Whilst giving headline figures, such a percentage approach does not align well with the wider Industry metric of reviewing water losses simply as Ml/d, a methodology which has the effect of deflecting the overall percentages of the losses.

Using the Sustainable Economic Levels of Leakage [SELL] principle suits the Tidworth PFI Inset model as within the Inset regime there is no mechanism to recover extra leakage costs from the customer base. Instead there is a more direct correlation between the water assessed as lost by leakage, the cost of treatment etc and the cost of finding and repairing leaks. The aspirational leakage figure of 1.2 Ml/d is the current estimate of an SELL value which may vary downwards once other factors discussed below are known in more detail.

In taking this approach VWPL nonetheless remains very conscious of its environmental imperatives to limit abstraction and associated impacts as set out in this Plan. We have a programme over the next 3 years to assess the potential benefits of wider network pressure management across Tidworth [balancing the requirements not to impact the Crown Fire Standards designed to protect the various types of military installations] allied to an enhanced Smart Metering initiative already underway designed to provide immediate, accurate data of water taken from the network by the civilian customers, SFA’s and the Military. This enhanced localised data will be used to inform our efforts in tasking our leakage detection resources in an even more focussed way than at present.

3.5 Climate Change

Studies predict that demand across VWP region in 25 years will be higher than it is today. We expect a minimum of 1,449 new houses will be built in the next 20 years. We expect overall demand to increase by 12%.

Demand is likely to increase as a direct result of climate change. *UKCP09* predictions for VWP region predict a net increase in temperature across the year. As historical

data shows, temperature increases have a direct relation to demand due to changes in water usage.

Climate change, potentially leading to longer and hotter summer periods, will also drive more frequent and higher peak seasonal demands. This is confirmed by the key findings of *UKCP09* projections, which have indicated that warming will be likely and more intensified in the summer months. Increases in temperature are directly linked with increases in demand with all water companies experiencing higher demand peaks in the summer months. Although the MoD usage does not show an overall peak in summer demand, the additional civilian customers from new developments and the effects of climate change means VWP will have to plan for higher summer peaks going forward.

4. Supply/Demand Balance

4.1 Target Headroom

Target headroom has been defined as:

> *"the minimum buffer that a prudent water company should allow between supply (including raw-water imports and excluding raw-water exports) and demand to cater for specified uncertainties (except those due to outages) in the overall supply-demand resource balance".*

Target headroom is defined as the minimum buffer introduced into the annual supply-demand balance to ensure that the chosen level of service can be achieved. Available headroom is the actual difference between Water Available For Use (WAFU) and demand at any given point in time. Where available headroom falls below target headroom a supply-demand balance deficit is introduced and as a result the level of service for WR cannot be met. The headroom assessment has been carried out in accordance with the WR/13 - *A Practical Method for Converting Uncertainty into Headroom* UKWIR 1998. As well as consulting the '*Improved Methodology'* UKWIR document of 2002.

The complicating factor affecting the assessment of Supply versus Demand in this PFI Inset Appointment is best described as the" Military Uncertainty Factor". As discussed in Section 3.2, the MoD Paper – Transforming the British Army, July 2012 [aka Army 2020 Rebasing Strategy] suggests that garrison demand may substantially increase in the future. Increases in consumption are highly uncertain due to the transient nature of MoD planning, however a best estimate in January 2013 of an increase in garrison consumption of 0.4 Ml/day has been made to account for these changes as described in section 3.2 above. Uncertainty around this increase has also been accounted for within headroom estimates between 2017 and 2020. Additionally, the deployment of troops on Operations and Exercise also produces some more nebulous consumption assessments of actual consumption throughout the year. There is no reliable advanced warning of these activities for obvious reasons of security and their effect may be to reduce the behind the wire soldiery to a very small percentage of the total established levels for several months at a time. The corollary of this situation maybe that an influx of Units consisting many hundreds of troops deploy to Tidworth and its environs on Salisbury Plain thus inflating consumption of services. This scenario often occurs several times per annum and can last for 2-3 weeks at any one time.

The current peak demand is some 27% above the average use. VWP have applied this percentage to the possible 0.4Ml/d for Army 2020 and the existing SFA usage to try and estimate what future peak demand may be, in addition to that to meet the LBA. These values have also been allowed for in headroom.

The Headroom components that are included in the methodology are:

Supply Related;
S5 Gradual pollution of sources causing a reduction in abstraction
S8 Uncertainty of climate change on yield
S9 Uncertain output from new resource developments
Demand Related;
D1 Accuracy of sub-component data
D2 Demand forecast variation
D3 Uncertainty of impact of climate change on demand

The six headroom components shown above have been considered within the target headroom assessment.

S5 – Gradual pollution of sources

VWP concern is over nitrate levels within the aquifer that its two main sources draw from. As shown in Figure 5, nitrate concentrations appear to be stabilising, however there still remains a level of risk associated with high nitrate levels.

S8 – Climate Change on supply

Climate change and potential reduction of groundwater levels by significant amounts is seen as a risk to one abstraction site in particular. However, due to the lower outputs required from CP, this does not impact on DO. Impacts of climate change on CP could also be mitigated against by increasing abstraction at BH2 and 3 to their licence capacities as required, however this will require significant investment.

S9 – Uncertainty of new sources
This refers to VWP need to increase deployable outputs to meet future demand (see section 4.2 and 5). This is currently at the options appraisal stage and a risk of uprated existing sources not delivering predicted capacity has been included into the headroom calculations.

D1 – Accuracy of sub-component data
As the VWP bottom up approach uses Netbase there are assumptions highlighted that this method uses which can decrease confidence. However current operation figures show we are meeting demand at an accurate known output level from sources.

D2 – Demand forecast variation
The largest risk is under predicting future use from the new developments, together with the aspirations of the Military, the headroom calculation will attempt to consider this risk as described above.

D3 – Climate change on demand
This is not considered to have as much impact as it would have on supply, factor in the significant change in civilian population over the next planning period and any climate change increased demand will not be relevant. This can be discounted from headroom calculations as a result.

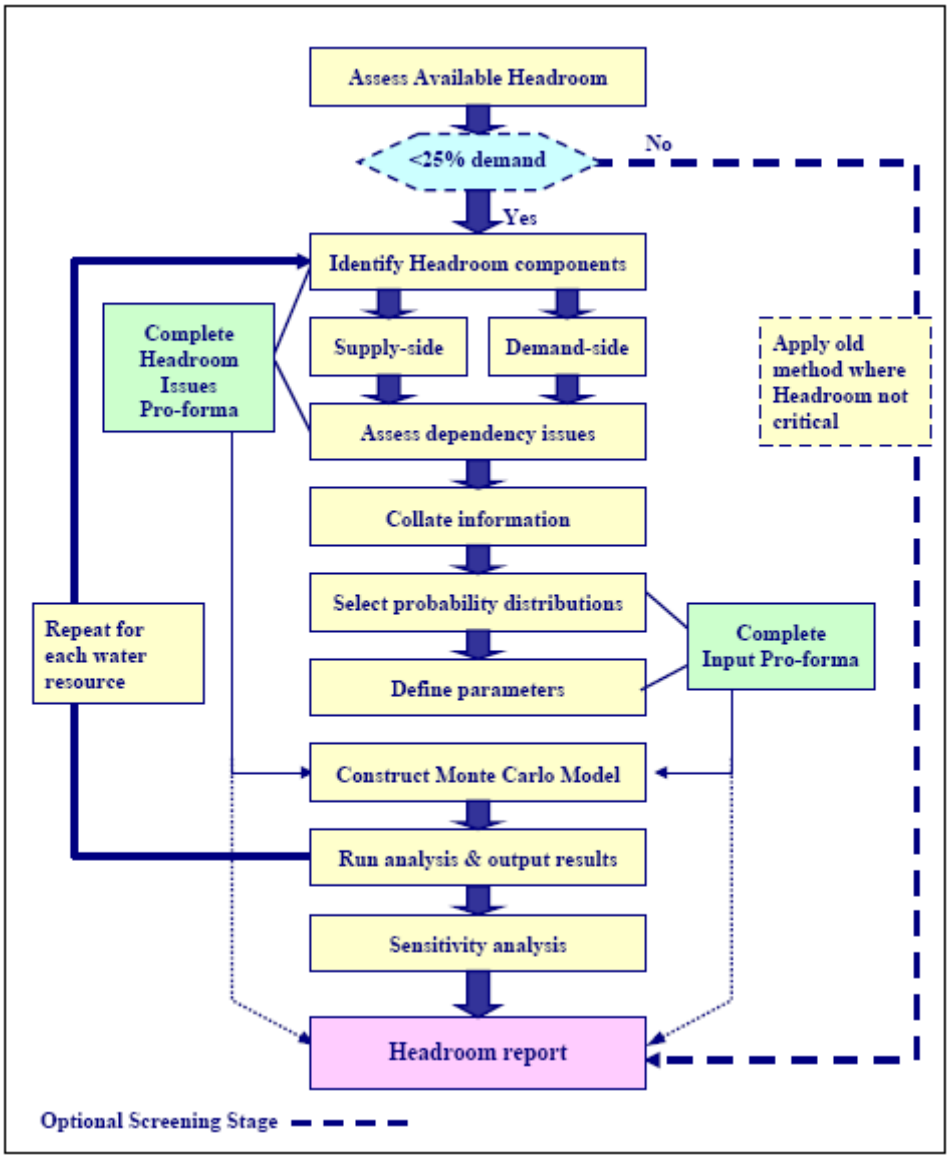


Figure 8: Overview of Headroom methodology, taken from UKWIR 2002 report

The following table shows the outputs from the headroom analysis at 5 year intervals, excluding the additional 1 Ml/day increase between 2017 and 2020 associated with possible increases in garrison populations.

Results from headroom analysis

Target Headroom		2012	2017	2022	2027	2032	2040
Company Average Baseline	%	4	5	6	7	8	9.5
	Ml/d	0.220	0.275	0.330	0.385	0.440	0.5225

The headroom figures range between 4 and 9.5%. Considering the size of VWP, the military uncertainty and the level of DI combined with the flexible distribution network, a headroom of 9.5% is a reasonable figure.

WAFU = DO - Outage

Available Headroom = WAFU - Demand

Available Headroom ≮ Target Headroom

Equations 3 – 5: (UKWIR WR/13, 2002)

The equations listed above were used in the headroom calculations as well as the supply demand balance in section 4.2.

4.2 Baseline Supply/demand Balance

Clarifying issues over different WAFU volumes due to CP source;

- 6.01Ml/d when CP is adhering to operational 10hrs to help EA agreement (currently this is breached to meet peak demand)
- 7.02Ml/d is the current peak demand experienced 2011/12.
- 7.68Ml/d has been recorded, however turbidity spikes after extended pumping (2days) have caused CP outage and thus is not sustainable.

Figure 9 shows the supply against demand balance over the 25 year planning period for the average baseline conditions in terms of current WAFU. Currently, VWP are technically unable to meet the current average demand if WW were to take their full entitlement. The demand line shows an initial small dip due to leakage and metering improvements, but as the new developments start to add to the baseline average demand in 2014 the deficit increases again. Further increases are then seen to 2020 with the proposed Army 2020 increases.

The peak demand and supply balance in terms of current WAFU is shown in Figure 10. Currently, VWP are technically unable to meet the current peak demand if WW were to take their full entitlement. The demand line shows an initial small dip due to leakage and metering improvements, but as the new developments start to add to the baseline average demand in 2014 the deficit increases again. Further increases in the deficit are then seen to 2020 with the proposed Army 2020 increases.

Whilst in WAFU terms VWP will be in a supply demand deficit, the new licence granted to VWP in March 2013 can allow for a WAFU of up to 8.18 Ml/d at average and 8.93 Ml/day at peak. This increase in WAFU would resolve the deficit, however investment is required to increase the deployable outputs of BH2 and BH3 to their licenced quantities. This is considered in the options reviewed below.

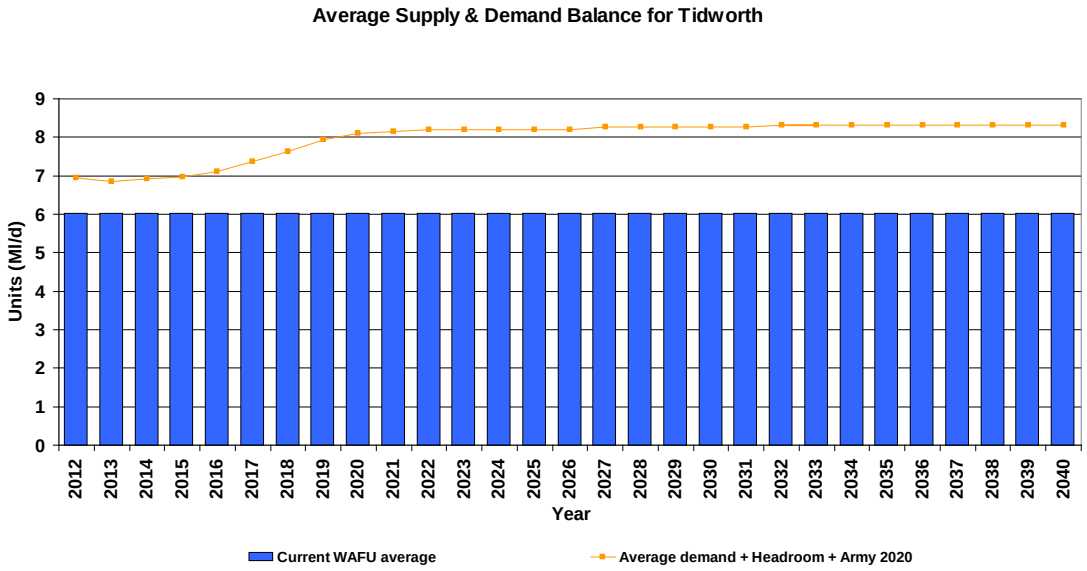


Figure 9: Baseline average supply demand balance

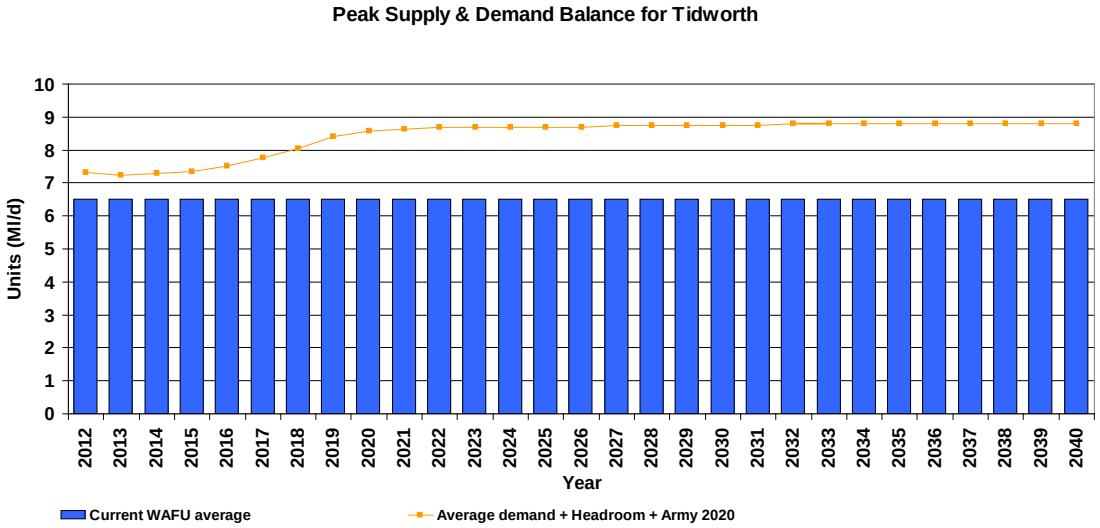


Figure 10: Baseline peak supply demand balance

5. Supply / Demand Options

5.1 Option Identification

The following sets out the key strategic parameters to which VWP options need to adhere;

I. Worse case planning scenario's to ensure security of supply
II. Cost of capital (see section 5.2 regarding the inability for VWP to pass through to customers' bills these costs due to the Inset Conditions.) considered along with good environmental practice
III. Protecting river flows and their supported ecology
IV. Conservation of water abstracted to stressed aquifers

The number of viable Options are limited in the Tidworth Inset Area for the reasons set out earlier in this Plan. Below is an overview review of the final options considered to create a realistic supply/demand balance over the remaining planning period. This overview summarises the basic tasks involved, the amount of water added to the balance and summing up the key issues associated with each option.

(1) Do nothing

This is always considered depending on the circumstances but for VWP it is not a viable option, as developments are certain to go ahead, even if properties do not fill at full capacity, by the end of the planning period a supply short fall needs addressing.

Water made available: 0 Ml/d
Environmental Impacts: Zero
Option Preference: Disregard

(2) Increase capacity of BH 2 & 3

BH's 2 & 3 will need capital investment to improve their DO levels to the new licence capacity. Investigative work has confirmed that the proposal to lower the pumps in these BH's is a straight forward exercise and the ground water levels recorded allow for adequate latitude to lower the pumps to suitable depths. This would in turn allow the option of minimising abstraction at CP thus reducing the impact of abstraction on flows from the 9MR.

The environmental impacts of abstracting more water from this location in the aquifer are minimal. The EA conceptual model recognises the winter bourne may be slightly affected from abstraction up catchment at certain times of the year

> *"In wet years some groundwater flow may be induced from the Bourne surface water system and minimal through flow. Up catchment effects will be to take flow from the Whiteway Rock (outcropping at Leckford Bridge), Chalk Rock (outcropping between Collingbourne Kinston and Collingbourne Ducis). The abstraction may extend the period when the river is dry, as well as the length of river that is dry"*

This is compared to the impact of the Tidworth STW discharges back into the aquifer.

> *"This discharge is via multiple lagoons which act as a soakaway. The water is thus returned directly into the aquifer albeit at a shallower level*

than the abstraction. 85-100% of Tidworth Abstraction is therefore likely to be discharged back to the surface system which will re-infiltrate into the Seaford Chalk and in wet months may flow south to the Bourne catchment."

Source: River Bourne & Nine Mile River Conceptual Modelling Report, EA South West Region, 2001.

Therefore any additional water taken from this part of the aquifer will all be re-introduced via discharge from the STW or leakage. Meaning at worse case only a small stretch of the river is slightly affected.

The concern as highlighted in Figure 5 is the higher nitrate levels produced from BH's 2 & 3, compared to the significantly lower CP levels. The nitrate loading in the effluent entering the WWTW will be increased as a consequence. However, should this loading rise to unacceptable levels work will be undertaken by and through the EA to identify and remediate as far as possible the potential sources of nitrate infiltration E.G. the farming community north and west of Tidworth. This would be similar to that work undertaken by the EA in and around Cholderton Water Co who have already experienced the same issues but at a higher level of criticality.

VWP would choose to prioritise the avoidance of water scarcity and low flows over its need to incur capital costs as well as suffering an increase in its nitrate burden, but would not wish to be penalised in its discharge consents as a result.

This option will also provide flexibility for the potential impacts of climate change as a reduction in availability of water at CP could be offset by an increase in abstraction at boreholes 2 and 3 up to their individual licence capacities.

Even with this option, to meet the projected future demands CP will at times be required to operate to its full Licence of 2 Ml/d average and up to 2.75Ml/d at peak. In the interim period, CP will be kept to its current mode of operation to minimise any impact on the Nine Mile River.

Water made available: 2.12 Ml/d (3.04Ml/d if 100% max daily licence)
Environmental Impacts: Minimal, more water taken from higher up catchment
Higher nitrate loading on STW
Option Preference: High

5.2 Option Appraisal and Preferred Option.

In assessing the Preferred Option VWP has to be mindful that, due to the nature of the Inset Appointment through OFWAT, there is no mechanism to recover any capital or associated costs from the Regulated customer base through the Periodic Review process as would normally be the case for WASCo's.

A further point for wider consideration must be the benefits that may derive for adjacent Water Companies in relation to Options that are not necessarily attractive to VWP per se. By way of example, the relationship between the Wessex Water requirements for abstraction to replace the LBA and the potential for Cholderton Water to benefit from a mutual aid bulk supply from VWP to partially alleviate their high nitrates problem are factors that the EA may wish to consider going forward.

As the new abstraction licence has been granted immediately prior to this Plan coming into force permitting an increased abstraction from BH2 and 3 in place of the disused BH1, the primary feasible remaining option is to increase the capacity of the pumps in these boreholes to increase the DO to the licenced quantities as originally planned. There are sub-options within the **Preferred Option 2** to "fine-tune" the required supply / demand balance by adjusting downwards the LBA volumetric take in discussion with Wessex Water. The likelihood and potential implications of these actions have been rehearsed with Wessex Water who has agreed to reflect the likelihood of such reductions in their WRMP and DMP where applicable.

Preferred Option 2 is to up rate the pumps in BH2 and 3 to allow the source DO to increase to licenced quantities. With the new Licence available from CP, VWPL can meet the projected average demand to the end of the Planning Period. If at any point demand exceeds this volume, we will consider revisions to the LBA with WW. However, there is significant uncertainty in the level of future demand and over the next 5 years it will become much clearer what the increase in both domestic and military demand is likely to be.

To meet peak demands, increased use (over current abstractions) of CP will be required (up to 2.75 Ml/d for short periods), and it is considered that this volume is available from the source, and will continue to be, even under reduced water levels caused by climate change impacts. Again, if the source does prove to be more sensitive under such conditions than the current evaluations suggest, and being mindful always of the source impact on the 9MR, VWP will consider changes to the LBA with WW.

Given the flexibility to negotiate changes with WW we have not set out a separate option to simply reduce the WW LBA in all circumstances. Whilst such a move would clearly achieve keeping the abstraction volumes stable in all scenarios for VWP, without detailed discussions with WW around a total re-negotiation of the Agreement it is anticipated that such flexibility benefitting VWP would create considerable difficulties for WW elsewhere.

Notwithstanding the WW demand under this agreement has, to date, been barely 50% of the available daily maximum, the Agreement already has a provision for phased reductions in the maximum demand by WW. These reductions would be brought into effect should any of the operating assumptions in this Plan be exceeded long term, including Military increases in consumption beyond those currently telegraphed. In essence the LBA may be considered as VWPL latent headroom but has not been described as such in this Plan.

A plot of the components of the projected demand at Tidworth at both average and peak is shown in Figures 11 and 12. These allow for the proposed civilian developments on former MoD land. A line for headroom which includes the possible demands for increases in military proposed in Army 2020 is also shown.

Emissions for baseline and preferred option

Table 1 below gives current emissions for borehole pumps at CP, BH2 and BH3 based on the Environment Agency National Grid Derived Emissions Factor.
Under the preferred option, borehole pumps in BH2 and BH3 will be uprated to increase the output of these boreholes to meet demand. It is currently unknown as to what capacity and power rating these new pumps will have. Whilst the new pumps may be more efficient than the current pumps, they will be pumping greater flow rates and with greater drawdowns. It has been assumed a nominal increase in power

rating of 5 kW will be required for the new pumps. This corresponds to an increase in carbon emissions of 0.41 tCO2e per year.
It should be noted that alongside the upgrade in pumps, further work may be required to upgrade treatment and other downstream processes. These additional upgrades may result in additional carbon emissions. These additional emissions are highly uncertain and consequently have not been considered in Table 1 below. In VWPL's annual review we will report further details of carbon emissions when the upgrade process has begun.

Parameter	**Value**	**Notes**
Current Pumps Total Power Rating (kW)	225	Assumes only 1 pump running at CP
Utilisation (fraction)	75	Fraction of 1 year, assumes 25% utilisation of Chalk Pit and 100% Utilisation of BH2 and BH3
Energy per year (kWh)	16875	
EA National Grid Derived Emissions Factor (tCO2e/kWh)	0.000541	
Current Annual carbon emissions (tCO2e/yr)	***9.129375***	
Future Pumps Total Power Rating (kW)	235	Assumes only 1 pump running at CP
Future Utilisation (fraction)	75	Fraction of 1 year, assumes 25% utilisation of Chalk Pit and 100% Utilisation of BH2 and BH3
Energy per year (kWh)	17625	
EA National Grid Derived Emissions Factor (tCO2e/kWh)	0.000541	
Future Annual carbon emissions (tCO2e/yr)	***9.535125***	
Increase in carbon emissions (tCO2e/yr)	***0.40575***	

Table1. Carbon Emissions – Current and Preferred Option Comparison.

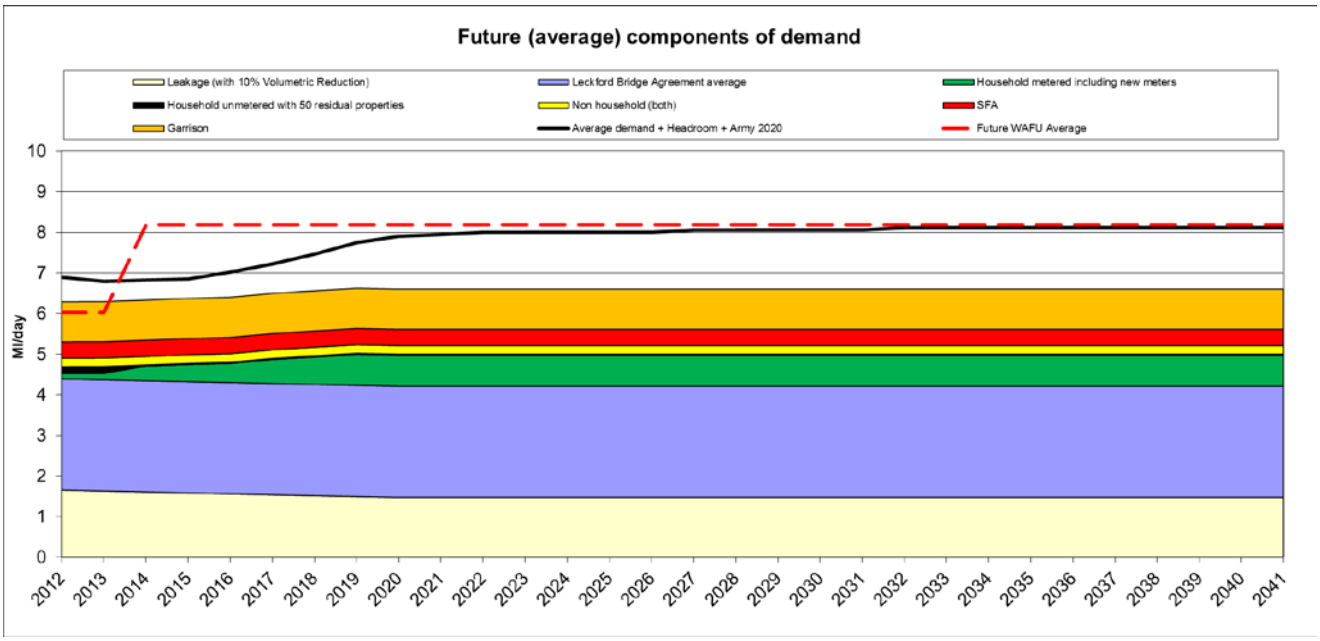


Figure 11 Future average supply demand balance

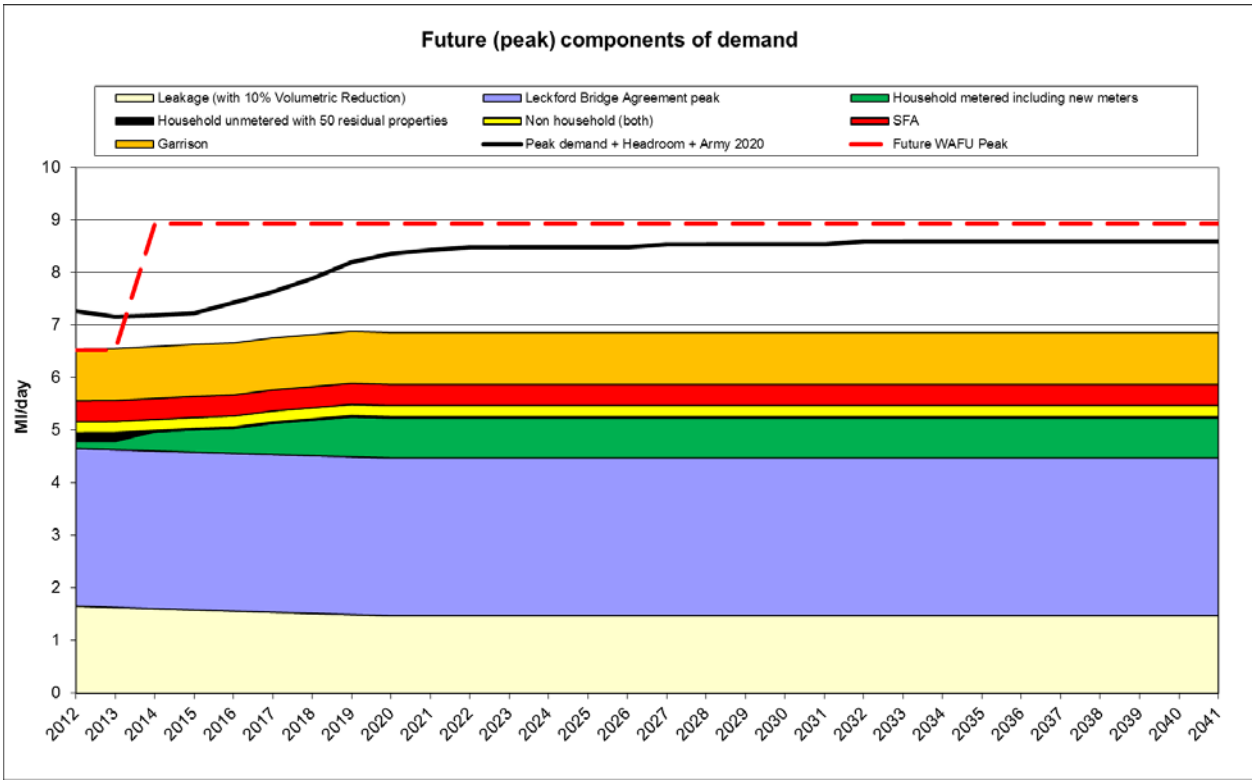


Figure 12 Future peak supply demand balance

Conclusion

A supply demand deficit has been demonstrated to theoretically exist through this WRMP update over the next 25 years of 2.29 Ml/d at average and 2.67 Ml/d at peak.

The preferred option to mitigate this position is to uprate the pumps at BH2 and 3 to allow an increase in DO to the new quantities given in the 2013 licence. This is a result of the removal of BH1 from the licence and the splitting of this quantity to BH2 and 3. This will allow VWP the ability to fully utilise both of these sources to meet the demand deficit while restraining use at the CP source. This is protecting the Nine Mile River from negative abstraction affects. However, should these demands materialise, it will require the use of CP at 2Ml/d average and 3 Ml/d peak. In the interim period, CP will be kept to its current mode of operation to minimise any impact on the Nine Mile River.

Should the sources prove to be incapable of producing the new licensed volumes, VWP will consider reducing or terminating the agreement with WW for the LB transfer.

Environment Agency catchment modelling studies show that the Winter Bourne is only marginally affected by abstraction at BH2 and BH3, potentially affecting its dry season length and reach. However this is offset by the sewage treatment works discharging treated effluent back into the same aquifer via soak away lagoons, slightly further down catchment and any leakage to ground will also return the same way. Although this option will be at greater capital cost to Veolia Water Projects, compared to maximising CP licence output, it has been assessed as the preferred option.

This being the Company's preferred option subject to and providing potential nitrate loading issues at the sewage treatment works can be resolved in terms of the agreed Discharge Consents.

APPENDIX C WESSEX BASIN GROUNDWATER MODEL TECHNICAL NOTE

Army Basing Programme – Groundwater Model Update:
Briefing note on Groundwater Model Scenario Output

1. Background

Amec Foster Wheeler has received a request from the DIO to run the Wessex Basin Groundwater Model (WBM) for a number of scenarios relating to the differing options for abstraction and discharge from the Larkhill, Upavon and Bulford Camps as part of the Army Basing Programme (ABP). These runs are summarised in **Section 2** and were agreed in consultation with the Environment Agency *(35647d077_DIO Model Runs_Agreed Rates_for GWABS_Leakage_STW SWDIS.xlsx)* on 1 December 2015.

This Briefing note is the third issued for groundwater modelling work related to ABP. The first two being:

- Wessex Basin Groundwater Model – Scenario Runs for the Defence Infrastructure Organisation (DIO) – September 2014 (35647tn025i2) which formed Technical Appendix 9A of the Masterplan EIA; and
- Wessex Basin Groundwater Model – Larkhill and Bulford Discharge Options – March 2015 (35647g058) which included initial thoughts on the Water Resources implications of differing sewage treatment discharge locations and rates as part of the ABP.

This Briefing note (35647tn025i1 – January 2016) provides details on a further set of runs which include up to date information on abstraction and discharge rates at MoD sites across the Hampshire Avon CAMS area and further optioneering around ABP abstraction and discharge rates and locations. The base model run also includes the latest agreements on the Sustainability Reductions undertaken by Wessex Water.

Section 2 outlines the model updates undertaken and the scenarios that have been run.

Section 3 discusses the scenario results and **Section 4** provides a brief summary.

At the end of this note, a series of draft figures are presented and the following text makes reference to these figures. This Briefing note is designed to support ongoing planning applications and the Water Management Strategy for the MoD sites across Salisbury Plain that is being produced by Kelda Water and WSP.

It is therefore assumed that the reader is aware of the overarching work and the ABP as well as being familiar with the concepts behind the Water Framework Directive (WFD) Review of Consents (RoC) and associated Environmental Flow Indicators (EFIs).

Throughout this document the term '**Full Licence**' should be read to include MoD abstractions even though they are not yet licensed.

2. Model Setup

Figures 1-3 contain the locations of the features mentioned throughout this note, in particular the water resources arrangements at Upavon, Larkhill and Bulford Camps.

The following work has been undertaken on the Groundwater Model as part of this most recent update:

- Made small amendments to existing artificial influences e.g. inserted Tilshead STW (previously omitted in error) and correctly located the Knook Camp discharge point;
- Introduced small 'farm' abstractions across SPTA;
- Included in the Full Licence runs the latest agreements on the Wessex Water Sustainability Reductions;
- Updated Tidworth abstraction rates, leakage rates & discharge rates based on information provided by the Environment Agency; and
- Updated MoD discharge rates, leakage rates and abstraction rates as supplied by Kelda. **Note that this included increasing discharges with the move from Recent Actual to Full Licence** (previous modelling had taken the conservative approach of increasing abstractions but not discharges). Leakage was not increased with abstraction as this is perceived to be a function of fully saturated pipe pressure (which would not change with increased consumption).

Details of the abstraction and discharge arrangements at Upavon, Larkhill and Bulford are provided in **Table 1**. The other changes made to abstraction and discharges as part of this work are as agreed by the DIO, Kelda Water, Wessex Water and the Environment Agency (email reference '35647d081_Wessex Basin Groundwater Model Runs - Update on Artificial Influences' – dated 1 December 2015).

The following runs were undertaken as part of this update:

- **(Run 251 remains the Natural Run against which other runs are compared)**
- Run 295 – updated Recent Actual (RA). **Note that the RA has not been altered to take account of Wessex Sustainability Reductions and so it is possible that abstraction in the RA is greater than in the FL at certain locations/times. This is not important for the ABP analysis, but care should be taking in using this run for other 'non MoD-ABP' analysis.**
- Run 296 – updated Full Licence (FL)
- Run 297 – updated Full Licence + Army Basing*
- Run 298 – as per Run 297 but with Bulford abstraction turned off
- Run 299 – as per Run 297 but with Larkhill abstraction turned off and Round O turned down
- Run 300 – as per Run 297 but with Bulford and Larkhill abstraction turned off and Round O turned down
- Run 301 – as per Run 297 but with Bulford and Larkhill abstractions turned down by 50% and Round O turned down by half as much as it was in Run 300

(* - As Tidworth is licensed and has available headroom between RA and FL, there is no further requirement to increase Tidworth between FL and FL+ABP even though there are Army Basing developments that will utilise abstraction from Tidworth)

Table 2 – Abstraction and Discharge Rates at ABP Locations on Salisbury Plain

Artificial Influence (values in m3/d)	Run 295	Run 296	Run 297	Run 298	Run 299	Run 300	Run 301
Upavon Abstraction (Hill and East)	251	308	326	326	326	326	326
Upavon Discharge	106	130	147	147	147	147	147
Upavon Leakage	140	140	140	140	140	140	140
Bulford Abstraction (BH1)	630	1398	1375	0	1375	0	688
Bulford Abstraction (BH2)	477	0	0	0	0	0	0
Bulford Discharge (contribution to Ratfyn above Recent Actual)	0	182	226	226	226	226	226
Bulford Leakage	376	376	376	376	376	376	376
Larkhill Abstraction	1016	1357	1357	1357	0	0	678
Round O Abstraction	652	977	1071	1071	846	846	958
Larkhill Discharge	665	934	0	0	0	0	0
Larkhill Discharge (contribution to Ratfyn)	0	0	1154	1154	1154	1154	1154
Larkhill Leakage	462	462	462	462	462	462	462
Round O Transfer Leakage	312	312	312	312	312	312	312

3. Model Output and Discussion

Figure 4 shows the in-combination modelled impact of all artificial influences compared to modelled Natural flows at Q95. Note that with the exception of a number of cells in the ephemeral reach, that the Bourne is now less than 10% impact as a result of the sustainability reductions. No further consideration of the Bourne is required at this stage. Note that the Natural flow in the Nine Mile is restricted to the last 2 model cells (a 500 m reach) and is significantly impacted by abstractions (EFI is 15% less than Natural Q95). The Till is also significantly impacted by abstraction (locally agreed RoC EFI is 10% less than Natural Q95). The impact on the Middle Avon is in parts above the locally agreed EFI (10% less than Natural Q95) but not above nationally agreed EFI (15% less than Natural Q95). **Figure 5** provides the same information but as absolute values on Ml/d.

Figure 6 provides the same detail but following the completion of the ABP. Note that at Upavon there is decrease in groundwater level at the abstraction point and an increase in groundwater level at the discharge point as would be expected. ABP impacts at Bulford are neutral as would be expected (Kelda supplied figures show abstraction at Bulford goes down from 1398 m3/d before ABP to 1375 m3/d after ABP)

The main impact of the ABP is not the increase in abstraction at Round O (977 m3/d before ABP and 1071 m3/d after ABP) or Larkhill (which remains at 1357 m3/d) but the removal of the 934 m3/d **groundwater** discharge from Larkhill STW and relocation to Ratfyn as a **surface water** discharge. The water level difference contours cover both the top of the Till and a reach of the Avon both upstream and downstream of Ratfyn STW. Therefore by comparing between Figures 4 and 6, it can be seen that flows are lower upstream of Ratfyn after ABP and higher downstream. Whilst downstream of Ratfyn the removal of Larkhill will still be 'reducing' baseflow inputs, this is counteracted and surpassed by the increased surface water discharge from the Ratfyn STW after ABP implementation. Comparison of Figures 5 and 7 show the influence of the increased discharge at Ratfyn on the modelled impact downstream of the discharge point.

Figure 8 provides the same information in accretion profile format at Q95. This clearly shows the impact of ABP switches from negative to positive (as far as flows on Avon are concerned) either side of Ratfyn STW as

would be expected. Results from Run 300 show how the in-combination impact of all abstractions at **Full Licence** would be reduced to within the national EFI for all but a short reach, were all Bulford and Larkhill supplies to be switched to Wessex Water.

Figure 9 is a set of modelled Flow Duration Curves (FDCs) upstream of the Ratfyn STW. This shows that at this point in the Avon, the removal of the Larkhill discharge has an impact of about -400m 3/d. This compares with an impact of +900 m3/d were Larkhill abstraction to be turned off. These are important considerations when contemplating any 'mitigation measures' as a result of relocation the Larkhill STW. In terms of Water Resources (though not necessarily Water Quality) the movement of discharges further downstream is likely to increase upstream abstraction impacts.

Figure 10 is a set of FDCs for Bulford on the Nine Mile. This illustrates that even turning off Bulford all together would not return flows to within 10% of the natural flows (i.e. above the green EFI line on the graph) at flows <~Q90. This is not surprising given the nearby Durrington PWS which operates at ~5 Ml/d at Full Licence and ~2.25 Ml/d at Recent Actual. This again is an important point when considering the use of water from Wessex Water (as a replacement to MoD abstraction) and how this would impact Recent Actual flow. Little would be achieved at Recent Actual if the turning off of Bulford was replaced by Durrington being increased (albeit within licence agreements) from Recent Actual towards Full Licence levels.

Figure 11 shows the same information in accretion format. Whilst Bulford has a clear impact on low flows, it is also clear that other abstractions also have an impact (e.g. Durrington). It should also be noted that the flowing section here is very short and the flows (even natural) are low.

Figure 12 looks at the number of days in which there is 'some' flow in the Nine Mile each under different scenarios. Comparison of the 2 plots on this figure highlights that there is no clear impact of ABP (compared to Full Licence)

Figure 13 illustrates that whilst Bulford has an impact on flows (in particular at the bottom of the Nine Mile) the impact, in terms of wetted stream bed does not stretch that far upstream. It is important to remember that these plots indicate the number of days in which there is some flow and not the magnitude of that flow. Nevertheless they are insightful with regard to the **modelled** conditions at the upstream ponds.

Figures 14 and **15** re-iterate previous model findings with regard to the modelled groundwater levels underneath the pond nearest to the abstraction (OMR Marsh Pond). These show that there is an impact of abstraction, but one that is focussed at the bottom of the hydrograph and hence the abstraction makes the lowest levels lower rather than significantly impacting on the duration of time (or timing) at which the groundwater levels are above the base of pond. These findings need to be considered in light of the ongoing fieldwork at the ponds. The groundwater model analysis assumes totally hydraulic connection between groundwater levels in the Chalk Aquifer and water levels in the pond. The fieldwork will highlight whether the water level in the ponds can remain perched above receding groundwater levels (e.g. due to a low permeability substrate). The investigations will additionally help determine whether the ponds fill up due to rising groundwater levels alone, or are also influenced by local surface and near surface drainage and its reaction to rainfall events.

Figure 16 shows that the model predicts that the influence of abstraction only changes the pass/fail criteria (water level >10cm above pond bottom for March-Sept) in 3 years (1989, 2000 and 2010) and that instead the impact of abstraction is for the ponds to 'fail' for slightly longer (though even that is limited to only one or two ~10 day stress periods in a given year).

Figure 17 shows the impact of abstractions and discharges on the low flows at Bury Bridge on the Till. This shows (comparison between Runs 297 and 296) that although the Larkhill discharge is nearer the Avon, and impacts the Avon more (see Figure 6), there is also an impact on the Till of relocating the Larkhill discharge. By comparing with Run 301, it can be seen that by reducing the Larkhill and Round O abstractions it is possible to 'neutralise' the impact of the relocation the sewage treatment work discharges to Ratfyn. If a mitigation measure such as this is required, the groundwater model could be used to inform/refine the decision making around proposed abstraction rates. It seems likely that reducing the Round O abstraction (which is more firmly in the Till catchment) will result in a proportionately higher flow return to the Till than will be the case with equal reductions at Larkhill (which more clearly impacts on both the Till **and** the Avon). With all these type of solutions it is important to remember that:

- the flow impact on the Till of relocating Larkhill is relatively modest at ~200 m3/d; and

- any changes need to be considered in terms of the other influences in the catchment (e.g. ~1 Ml/d ongoing abstraction at Round O and the ~2.2 Ml/d Wessex Water Abstraction at Shrewton).

Figures 18-21 illustrate the impacts of turning off (or down) the abstractions at Round O, Bulford and Larkhill on groundwater levels and hence flows in the baseflow dominated rivers.

4. Summary

The main impact of ABP is the relocation of the Larkhill sewage discharge point rather than the modest increases in abstraction that are required. The degree to which this relocation (in water quantity terms, rather than water quality) can be mitigated depends on the level to which Wessex Water supply is used to replace/supplement abstraction from the MoD boreholes.

There is nothing that surprising in any of these results and it follows that the more the MoD sites rely on existing licence volumes from Wessex Water (and the less they ask for in their own forthcoming licence discussion) the better the flows will be at **modelled** full licence conditions. However it should be remembered that this generic statement is heavily hypothetical when it comes to the more immediate impacts of ABP (and ongoing MoD abstractions) on current flows in the Avon, Till and Nine Mile. By switching to Wessex Water supplies, **recent actual flow improvements** will only be potentially achievable if the replacement water is abstracted by Wessex Water from outside the catchments of concern and moved across the Wessex Water Supply Network (i.e. the new 'Grid') to supply the camps. If the replacement water is actually sourced, albeit within existing Wessex Water licence conditions, from within the catchments (e.g. from the Shrewton or Durrington sources) at times of low flow, then **actual** flow improvements might not be readily realised.

It is therefore important that any mitigation measures and/or planning conditions in this regard remain pragmatic and achievable and do not confuse future protection of the environment under full licence conditions with nearer term improvements in ecology ('future recent actual conditions'). Clearly the move to catchment based solutions and regulation (which to date has not been enforceable due to Crown Exemption) is a step forward, though year to year ecological status will continue to be (more) strongly influenced by other external factors such as climate, river management and water quality.

Author	Reviewer
Tim Power	DRAFT – NOT FORMALLY REVIEWED

Figure 1 – Key Abstractions and Discharges

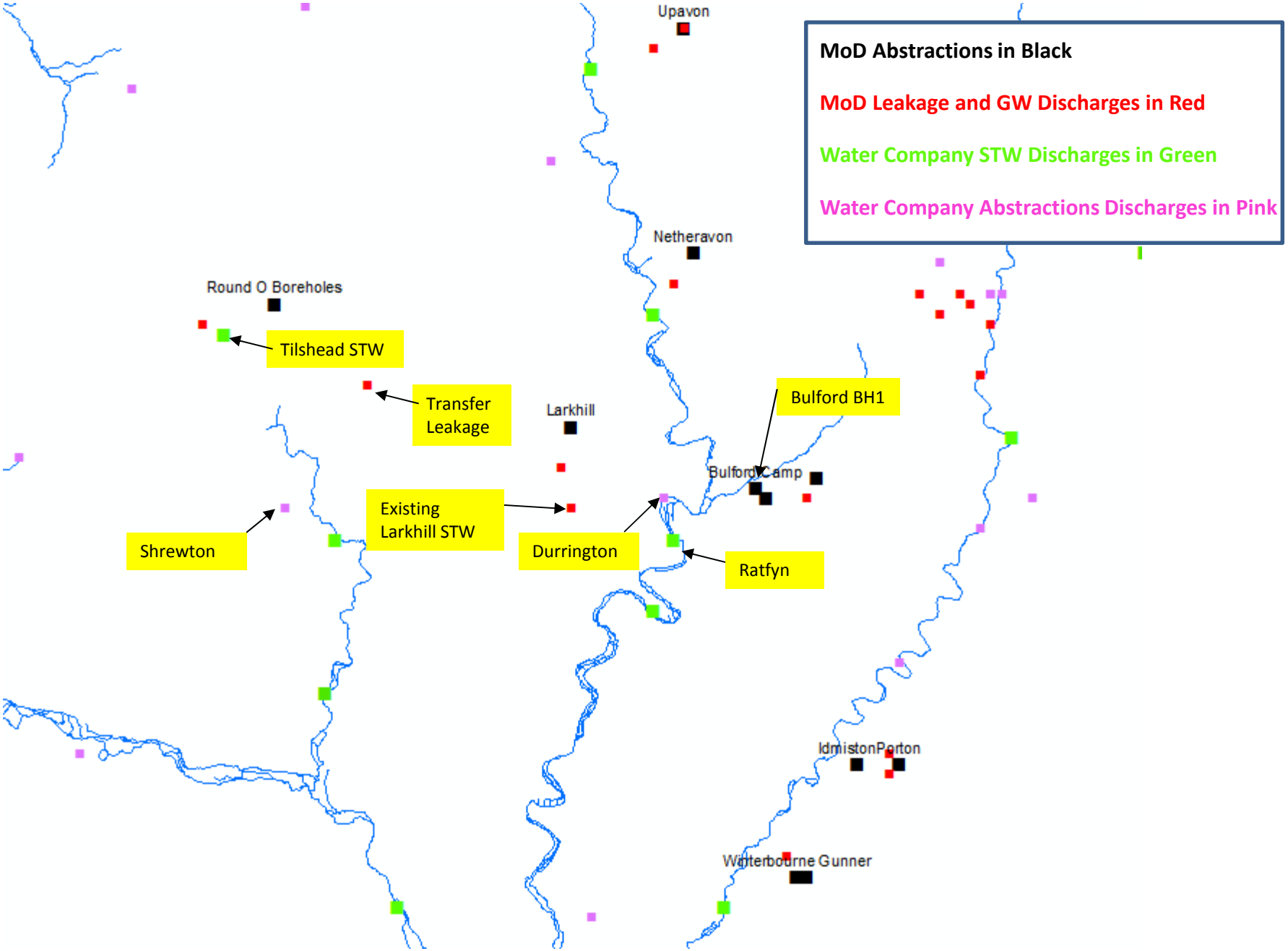


Figure 2 – Flow Comparison Locations (selected sites labelled)

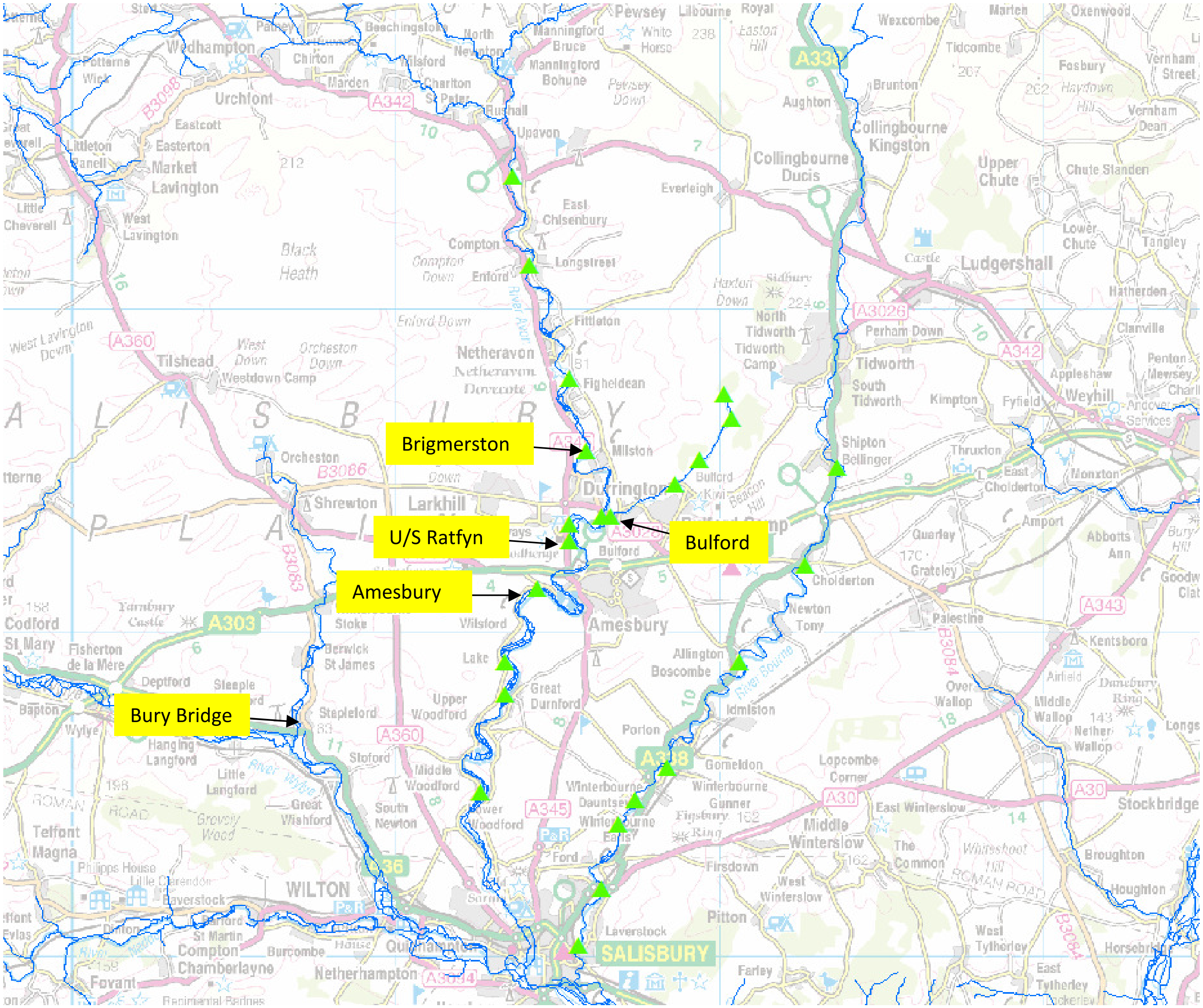


Figure 3 – Locations of ponds of ecological interest

Figure 4 – Full Licence (Run 296) Impact of abstraction as a % of Natural Flow (Run 251) at Q95

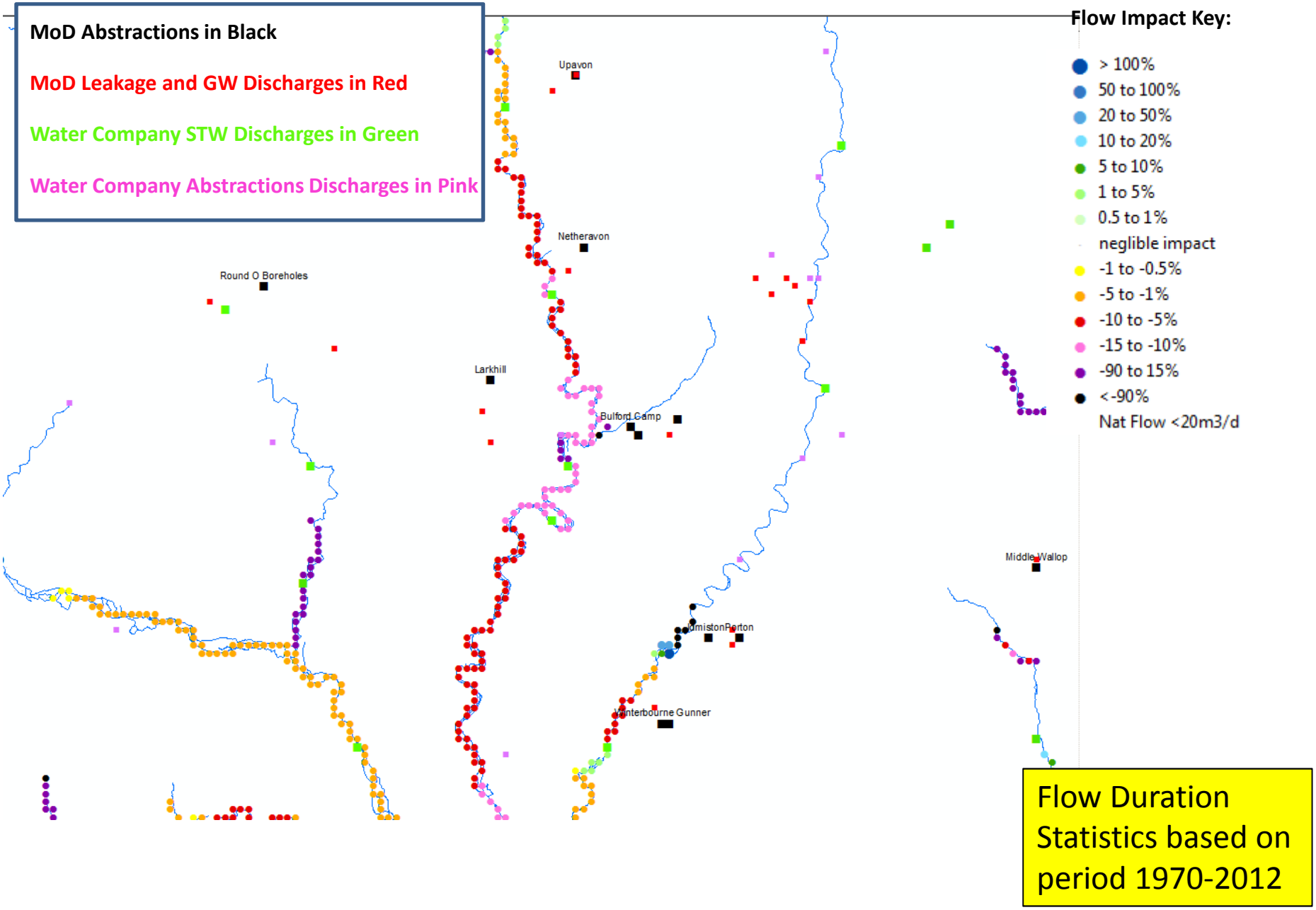


Figure 5 – Full Licence (Run 296) Impact of abstraction in Ml/d compared to Natural Flow (Run 251) at Q95

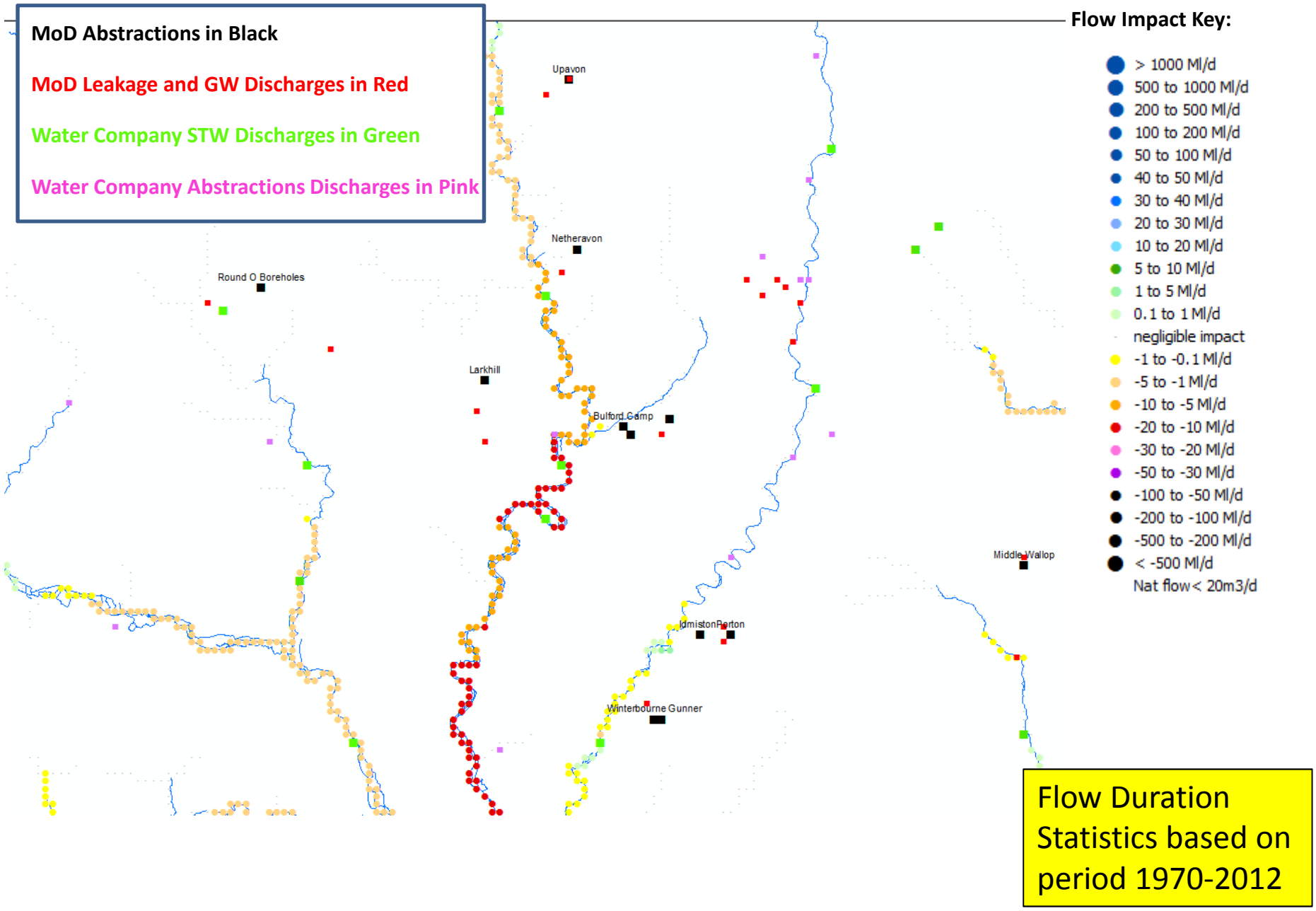
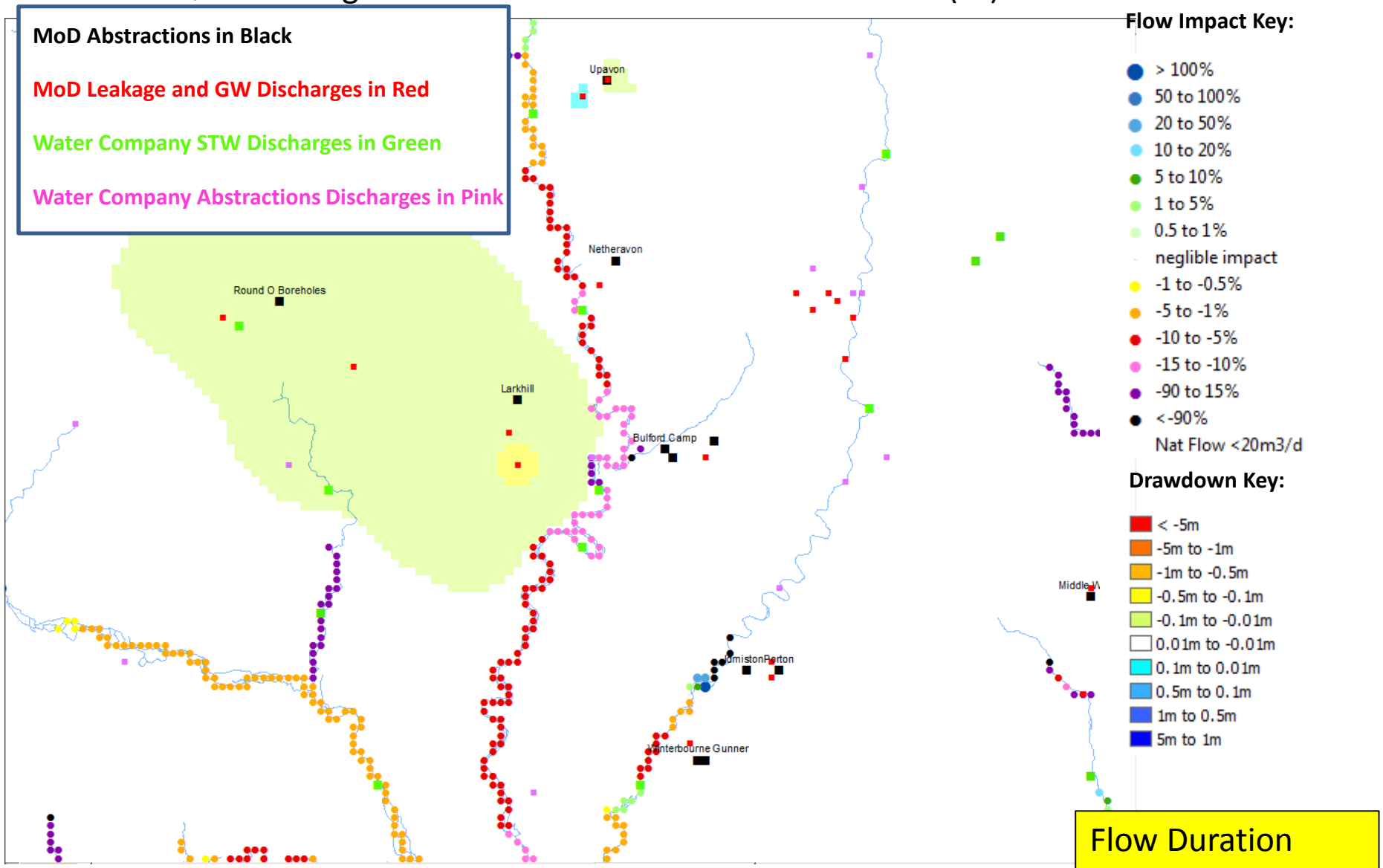


Figure 6 – Full Licence +ABP (Run 297) Impact of abstraction as a % of Natural Flow (Run 251) at Q95 and Aug 2003 GWL Difference between Run 296 (FL) and Run 297



Flow Duration Statistics based on period 1970-2012

Figure 7 – Full Licence (Run 297) Impact of abstraction in Ml/d compared to Natural Flow (Run 251) at Q95

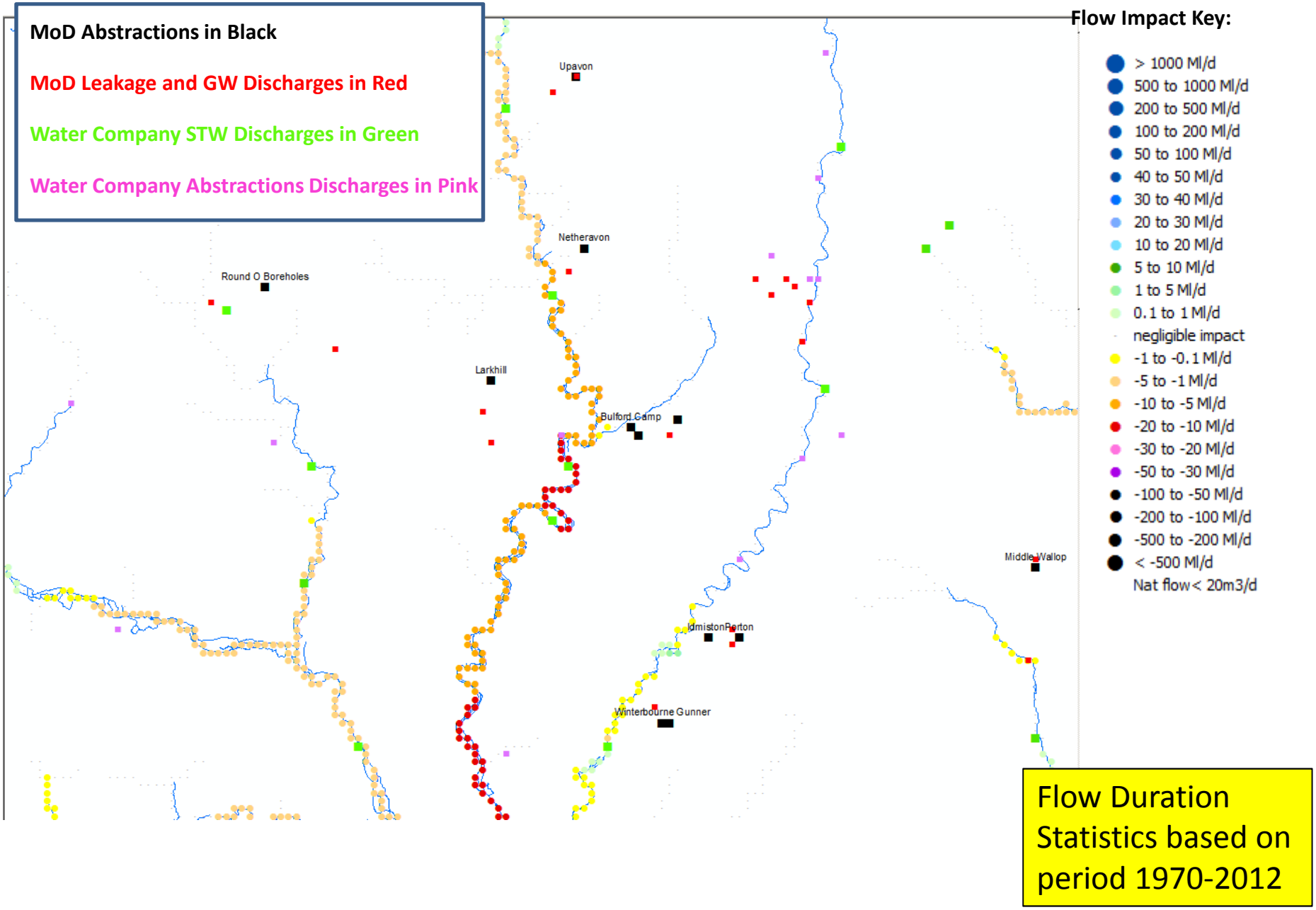
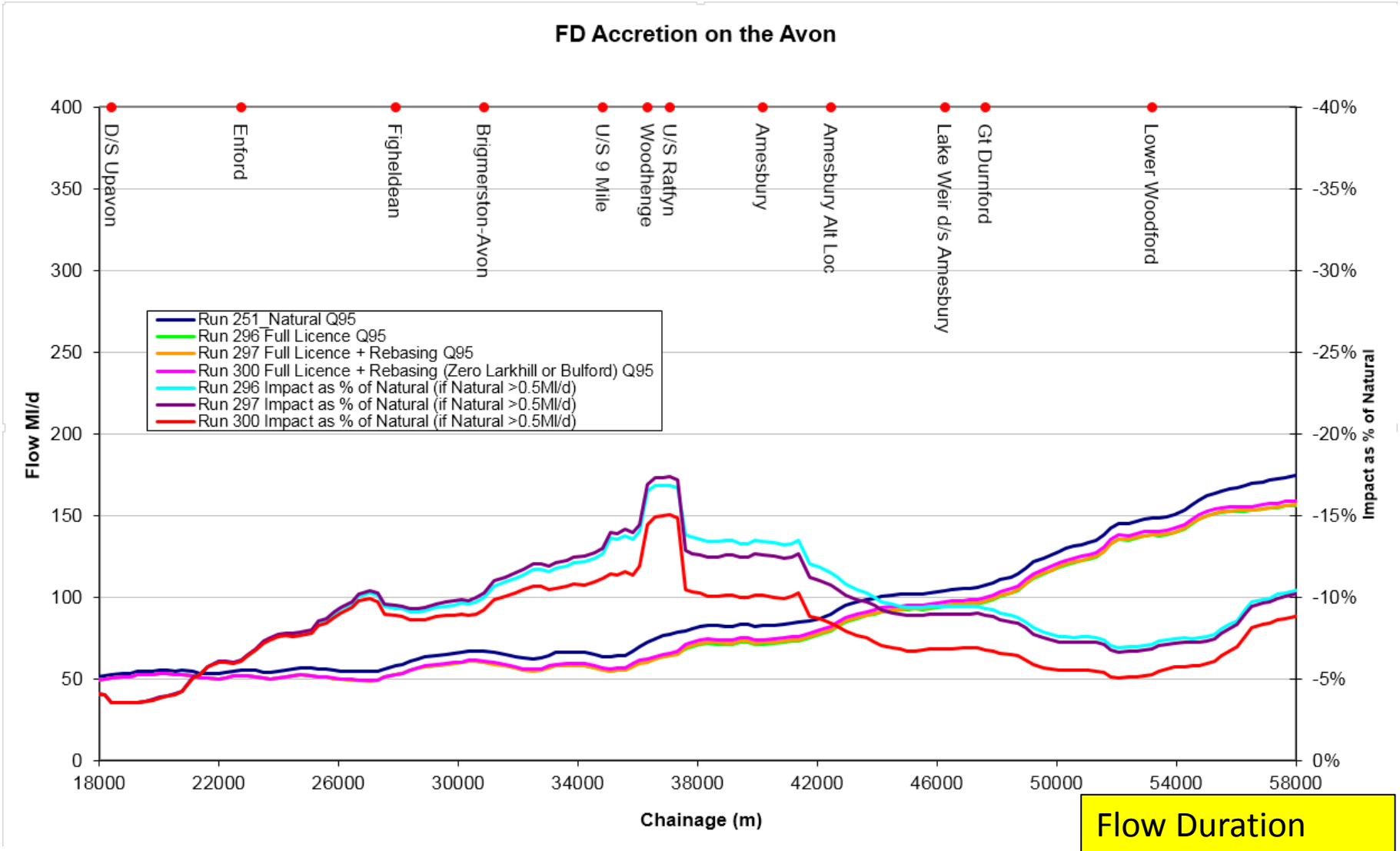
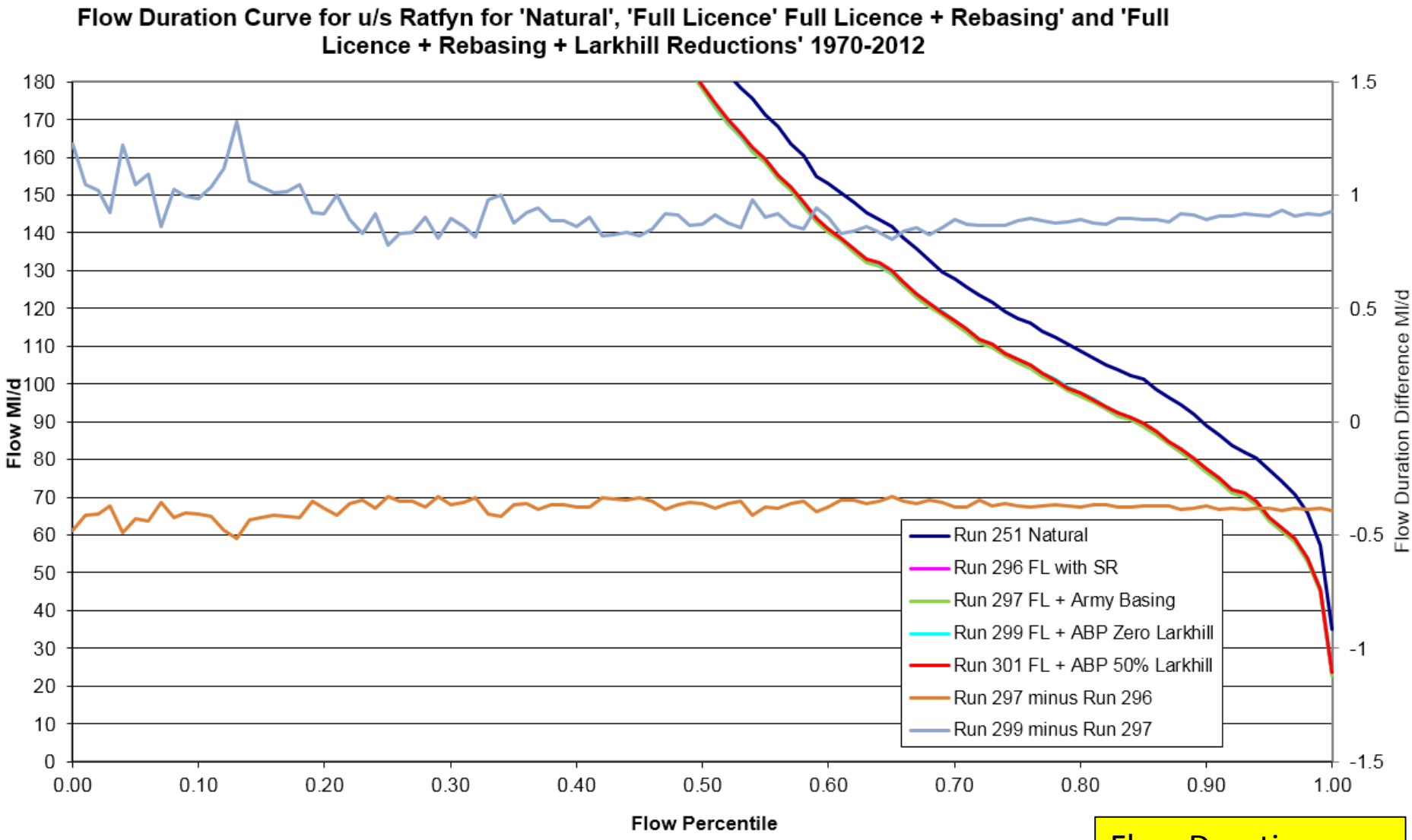


Figure 8 – Accretion Profile down the Avon at Q95



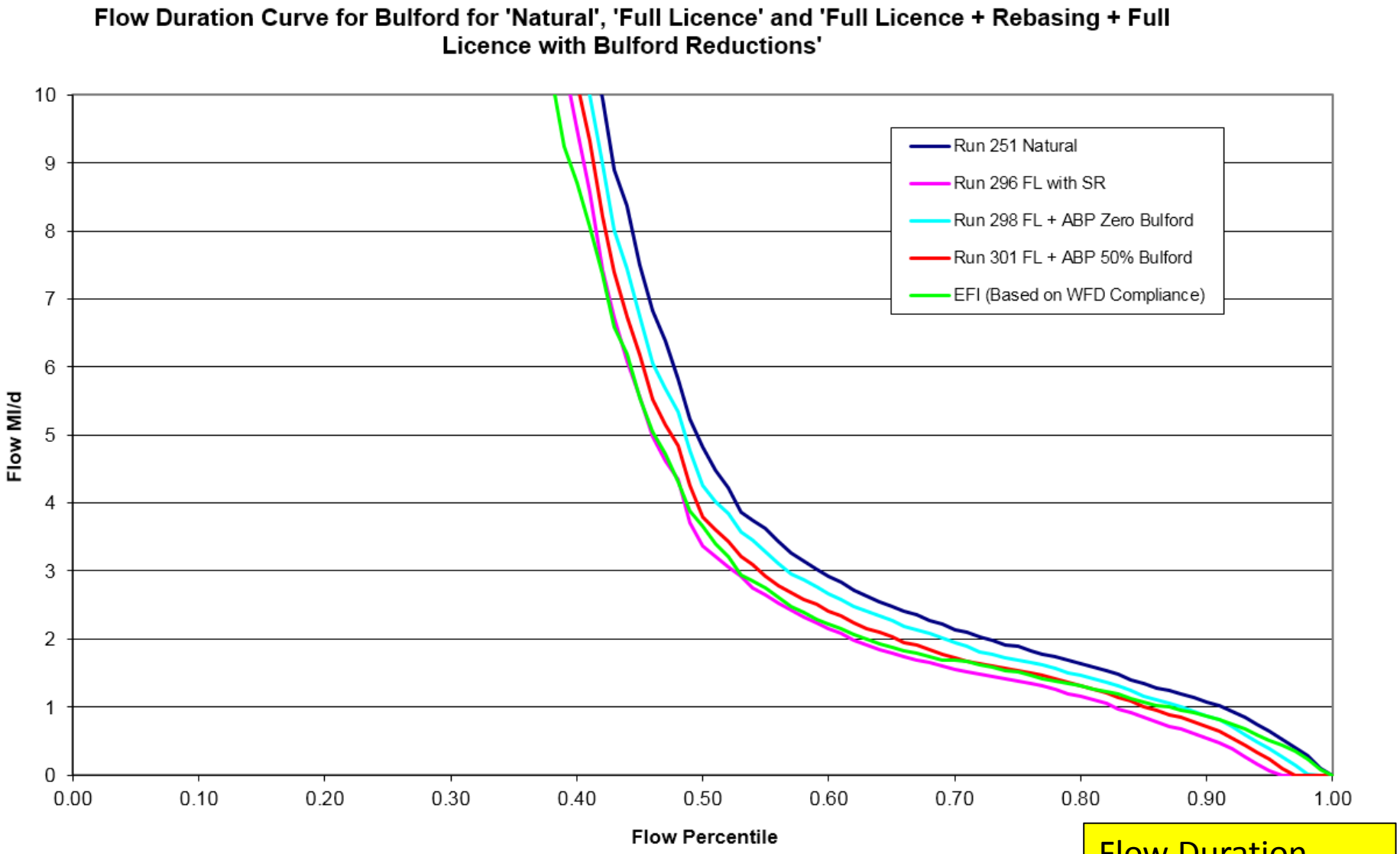
Flow Duration Statistics based on period 1970-2012

Figure 9 – Flow Duration Curve u/s Ratfyn STW



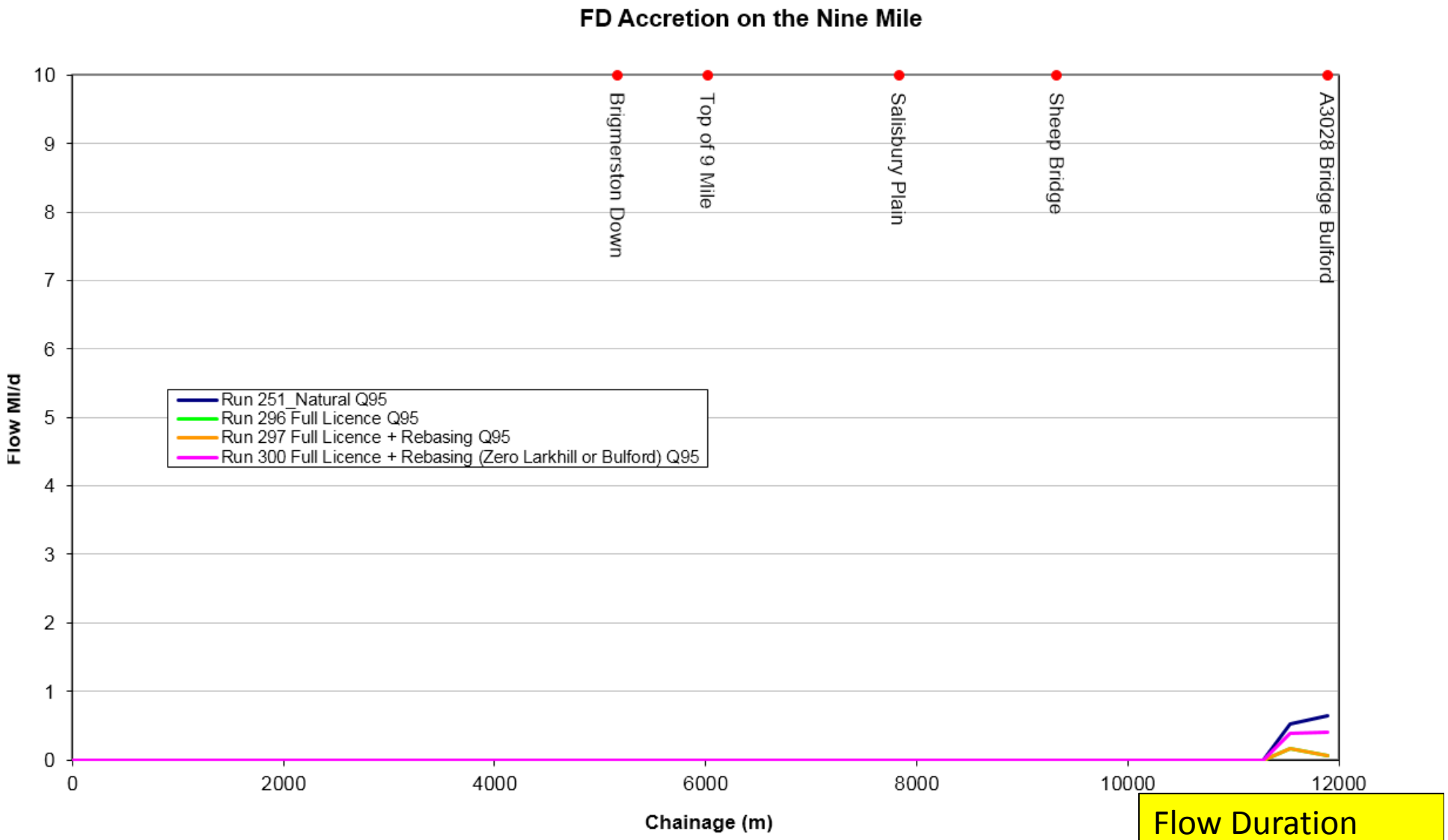
Flow Duration Statistics based on period 1970-2012

Figure 10 – Flow Duration Curve at Bulford



Flow Duration Statistics based on period 1970-2012

Figure 11



Flow Duration Statistics based on period 1970-2012

Figure 12

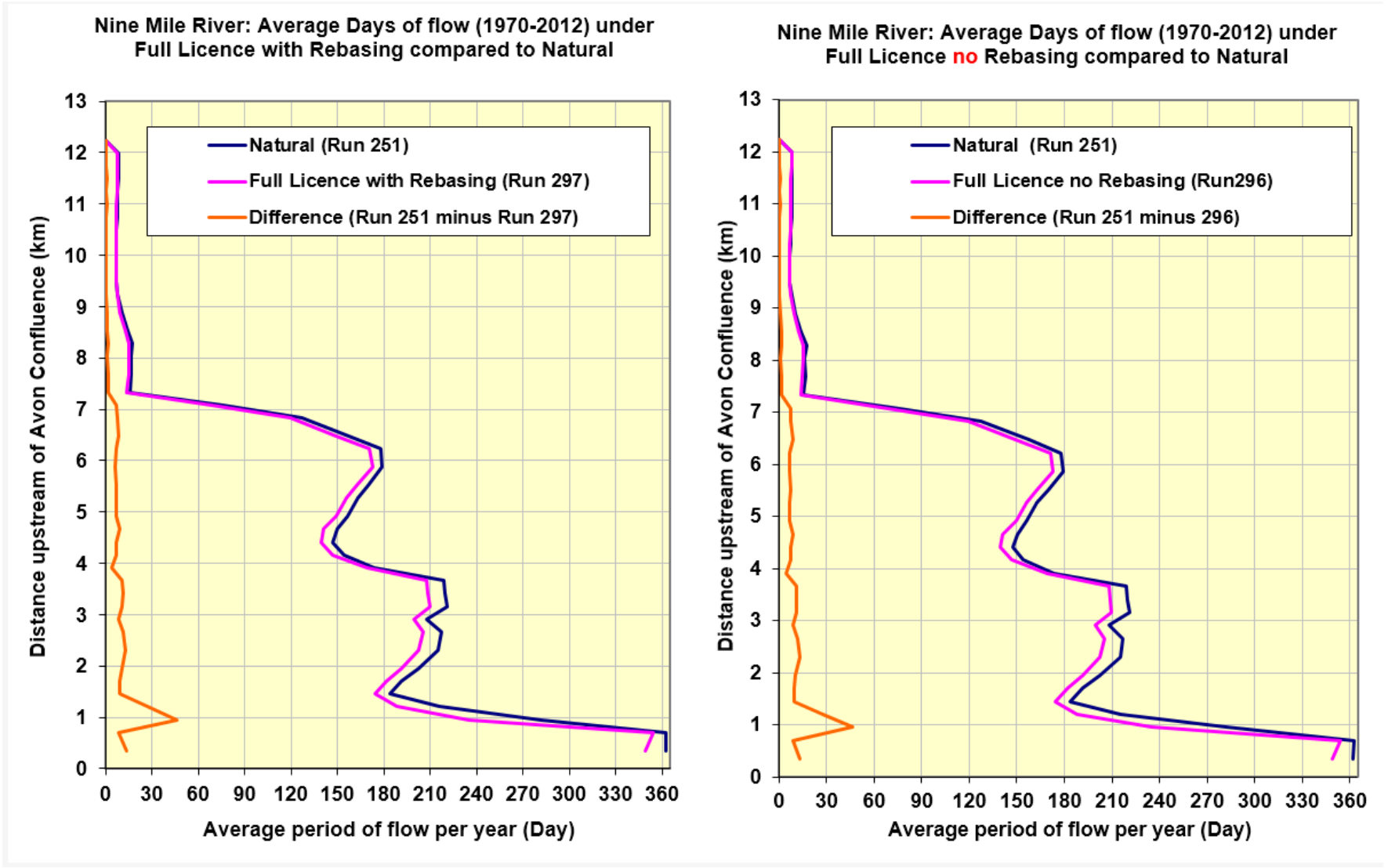

Nine Mile River: Average Days of flow (1970-2012) under Full Licence with Rebasing compared to Natural
Natural (Run 251)
Full Licence with Rebasing (Run 297)
Difference (Run 251 minus Run 297)
Distance upstream of Avon Confluence (km)
Average period of flow per year (Day)
Nine Mile River: Average Days of flow (1970-2012) under Full Licence no Rebasing compared to Natural
Natural (Run 251)
Full Licence no Rebasing (Run296)
Difference (Run 251 minus 296)
Distance upstream of Avon Confluence (km)
Average period of flow per year (Day)

Figure 13

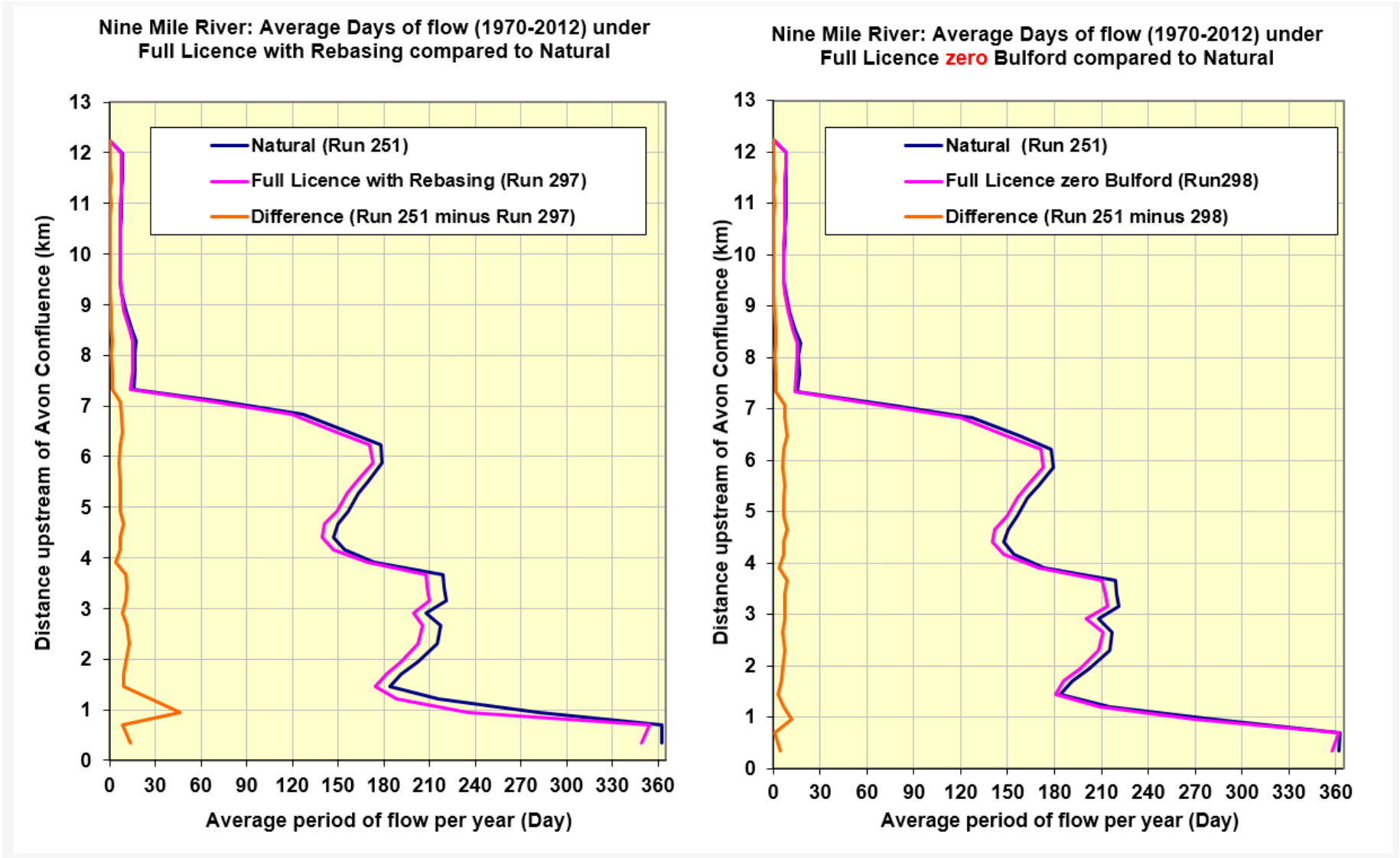

Nine Mile River: Average Days of flow (1970-2012) under Full Licence with Rebasing compared to Natural
Natural (Run 251)
Full Licence with Rebasing (Run 297)
Difference (Run 251 minus Run 297)
Distance upstream of Avon Confluence (km)
Average period of flow per year (Day)
Nine Mile River: Average Days of flow (1970-2012) under Full Licence zero Bulford compared to Natural
Natural (Run 251)
Full Licence zero Bulford (Run298)
Difference (Run 251 minus 298)
Distance upstream of Avon Confluence (km)
Average period of flow per year (Day)

Figure 14 – Impact of Groundwater Abstraction on Groundwater Levels underneath Ponds in the Nine Mile Valley

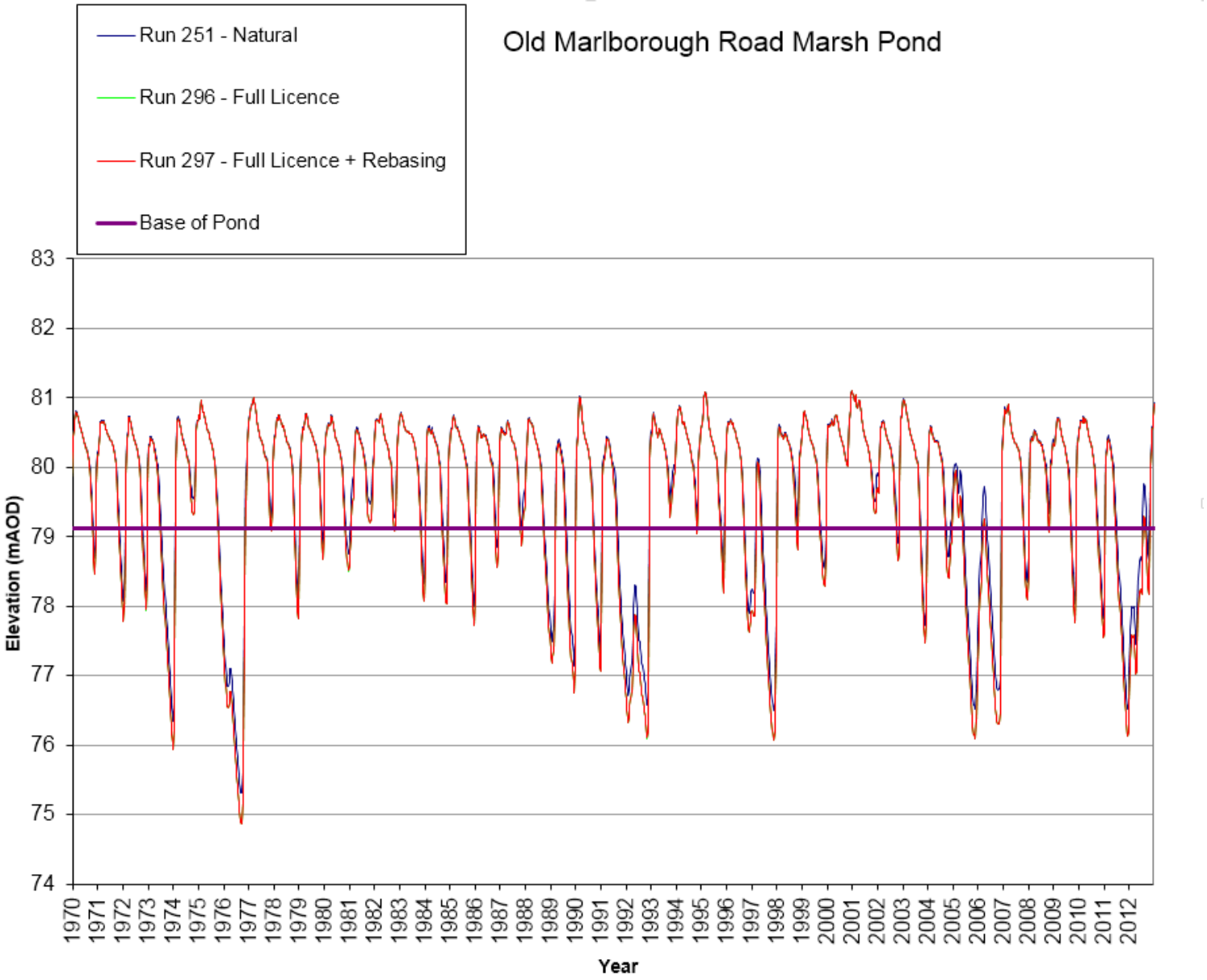


Figure 15 – Impact of turning off Bulford on Groundwater Levels underneath Ponds in the Nine Mile Valley

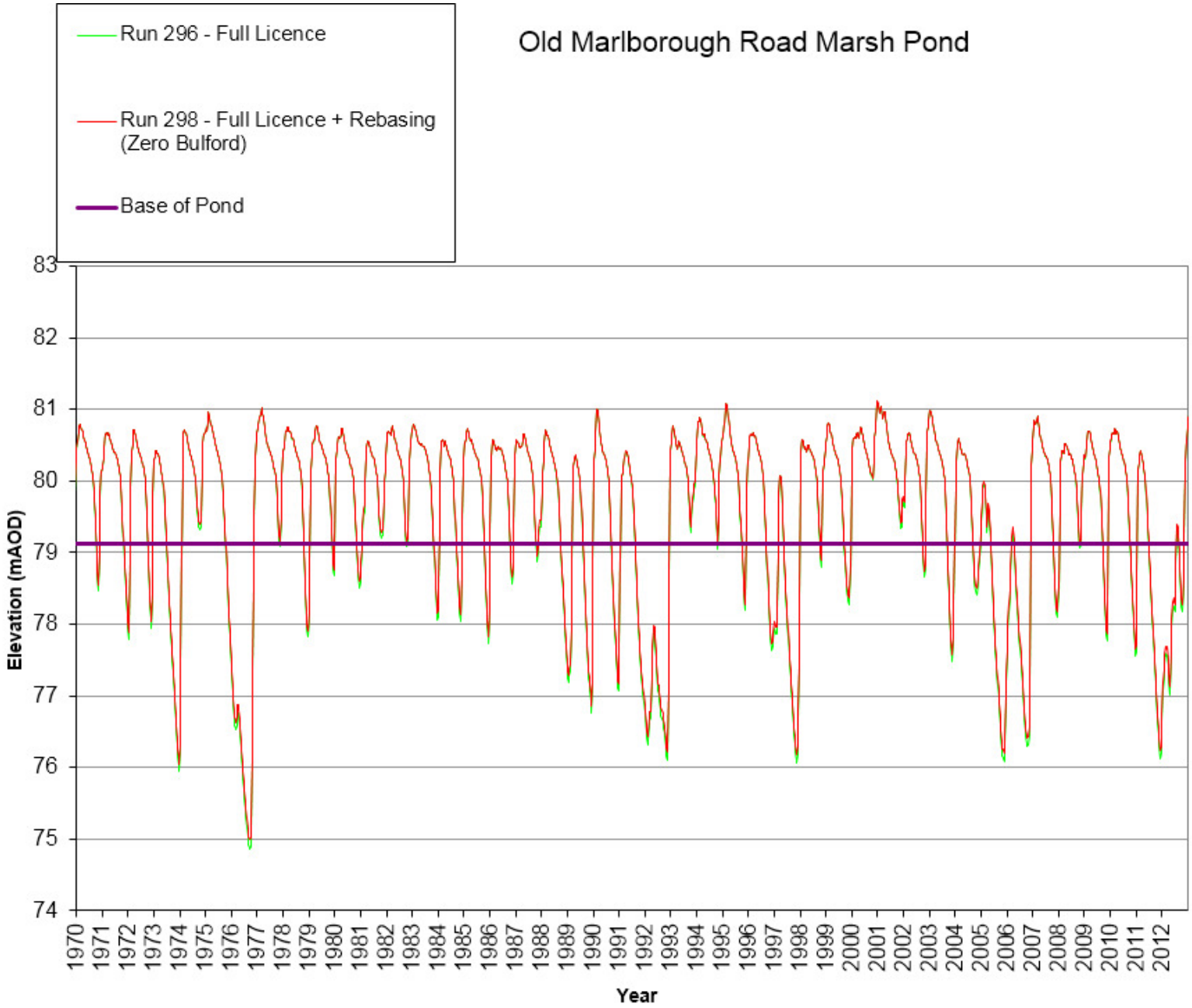


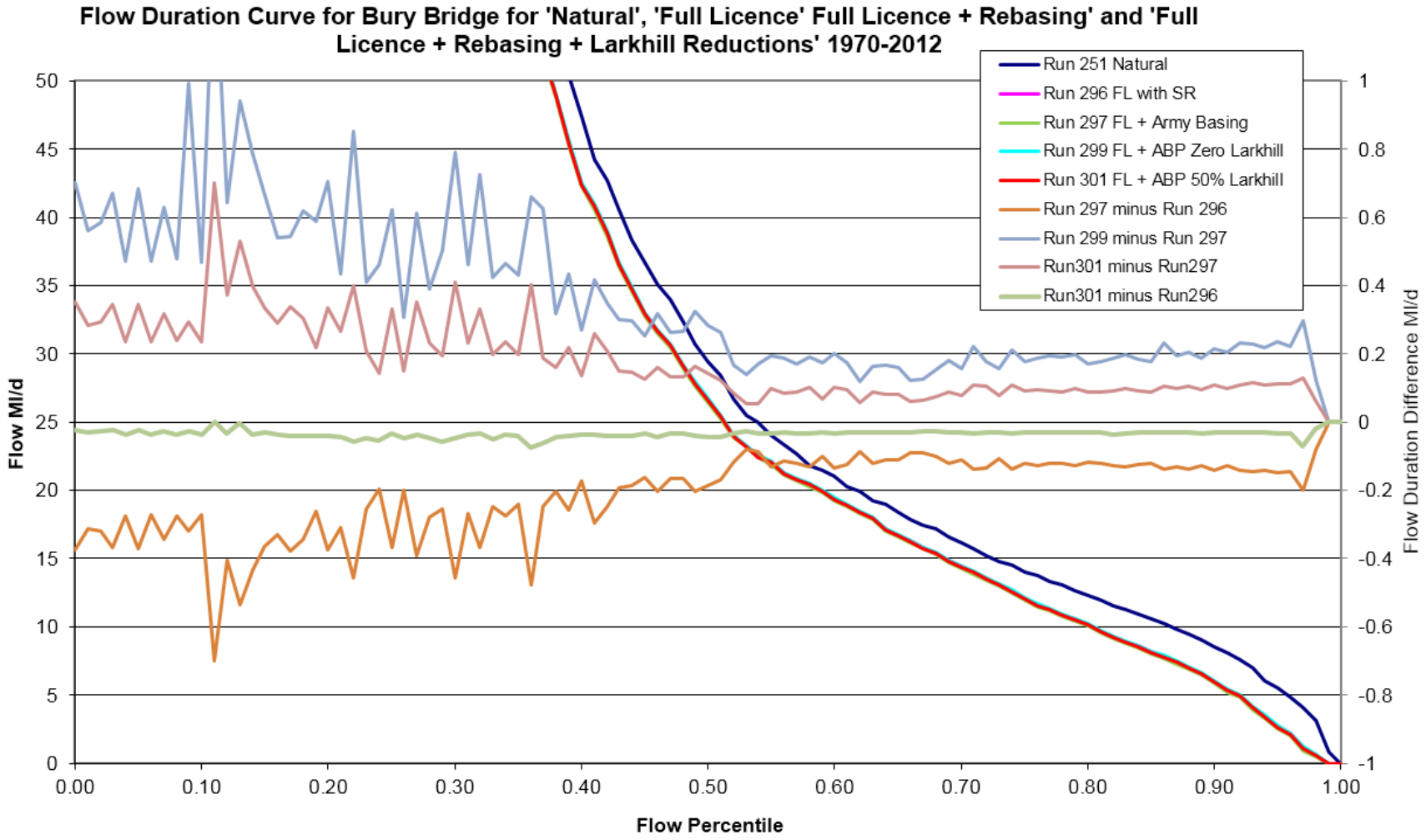
Figure 16 – Duration of wetted pond each year under different scenarios at Old Marlborough Road Marsh Pond

Pond Bottom Elevation

79.12 mAOD Topo says 79.12mAOD

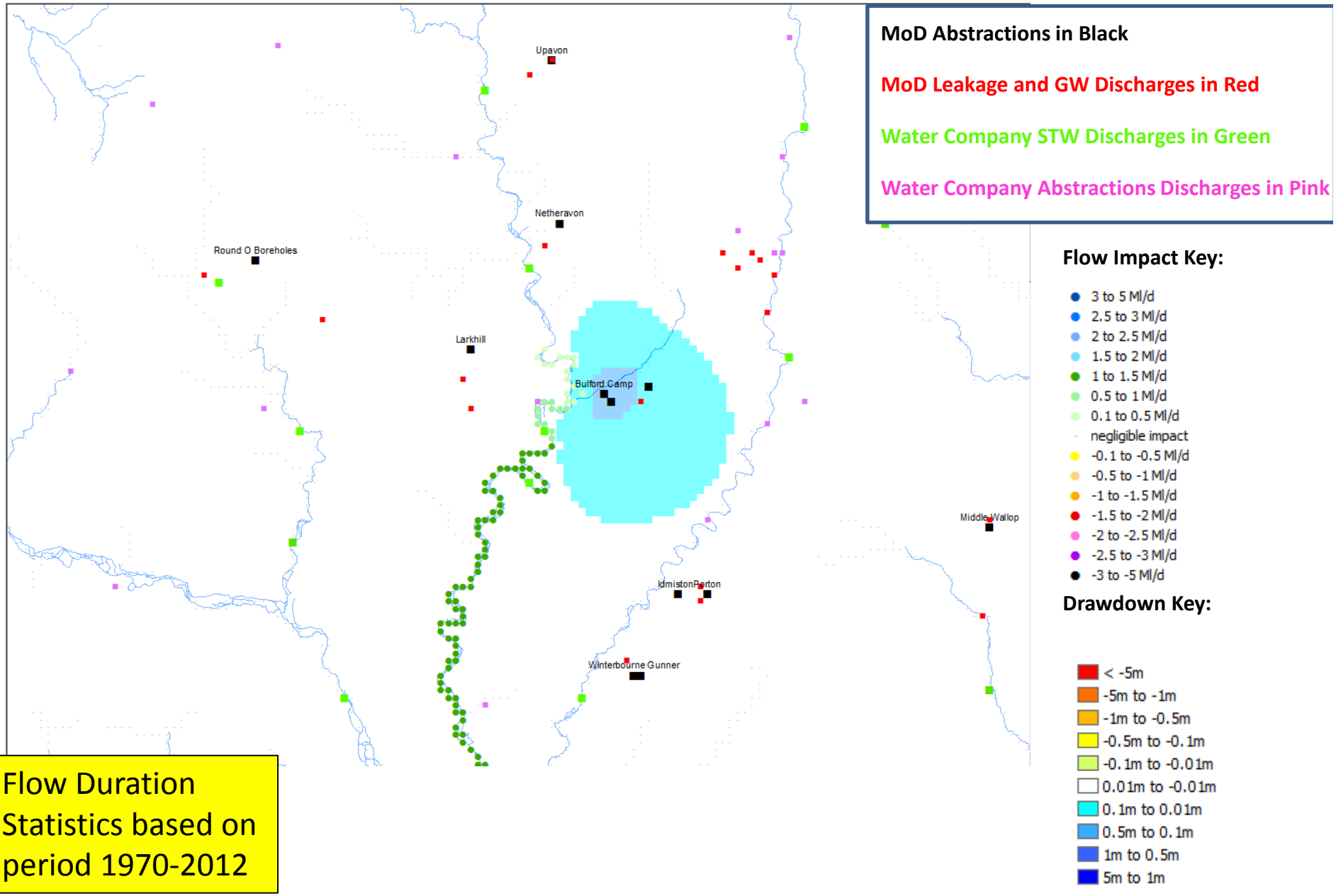
	Natural		Recent Actual		Full Licence		Full Licence + Rebasing		Full Licence+Rebase (Zero Bulford)		Full Licence+Rebase (50% Bulford)	
Year	Pass/Fail	Wet Critical Stress Periods	Pass/Fail	Wet Critical Stress Periods	Pass/Fail	Wet Critical Stress Periods	Pass/Fail	Wet Critical Stress Periods	Pass/Fail	Wet Critical Stress Periods	Pass/Fail	Wet Critical Stress Periods
1970	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1971	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1972	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1973	Fail	12	Fail	11	Fail	11	Fail	11	Fail	11	Fail	11
1974	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1975	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1976	Fail	0	Fail	0	Fail	0	Fail	0	Fail	0	Fail	0
1977	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1978	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1979	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1980	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1981	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1982	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1983	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1984	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1985	Fail	19	Fail	19	Fail	18	Fail	18	Fail	19	Fail	19
1986	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1987	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1988	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1989	Pass	20	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
1990	Fail	16	Fail	16	Fail	15	Fail	15	Fail	15	Fail	15
1991	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
1992	Fail	9	Fail	9	Fail	8	Fail	8	Fail	8	Fail	8
1993	Fail	7	Fail	7	Fail	7	Fail	7	Fail	7	Fail	7
1994	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1995	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1996	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
1997	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
1998	Fail	8	Fail	8	Fail	7	Fail	7	Fail	7	Fail	7
1999	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2000	Pass	20	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
2001	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2002	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2003	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2004	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
2005	Pass	20	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
2006	Fail	9	Fail	8	Fail	7	Fail	7	Fail	8	Fail	8
2007	Fail	6	Fail	5	Fail	1	Fail	1	Fail	2	Fail	2
2008	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2009	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2010	Pass	20	Fail	19	Fail	19	Fail	19	Fail	19	Fail	19
2011	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20	Pass	20
2012	Fail	12	Fail	12	Fail	11	Fail	11	Fail	11	Fail	11

Figure 17 – Flow Duration Curve at Bury Bridge on the the Till



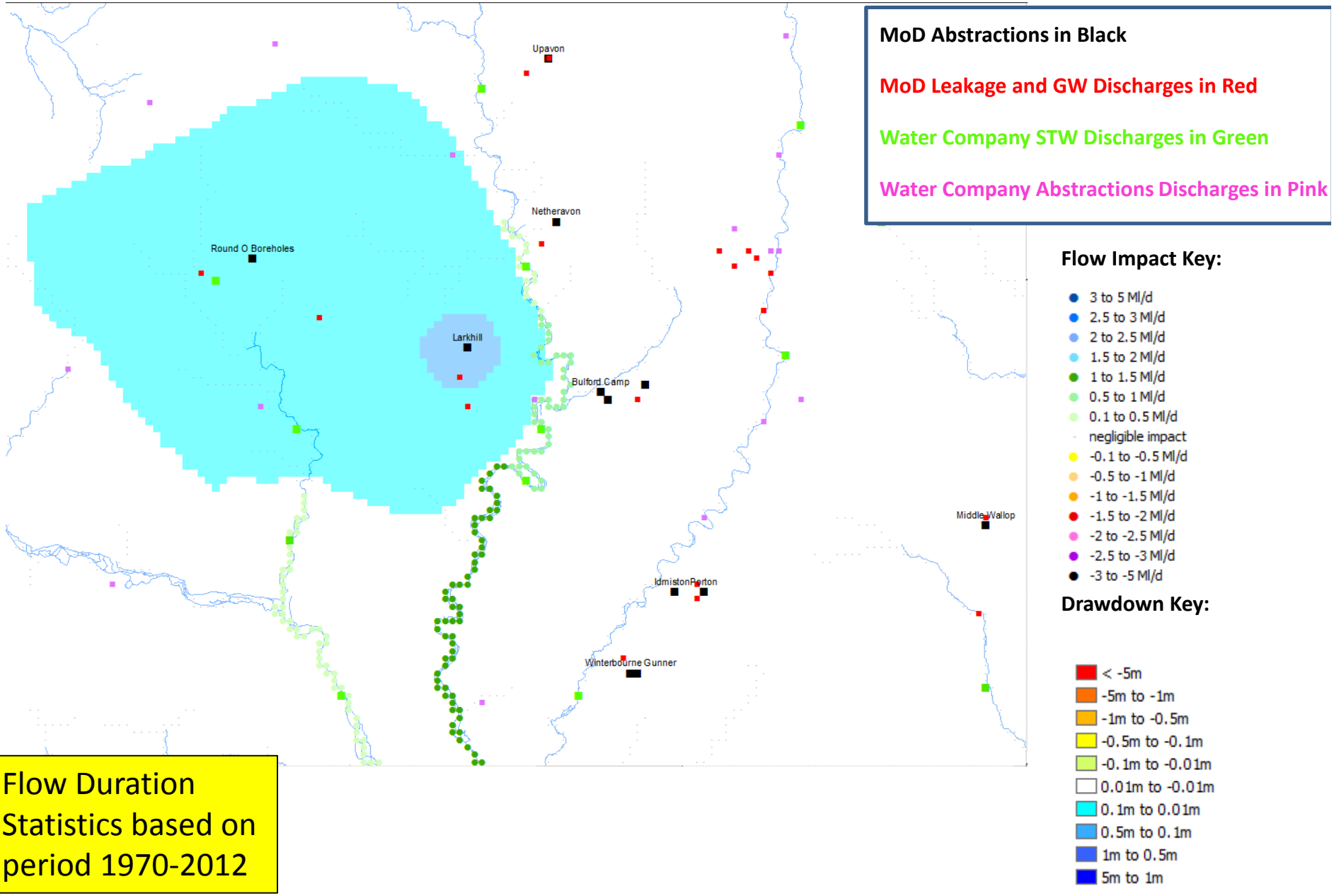
Flow Duration Statistics based on period 1970-2012

Figure 18 – Impact of turning off Bulford (Run 298) compared to Full Licence ABP (Run297)



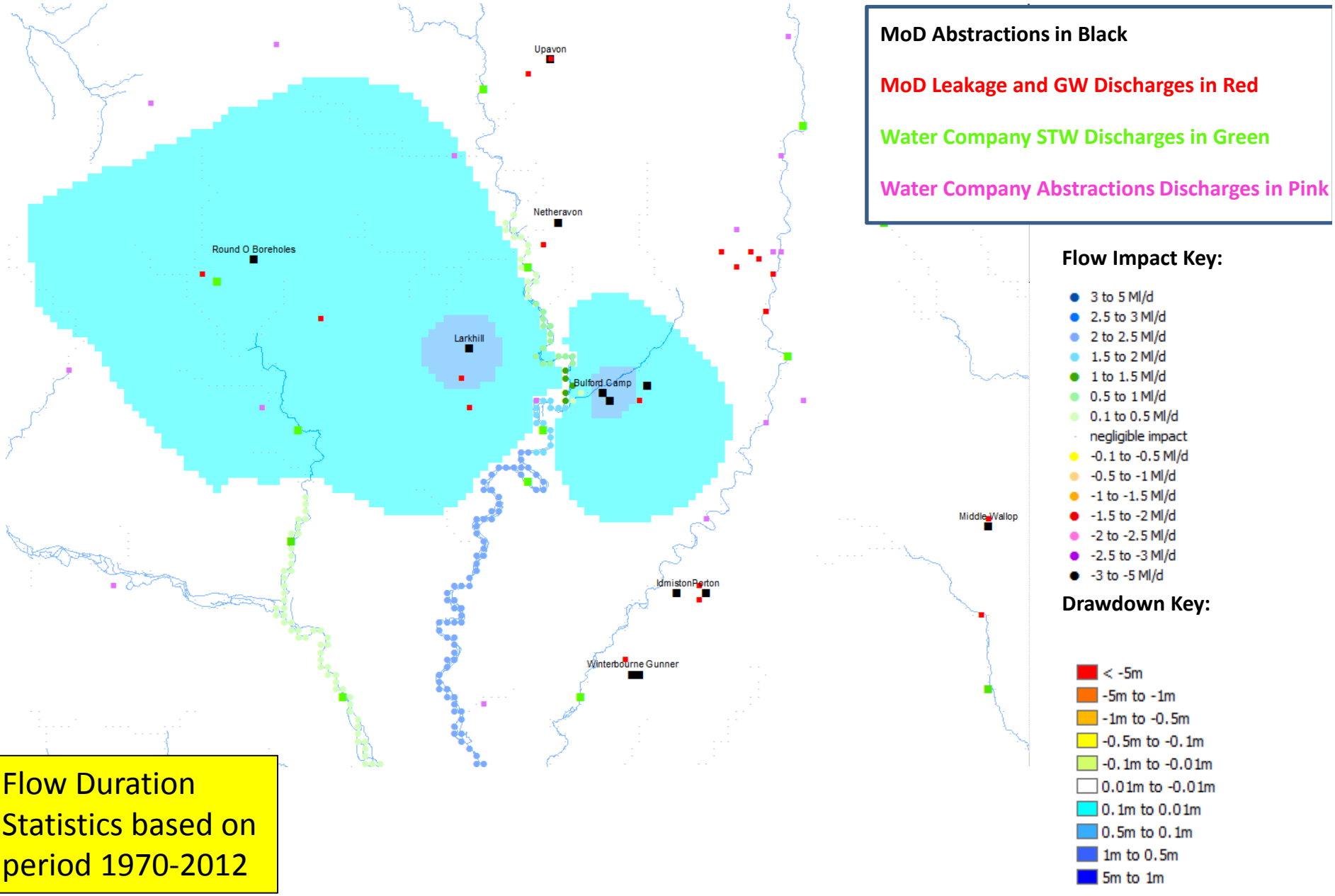
Flow Duration Statistics based on period 1970-2012

Figure 19 – Impact of turning off Larkhill (Run 299) compared to Full Licence ABP (Run297)



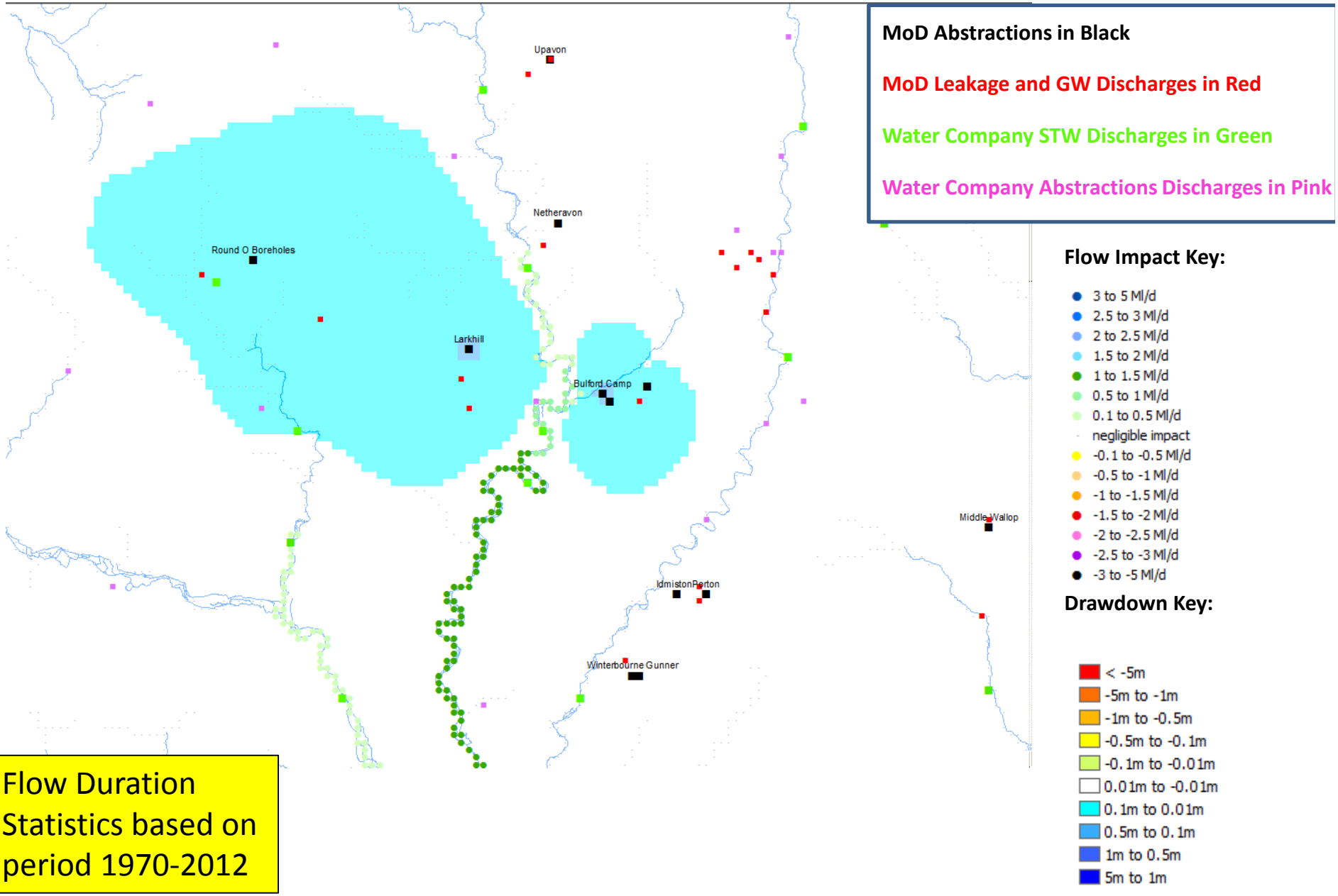
Flow Duration Statistics based on period 1970-2012

Figure 20 – Impact of turning off Bulford & Larkhill (Run 300) compared to Full Licence ABP (Run297)



Flow Duration Statistics based on period 1970-2012

Figure 21 – Impact of turning down Bulford & Larkhill by 50% (Run 301) compared to Full Licence ABP (Run297)



Flow Duration Statistics based on period 1970-2012

Army Basing Programme – Groundwater Model Update:
Briefing note on Alternative Army Basing Scenarios

1. Background

Amec Foster Wheeler has received a request from the DIO to run the Wessex Basin Groundwater Model (WBM) for two further scenarios relating to the differing options for abstraction and discharge from the Larkhill, Upavon and Bulford Camps as part of the Army Basing Programme (ABP). These runs are summarised in **Section 2** and were formulated in consultation with the Environment Agency, Natural England and Wiltshire Council at a meeting in Blandford on 24 February 2016.

This Briefing note is the fourth issued for groundwater modelling work related to ABP. The first three being:

- Wessex Basin Groundwater Model – Scenario Runs for the Defence Infrastructure Organisation (DIO) – September 2014 (35647tn025i2) which formed Technical Appendix 9A of the Masterplan EIA; and
- Wessex Basin Groundwater Model – Larkhill and Bulford Discharge Options – March 2015 (35647g058) which included initial thoughts on the Water Resources implications of differing sewage treatment discharge locations and rates as part of the ABP.
- Army Basing Programme – Groundwater Model Update – January 2016 (35647i1_Runs295_301.docx) which included updated details on the abstraction and discharge rates at the various camps along with an improved understanding of the future requirements under the Army Basing Programme. The baseline runs were also updated to include the latest agreements on the Sustainability Reductions undertaken by Wessex Water. Further scenarios were undertaken to understand the potential mitigation that could be provided by reducing abstractions at Larkhill and Bulford

This Briefing note (35647tn084i1 – March 2016) seeks to inform the various Habitat Regulations Assessments (HRAs) required for the ABP and focusses specifically on the **standalone** hydrological impact of the ABP changes on the 'Full Licence' condition. It does not reference the standalone or in-combination impacts of the existing MoD abstractions and discharges.

Section 2 outlines the model updates undertaken and the scenarios that have been run.

Section 3 discusses the scenario results and **Section 4** provides a brief summary.

At the end of this note, a series of draft figures are presented and the following text makes reference to these figures. This Briefing note is designed to support ongoing planning applications and the Water Management Strategy for the MoD ABP sites across Salisbury Plain that is being produced by Kelda Water and WSP.

It is therefore assumed that the reader is aware of the overarching work and the ABP as well as being familiar with the details behind the HRAs.

Throughout this document the term '**Full Licence'** should be read to include MoD abstractions (at 'proxy' Full Licence) even though they are not yet licensed.

2. Model Setup

Figures 1 and 2 contain the locations of the features mentioned throughout this note, in particular the water resources arrangements at Upavon, Larkhill and Bulford Camps.

Results from previous runs (Runs 295-301) highlighted that the proposed relocation of Larkhill discharge from the Larkhill STW (discharge to ground) to the existing Wessex Water STW (discharge to the River Avon) at Ratfyn would potentially cause an impact on flows upstream of Ratfyn STW on the Avon and in general on flows in the River Till. In summary this relates to the position of the existing Larkhill STW on the (variable) groundwater catchment divide between the perennial River Avon and the ephemeral River Till.

In order to investigate methods of mitigating these impacts, two further runs (Run 307 and Run 308) have been undertaken.

Details of the abstraction and discharge arrangements at Upavon, Larkhill and Bulford for the runs discussed in this note are provided in **Table 1**.

The following runs were undertaken (or referenced) as part of this update:

- Run 296 remains the Full Licence run (pre-ABP) against which other runs are compared;
- Run 297 the 'original' Full Licence + ABP solution is also presented for reference and to highlight the mitigation options that are presented through Runs 307 and 308;
- Run 307 is the first alternative ABP option presented and represents a 934 m^3/d reduction in abstraction at Larkhill to offset the commensurate reduction in discharge at the Larkhill STW ; and
- Run 308 is the second alternative ABP option and represents a cumulative reduction in abstraction of 934 m^3/d, through a reduction of 580 m^3/d at Larkhill and 354 m^3/d at Round O to offset the commensurate reduction in discharge at the Larkhill STW.

The assumption on Runs 307 and 308 is that the reduction in abstraction from MoD sources will be replaced by supply from Wessex Water within existing licence conditions. **Hence** the volume of water abstracted in Runs 307 and 308 will be less than both Runs 296 and 297. Therefore the groundwater modelling runs are being investigated to understand the timing and spatial distribution of the changes rather than the overall 'direction of impact' at a catchment scale.

It is important to note the changes to abstraction and discharges at both Bulford and Upavon are integral parts of the 'plan or scheme' that are being assessed as part of the HRAs. However with reference to **Table 1** and specifically comparison with Run 296, it can be concluded, on the basis of water quantity, that:

- the changes proposed at Bulford (decreased abstraction through efficiency measures and increased discharge) will have a net positive impact on flows and groundwater levels; and
- the changes proposed at Upavon (only a minimal 1 m^3/d increase in net abstraction) are negligible compared to the flows in the Avon adjacent to the site (combined LTA flow at Upavon East and West is ~130 Ml/d).

As a result of this, no further consideration is given to the Bulford and Upavon ABP changes in this document.

Table 2 – Abstraction and Discharge Rates at ABP Locations on Salisbury Plain

Artificial Influence (values in m3/d)	Run 296	Run 297	Run 307	Run 308
Upavon Abstraction (Hill and East)	308	326	326	326
Upavon Discharge	130	147	147	147
Upavon Leakage	140	140	140	140
Bulford Abstraction (BH1)	1398	1375	1375	1375
Bulford Abstraction (BH2)	0	0	0	0
Bulford Discharge (contribution to Ratfyn above Recent Actual)	182	226	226	226
Bulford Leakage	376	376	376	376
Larkhill Abstraction	1357	1357	**423**	**777**
Round O Abstraction	977	1071	1071	**717**
Larkhill Discharge (to ground at Larkhill STW)	934	0	0	0
Larkhill Discharge (contribution to Ratfyn) following relocation from Larkhill STW and increase due to ABP	0	1154	1154	1154
Larkhill Leakage	462	462	462	462
Round O Transfer Leakage	312	312	312	312

3. Model Output and Discussion

Please note that relative to figures produced in previous Technical Notes on this topic, the keys for flow impact and groundwater level drawdown have been further refined and so care should be taken in comparing between Technical Notes. For the accretion profiles and flow duration curves, each scenario has been assigned a fixed trace colour, though again these will be different to previous reports.

On the impact maps (e.g. Figure 3) the 'Negligible Impact' symbol is faded so as to allow prominence to areas of flow impact (both positive and negative).

Figure 3 presents the Q30 flow impacts between Run 297 and Run 296 and a comparison of groundwater levels (at high water levels) between the two runs. This highlights the impact of the original ABP changes, with impacts on the Avon upstream of Ratfyn STW and along a long length of the Till. Downstream of Ratfyn STW, the flows are improved as a result of the relocated discharge from Larkhill and the overall increase in discharge following ABP. **Figures 4 to 6** present the similar impacts at Q50, Q70 and Q95 respectively. Impacts for flows greater than Q30 can be seen through the flow durations curves presented in Figures 16 to 22.

Figure 7 shows the Q30 impact and groundwater level difference between Runs 296 and 307. The impact (higher water level) of turning down Larkhill abstraction is clear as is (still) the impact of the Larkhill STW being turned off. Relative to Run 297, the impact upstream of Ratfyn STW is now an increase in flow. Nevertheless, there is still a negative impact on flows in the River Till. **Figures 8 to 10** show the impact at the lower flow percentiles and of note is the reduction in impact (in absolute terms) on the Till at the lower flow percentiles. This exemplifies that the Till, unsurprisingly as a winterbourne, is much better connected to the aquifer (and hence changes to abstraction) at times of higher water levels than lower water levels.

Figures 11 to 14 provide the same suite of output for Run 308 (compared to Run 296). By reducing the abstraction at Round O (and by less at Larkhill) it is possible to improve flows on both the Till and the Avon upstream of Ratfyn (though the improvement upstream of Ratfyn will be less in Run 308 than Run 307). This

provides an alternative option whereby more benefit is given to the smaller watercourse than the larger less vulnerable watercourse.

Figure 15 provides the same information in a different format (namely a Q95 accretion along the length of the Avon). All 3 runs (Run 297, 307 and 308) shower higher flows, relative to Run 296, downstream of Ratfyn STW, whilst both Run 307 and, to a lesser extent, Run 308 show a positive impact upstream too as a result of the lower overall abstraction.

Figures 16 to 19 are flow duration curves for different points along the Avon and re-iterate previous findings. **Figure 16** upstream of Ratfyn shows a smooth impact profile across the range of flows as would be expected given the constant rate of change in artificial influences that are well connected and close to the major discharge boundary of the River Avon. **Figure 17** represents the situation downstream of Ratyfn STW and **Figure 18** upstream of the Wylye confluence. In both plots, the impact profiles across the range of flows are relatively constant. In contrast, **Figure 19** from downstream of the Wylye confluence presents a 'noisier' impact profile with greater impacts visible at higher flows in Runs 297 and Runs 308. Runs 297 and 308 include larger spatial variation in the location of artificial influence changes (relative to Run 307 where the changes at Larkhill STW and Larkhill abstraction act to counteract one another as they are so close together in the same part of the aquifer) and produce impacts that are more variably across the range of flows in the River Till. The changes are more visible at higher flows, as the Till system is more active and better connected at high flows.

This pattern is also shown in **Figures 19-21** which highlight the impact of the different scenarios across the range of flows at 3 locations on the Till.

At the meeting on the 24 February 2016 and in response to previous model results, a question has been raised on the impacts of ABP on water levels close to the Avon and the preferred habitat of the Desmoulin's whorl snail. **Figures 10 and 14** (for Runs 307 and 308 respectively) highlight that the changes to water levels in the Chalk Aquifer underlying the riverine areas are less than 1 cm and are probably close to 0 cm given that water levels will be 'pinned' in this location by the discharging boundary formed by the River Avon.

4. Summary

Compared to the original ABP proposals (Run 297), both Run 307 and Run 308 provide an overall improvement in flow (relative to Run 296) as would be expected given the overall reduction in catchment scale abstraction. Both Runs 307 and 308 result in improved flows in the Avon across the flow duration curve. Run 307 does have a small negative impact on flows in the River Till, albeit that these impacts are felt more significantly at higher water levels (and flows) when the Till is much better connected to the underlying Chalk Aquifer. In contrast, Run 308, provides less flow improvement to the Avon, but does provide limited improvements to flows in the Till (again with more impact felt at higher flows than lower flows). Both the flow impacts and flow improvements are relatively modest and would potentially be difficult to 'see in the field'. The groundwater model allows for examination of the flow differences at these lower levels and the conclusion from the model runs would be that the ABP options presented in **Run 307** would result in a negligible, but negative, impact on flows in the River Till whereas the options presented in **Run 308**, would result in a negligible, but positive, impact on flows in the River Till. Both options, relative to current Full Licence, would results in a positive impact on flows in the River Avon both upstream and downstream or Ratyfn STW.

Author	Reviewer
Tim Power	pp Rob Soley

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Third party disclaimer

Management systems

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Figure 1 – Key Abstractions and Discharges

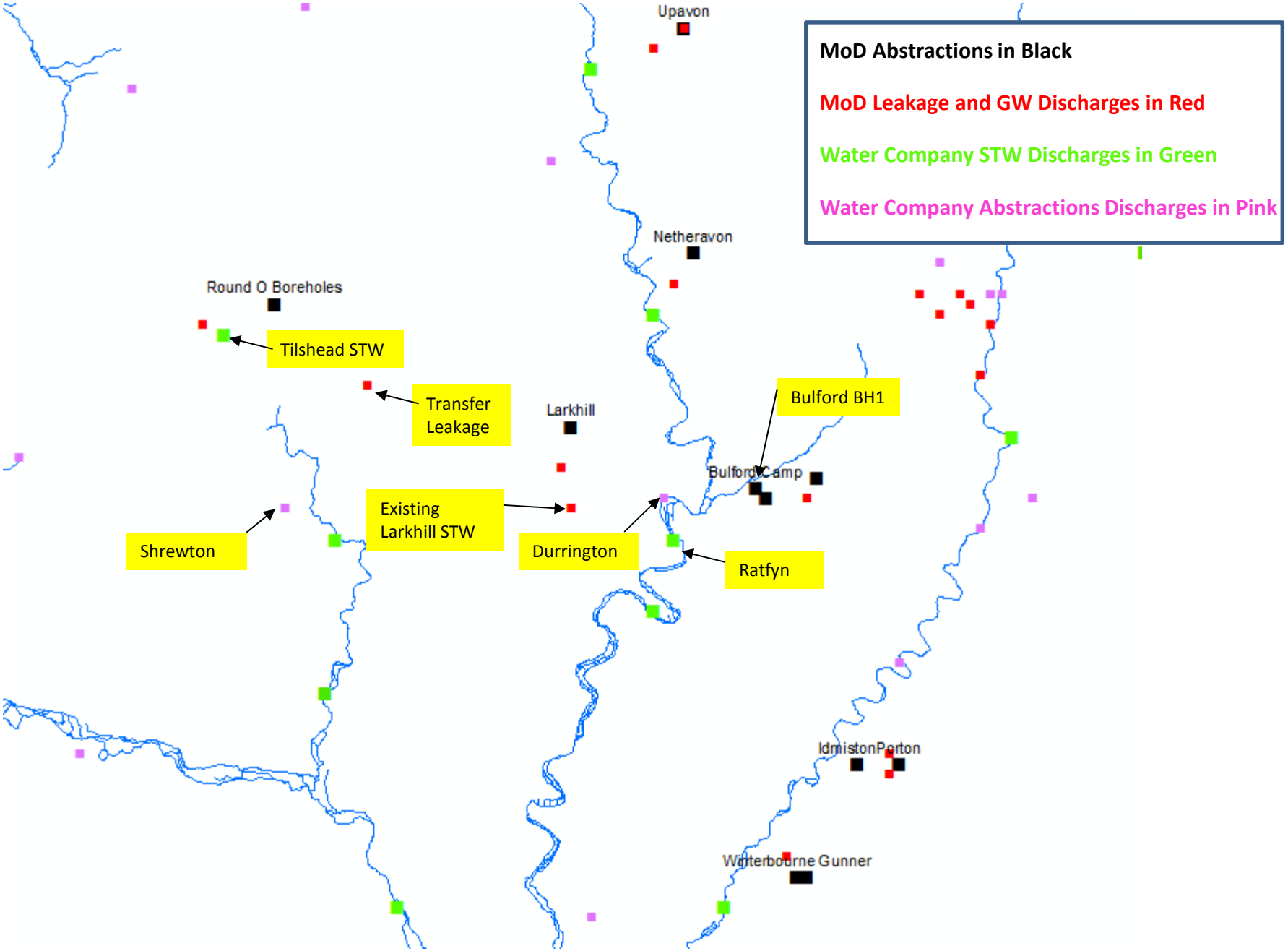


Figure 2 – Flow Comparison Locations (selected sites labelled)

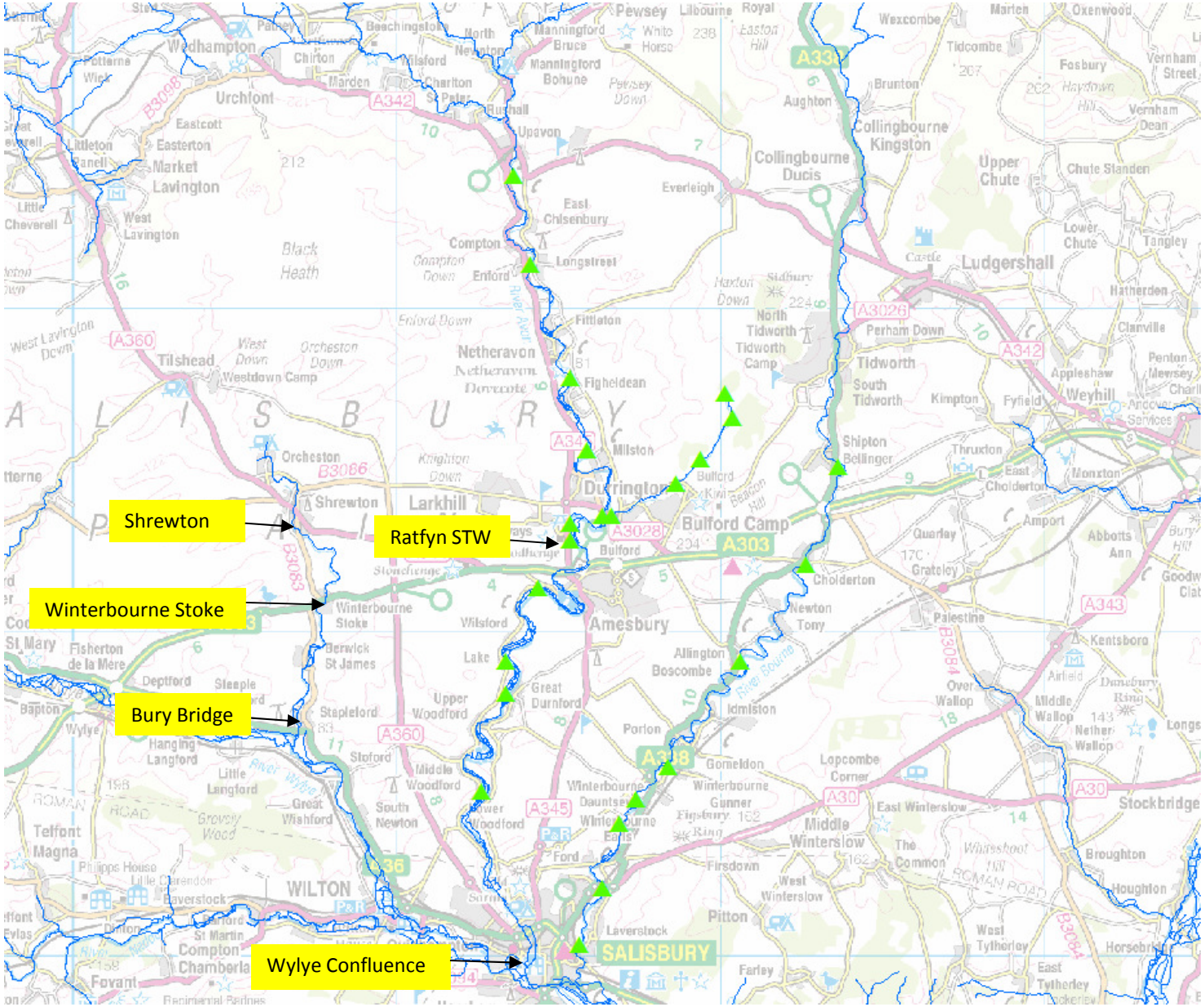
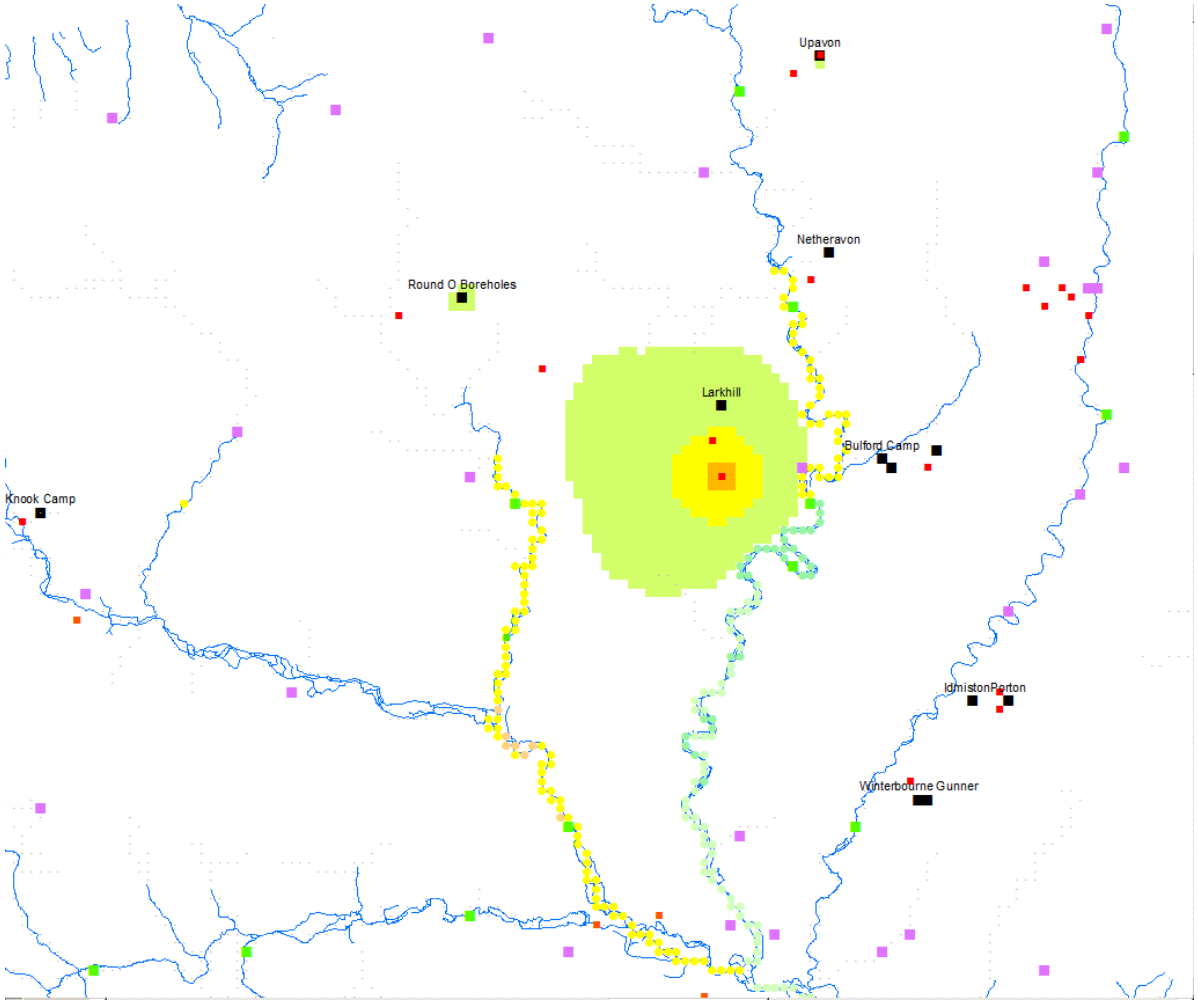


Figure 3 – Q30 Flow Impact and February 1995 Drawdown Impact of original Army Basing Scenario (Run 297) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Drawdown Key:

- < -1m
- -0.5m to -1m
- -0.1m to -0.5m
- -0.05m to -0.1m
- -0.01m to -0.05m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.1m
- 0.1m to 0.5m
- 0.5m to 1m

Flow Duration Statistics based on period 1970-2012

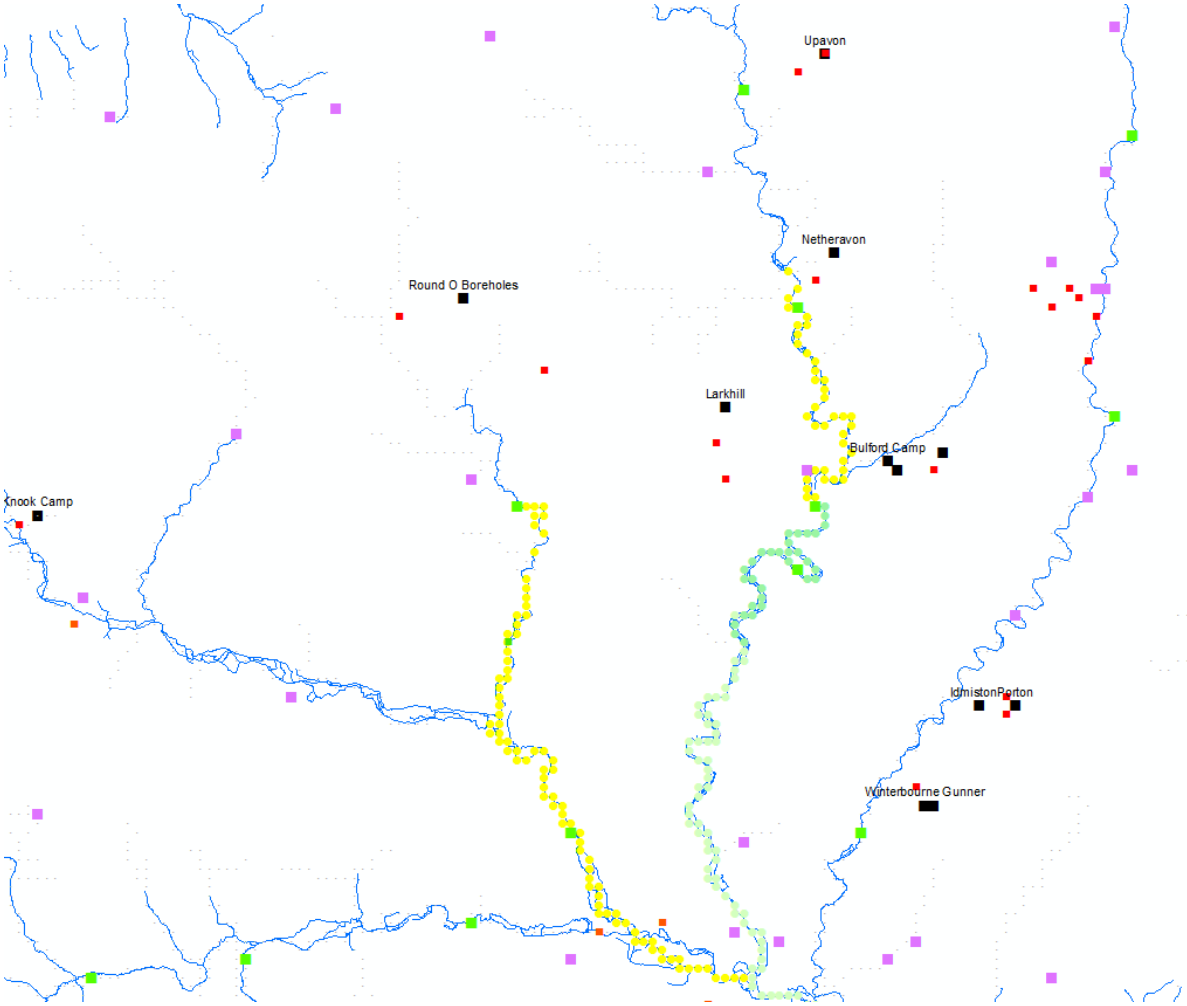
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 4 – Q50 Flow Impact of original Army Basing Scenario (Run 297) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Flow Duration Statistics based on period 1970-2012

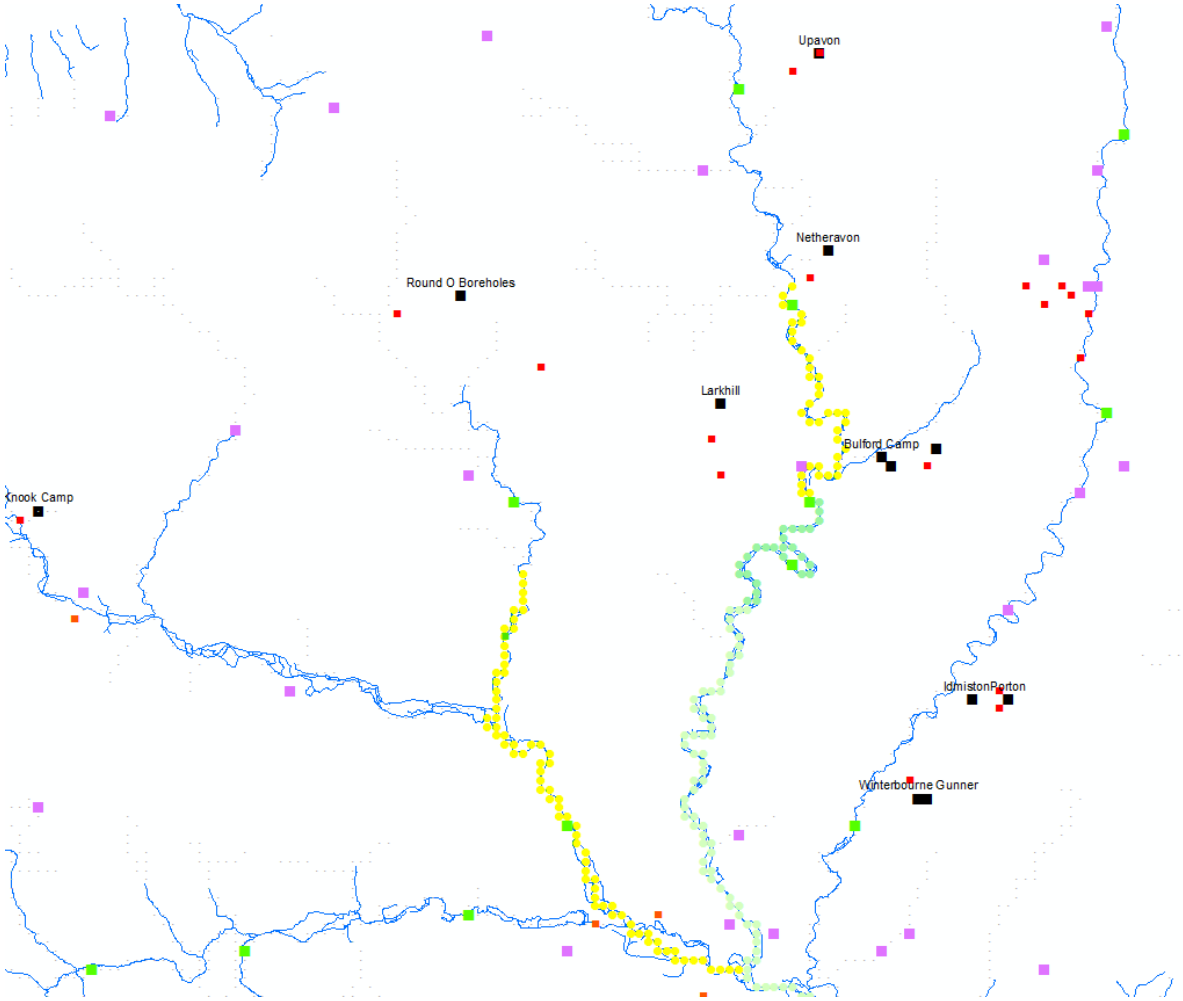
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 5 – Q70 Flow Impact of original Army Basing Scenario (Run 297) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Flow Duration Statistics based on period 1970-2012

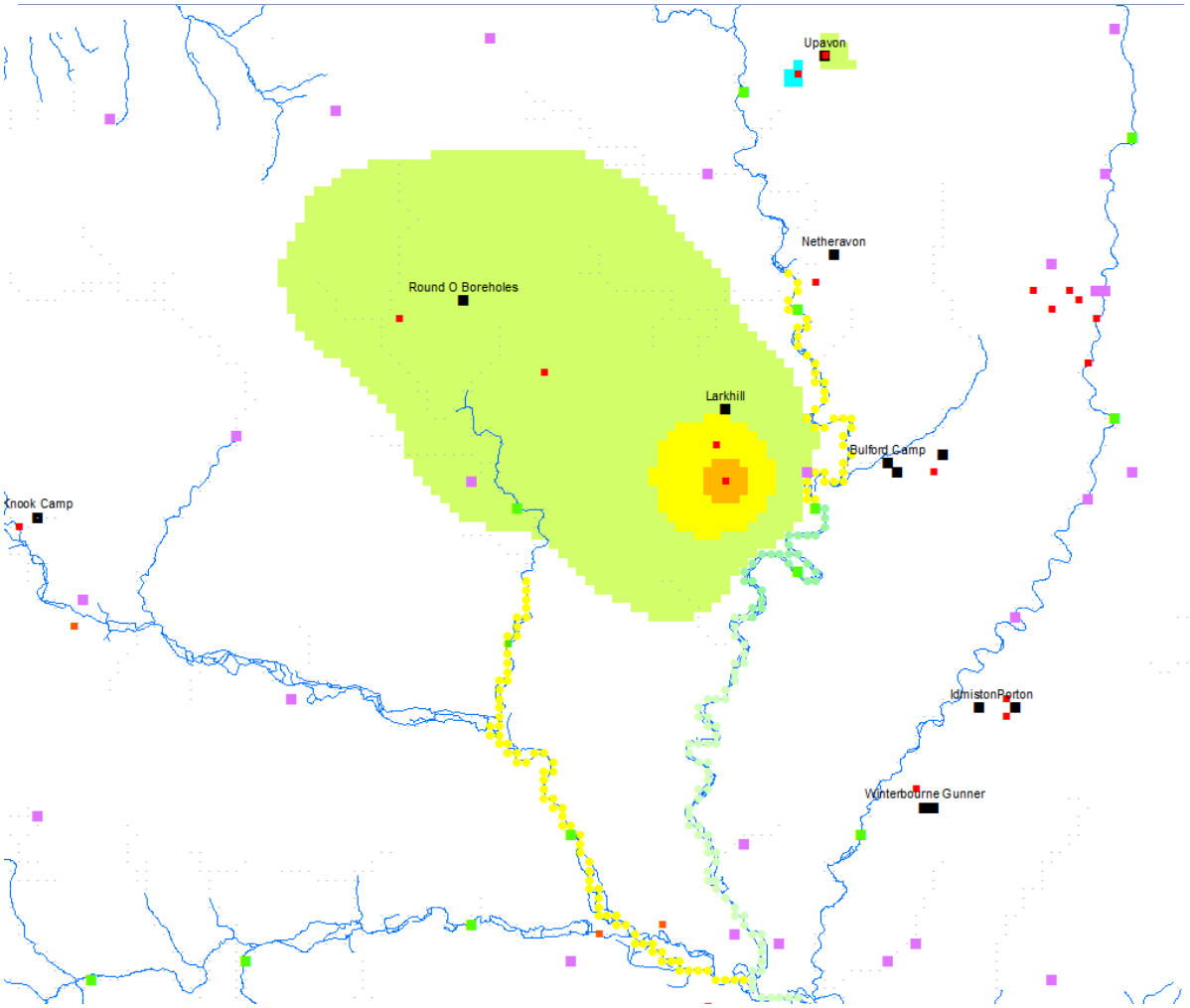
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 6 – Q95 Flow Impact and August 2003 Drawdown Impact of original Army Basing Scenario (Run 297) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Drawdown Key:

- < -1m
- -0.5m to -1m
- -0.1m to -0.5m
- -0.05m to -0.1m
- -0.01m to -0.05m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.1m
- 0.1m to 0.5m
- 0.5m to 1m

Flow Duration Statistics based on period 1970-2012

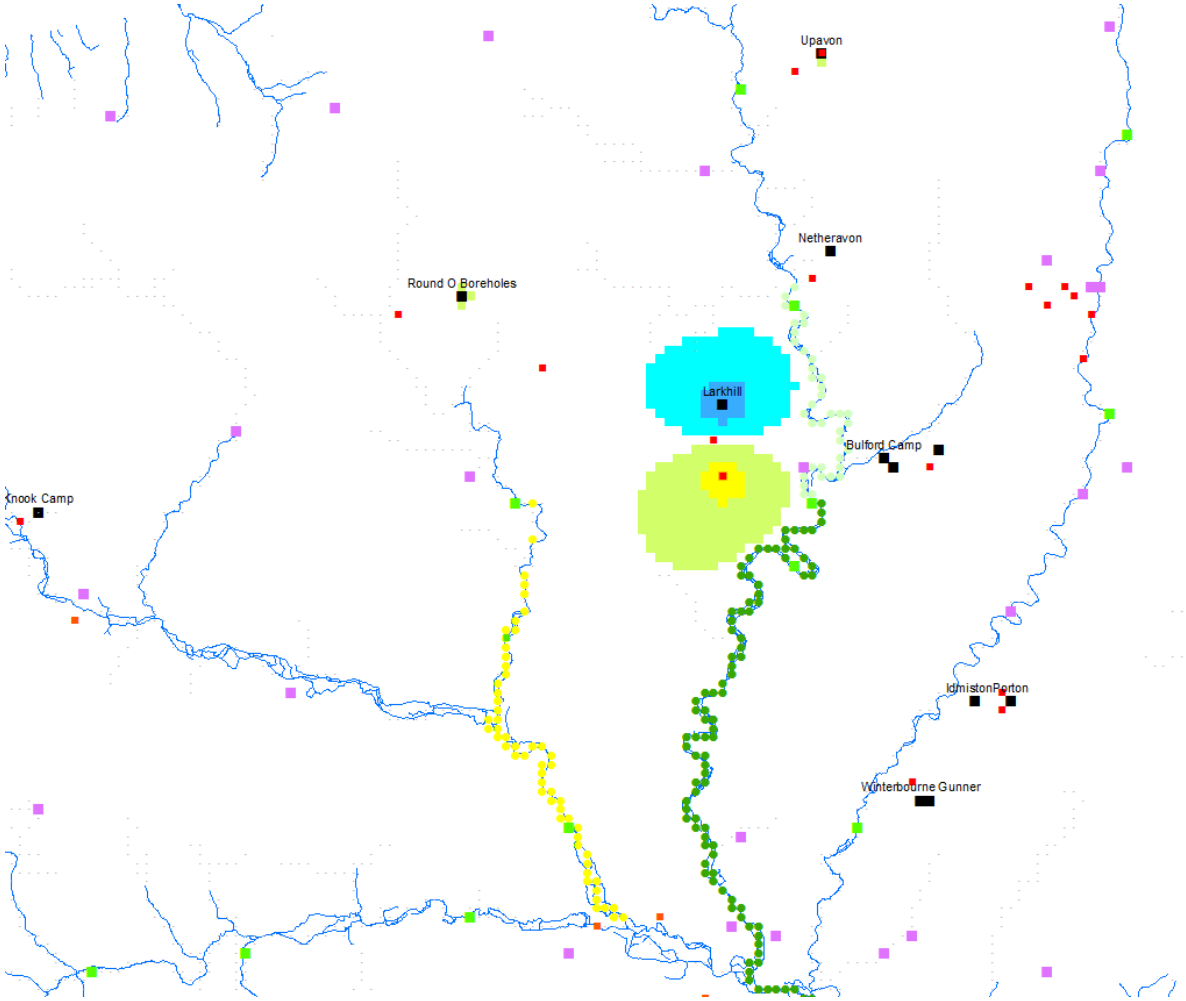
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 7 – Q30 Flow Impact and February 1995 Drawdown Impact of alternative Army Basing Scenario 1 (Run 307) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Drawdown Key:

- < -1m
- -0.5m to -1m
- -0.1m to -0.5m
- -0.05m to -0.1m
- -0.01m to -0.05m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.1m
- 0.1m to 0.5m
- 0.5m to 1m

Flow Duration Statistics based on period 1970-2012

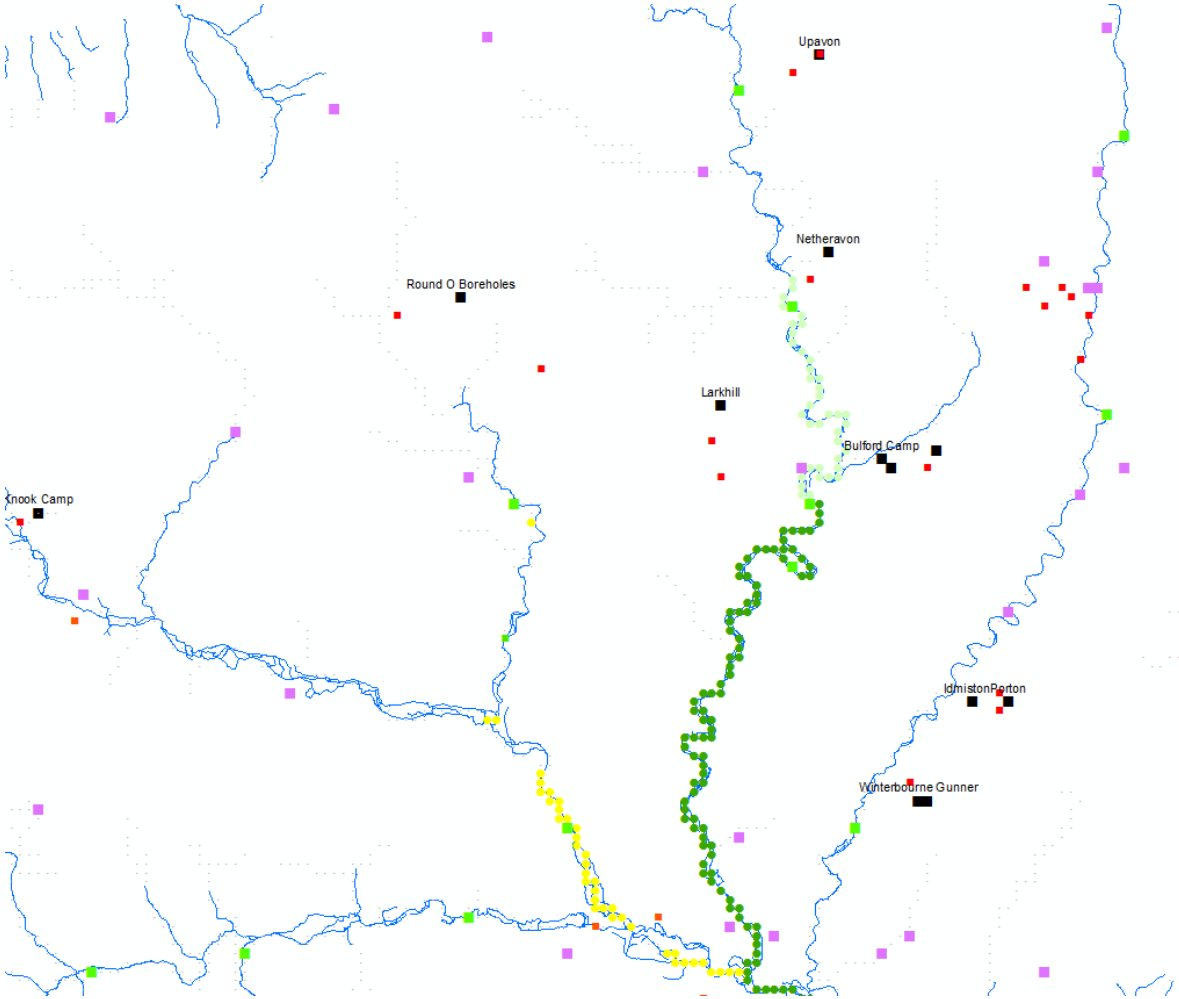
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 8 – Q50 Flow Impact of alternative Army Basing Scenario 1 (Run 307) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Flow Duration Statistics based on period 1970-2012

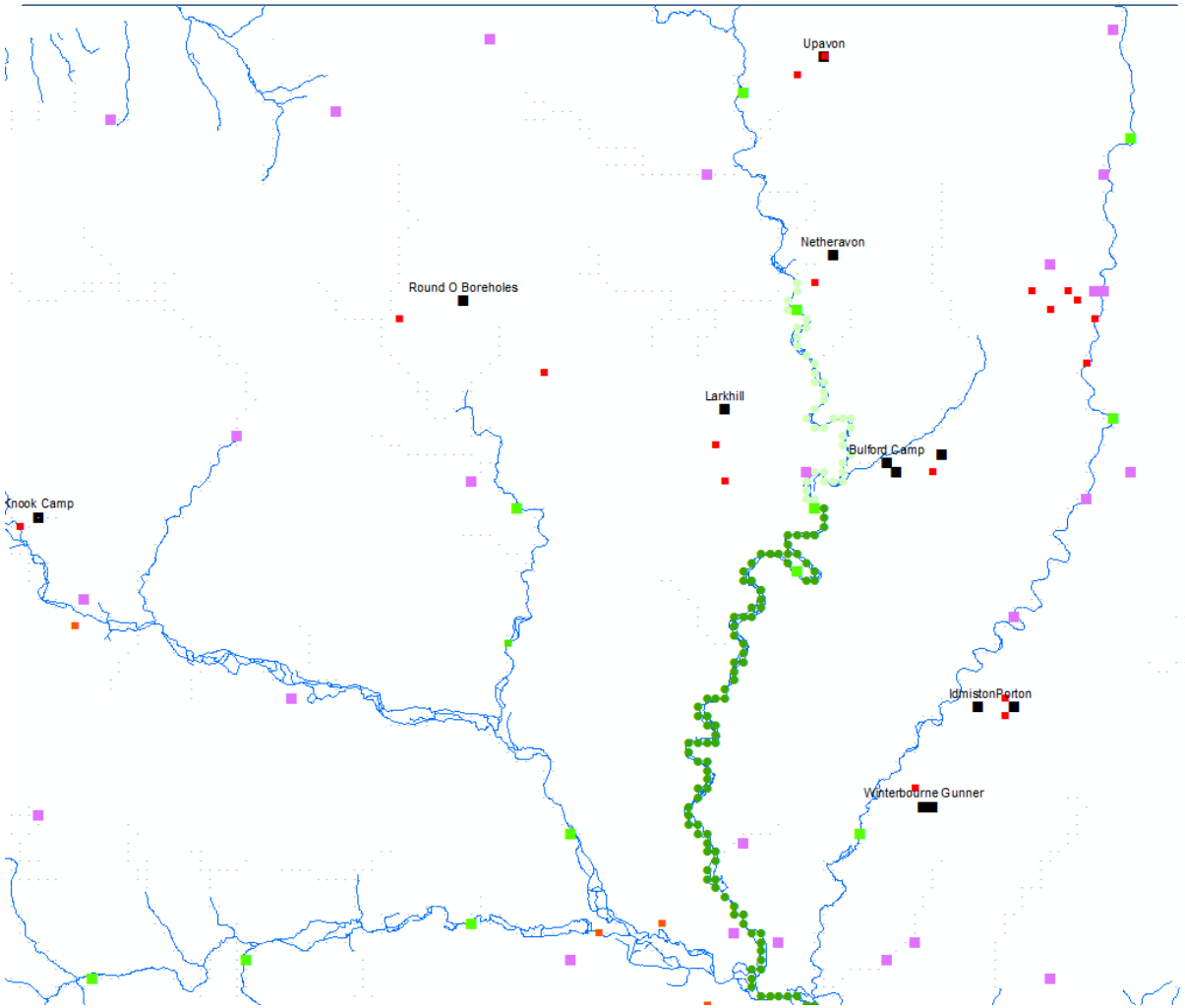
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 9 – Q70 Flow Impact of alternative Army Basing Scenario 1 (Run 307) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Flow Duration Statistics based on period 1970-2012

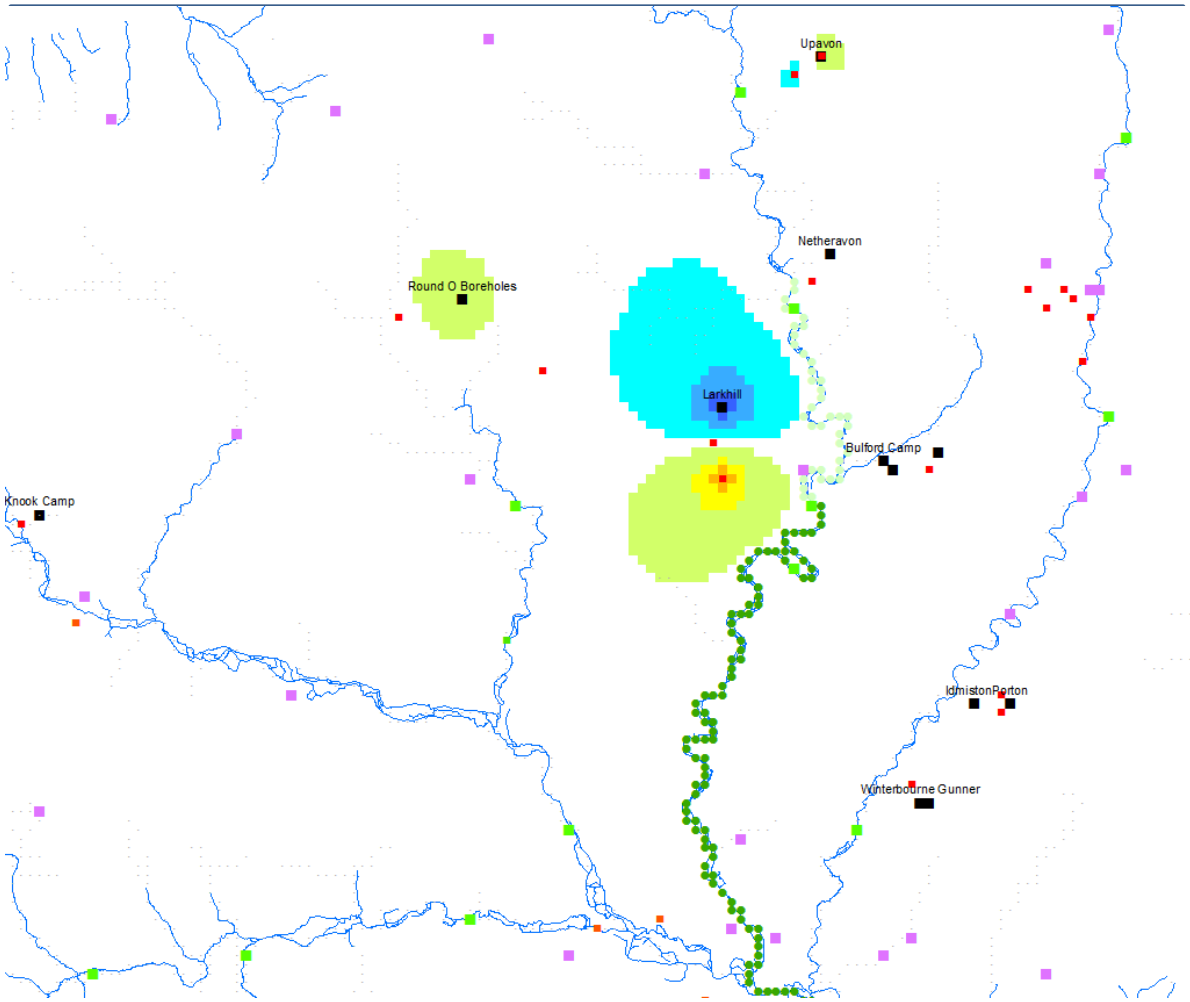
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 10 – Q95 Flow Impact and August 2003 Drawdown Impact of alternative Army Basing Scenario 1 (Run 307) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Drawdown Key:

- < -1m
- -0.5m to -1m
- -0.1m to -0.5m
- -0.05m to -0.1m
- -0.01m to -0.05m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.1m
- 0.1m to 0.5m
- 0.5m to 1m

Flow Duration Statistics based on period 1970-2012

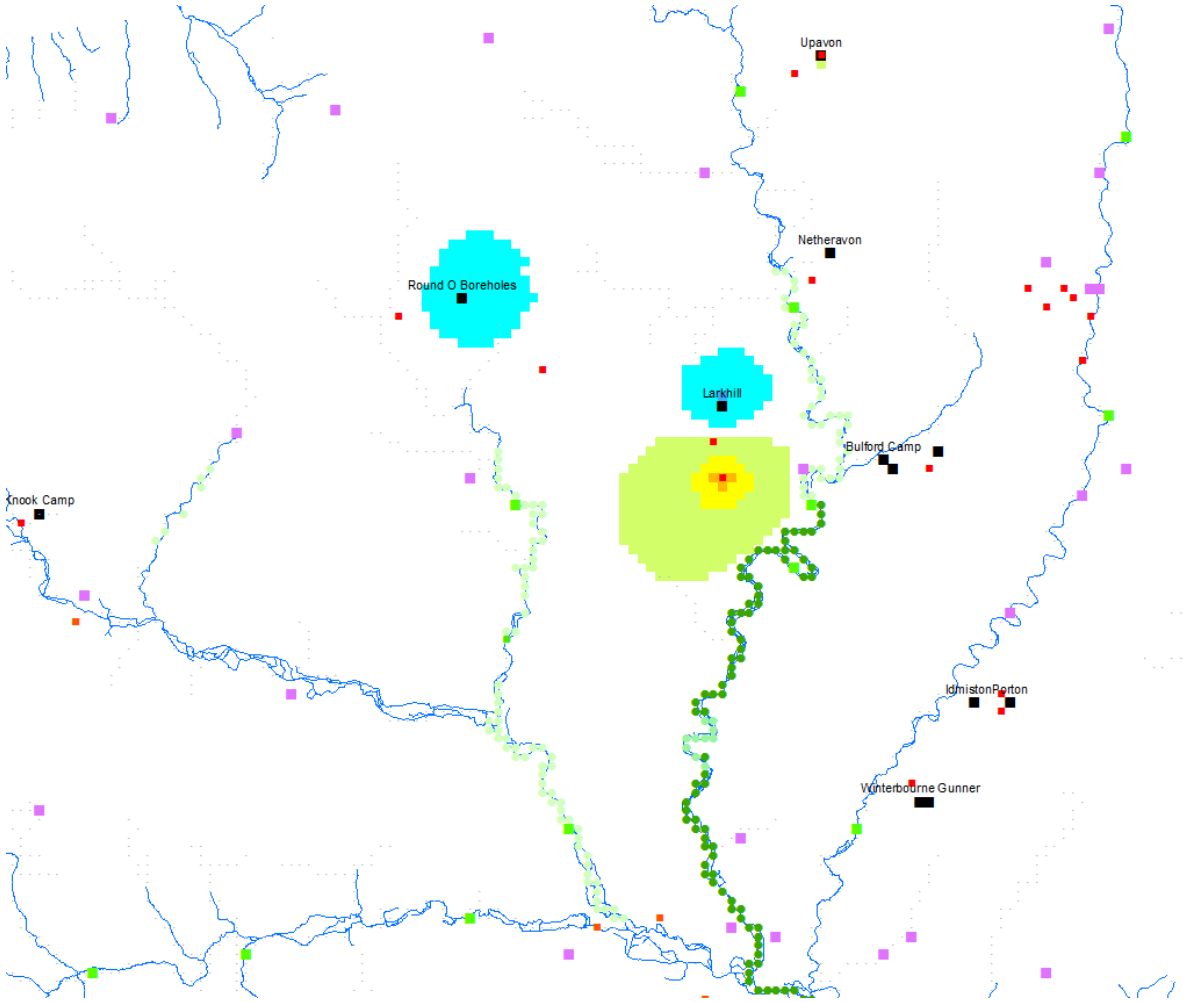
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 11 – Q30 Flow Impact and February 1995 Drawdown Impact of alternative Army Basing Scenario 2 (Run 308) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Drawdown Key:

- < -1m
- -0.5m to -1m
- -0.1m to -0.5m
- -0.05m to -0.1m
- -0.01m to -0.05m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.1m
- 0.1m to 0.5m
- 0.5m to 1m

Flow Duration Statistics based on period 1970-2012

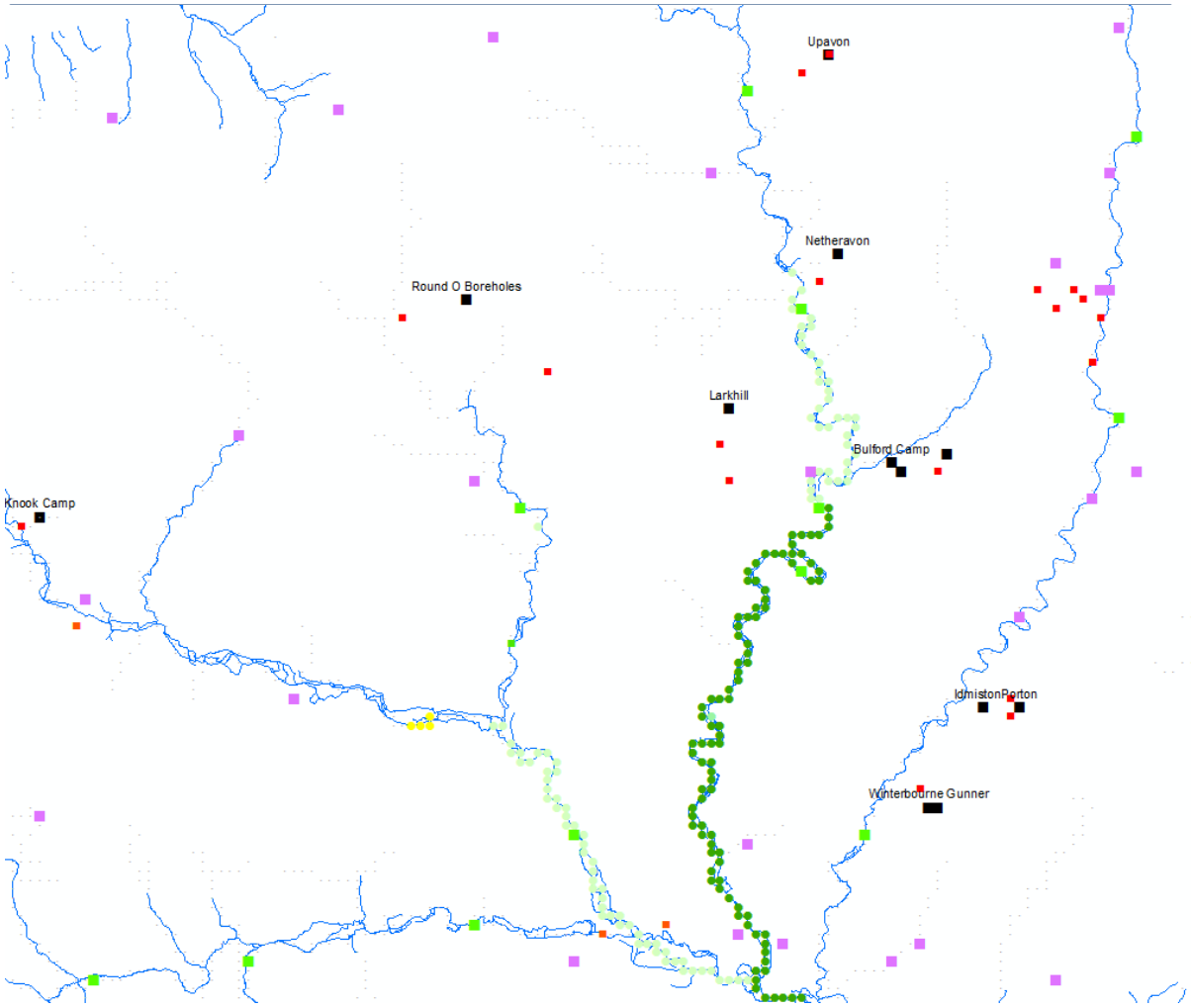
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 12– Q50 Flow Impact of alternative Army Basing Scenario 2 (Run 308) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Flow Duration Statistics based on period 1970-2012

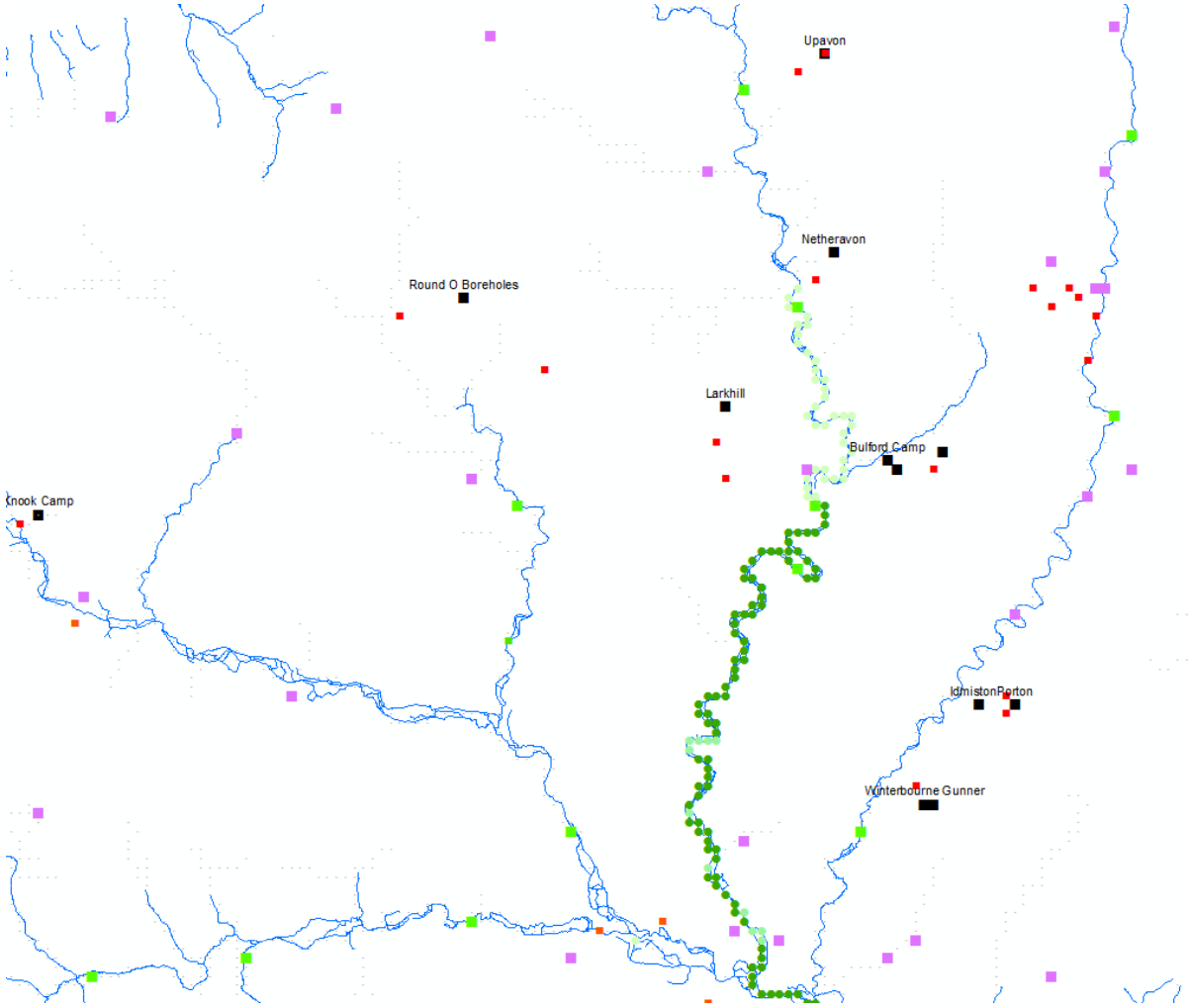
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 13– Q70 Flow Impact of alternative Army Basing Scenario 2 (Run 308) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Flow Duration Statistics based on period 1970-2012

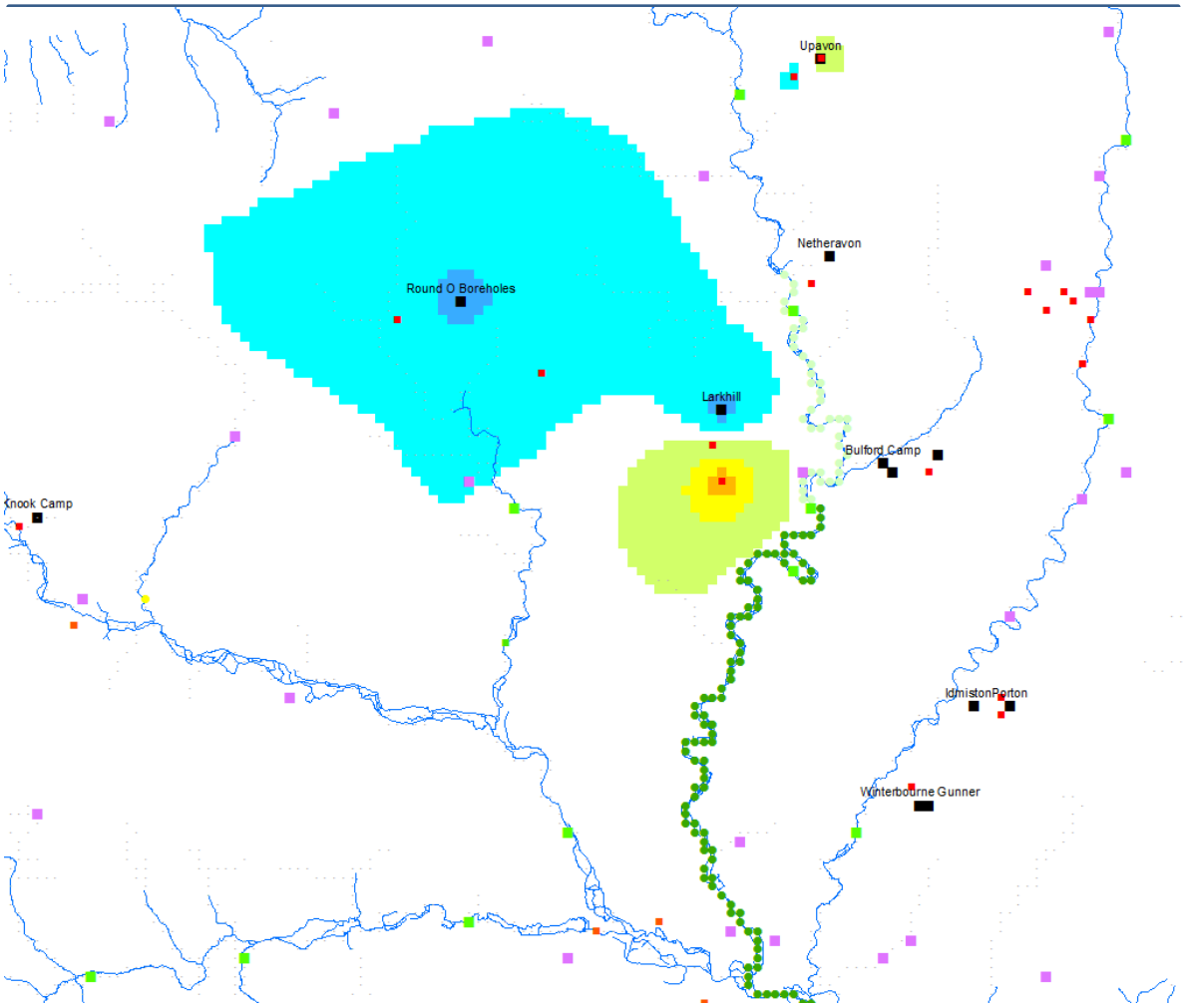
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

Water Company Abstractions Discharges in Pink

Figure 14 – Q95 Flow Impact and August 2003 Drawdown Impact of alternative Army Basing Scenario 2 (Run 308) compared with Full Licence Scenario (Run 296)



Flow Impact Key:

- > 1000 Ml/d
- 500 to 1000 Ml/d
- 200 to 500 Ml/d
- 100 to 200 Ml/d
- 5 to 100 Ml/d
- 3 to 5 Ml/d
- 2.5 to 3 Ml/d
- 2 to 2.5 Ml/d
- 1.5 to 2 Ml/d
- 1 to 1.5 Ml/d
- 0.5 to 1 Ml/d
- 0.05 to 0.5 Ml/d
- Negligible Impact
- -0.05 to -0.5 Ml/d
- -0.5 to -1 Ml/d
- -1 to -1.5 Ml/d
- -1 to -2 Ml/d
- -2 to -2.5 Ml/d
- -2 to -3 Ml/d
- -3 to -4 Ml/d
- -5 to -200 Ml/d
- -200 to -500 Ml/d
- -500 to -1000 Ml/d
- Nat Flow <20m3/d

Drawdown Key:

- < -1m
- -0.5m to -1m
- -0.1m to -0.5m
- -0.05m to -0.1m
- -0.01m to -0.05m
- -0.01m to 0.01m
- 0.01m to 0.05m
- 0.05m to 0.1m
- 0.1m to 0.5m
- 0.5m to 1m

Flow Duration Statistics based on period 1970-2012

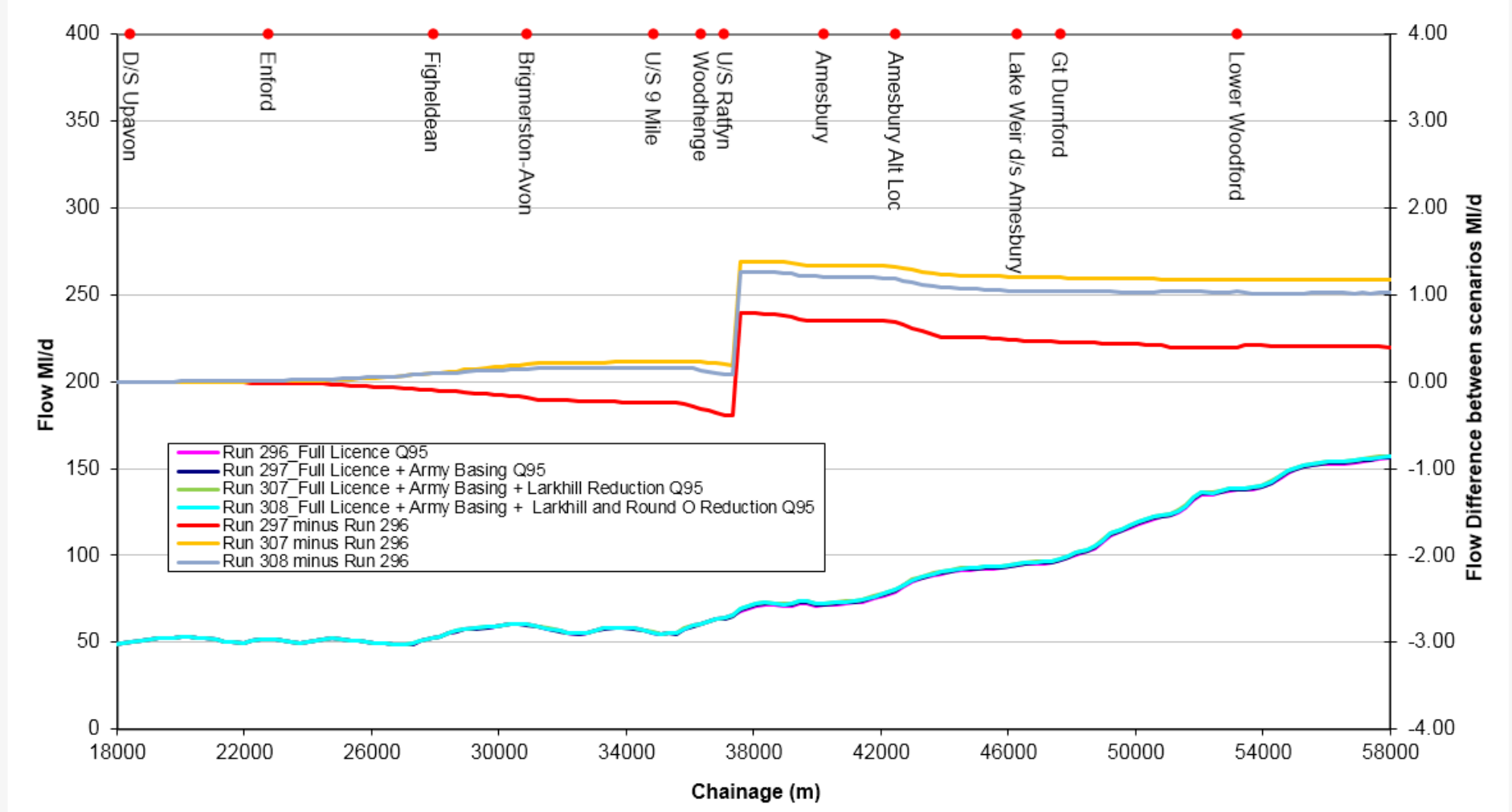
MoD Abstractions in Black

MoD Leakage and GW Discharges in Red

Water Company STW Discharges in Green

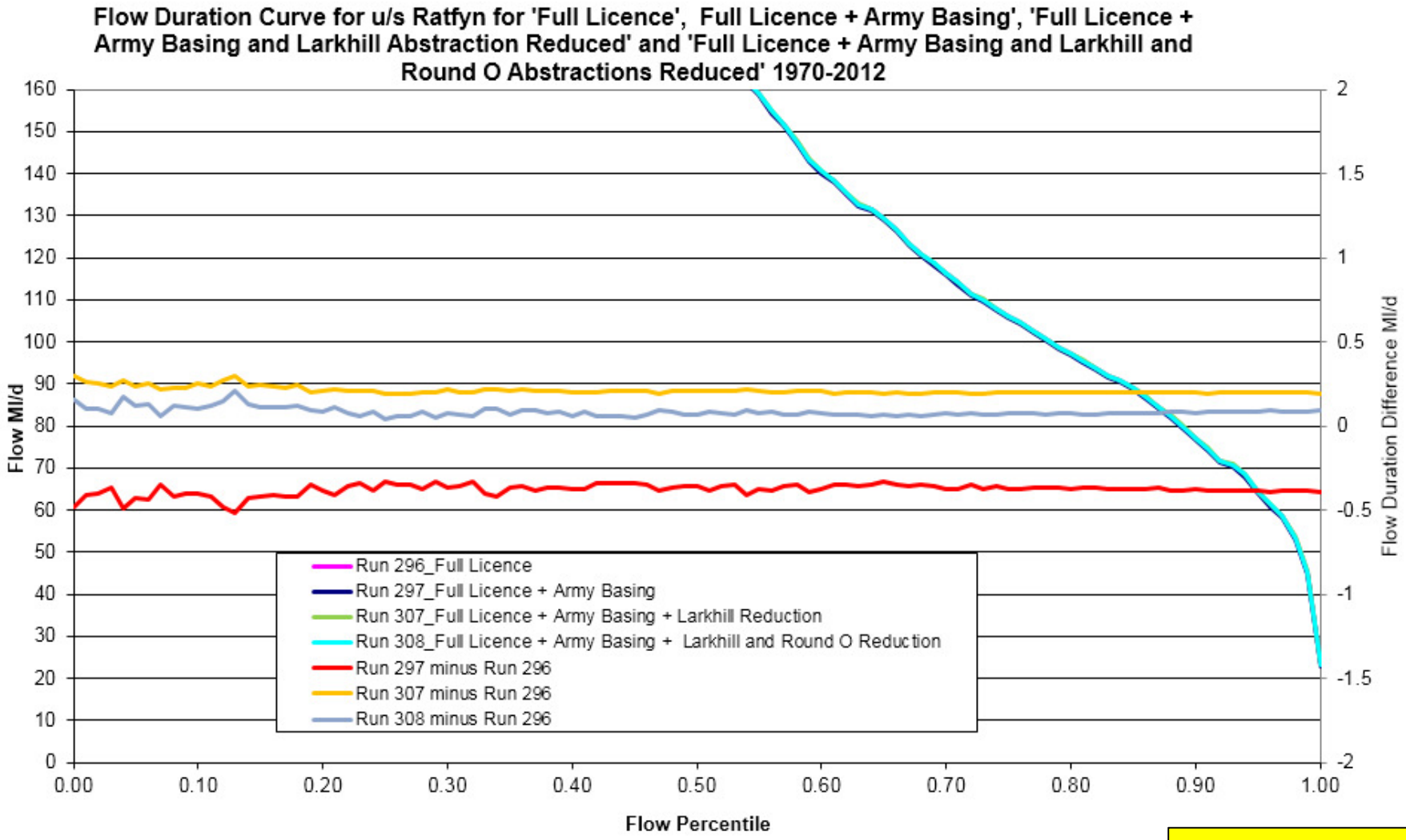
Water Company Abstractions Discharges in Pink

Figure 15 – Accretion Profile down the Avon at Q95 for different scenarios



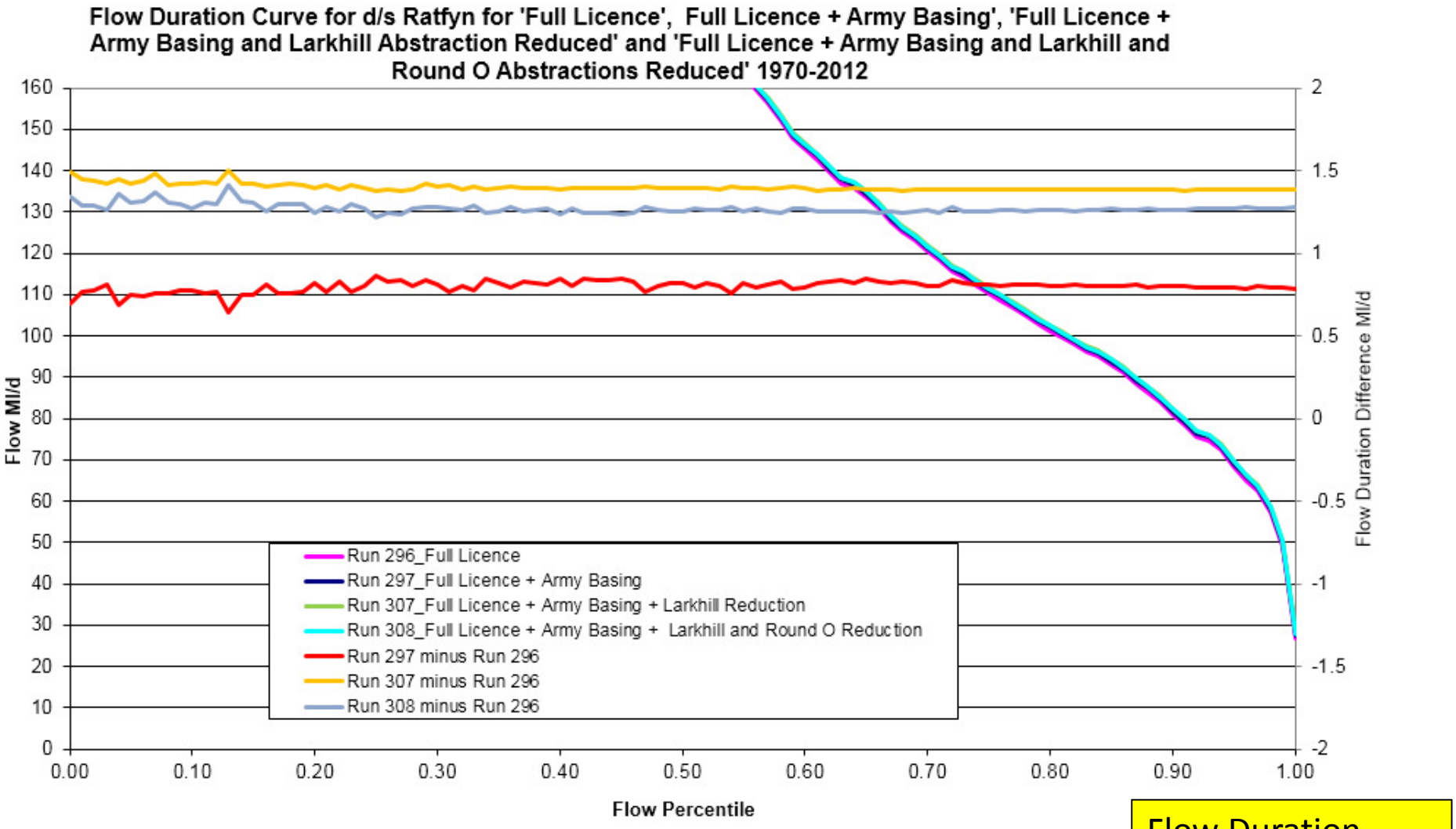
Flow Duration Statistics based on period 1970-2012

Figure 16 – Flow Duration Curve for the Avon u/s Ratfyn STW



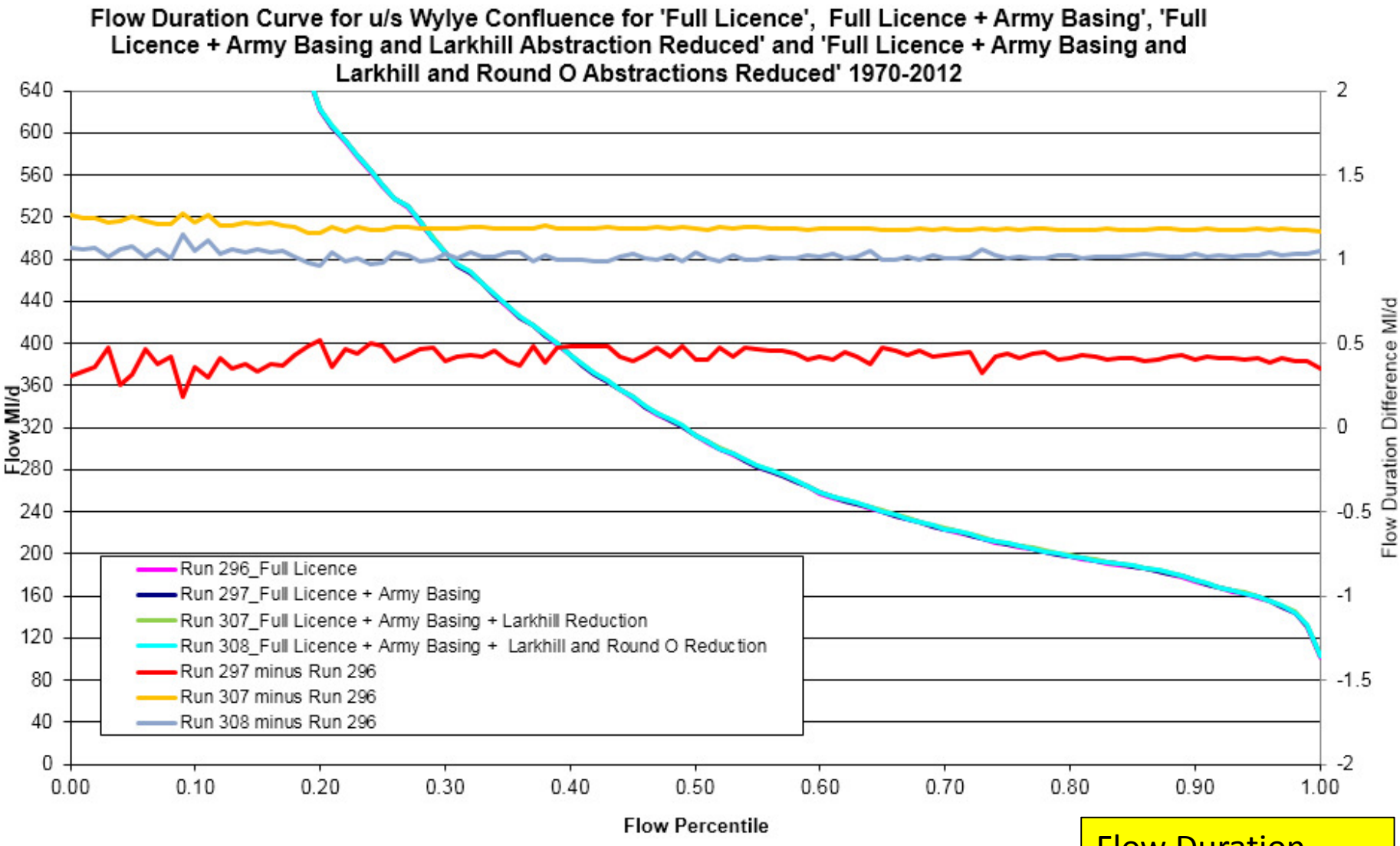
Flow Duration Statistics based on period 1970-2012

Figure 17 – Flow Duration Curve for the Avon d/s Ratfyn STW



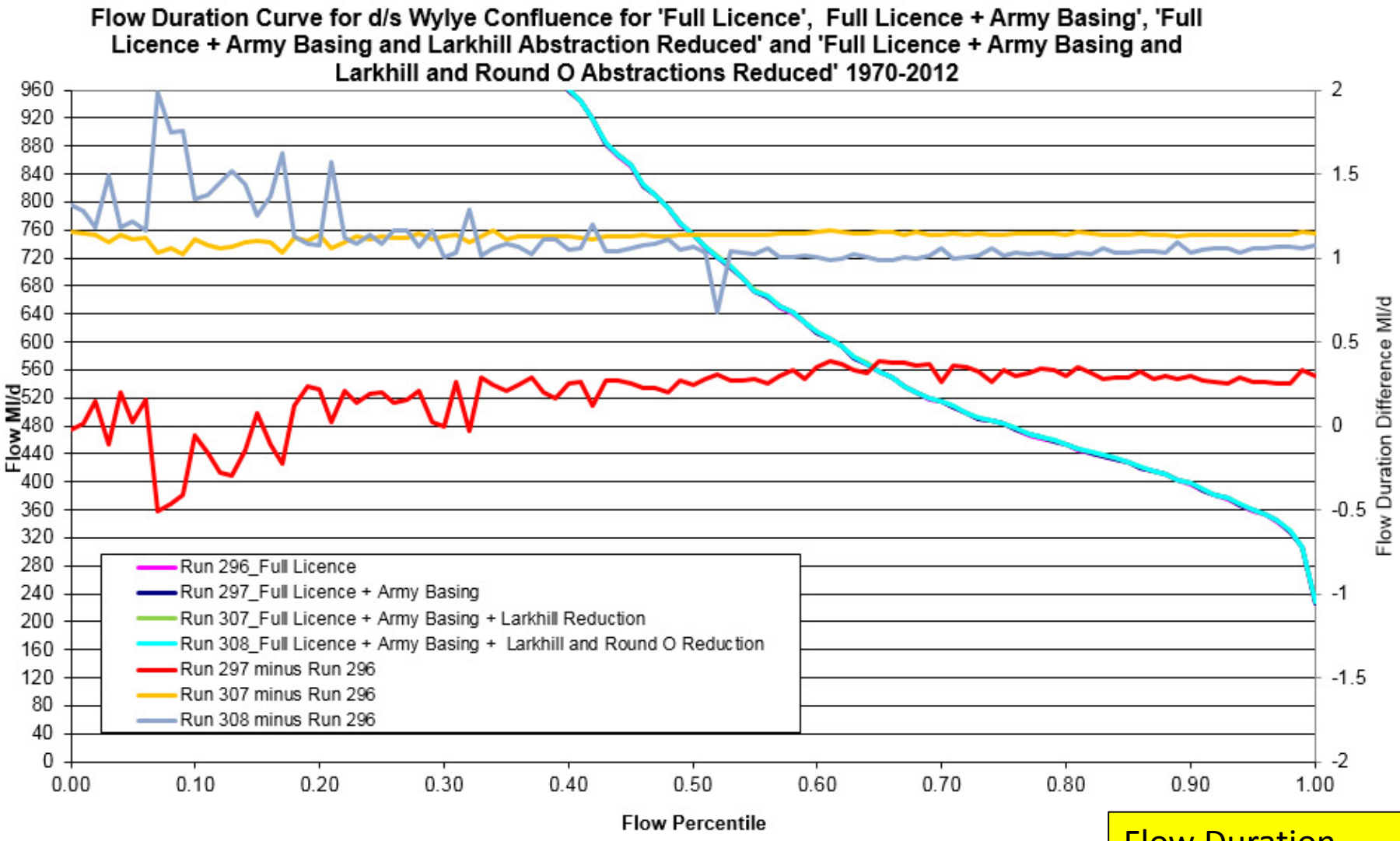
Flow Duration Statistics based on period 1970-2012

Figure 18 – Flow Duration Curve for the Avon u/s Wylye Confluence



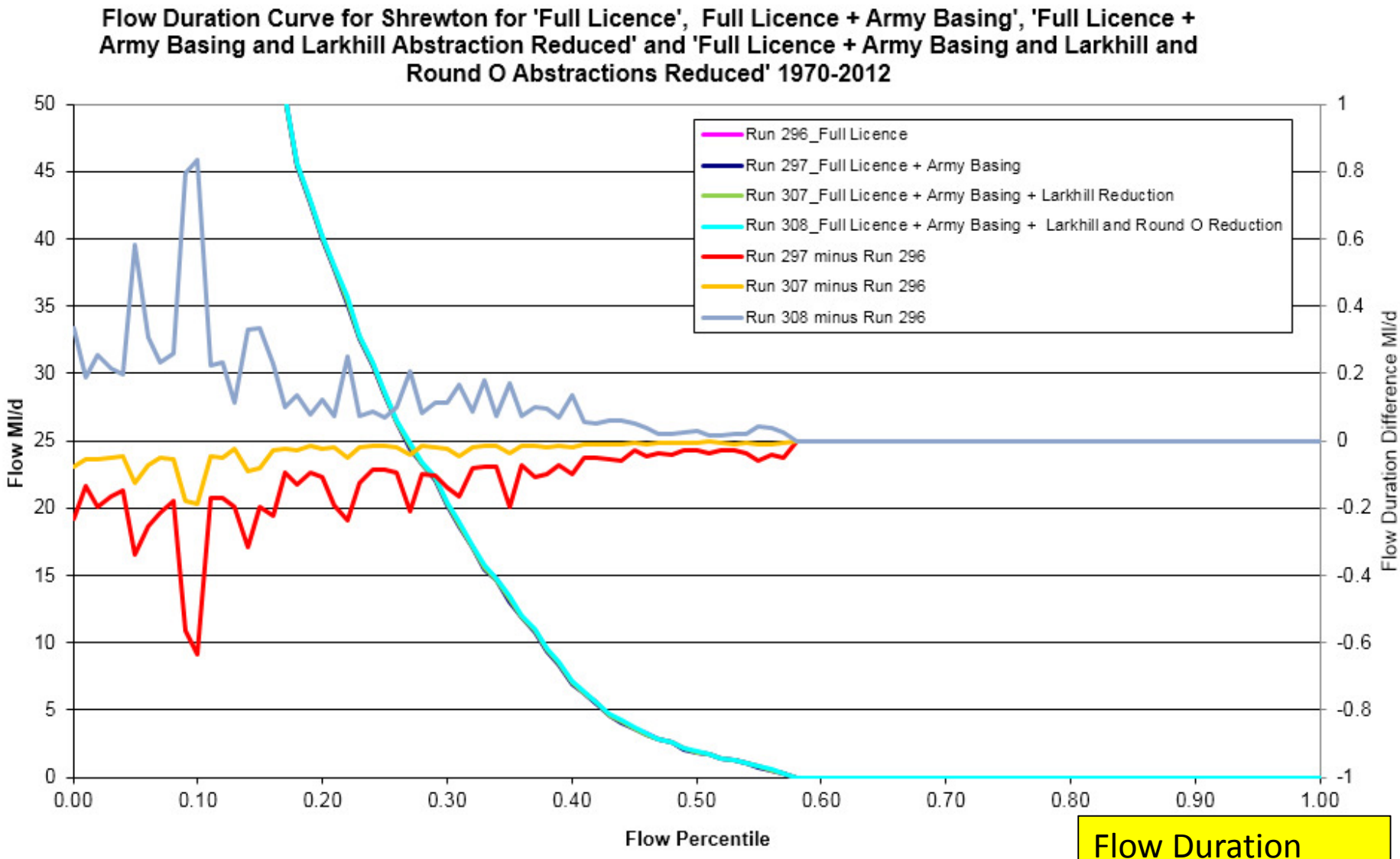
Flow Duration Statistics based on period 1970-2012

Figure 19 – Flow Duration Curve for the Avon d/s Wylye Confluence



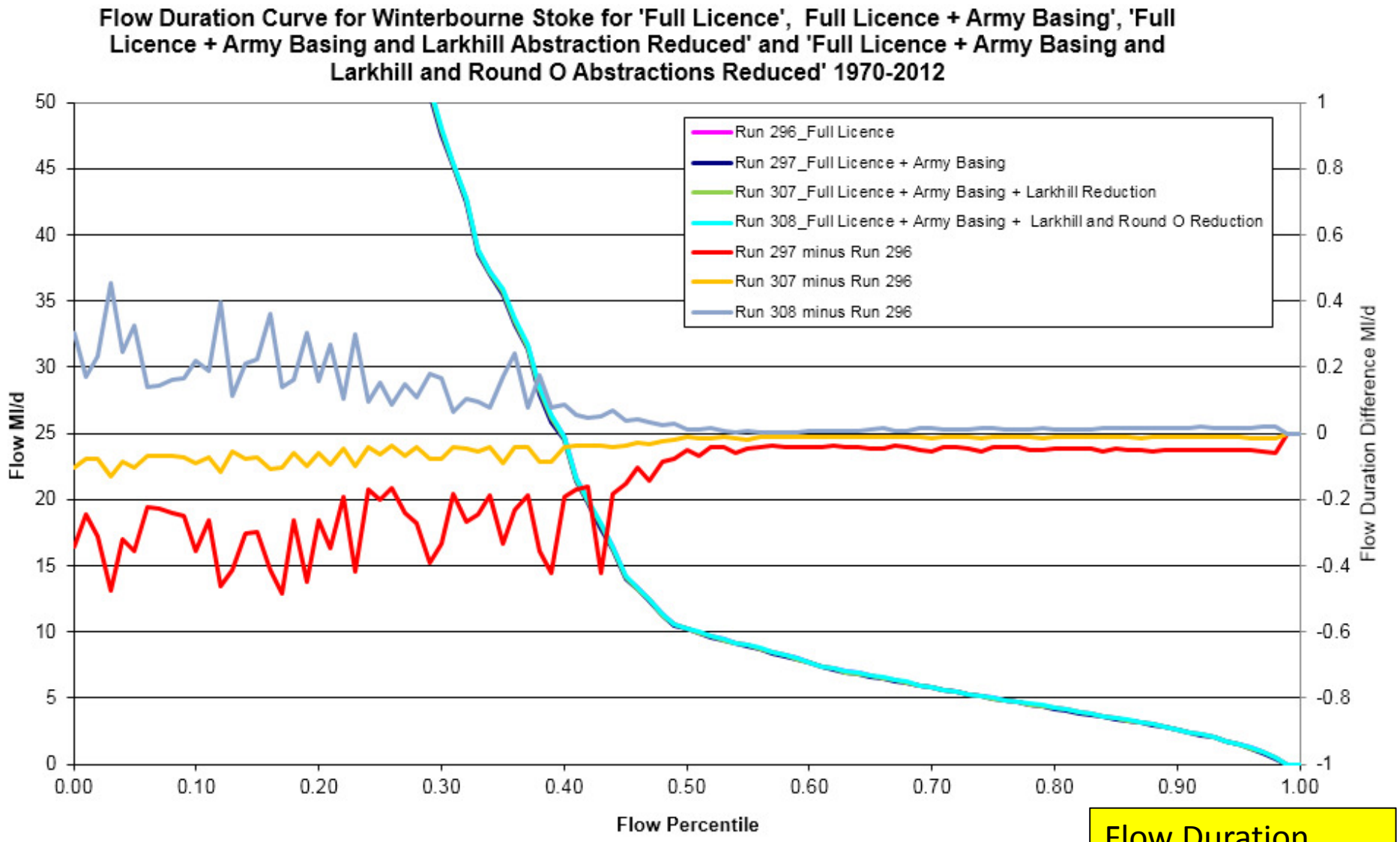
Flow Duration Statistics based on period 1970-2012

Figure 20 – Flow Duration Curve for the Till at Shrewton



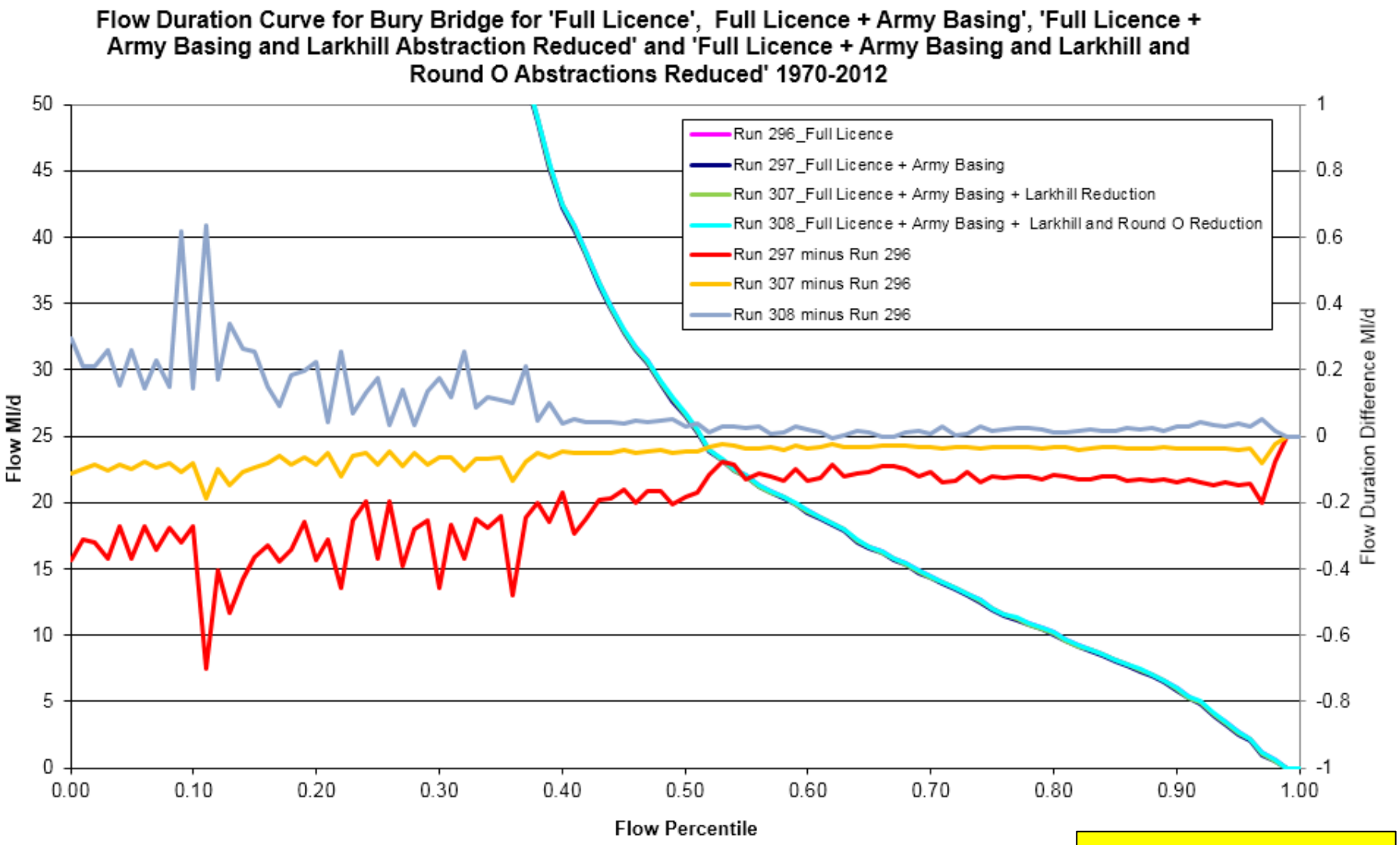
Flow Duration Statistics based on period 1970-2012

Figure 21 – Flow Duration Curve for the Till at Winterbourne Stoke



Flow Duration Statistics based on period 1970-2012

Figure 22 – Flow Duration Curve for the Till at Bury Bridge



Flow Duration Statistics based on period 1970-2012

APPENDIX D FLOOD MAPS

APPENDIX D – ENVIRONMENT AGENCY FLOOD MAPS

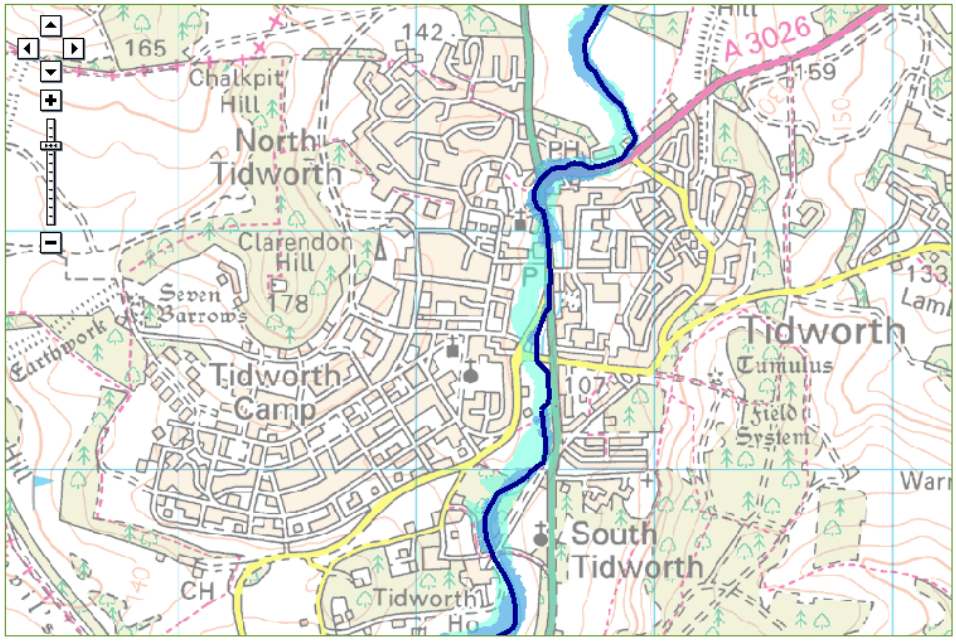


Figure D-1 – Extract of Flood Map for Planning for Tidworth Garrison, Environment Agency.

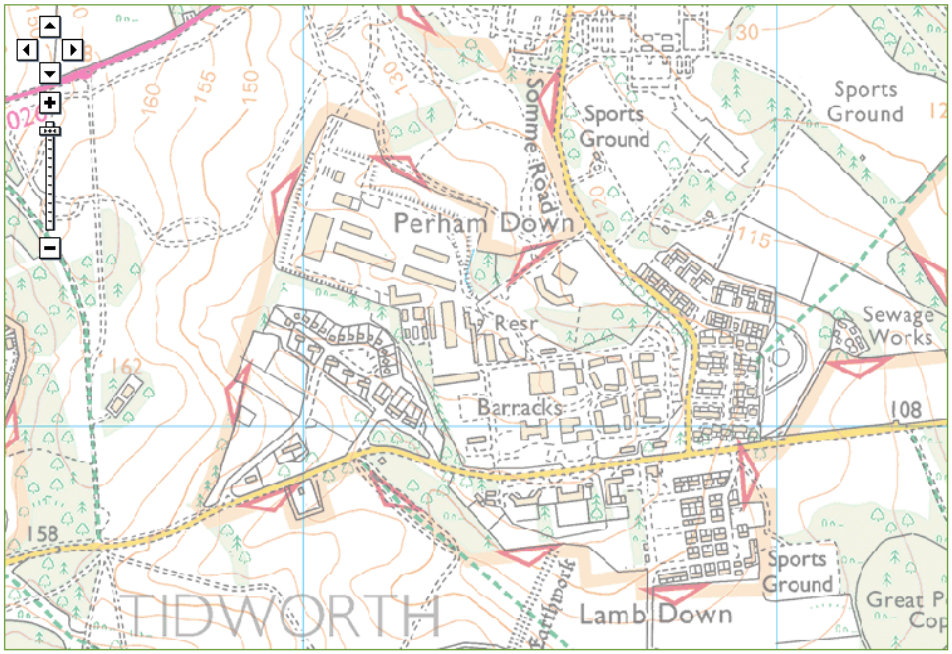


Figure D-2 – Extract of Flood Map for Planning for Perham Down, Environment Agency.

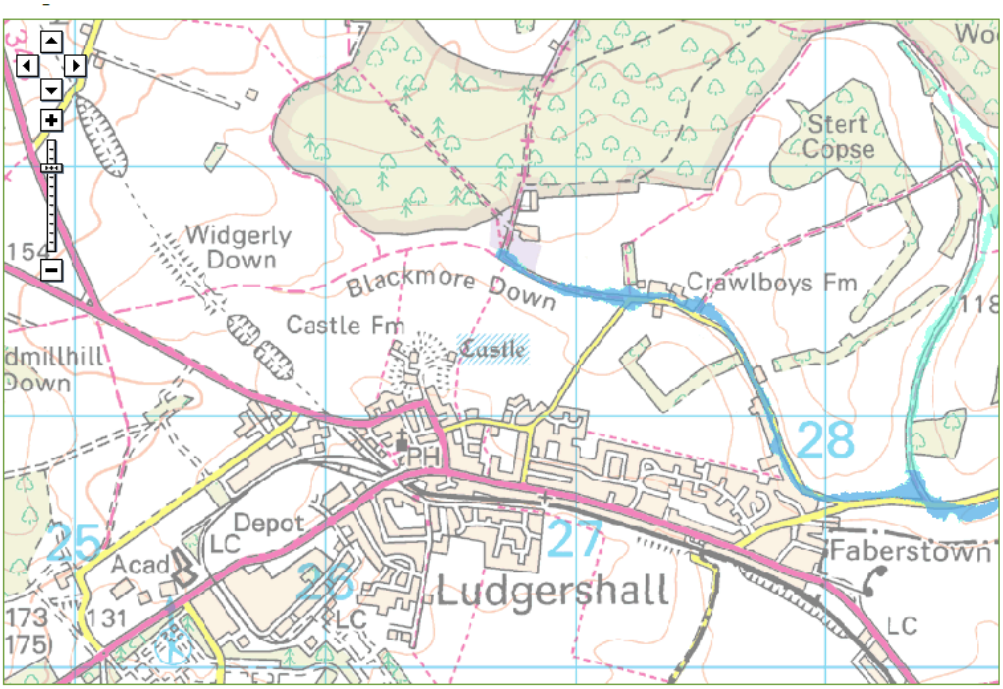


Figure D-3 – Extract of Flood Map for Planning for Ludgershall Garrison, Environment Agency.

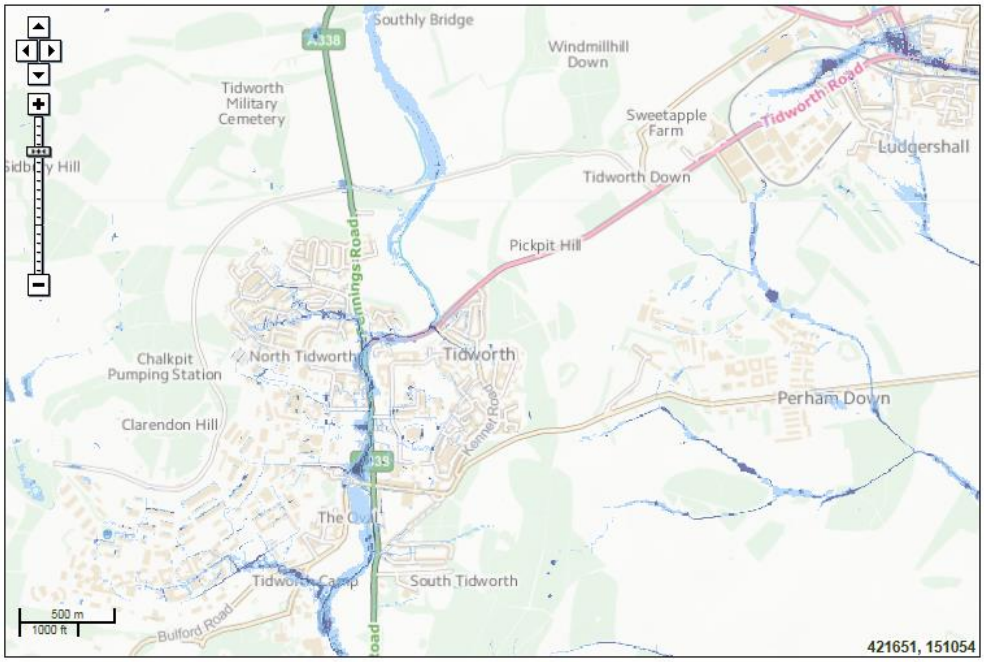


Figure D-4 – Extract of Risk of Flooding from Surface Water Map for Tidworth, Environment agency.

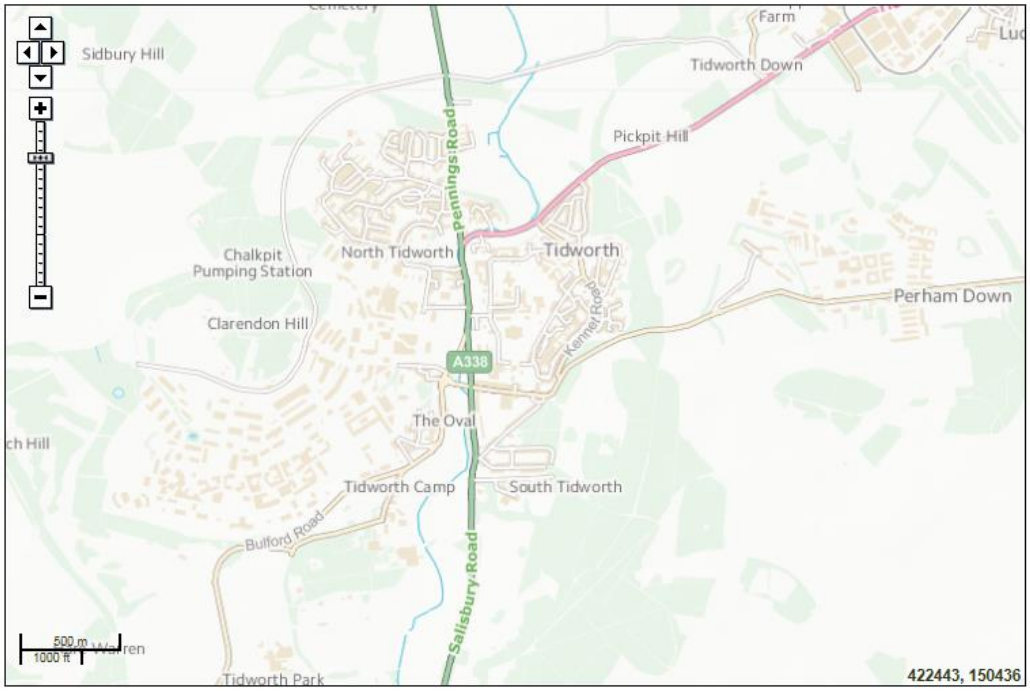


Figure D-5 – Extract of Risk of Flooding from Reservoirs Map for Tidworth Garrison, Environment Agency.

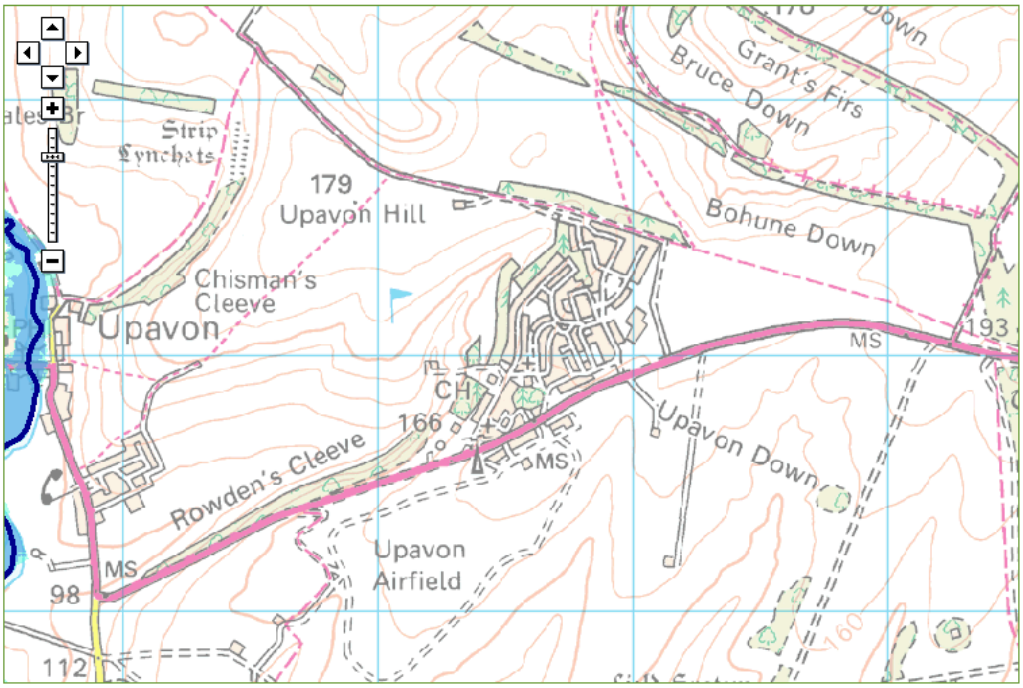


Figure D-6 – Extract of Flood Map for Planning for Upavon Camp, Environment Agency.

Figure D-7 – Extract of Risk of Flooding from Surface Water Map for Upavon Camp, Environment Agency.

Figure D-8 – Extract of Risk of Flooding from Reservoirs Map for Upavon Camp, Environment Agency.

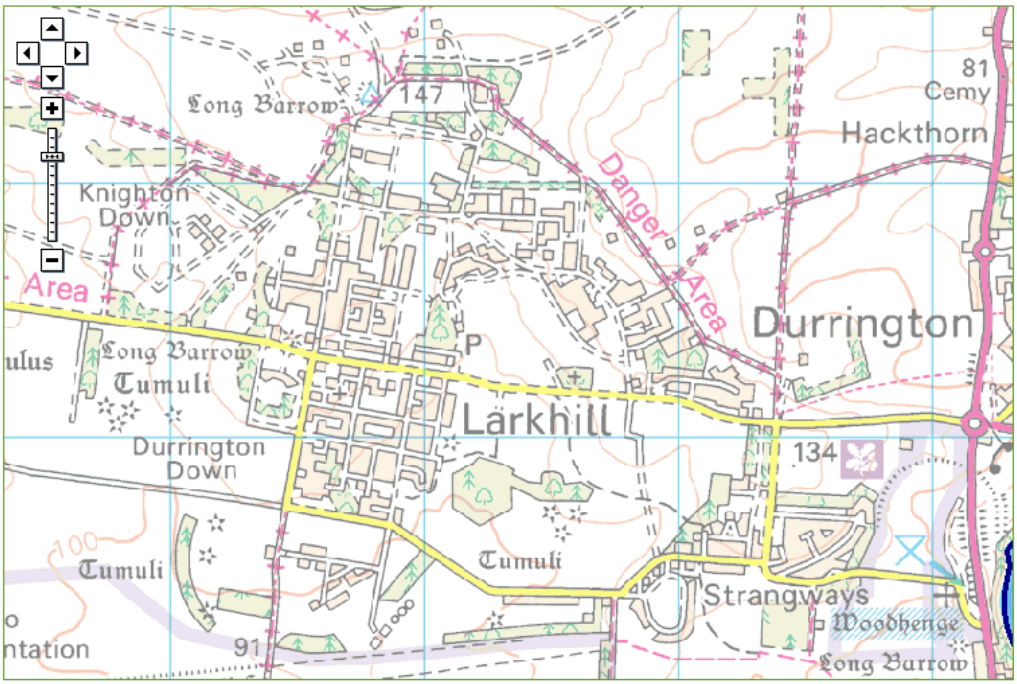


Figure D-9 – Extract of Flood Map for Planning for Larkhill Camp, Environment Agency.

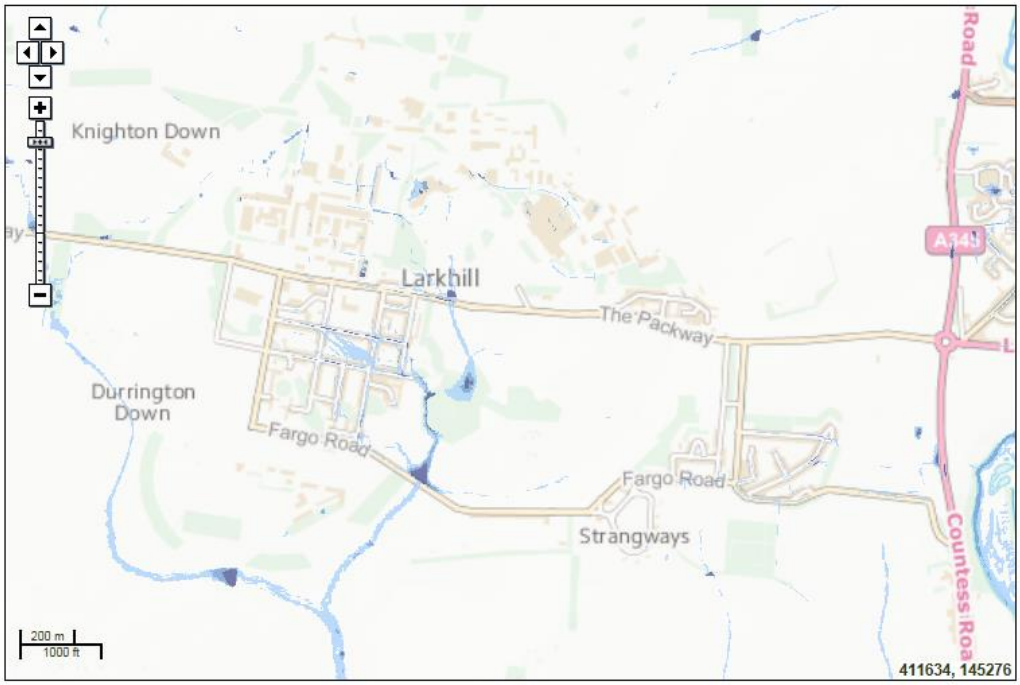


Figure D-10 – Extract of Risk of Flooding from Surface Water Map for Larkhill Camp, Environment Agency.

Figure D-11 – Extract of Risk of Flooding from Reservoirs Map for Larkhill Camp, Environment Agency.

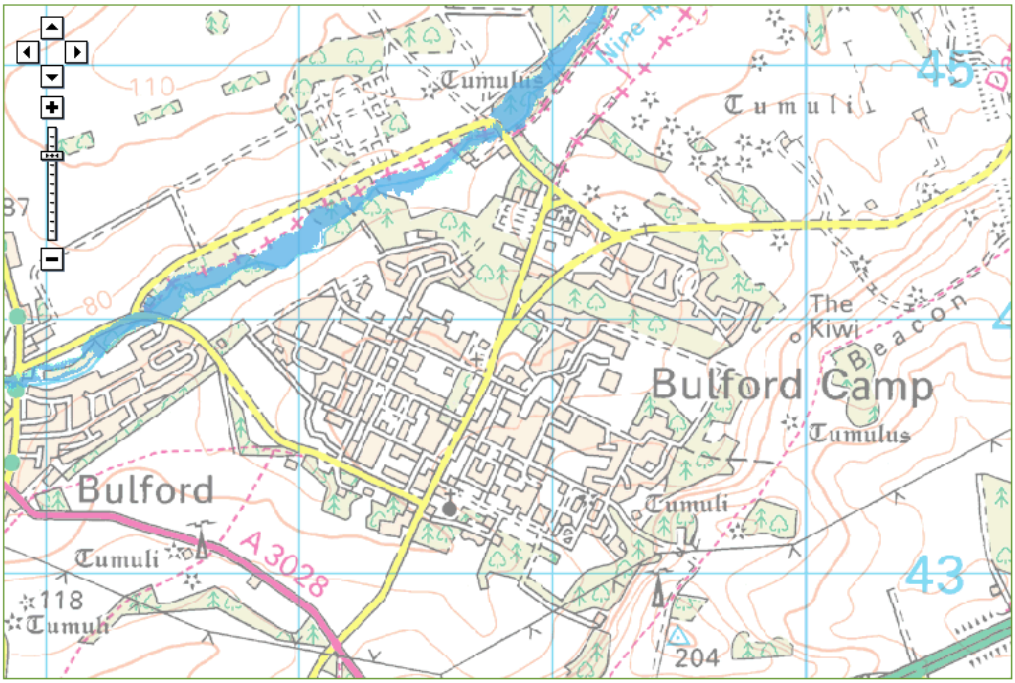


Figure D-12 – Extract of Flood Map for Planning for Bulford Camp, Environment Agency.

Figure D-13 – Extract of Risk of Flooding from Surface Water Map for Bulford Camp, Environment Agency.

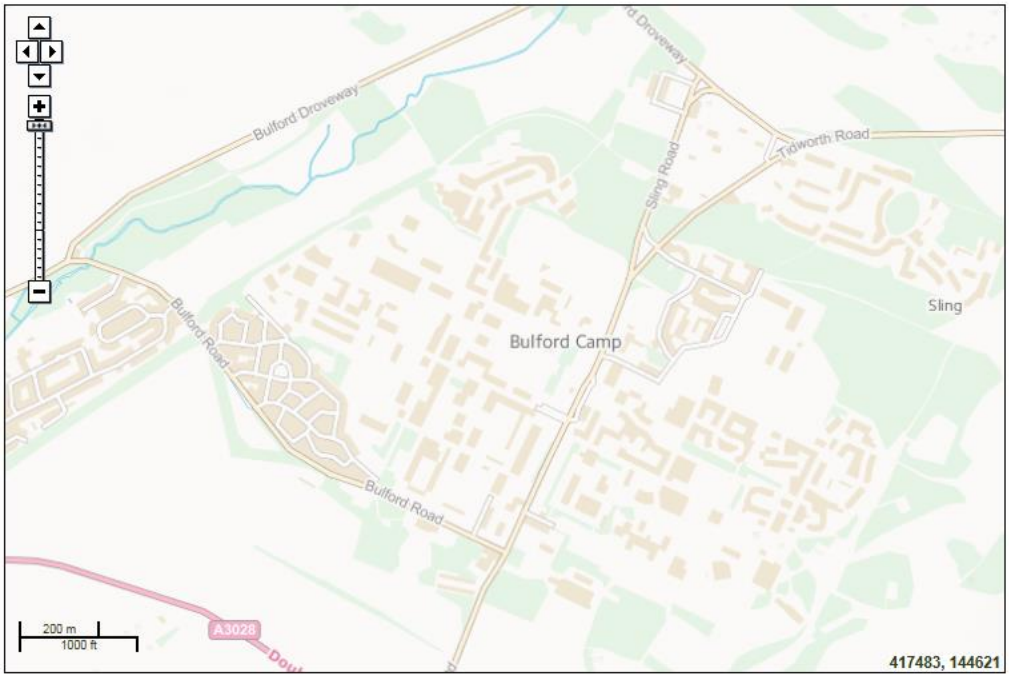


Figure D-14 – Extract of Risk of Flooding from Reservoirs Map for Bulford Camp, Environment Agency

APPENDIX E WATER LEVEL GRAPHS

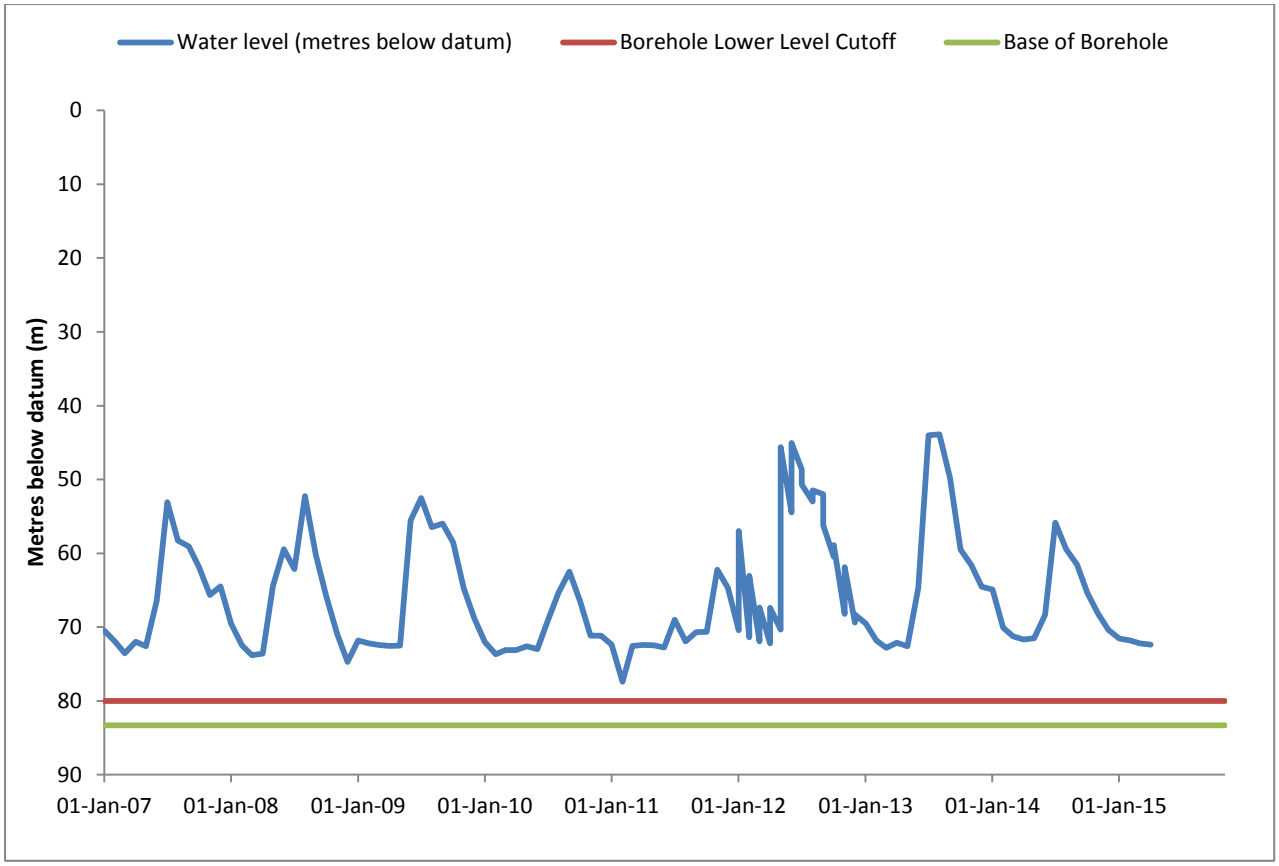


Figure 1 – Round O BH10 operational water level time series and borehole levels.

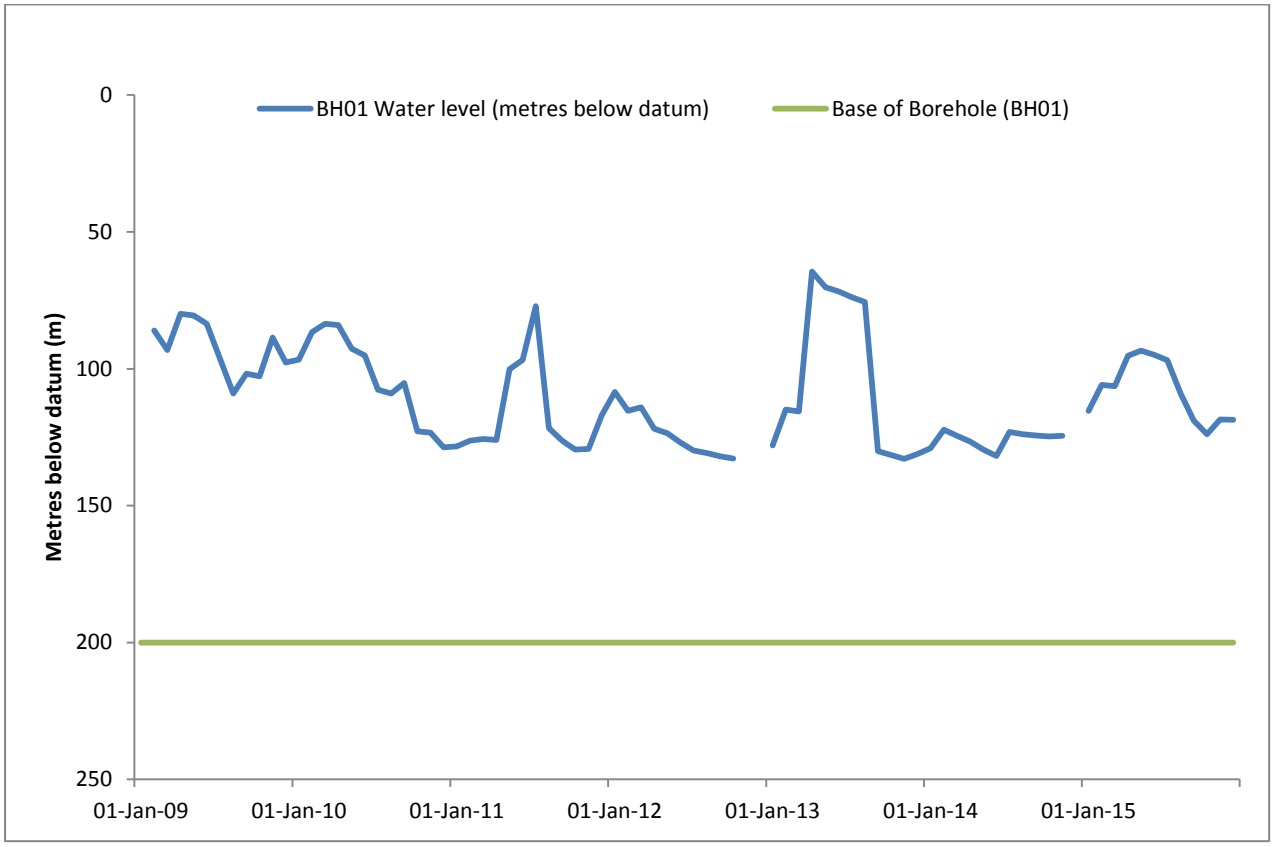


Figure 2 – Larkhill BH01 operational water level time series and borehole levels.

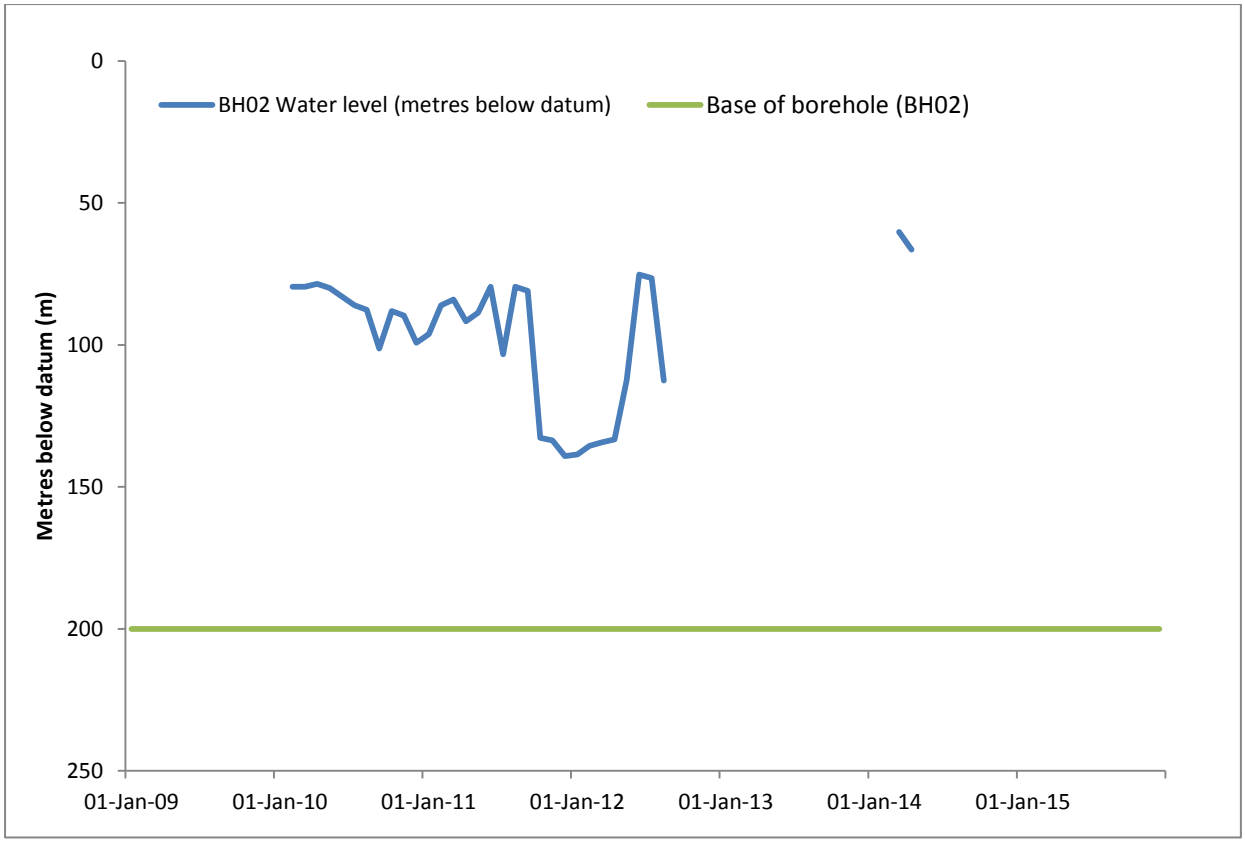


Figure 3 - Larkhill BH02 operational water level time series and borehole levels.

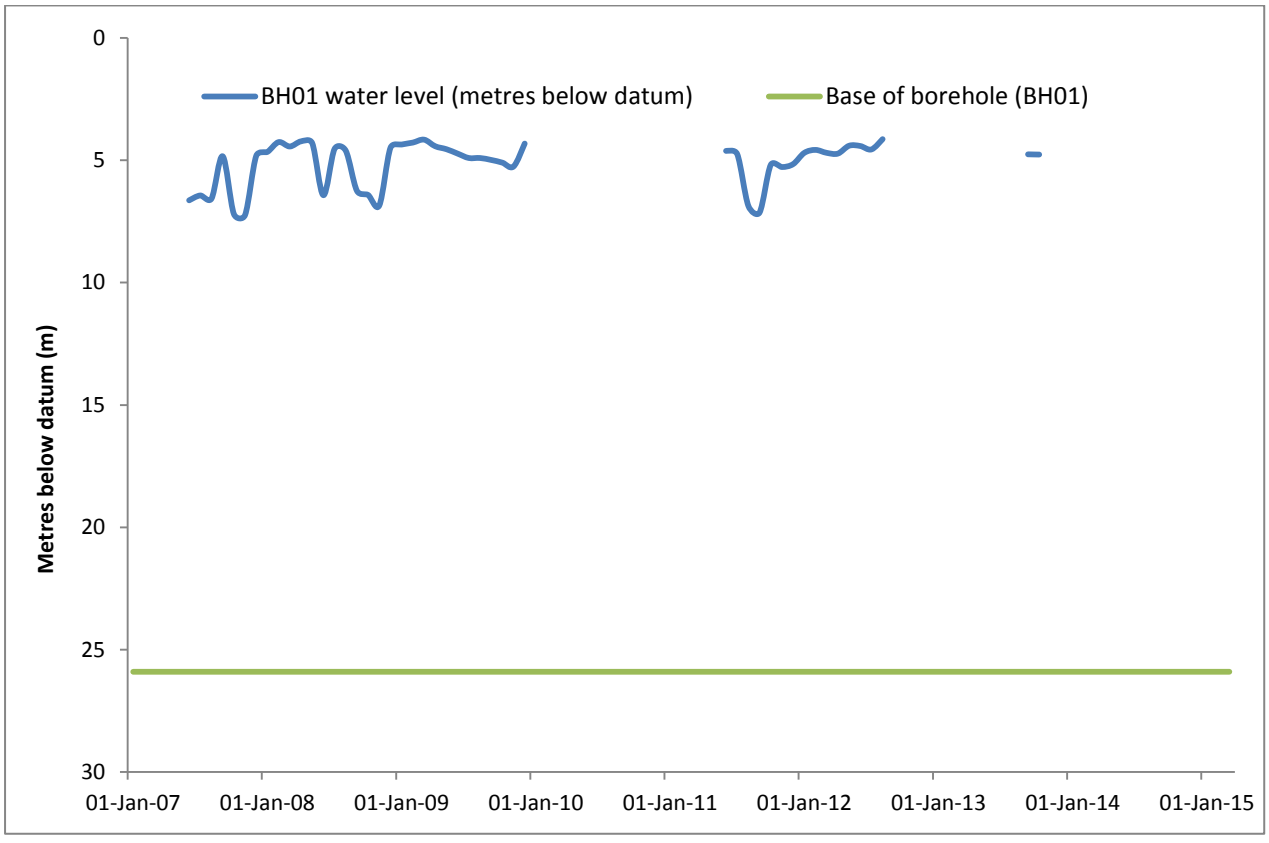


Figure 4 - Bulford BH01 operational water level time series and borehole levels.

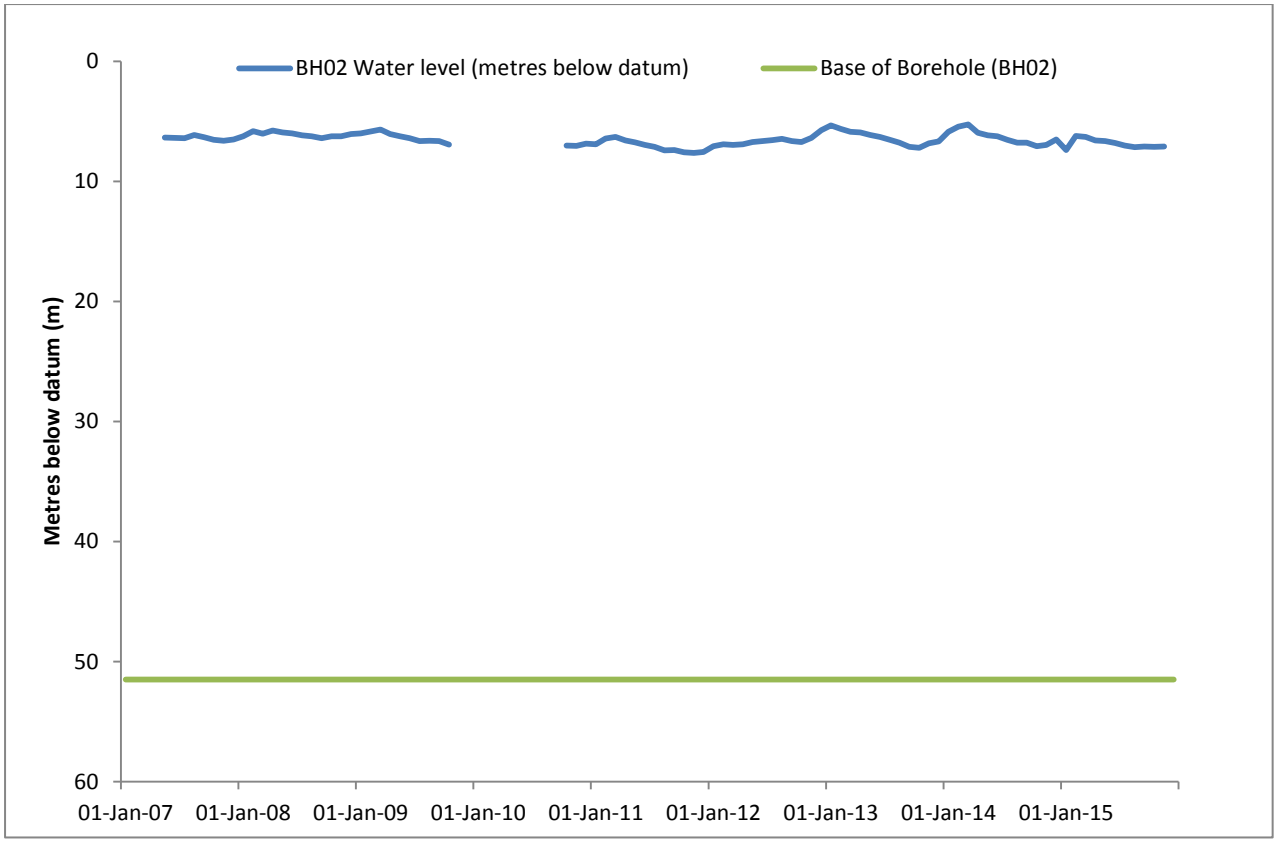


Figure 5 - Bulford BH02 operational water level time series and borehole levels.

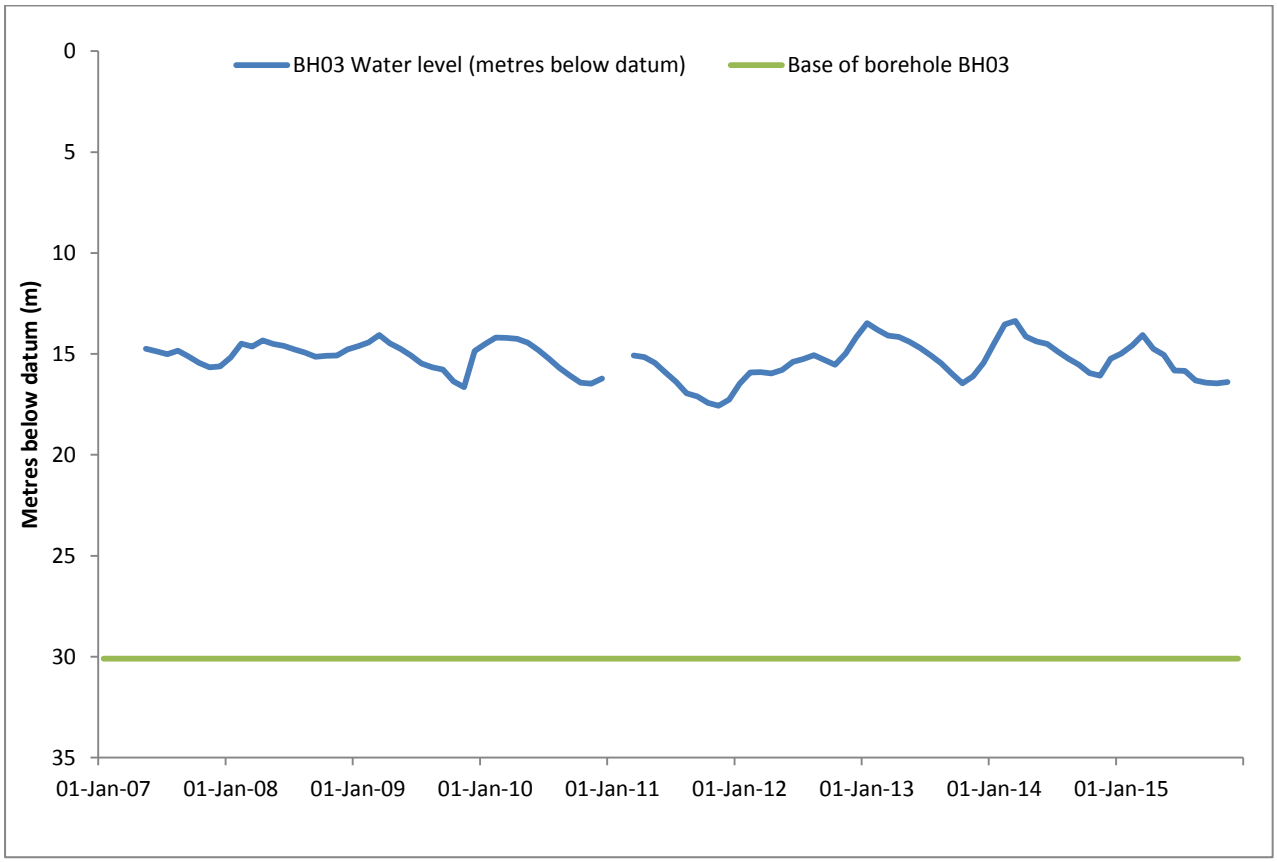


Figure 6 - Bulford BH03 operational water level time series and borehole levels.

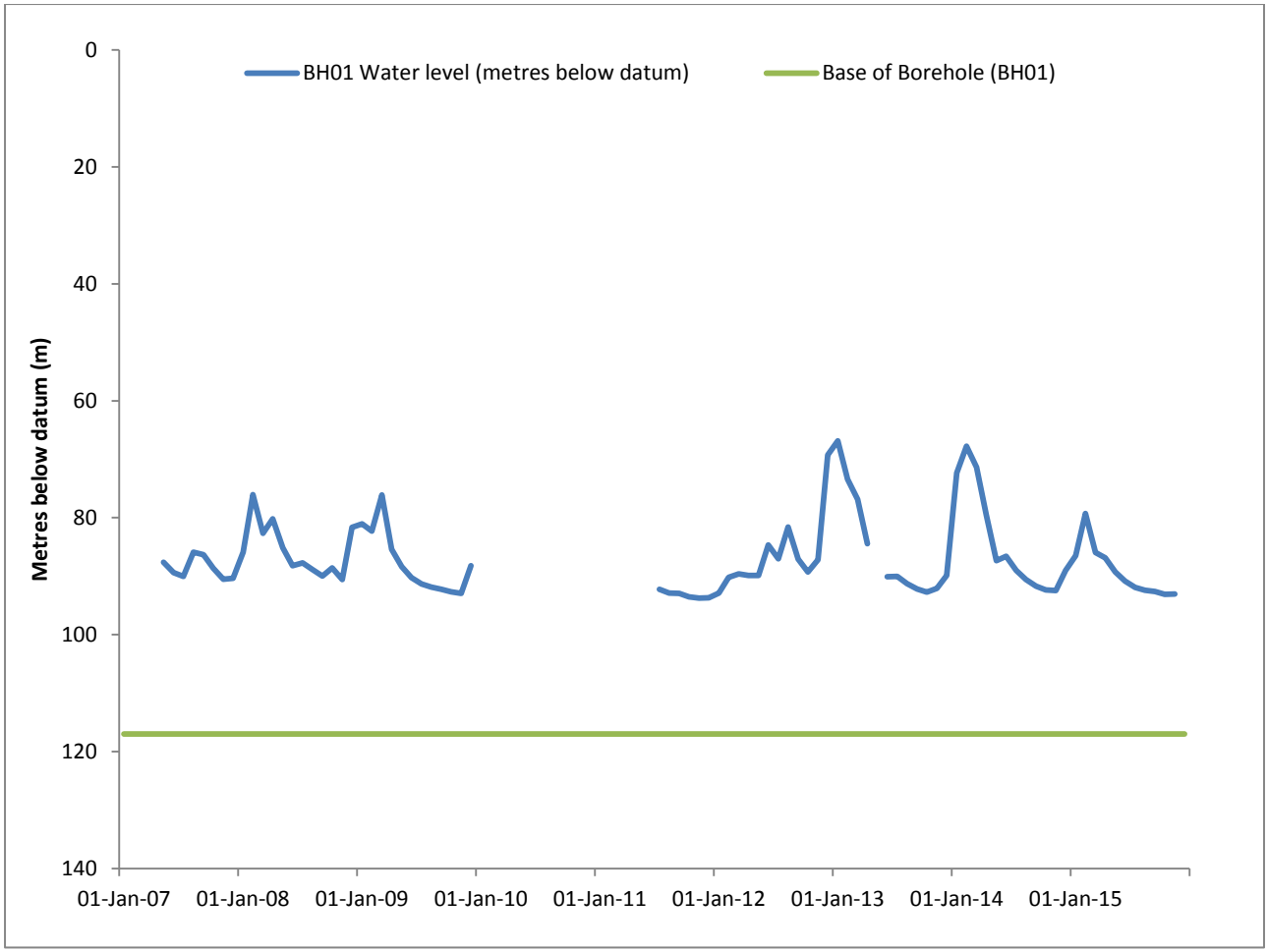


Figure 7 - Trenchard Lines (Upavon) BH01 operational water level time series and borehole levels.

Note: Trenchard Lines (Upavon) BH03 was not included as reliable data was not available.

APPENDIX F PHOSPHORUS OPTIONS REPORT AND ACTION PLAN

APPENDIX F

PART 1

Options Assessment for managing sewage-derived Phosphorus discharges to the River Avon SAC from Army Basing developments at Bulford and Larkhill

1. Issue

1.1 The Army Basing Programme (ABP) will result in increased sewage discharges from the camps and associated SFA on Salisbury Plain.

1.2 MOD's Larkhill STW cannot deal with the uplift from Larkhill camp or SFA and cannot be upgraded, so new treatment capacity is required. Bulford camp and SFA are already connected to the Wessex Water (WW) Ratfyn STW at Amesbury and the uplift will be sent there. The decision by ABP to send *all* foul flows from Larkhill and Bulford to the WW Ratfyn STW and close Larkhill STW (rather than build a new MOD STW north of the Packway) will increase the direct discharge of phosphorus ('P') into the River Avon, which is a European-protected habitat. This figure is currently estimated to be approximately 567g Total P/ day (calculation at **Part 2**).

1.3 Whilst this additional P would be within Wessex Water's existing discharge consent, doing so will make it more difficult to deliver the objectives of the recently-agreed River Avon Nutrient Management Plan (NMP)[1], which is implementing legal requirements under the Habitats and Water Framework Directives to reduce nutrient impacts in the river.

1.4 NE therefore advised that MOD removes or offsets the majority, if not all, of the additional Phosphorus (originally calculated at 933g Total P/ day) that ABP development has been estimated to input to the Avon from Q3 2017 onwards. Wiltshire Council would not be able to grant Planning Permission for the Camp or SFA developments at Bulford or Larkhill until satisfied (through determination of project-level Habitats Regulations Assessments) that ABP would have no detrimental impact to the River Avon SAC, both in the short and longer term. Responsibility cannot be devolved to Wessex Water.

1.5 Delivering offsetting is not straightforward and has potentially significant cost and programme implications. In addition, recent European case law (*the Briels judgment*) now means that effective offsetting measures may need to be implemented *before* the additional connections to Ratfyn STW can be made.

2. Recommendation

2.1 This options assessment reviews the method(s) available to MOD to minimise and/or offset the additional estimated 567g/ day of P that will be discharged to the River Avon SAC from ABP uplift and closure of Larkhill STW, in order to conclude the HRAs positively and allow Planning approvals to be granted. A series of potential options is provided below.

2.2 It is concluded that the most cost-effective method of dealing with the uplift is to fund to the NE Catchment-Sensitive Farming (CSF) initiative in the Avon catchment to

[1] Wiltshire Council; Natural England; Environment Agency. River Avon Special Area of Conservation – Nutrient Management Plan for Phosphorus. Final Version; 30 April 2015.

2020/21, to secure long term reductions in P loading. The CSF Officer should be in post in advance of the closure of the STW.

2.3 Whilst MOD could keep Larkhill STW (which discharges to a surface soakaway) operating at its current level until such time as additional P reduction technology is installed at Ratfyn/ Salisbury STW some time after 2020, it would be very expensive to maintain the facility, which is at the end of its life, for a further decade or so. This option should only be considered if CSF alone is not deemed sufficient by Wilts C to offset the additional P loading.

2.3 Should relevant factors change before Spring 2021 (such as an amendment to the nutrient targets for the River Avon), their implications for offsetting would be reviewed and agreed with the Hydrology Steering group as appropriate.

3. Background

3.1 ABP will see between 3,300 and 3,900 additional people (service personnel and families) based at Larkhill camp, and approximately 1,600 at Bulford camp. Whilst sewage from Bulford SFA and camp is currently handled at Wessex Water's Ratfyn STW on the River Avon, foul flows from Larkhill are handled at the MOD Larkhill STW, which discharges to ground and lies within the Stonehenge World Heritage Site (WHS).

3.2 Removal of all MOD STW infrastructure within the WHS is a stated objective in Heritage England's recently-updated WHS Management Plan, and it would be very difficult (if not impossible) to obtain Statutory approval for any upgrade or extension to the STW, which is currently operating close to capacity and its end-of-life. MOD has therefore agreed with Heritage England to work towards eventually closing Larkhill STW and removing as much of the above-ground infrastructure as possible.

3.3 With the closure of Larkhill STW, foul flows from a population of 5,604 people (3,104 service personnel and family members returning under ABP and the estimated 2,500 population equivalent connected to Larkhill STW) will therefore need to be dealt with. Based on a current total phosphorus (P) concentration of 0.6 mg/l in the final effluent from Ratfyn STW, this equates to an estimated additional 567g P/day being discharged into the River Avon above Amesbury. Even taking increased effluent flow into account, this discharge will increase the overall P concentrations in the middle Avon, which currently sits at an average value of between between 0.08 and 0.1 mg/l (see calculation methodology at **Part 2**).

3.4 In 2014, Kelda Water undertook an assessment of the Waste Water Treatment options for Bulford and Larkhill. This concluded that connecting the garrisons and SFA from both sites to the Wessex Water mains sewage network provided considerable cost-benefit over the principal alternative option of building a new STW outside the WHS boundary at Larkhill. However, subsequent environmental assessments for the Salisbury Plain Masterplan established that changing the discharge of final effluent from the surface soakaway at Larkhill to a point source on the River Avon Special Area of Conservation (SAC) would have observable impacts on both water quality (through increased phosphorus discharge) and groundwater hydrology (through removal of the water input from the Larkhill soakaway).

3.5 In Spring 2015 (after the SP Masterplan was published), the River Avon Nutrient Management Plan (NMP) was finalised. The NMP aims to stop the deterioration in condition of the SAC and restore it to Favourable condition in line with the Statutory requirements of the EU Habitats and Water Framework Directives, by reducing both consented (point source) and diffuse P discharge. The recommendation is Section D5 of the NMP states:

'Additional connections to STWs should continue to be made, as long as discharges are within existing consented headroom and the development does not compromise the deliverability of the NMP.'

3.5 Deliverability of the NMP is based on short and long-term targets which factor in a range of measures to deal with both point and diffuse sources. Where the allocation of permitted headroom is considered to compromise the deliverability of the NMP, phosphorus removal or offsetting will be required.

3.6 NE assessed the additional 'worst case' flows to Ratfyn from ABP in September 2015 (based on an additional 933g P/ day) and calculated that the NMP would remain 'just deliverable' with an additional inputs; however, it concluded that it would make delivering the nutrient reduction objectives through voluntary means more difficult to achieve. NE concluded that MOD should:

'Include measures to reduce or offset the additional P load discharged to the River Avon from MOD growth to reduce uncertainty on whether the project will compromise deliverability of the SAC conservation objectives.'

The full NE response is reproduced in **Part 3**.

3.7 MOD *could* make the case for not having to offset the additional 567g P/ day, since even the original 933g P/ day would not *technically* compromise the deliverability of the NMP. Wessex Water has confirmed that it can accommodate the additional ABP load within its existing permitted capacity at Ratfyn, and considers that the NMP takes this permitted headroom fully into account[2]. However, the ABP Masterplan HRA (and subsequent project-level HRAs) have to conclude with confidence that the activity will **not** have a negative impact on the SAC. Rendering delivery of the NMP more difficult by sending all flows to Ratfyn would make it harder for MOD to conclude this with confidence, especially in light of the currently sub-optimal condition of the SAC . In addition, as a Government department, MOD has a Statutory duty to protect and enhance protected habitats.

3.8 The 'IROPI' (Imperative Reasons of Over-riding Public Interest) clause within the Habitats Regulations cannot be invoked since MOD does have a technically-viable alternative of building a new STW outside the World Heritage Site, with discharge to a soakaway.

3.9 In conclusion, MOD has to ensure that Wiltshire Council could make a positive determination of the project-level HRAs for ABP developments at Bulford and Larkhill. To achieve this, it must demonstrate how it will offset the additional P loading and provide a workable plan for doing this that can be agreed to by Natural England and the Environment Agency. Delivery of the Plan will be enshrined within the Section 106 agreement and the imposition of Planning Conditions on the consented developments.

[2] Reference: Wessex Water Position Statement on phosphate: https://www.wessexwater.co.uk/uploadedFiles/Corporate_Site/Sustainability/Environment/4625%20Position%20statement%20(Phosphorous)%20(web).pdf

4. Options matrix

The following options are indicatively assessed for their potential cost-benefit and programme impacts. A 'do nothing' option of not returning troops to Larkhill or Bulford under ABP is not included in the Table as it does not deliver the ABP's Key User Requirements.

Option	Description	What does it achieve?	Cost/ programme implications	Summary	Consider further?
1	No change - send all foul flows to WW Ratfyn STW as currently planned, since the uplift does not technically compromise the deliverability of the NMP.	Avoids mitigation costs; aligns with Wessex Water's position that the NMP takes Ratfyn's discharge permit into account. P loading into the River Avon will increase by approximately 567g/ day (based on an average final effluent concentration of 0.6ppm).	In light of Regulatory feedback, there is a risk that Wilts C will not determine project-level HRAs positively and/or that NE will object; in both cases development consent is at risk. In light of the river's status and recent Case law, the risk of legal challenge from third parties cannot be ruled out.	Avoids any mitigating action but has significant Planning risk. Legal action may risk programme delivery.	No
2a	Replace MOD Larkhill STW with new facility north of the Packway to manage all flows from Larkhill and Bulford.	Avoids additional (direct) P discharge into the Avon by sending **all** flows to the Larkhill soakaway. Continues to support groundwater levels in the Larkhill aquifer.	Costly to build; likely to take between 3-4 years to obtain Planning permissions and develop, which does not fit with ABP programme. New connection to Bulford Camp is likely to be required. Site is close to WHS boundary but not directly constrained by it. Requires approval from Heritage England to expand the soakaway, which they are currently content with. Army/ public concerns ref odour, noise, visual impact etc can be eliminated through careful design, however this will bring potentially significant additional costs for a bespoke design and build.	Resolves the issue completely but very expensive, has planning risk and unlikely to meet ABP programme.	Yes - as a comparator.

2b	Replace MOD Larkhill STW with new facility north of the Packway to manage all flows from LH only. Bulford uplift will be sent to Ratfyn.	Reduces the additional P discharge into the Avon by sending all flows from Larkhill to the Larkhill soakaway. Gives uround 81% reduction in P discharge compared to option 1.	As above. Discharges from Bulford will increase by approx 102 g/day; could require offsetting through other means.	As above.	As above.
3	Upgrade MOD Larkhill STW operational to handle all current and uplift flows from Larkhill and Bulford.	Avoids additional (direct) P discharge into the Avon by sending **all** flows to the Larkhill soakaway. Continues to support groundwater levels in the Larkhill aquifer.	Larkhill STW will require considerable investment to upgrade or replace. Reverses existing commitment to Heritage England to close the site; highly unlikely to obtain development consent given its location and potential impact on the WHS.	Resolves the issue completely but has very high planning risk. Difficult if not impossible to obtain Statutory approvals.	No
4a	Keep MOD Larkhill STW operational indefinitely to handle **current** loading from Larkhill; send all uplift flows from Larkhill and Bulford to Ratfyn STW.	Minimises additional P discharge into the Avon by maintaining current flows to the Larkhill soakaway. Reduces direct P discharge by 30% compared to option 1.	Connections from Larkhill to Ratfyn still required to manage the ABP uplift. Installing new pipe networks to split garrison flows effectively between Larkhil land Ratfyn would be technically difficult, as would maintaining an effective treatment regime during garrison development. The existing STW and soakaway would require significant investment to maintain the infrastructure indefinately. Risk of P stripping infrastructure being required, which would not be acceptable to HE due to visual impact. Reverses existing commitment to Heritage England to close the site; clearances may be therefore be	Largely resolves the issue by minimising uplift in flows to Ratfyn, but has a very poor cost-effectiveness. High planning risk if any additional infrastructure is required.	Yes – as a comparator

			difficult/ onerous/ expensive to obtain.		
4b	Keep MOD Larkhill STW operational in the short term until new technology is installed at Ratfyn/ Salisbury STW, sometime after 2020. Send uplift flows from LH and BF to Ratfyn.	As above.	As above. However, Heritage England would accept the STW remaining operational in the short-term *if* MOD commits to close the site as soon as practicable. However, no firm date for closure can be given until at least 2019 as the decision about when to install new technology at Ratfyn sits with OFWAT and Wessex Water, and is therefore outside MOD's control.	Smaller but still clear risk of objection from Heritage England. May be difficult to obtain approval.	Yes but as a back-up option only.
5a	Agree use of enhanced metal dosing at Ratfyn STW with Wessex Water ahead of ABP increases.	Reduces P discharge to the Avon slightly by increasing the Fe dosing level at the existing STW. Could reduce P levels from 0.6 to 0.5 ppm, giving a 17% reduction in P discharge compared to option 1.	Does not require new equipment but brings additional running costs and may affect working life of STW. Wessex Water has confirmed that it will not implement this change ahead of time.	Small reduction in P discharged but implementation is not within MOD's control.	No
5b	Fund installation of new (enhanced) P stripping technology at Ratfyn STW ahead of ABP increases.	Reduces P increases in the Avon by removing P down from 0.7ppm to ca. 0.1ppm. Gives >80% reduction in P discharge compared to option 1.	Technologies are still being developed and immature; Capital and additional running costs are unknown. Wessex Water will not install any new technology until at least the 2020-25 AMP period and has confirmed that no funding mechanism is in place for MOD to pay for any such installation.	Reduces the amount of P discharged but implementation is not within MOD's control.	No
6	Reduce existing surface-water runoff to	Reduces wet weather flows to WW Ratfyn STW, minimising	Requires large surface drainage connections to be diverted to soakaway	Reduces the scale of the issue	Yes, as part of

	sewer from Bulford and Larkhill garrisons	the risk of overflows across the system. A phosphate 'spike' measured in the Nine-Mile River at Bulford may indicate a misconnection or foul overflow from the Camp.	and/or additional foul storage capacity to be installed to even out flows. Cost, timescale and feasibility of providing additional SuDS areas on garrison unknown. Likely to be most cost-effective if undertaken during groundwork for ABP developments.	by an as-yet unquantifiable amount, but will not resolve it alone. Cost and timescales as yet unknown.	discussions with Wessex.
7	Reduce silt runoff into the river from military tracks and training infrastructure.	Offsets P increases in the river by reducing diffuse P inputs from silt and surface water on SPTA.	Long-term solution, although some measures may be quick and simple. Extent of problem is not known; a catchment appraisal to identify likely sources and mitigation measures has been started by the EA with DIO input, as part of the SAC Site Improvement Plan. Extent of impact on training practices would need to be quantified.	Offsets the increased discharges by an as-yet unquantifiable amount. Addresses a key issue for the NMP.	Yes – continue supporting.
8a	Fund a Catchment-Sensitive Farming officer with NE	Offsets P increases in the river Avon catchment by reducing diffuse P inputs from both MOD–owned and private farmland.	Long-term solution, although some measures may be quick and simple. Farming practices may take several years to change and MOD has limited control on tenants' land use (depending on the nature of individual tenures). Amount of offsettable P is currently unquantifiable. Reducing diffuse pollution on MOD land will help longer-term obligations to improve SAC condition. MOD may need to fund CSF initiatives until additional P stripping is installed at Ratfyn and/or Salisbury STW. ABP funding would need to be replaced by other sources from 2021.	Offsets the increased discharges by an as-yet unquantifiable amount. Addresses a key issue for the NMP.	Yes - work with NE to fund post.

8b	Fund direct initiatives to reduce diffuse nutrient pollution with MOD tenant farmers	As above.	Provides additional funding to help farmers implement direct on-farm improvements and access additional CAP Stewardship grants, e.g. by funding new equipment, repairing/ upgrading infrastructure or compensating farmers for reversion to less intensive agriculture.	As above	Yes
8c	Remove MOD-owned farmland close to the river from active cultivation	Significantly reduces or may remove diffuse P discharges into the river from MOD–owned farmland.	Degree of benefit depends how the land is used, both currently and in future. Complete cessation of arable cropping with fertilizer inputs stopped will bring the biggest benefit. Taking land out of active production is likely to be highly expensive and time-consuming, as MOD would have to buy out farmers from often multi-generational tenancy agreements. Opportunity to increase the connectivity of military training areas on SPTA by enhancing the amount of accessible land across the Avon valley.	As above. More permanent solution which could enhance military training capacity across SPTA; however potentially very expensive to implement. Sediment runoff would have to be controlled.	Yes, as a fallback if the other CSF measures do not deliver expected benefits in a timely manner.

PART 2

ABP Phosphorus Calculation Methodology

The ABP troop figures used to calculate estimated the Dry Weather Flow (DWF) to Ratfyn are shown in Table 1, whilst the associated Service Family numbers are shown in Table 2. These figures are updated from those in the 2014 ABP Salisbury Plain Masterplan, and reflect among other factors a reduction in the estimated number of service children and the revised military laydown plan for Salisbury Plain. The key figures used to calculate DWF are shown in Blue type.

Site	**ABP Impact (people; gross)**	**Non-ABP Impact (people; gross)**	**Net Impact from ABP (people)**	**Previously - Communicated Masterplan no^{s} (people)**	**Variation**
Bulford	817	-180	**637**	735	-98
Larkhill	1995	-1	**1994**	2053	-59
Perham Down	624	13	637	627	+10
Tidworth	400	86	486	609	-123
Upavon	204	0	204	254	-50
SPTA Impact	**4040**	**-82**	**3958**	**4278**	**-320**

Table 1 – Estimated ABP impact on net troop numbers based on Salisbury Plain.

Site	**New SFA (no^{s})**	**Spouses (people)**	**Service children (based on Wilts C's 1.5 per family assumption)**	**Dependants only Population Impact (people)**
Bulford	227	**227**	**341**	568
Larkhill	444	**444**	**666**	1,110
Perham Down	0	0	0	0
Ludgershall -Tidworth	246	246	369	615
Upavon	0	0	0	0
Total	**917**	**917**	**1,376**	**2,293**

Table 2 – Estimated ABP impact on net service family numbers based on Salisbury Plain.

Note that those soldiers based on a site (eg those accounted for in Table 1) but living in SFA are accounted for in the SFA calculations only, to avoid double-accounting. For example, the uplift at Bulford is 637, but an estimated 227 soldiers will be in SFA, giving a net figure of 410 soldiers living in SLA. However the daily occupational use by soldiers on each site is treated as an additional use. This may represent a degree of double-accounting but has been added to give a 'worst case' figure.

The Total phosphorus ('P') calculations are based on the following estimated water use:

Larkhill SFA uplift @105l /p/ day	**Larkhill SLA uplift @83l/p/d**	**Larkhill daily non-domestic uplift @18l/p/d**	**Larkhill existing flow (measured at Larkhill STW inlets)**	**Bulford SFA uplift @ 105l/p/l/d**	**Bulford SLA uplift @83l/p/ d**	**Bulford daily non-domestic uplift@18l/p/d**
1554 people	1550 people	1994 people	-	795 people	410 people	637 people
163.2m^3/ day	128.7m^3/ day	35.9m^3/ day	200m^3/ day	83.5m^3/ day	34m^3/ day	10.8m^3/ day

Table 3 – Estimated ABP – related uplift in foul flows to Ratfyn STW (Dry Weather Flow).

Total projected increase in flow to Ratfyn STW = 656 m^3 per day (DWF). Note that this figure is estimated and can only be verified by flow metering, once connections to Ratfyn are installed and operational. The usage figures are based on the development of SLA and technical accommodation meeting MOD's 'DREAM Excellent' building standard and the SFA meeting the Code for Sustainable Homes Code 4 standard, as required by the Wiltshire Core Strategy.

Projected phosphorus discharges from Ratfyn STW for ABP are calculated using the standard methodology adopted by Wessex Water:

- Ratfyn STW discharge consent = 1mg/l Total P with a total DWF flow of 4546m^3/day. This equates to a total consent figure of 4.55kg P/ day into the River Avon.
- However, Ratfyn performs significantly better than 1mg/l, typically achieving 0.6mg/l. Given that the typical 'average' flow = 3,500 m^3/day, the actual average load = 2.1kg P/day.
- The expected total Dry Weather Flow from MOD (explained below) is 656.1m^3/ day, assuming Larkhill STW is closed. Assuming a multiplication factor of 1.2 for average flow (including wet weather) and 1.2 for infiltration into the system, the total estimated volume = 656.1x 1.2 x 1.2 = 944.8m^3/ day.
- Assuming a similar standard of stripping is achieved (i.e. 0.6 mg/l in final effluent), the anticipated additional P load = 944.8 x 1000 = 944,800 l/day @ 0.6mg/l = 566,880mg/ day, or **567g P/ day.** Note that the figures are assessed as Total phosphorus which includes *all* phosphorus compounds, irrespective of their bioavailability in the river environment.

PART 3

MOD Phosphorus Action Plan for discharges from Army Basing developments to the River Avon

July 2016

MOD will implement the following measures to offset, as far as reasonably practicable, the additional estimated 567g/ day of phosphorus that will be discharged into the River Avon system from Q3 2017 onwards as a result of Army Basing Programme developments at Larkhill and Bulford:-

1. When Planning permissions for the four main garrison and three housing developments are granted by Wiltshire Council, MOD will convene a Regulatory Hydrology Steering Group to replace the Masterplan Hydrology Sub-Group. This Group will oversee and monitor the implementation of all hydrological mitigation measures associated with the Army Basing Programme. This will consist principally of the Sub-Group members; terms of reference will be developed by DIO and agreed by the members at the first meeting.

2. MOD will keep the estimated ABP phosphorus loading into the River Avon from Ratfyn STW under review. The calculation will be updated whenever new information is received, to help ensure that the right target reduction is being worked towards. Measures that could affect the figure going forward include more accurate data on measured flow (given that the uplift figures in the current calculation are estimated on a per-Capita basis); revision to the target P figure for the SAC Conservation objectives and/ or longer-term changes to final effluent concentrations brought about by technological changes at Ratfyn STW.

3. MOD will fund a Natural England Catchment-Sensitive Farming Officer, from Spring 2016 until the ABP programme ends in Spring 2021. This post will develop working relationships with farmers on both MOD and non-MOD land in the River Avon catchment, to identify potential improvements to farming practices and to assist them in obtaining Stewardship and other funding to address diffuse phosphorus inputs into the river. As part of this, MOD will provide funding as required for the CSF officer to procure any further technical assessments (e.g. Farmscoper; SIMCAT etc) needed to support the programme.

4. MOD will continue to support the ongoing EA/ NE Sediment Tracks programme to identify tracks and training infrastructure on MOD land (including areas subject to more intensive agricultural management) that could be providing a pathway for silt to enter the river. Where the study identifies significant sediment pathways, MOD will undertake appropriate measures (in agreement with the CSF officer) to reduce or eliminate the runoff. The benefits of sampling for phosphorus levels in these sediment sources will also be investigated.

5. MOD will also make additional Capital funding available (up to a total of £50k per annum) from Spring 2017 to Spring 2021 inclusive, to provide an alternative funding stream supporting direct improvement measures. This funding will help farmers make smaller-scale infrastructure improvements that could bring rapid results, although it is not intended to replace Stewardship funding, which is likely to involve much larger sums and potentially changes to agricultural practices. The funding will be targeted primarily at MOD tenant farmers to implement measures that will bring long-term

savings; however MOD will investigate if current funding rules allow funding to be used on non-MOD land in the catchment.

6. Working with the CSF officer, MOD and its industry partners will also investigate point-source pollution from un-sewered MOD-owned buildings in the catchment; e.g. from failing septic tanks or drainage mis-connections. Repairs will then be undertaken as required.

7. MOD will monitor the progress of the CSF initiative in reducing phosphorus loading and managing water quality on a regular basis in conjunction with NE. If the expected phosphate offset is not reasonably on track to be at least largely met (e.g. ≥80% of the target figure) after 2 years of the programme in Spring/summer 2018, MOD will then investigate a more comprehensive programme of reforms to Schedule 1 MOD farmland in the Avon Valley and other areas close to water bodies with direct pollutant linkages to the river. This programme will quantify the shortfall in Phosphorus reduction and then implement effective measures to further reduce diffuse and small-scale point inputs. Measures could involve reducing the intensity of agricultural production, for example reversion from arable to low-intensity grazing or, in extreme circumstances, taking land out of agricultural production altogether, e.g. by reverting it to wetland habitat. Since this latter measure may affect the viability of some farm businesses, MOD would look to work with farmers in the first instance to permanently change land use, rather than buy out agricultural tenancies.

The success of the above measures will be monitored on at least a six-monthly basis by the Hydrology Steering Group.

PART 4

Natural England response on Phosphorus Offsetting requirements

From: Natural England
Sent: 25 September 2015
To: MOD
Cc: Environment Agency, Wessex Water, Wiltshire Council
Subject: Ratfyn STW Phosphorus uplift calculation from ABP - NMP RESULTS
Importance: High

Thank you for this email providing 'MoD growth' data for the Army re-basing at Larkhill and Bulford.

Attached is a spreadsheet that provides revised calculations with MoD growth for the information given in Tables D.4 and D.5 of the River Avon SAC NMP. These tables inform deliverability of the NMP objectives which are:

- Objective 1 growth with deliverable reduction options meets the phosphorus ambition reduction targets by 2021 (the 'interim progress goal' SAC targets, as to be taken forward into the next WFD River Basin Management Plan, 2015-2020);
- Objective 2 growth with deliverable options does not compromising deliverability of the proposed long-term SAC targets (the SAC conservation objectives).

The SAC interim progress goals and proposed long-term SAC targets are published here: http://publications.naturalengland.org.uk/publication/4520877345472512

The revised calculations are provided for only the 2 water bodies in the River Avon SAC affected by MoD growth at Larkhill and Bulford:

- Upper Avon (Nine Mile River to Salisbury)
- Lower Avon (Salisbury to Christchurch)

In doing this exercise a probable error was noticed in data for Ratfyn STW used in the NMP. The data give a discharge quality of 183 ug/l TP which is exceptionally low compared with other STWs (most are in the range of 500-600 ug/l TP) and is also well adrift of the figure of 600ug/l given in your email. Two sets calculations are therefore provided 1) the NMP data revised only by adding MoD growth data using 600 ug/l discharge quality and 2) the NMP data revised with all Ratfyn STW discharge at 600 ug/l TP and by adding MoD growth.

Using the revised 600ug/l figure for Ratfyn STW, the proportion of total growth that is MoD growth expressed as increased STW phosphorus load received by the two SAC water bodies is:

- Upper Avon 55% from MoD growth
- Lower Avon 17% from MoD growth

(The calculation assumes no 'decay' in TP load from upstream STWs but also does not include the discharge from smaller STWs)

On NMP objective 1 the results show that adding MoD growth to the forecast growth used in the NMP (and both without and with revision of the Ratfyn discharge quality) the NMP just remains deliverable for the two water bodies through CSF measures alone. However deliverability is very marginal requiring more than 91% achievement of CSF optimum delivery across the catchment of the Upper Avon water body (ie north of Salisbury) and 94 % across the catchment of the Lower Avon water body (ie the whole Avon catchment). CSF optimum delivery requires an uplift on current CSF delivery both in terms of geographical

extent and intensity. To date no significant additional delivery resource has been provided to give the uplift required (although the new Countryside Stewardship scheme could go some way towards Optimum delivery if there is sufficient voluntary uptake into the scheme and this more than negates land falling out of expiring Environmental Stewardship Agreements). There is thus poor certainty that objective 1 can be met with forecast growth and MoD growth combined through CSF delivery alone. To increase certainty other phosphorus reductions options would need to be brought forward by 2021 and some are outlined in the NMP.

On objective 2, MoD growth shifts the Upper Avon SAC water body from Moderate risk of growth compromising deliverability of the SAC conservation objectives to High risk (since nearly all CSF capacity for reduction is used up in achieving objective 1 and additional reduction from STWs is insufficient – in NMP see Table C.4 for scale of further reduction required and Table C.3 option B for STW reduction at 200 ug/l operating standard). The Lower Avon water body remains at High risk but is slightly more so.

Across the whole of the River Avon SAC these two water bodies are assessed as the most serious at risk of failing to meet their SAC conservation objectives on phosphorus with development growth (taking into account uncertainty on targets where there is a high influence from Upper Greensand groundwater). One other water body is also at high risk – Wylye headwaters – although involves a relative short stretch of SAC river.

I trust this information now allows you to progress with your Habitats Regulations Assessment for the ABP-O option in relation to the River Avon SAC water quality. The results suggest you should include measures to reduce or offset the additional P load discharged to the River Avon from MoD growth to reduce uncertainty on whether the project will compromise deliverability of the SAC conservation objectives. I would be pleased to provide advice on this aspect if required.

Natural England
Dorset, Hampshire and Isle of Wight Area Team

APPENDIX G LEAKAGE REDUCTION/WATER EFFICIENCY MEASURES

DEFENCE

sodexo
QUALITY OF LIFE SERVICES

WATER EFFICIENCIES RESPONSE

14 October 2015

INTRODUCTION

This paper aims to provide an overview of the existing water efficiency measures utilised primarily within catering locations across Project Allenby/Connaught. Whilst it is recognised that all Sodexo services utilise water to greater/less extents the greatest consumption occurs during the production of food. It must be recognised that existing data sources do not offer data of sufficient granularity to establish a clear cause and effect link for water saving initiatives.

EFFICIENCY MEASURES ADOPTED

During the period from March 2014 to March 2015 Project Allenby/Connaught transitioned from the Daily Food Charge regimen to Pay as You Dine. This fundamentally changed the model of service delivery and production within food outlets across the project footprint.

Change in Methodology

During the implementation of the PAYD project all Sodexo employed and CCM chefs were trained in modifying food preparation and production techniques to support batch cooking by a group of experts highlighting environmental controls.

Change in Method	Benefit
Batch cooking	This reduces the volume of food cooked at a time which serves to reduce food waste but also waste energy and water associated with overproduction
Equipment start up times education	Equipment which is turned on too early and stands idle before use consumes both energy and in some instances e.g. dish-washers and combination ovens water. Ensuring that machines are turned on just in time reduces wasteful consumption.
Production planning	A quantity of water is used in the preparation of vegetables. Chefs have been trained to better evaluate the food production requirements to reduce overproduction. This minimises the vegetables to be washed, prepared and cooked.

Change in Equipment

The catering equipment within Allenby/Connaught's new build and refurbished estate was initially specified to have an estimated life span of 7 plus years, with many of the original new builds now in their 8th year of use with many catering equipment pieces being subject to lifecycle replacement or entering lifecycle planning stages.

The contract has a few remaining sites with old catering equipment within them which are referred to as retained estate, namely Aldershot: Lille, Normandy and Mons Bks Junior Ranks kitchens,

Larkhill: Roberts and Allenbrooke Bks Junior Ranks Kitchens and Tidworth Garrison having various kitchens which have had no refurbishment afforded to them.

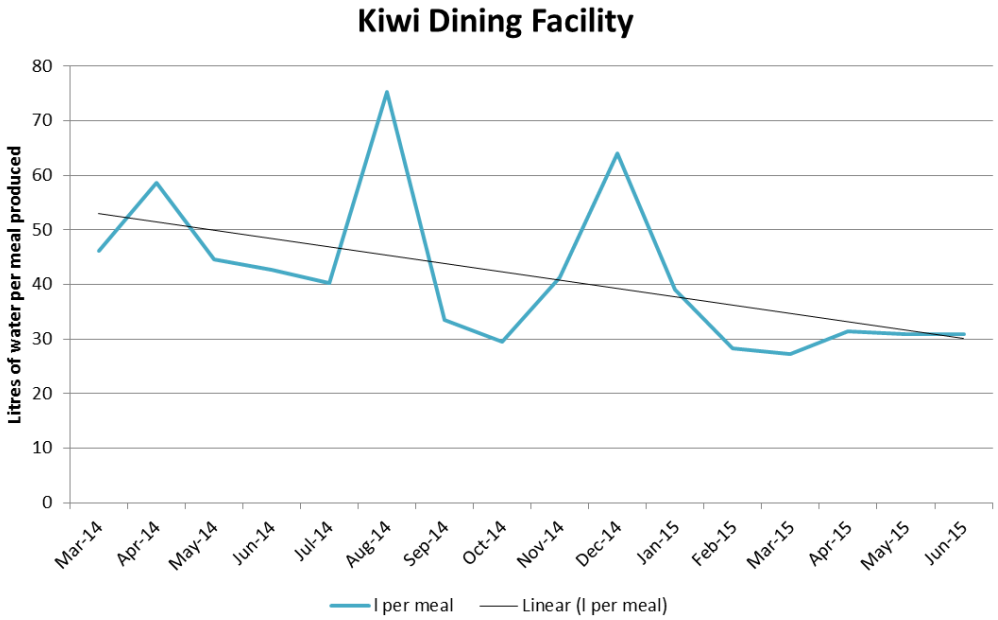
All catering equipment identified for lifecycle through either planned or reactive replacements are replaced with the most up to date appliances identified for use within the 2020 Catering Equipment Journal which encompasses future new build requirements and currently used / Retained estate replacements.

Examples of recent lifecycle replacements are:

- 3 x Rack & Flight dishwashers have been replaced with either like for like equipment or double hood dishwashers that have modern and sophisticated compartmentalised water filtration and heat exchange systems which reduce energy consumptions through using less electricity for heating and water saving features benefitting from a once daily fill requirement.
- Combination Ovens are now being replaced with boiler less models which have cavity injection systems to produce steam in to the cooking process which again benefits from reduced water and electricity consumptions whilst also reducing maintenance and repair costs from scale issues.

Behavioural Change

Sodexo utilises a network of green champions across its business in order to drive front line behavioural change initiatives. A network of 78 environmental champions is well established across Project Allenby/Connaught. The behavioural change programme is well established and can be easily demonstrated in the Kiwi JRDC where water consumption per meal produced has decreased by 33.25% since the introduction of PAYD.



It must be recognised that this is not a single purpose building so not all water usage is related to food production. Specific activities conducted by Sodexo in support of water efficiencies include:

- Green Champion training relating to water conservation;
- Poster campaigns to use less water and report dripping taps;
- Newsletter articles to all colleagues;
- Better Tomorrow Plan guidance notes relating to tips to save water when cooking.

LOOKING FORWARD - DEVELOPING CONSISTENCY

Sodexo has a continuing global commitment to reduce its water footprint on all client sites within its Better Tomorrow Plan. Within Project Allenby/Connaught the remaining opportunities which provide the best and quickest 'wins' relate to developing consistency across the project footprint.

Extending the scope of sub metering

Current data exists at asset (building) level. To identify and impact assess opportunities for improvement a detailed sub-metering study within low consumption and higher consumption areas is recommended.

This will serve to make the routine 'invisible' consumption visible to those working in Sodexo operated areas. Once the impact of actions and non actions is understood a detailed plan addressing the root causes of inconsistencies will be developed. In a paper published by Waterwise on behalf of the Greater London Authority various case studies of the benefits of sub-metering were examined. All demonstrated a decrease in per capita demand following the introduction of effective sub metering. At the time of publication (December 2007) it was noted that Melbourne had experienced a decrease in per capita demand of 22% toward their target of a 30% reduction by 2020.

It should be recognised that in a domestic environment there is a clear cost benefit to immediate consumers which does not exist in a workplace setting. There is however the opportunity to move forward at a consistent pace through strong leadership.

Optimising Equipment

As new catering equipment is introduced and installed in to the contract Sodexo's Maintenance and Repair contractor (Hobart Ltd) conduct equipment training to all equipment users on the day of install and commissioning, offering free refresher training sessions for the life of the equipment, this training is recorded on the users training record card, Sodexo and Hobart have introduced a series of Equipment Training Cards specific to particular equipment types i.e. Combination Ovens, Dishwashers, boilers etc, which are quick reference guides to their use, operating, start up, heat up times and fault finding etc, which in turn reduces energy consumption through heat up times.

Hobart conduct scheduled annual planned preventative Maintenance (PPM) and Portable Appliance Testing (PAT) to all asseted catering equipment within the estate which identifies all operator unidentified faults are reported and actioned which ensures the equipment is maintained to its optimum operating capabilities thus preventing early equipment failure and reduced life expectancy of equipment.

The PPM and PA Testing is up and above the routine equipment fault reporting procedure with Hobart, Allenby Connaught has 9 dedicated engineers on the contact which benefits from an average of over 90% first time fixes on reported faults, overnight parts to van spares services which reduces equipment down time once estimates have been funded.

Continuing Behavioural Change

We have significant experience in successfully managing behavioural change and attitudes within Health and Safety. We are able, and will, apply this knowledge and experience to support an improvement in the consumption of water. All Sodexo staff undergo annual training through a series of environmental great cards one of which focuses on water savings

We first need to really analyse the data and it would be beneficial if this could be provided monthly and not quarterly, we will inform site champions and get inside the data understanding ebbs and flows and creating comprehensive lessons learned plans.

Aspire Defence Services Limited

Water Project 2015 Executive Summary

October 2015

EXECUTIVE SUMMARY

Introduction

ADSL were tasked with surveying all assets at Larkhill and Bulford with regards to water efficiency to support the ABP planning application and the EA's concerns over abstraction rates and water leakage. In undertaking this work ADSL were also asked to take positive actions to improve efficiency where inefficiencies were found.

The project ran for 6 months from March – August. In total 495 buildings were surveyed.

Survey Methodology and Scope

The survey methodology included the following:

- Estimation of the leakage flow rate within the surveyed assets.
- Where water meters were installed the consumption was recorded in m^3/hr. If no water meters were installed then measurement was taken by non-intrusive means. From these figures a calculated daily consumption was made.
- Within all of the building Assets visual inspections were carried out of all water appliances. However, as the aim was fundamentally to concentrate on constant flow, overflows and urinals were the focus, inspections did include for assessment of all processes where water was used.

The scope for each building surveyed was to:

- Understand how the selected buildings were operating. Temporary non-intrusive sub metering was installed if required.
- Site surveys were conducted identifying water saving opportunities and equipment which required fixing.
- Any 'on the day' reductions were made and recorded.
- Actions taken and savings made were recorded, tabulated and communicated to the PAC CMT and DIO on a weekly reporting basis throughout the exercise.

Actions

During the survey the ADSL identified actions where water could be saved and these actions were either implemented on the spot by adjusting flow rates or by placing Help Desk calls for Garrison Maintenance Teams to rectify at a later date. During the survey some 250 Help Desk calls were raised with the top four issues being taps, urinals, toilets and general leaks.

Outcome

The overall outcome of the efficiency drive resulted in a total of 495 buildings being surveyed and 250 help desk calls placed to address identified issues. The surveys identified savings of 70,403 m^3 per year based upon 252 annualised working days and equates to £105k if priced at £1.5/ m^3.

APPENDIX H PLAN LEVEL HRA

MOD Form 2223 (Revised)

Habitats Regulations Assessments (HRA)[1]:
Consideration of Plan/Project (P/P)
Judgement of Likely Significant Effect (JLSE)

Title of Proposal: Salisbury Plain Army Basing Programme

Name of Natura 2000 and Ramsar[2] Site(s):
- **Salisbury Plain Special Protection Area**
- **Salisbury Plain Special Area of Conservation**
- **River Avon Special Area of Conservation**

This Decision Form is a record of the assessment, undertaken by the Defence Infrastructure Organisation on behalf of the Ministry of Defence in respect of the above plan / project, in accordance with the EC Habitats Directive (92/43/EEC) and transposing Regulations.

The Habitats Regulations (Reg. 61 in England and Wales; Reg 48 in Scotland & NI) require that a Competent Authority carries out an Appropriate Assessment (AA) before deciding to undertake, or give any consent, permission or other authorisation for a plan or project which is likely to have a significant effect on a European site.

Summary of the Project

Redevelopment of Larkhill, Bulford, Tidworth, Perham Down and Upavon garrisons with associated Utility improvements to accommodate increased military personnel, provision of new Service Family Accommodation (off garrison) at Larkhill, Bulford and Ludgershall, and creation of Nine Mile River crossing and associated washdown facility and new access track from Bulford garrison to the SPTA.

References:

A. Salisbury Plain Masterplan HRA. DIO, October 2014.
B. Bulford Back Gate HRA. DIO, January 2015.
C. Progress Report and Management Plan for Stone Curlew on Salisbury Plain Training Area. DIO, December 2014.
D. River Avon SAC Nutrient Management Plan for Phosphorous. Wiltshire Council, NE and EA April 2015.
E. HRA and Mitigation Strategy for Salisbury Plain SPA in relation to recreational pressure from development, Wiltshire Council March 2012.
F. Wessex Water Water Resource Management Plan, June 2014.
G. Salisbury Plain Visitor Survey. Footprint Ecology, Nov 2015 (Currently in draft).
H. Conservation Objectives and Definitions of Favourable condition for Designated Features of Interest: River Avon System; Consultation Draft; Natural England; 2008.
I. Salisbury Plain Army Basin Programme HRA. DIO, December 2015
J. European Site Conservation Objectives Supplementary Advice – River Avon Special Area of Conservation (SAC). Natural England *Currently Unpublished.*

[1] The 'Habitats Regulations' differ between UK nations:
England and Wales - The Conservation of Habitats and Species Regulations 2010 SI 2010/490
Scotland - The Conservation (Natural Habitats, etc.) Regulations 1995 (as amended in Scotland);
Northern Ireland - The Conservation (Natural Habitats, etc.). Regulations (Northern Ireland) 1995 SI 95/380
[2] Wetlands of International Importance identified under the 1979 Ramsar Convention: it is Government policy to also apply the Habitats Regulations Assessment processes to the special features of Ramsar Sites

Annexes:

A. Technical Consideration
B. Summary of Avoidance and/or Mitigation Measures
C. Army Basing Programme, Salisbury Plain - Recreational Access Action Plan. Report produced for DIO by WYG; February 2016. .
D. AMEC FW Wessex Water Groundwater Model: Scenario Runs for the Defence Infrastructure Organisation (DIO), September 2014
E. Waste Water Treatment Implications for Army Rebasing. Kelda Water. July 2015.
F. Options for managing sewage-derived Phosphorous discharges to the River Avon SAC from Army Basin developments at Bulford and Larkhill
G. AMEC FW Briefing Note on Alternative Army Basing Scenarios, January 2016
H. DIO ABP Water Abstraction Commitment

1. What are the Plan/ Project proposals?

1.1 The Defence Infrastructure Organisation (DIO) proposes to seek planning permission for developments in and around Salisbury Plain as part of the Army Basing Programme (ABP), which provides accommodation for Army personnel returning from Germany or otherwise relocating during the period to 2020. This HRA assesses the potential impacts of the confirmed ABP proposals, which show a reduction in scope on those assessed within the 2014 Salisbury Plain Masterplan HRA (ref A) in both personnel numbers and linked enhancement of training features.

1.2 The elements included in the Masterplan HRA which have now been removed or reduced in scope are:

- The enhancement of training features on Salisbury Plain Training Area (SPTA), including the proposed new additional Electric Target Range (ETR) at Bulford Ranges and Individual Battle Shooting Range (IBSR) in the Central Impact Area are no longer proposed and have been removed.
- The assessment of potential impacts on the River Avon SAC is now of those from ABP impacts alone and not "in-combination" with non-MOD sources and existing MOD impacts. This change has been made on the advice of Natural England (NE) and Wiltshire Council (WC) given at a meeting of the Hydrology Sub-Group in February as detailed later in this document.

1.3 The elements of ABP covered by this assessment are summarised below with further detail in following sections:

- Extensive new build Single Living Accommodation (SLA), conversion of existing SLA blocks, additional mess facilities, new build and some conversion of existing technical accommodation within Bulford, Larkhill, Perham Down, Tidworth and Upavon Garrisons;
- New build of 917 Service Family Accommodation (SFA) houses (totalling 444 Larkhill SFA, 227 Bulford SFA, 246 Ludgershall SFA);
- The closure of MOD's Larkhill STW and provision of new sewerage pipelines and connections from Bulford and Larkhill to Wessex Water's Ratfyn STW;
- Provision of potable supplies from Wessex Water and Veolia to the new SFA and a 100% capacity secondary supply from Wessex Water to Larkhill and Bulford camps;
- Upgrade to existing Wessex Water potable water supply connections at Larkhill and a new Wessex pipeline to Bulford from Allington and potentially through another location near the Canadian Estate to provide the secondary water supply;
- A new vehicle access onto SPTA from Bulford garrison via a crossing over the Nine Mile River, with associated vehicle washdown facility.

1.4 The elements arising from ABP which are required to ensure a conclusion of no likely significant effect and therefore form part of the plan or project are summarised below with further detail in following sections:

- A requirement for back-up water supply of up to 934 m^3/d from Wessex Water to ensure that abstraction levels from MOD boreholes are not increased and to enable reduction in abstraction from MOD's Larkhill and Round O boreholes of up to 580 and 354 m^3/d respectively. This will remove ABP impacts from increased demand for potable water supply and from changes to groundwater levels and river flow from closure of Larkhill STW and soakaway;
- A requirement for a staged approach to offset additional inputs of (currently-estimated) 686g/day of Phosphorous to the River Avon resulting from the closure of Larkhill STW and soakaway and transfer of foul water flows to Ratfyn STW. This is outlined further in this

document and in a Phosphorous Action Plan. Target is to offset ≥80% by spring/summer 2018;

- Measures to reduce Phosphorous are; to continue to work with the water supply chain to identify and install appropriate infrastructure improvements; funding of both a Catchment Sensitive Farming Officer (CSFO) until FY 20/21 and capital works to reduce inputs; identifying tracks on MOD land that could allow silt to enter the river;
- If the Phosphorous offset is not on track to be at least largely met after 2 years, investigation of a more comprehensive programme of reforms to MOD land in the Avon Valley and other areas with direct pollutant linkages to the river;
- The above measures are further detailed in the Water Management Strategy, a draft of which has been produced and is being updated. Progress against this will be monitored via continuation of the existing Hydrology Sub-Group;
- An increase in potential access/recreational visits to SPTA as a result of additional numbers of service personnel and families in combination with increases identified from Wiltshire Council's Core Strategy. In addition to measures outlined in Wiltshire Council's Mitigation Strategy, MOD will implement a Recreational Access Action Plan to increase and improve existing paths and open spaces to reduce visits to the SPA. An updated MOD Stone Curlew Management Plan has also been issued;
- The new vehicle track over the Nine Mile River has been routed to avoid the designated sites. The width of the bridge and track through the floodplain has been reduced and a Construction Environment Management Plan (CEMP) will be in place. The associated washdown will be situated so that vehicles are clean before using the river crossing.

2. What Consents, Permissions and Authorisations are required from other Competent Authorities under the Habitats Regulations?

2.1 Planning permission from Wiltshire Council will be required for most aspects of the scheme, with the exception of the new vehicle access onto SPTA at Bulford garrison which is classified as Permitted Development. Wiltshire Council would therefore constitute a Competent Authority for these aspects.

2.2 Elements involving abstraction and wastewater consents would involve the Environment Agency who would normally act as Competent Authority for those consents. MOD is currently exempt from abstraction licensing, but acknowledges that this will change and has undertaken extensive study to evaluate impacts to ensure compliance with likely future conditions.

2.3 This HRA is an update to the previous versions submitted as part of the Overarching Environmental Appraisal for the Salisbury Plain Masterplan in 2014 and the updated version submitted on 21st December 2015 (ref I). This version is based on the latest information as submitted with the individual planning applications for ABP and includes additional information/ clarifications as requested by NE and EA in their response dated 3rd February 2016 and outlined through subsequent meetings.

3. What other designated sites or protected species may be affected?

3.1 The Army Basing Programme (ABP) has the potential to affect features of the Salisbury Plain SSSI and Rivers Till and Avon SSSI. It is also likely to have effects on protected species, including bats (including removal of several bat roosts), reptiles and great crested newts.

Consideration of Plans and Projects under the Habitats Regulations

4. Is the proposal a Plan or Project?

4.1 This is a record of the consideration undertaken by the Defence Infrastructure Organisation, on behalf of the Ministry of Defence to determine whether the above proposal is a 'plan or project' in terms of the EC Habitats Directive (92/43/EEC) and transposing regulations, and to determine whether the PP is directly connected with or necessary to the [conservation] management of the site.

4.2 The MOD considers that:

a) The proposal is a 'plan or project' in terms of the EC Habitats Directive (92/43/EEC) and transposing regulations.

b) The proposed project is not directly connected with or necessary to the [conservation] management of the sites concerned.

Judgement of Likely Significant Effects (JLSE)

5. What SPAs / SACs or Ramsar Sites may be affected by this Plan or Project; what are the qualifying interest features and their conservation objectives?

5.1 Salisbury Plain Special Protection Area[3]

This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:

During the breeding season

Stone curlew (*Burhinus oedicnemus*)
Quail (*Coturnix coturnix*)
Hobby (*Falco subbuteo*)

and for wintering (non-breeding) populations of

Hen harrier *(Circus cyaneus)*

5.2 Salisbury Plain Special Area of Conservation[4]

Annex 1 Habitats that are a primary reason for selection of this site:

H5130 *Juniperus communis* formations on heaths or calcareous grasslands. (Juniper on heaths or calcareous grasslands)

H6210 Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) (important orchid sites). (Dry grasslands and scrublands on chalk or limestone, including important orchid sites)*

***** **Priority habitat**

This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex 2 of the Directive:

S1065 Marsh fritillary butterfly (*Euphydryas (Eurodryas, Hypordryas) aurinia)*)

5.3 River Avon Special Area of Conservation[5]

Annex 1 Habitats that are a primary reason for selection of this site:

H3260 Water courses of plain to montane levels with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation communities

Annex 2 Species that are a primary reason for selection of this site:

1016 Desmoulin's whorl snail (*Vertigo moulinsiana*)
1095 sea lamprey (*Petromyzon marinus*)

[3] From the SPA Review Site Account at http://jncc.defra.gov.uk/default.aspx?page=2050]

[4] From the SAC Site Account at http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0012793]

[5] From the SAC Site Account at http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0013016

1096 brook lamprey (*Lampetra planeri*)
1106 Atlantic salmon (*Salmo salar*)
1163 bullhead (*Cottus gobio*)

The Rivers Till, Bourne and Wylye are tributaries included in the SAC. The Nine Mile River is a winterbourne which also drains to the SAC. The upper reaches of the Nine Mile are included as a feature of Salisbury Plain SSSI.

5.4 The Conservation Objectives for all of these features are to maintain them in favourable condition, with the caveat that maintenance implies restoration if the feature is not currently in favourable condition.

6. What is the current and potential condition of the qualifying interest features?

6.1 Salisbury Plain SSSI is 40.56% favourable and 58.49% unfavourable recovering and 0.95% partially destroyed.

6.2 River Avon System SSSI is 3.48% favourable & 36.96% unfavourable recovering, 56.76% unfavourable no change and 2.80% unfavourable declining.

6.3 River Till SSSI is 100% unfavourable recovering.

7. What are the possible impacts of the Plan/ Project?

7.1 The Army Basing Programme emanates from the 2010 Strategic Defence and Security Review and 'Army 2020' Plan, which recommended the return of personnel from Germany and a reconfiguration of the Army into five regionally-based multi-role brigades. The Ministerial announcement on 5th March 2013 confirmed Salisbury Plain as a major focus of the Reaction Force, with three Armoured Infantry brigades based around Salisbury Plain. In total around 6,251 extra people (3,958 additional service personnel plus families) will be living around Salisbury Plain by 2020, based on the latest figures supplied after a review of the ABP. The increase in personnel will place additional pressure on water resources, sewage treatment capacity and the potentially on the wider environment through increased recreational visits..

7.2 Based on current information the potential impacts of the plan are identified below:

7.3 Water quality impacts on the River Avon SAC due to construction and use of the Nine Mile River crossing from Bulford garrison;

7.4 An 'in combination' recreational pressure/ disturbance impact on the stone curlew population of Salisbury Plain SPA due to SFA, when considered in combination with housing to be delivered under the Wiltshire Core Strategy;

7.5 A water resource impact on the River Avon SAC flows due to increased groundwater abstraction for ABP;

7.6 A new water resource impact on flows in the River Avon SAC catchment due to decreased groundwater discharge resulting from the closure of Larkhill STW soakaway and diversion of all foul flows to Ratfyn STW.

7.7 A new water resource impact on the habitats of the SAC feature Desmoulin's Whorl Snail through changes to groundwater levels due to increased abstraction/ reduced groundwater discharge from Larkhill STW.

7.8 A water quality "in-combination" impact on the River Avon SAC from increased wastewater flows and diversion of existing flows from MOD's Larkhill STW (discharge to ground) to Wessex Waters Ratfyn STW (point discharge to the Avon);

7.9 Potential impacts are summarised in the Technical Consideration at Annex A.

8. What mitigation measures have been identified to avoid any likely significant effects of the P/P on the SPA/SAC/Ramsar Sites?

Rear Access from Bulford Garrison to SPTA

8.1 A project specific HRA was completed in January 2015 (ref B), which detailed all potential impacts of the works and mitigation to be included, with no likely significant impact predicted for Salisbury Plain SAC & SPA and River Avon SAC once the mitigation measures were considered.

8.2 Mitigation included within the project is detailed below:

- An initial option study, based on four possible route alignments, recommended the current proposed route which has been refined in the detailed design based on the results of environmental studies and consultations with statutory bodies. Following Environment Agency feedback, the river crossing will be a 15m long, low-profile pre-cast clear-span structure with no walkway. Whilst this will permanently shade up to 7 metres of the watercourse, it will keep the existing banks intact, retain habitat corridors for free movement of wildlife, reduce potential interaction with vehicles and discourage public use. The route across the floodplain has been refined and reduced from eight metres wide to five following discussion with NE. It takes the shortest route of the feasible options, through the floodplain, leading to the loss of approx. 625 m^2 of floodplain habitat. It will exploit an existing gap in the hedge line, minimising hedge removal and land take. The track will be at floodplain level to allow free movement of water and animals and avoid habitat fragmentation. To minimise the risk of sediment and other pollutants entering the river, the associated washdown has been positioned to the north of the Nine-Mile River to ensure that vehicles are clean when they cross the floodplain in either direction;

- The track has been designed to avoid any direct land take within Salisbury Plain SAC/ SPA with a 5m buffer to site boundaries;

- All suitable vegetation for nesting birds (including ground nesting) will be cleared or made unsuitable through management (grazing) during the September to February period;

- A CEMP will be used to minimise the risk of pollution events, and the floodplain section will be constructed during the summer months when the river is unlikely to be flowing and the ground should be relatively dry;

- DIO's wider Salisbury Plain Environmental Commitments include measures to protect and enhance the habitat of Nine-Mile River. Mitigation for loss of the floodplain habitat will be undertaken using the DEFRA biodiversity offset calculator; measures will include habitat improvements along the wider middle section of the river including removal of plantation poplars, scrub clearance, creation of scrapes and shallow ponds and development of wetland meadow features.

Recreational Pressure

8.3 Mitigation has been identified to address in combination effects for the contribution of ABP to recreational pressure impacts on Stone Curlew, bearing in mind that approximately 80% of the predicted effect will be due to the new housing required by the Wiltshire Core Strategy.

8.4 The HRA of Wiltshire Council's Salisbury Plain Mitigation Strategy (ref E) concluded that the Strategy is adequate to address this issue with respect to Wiltshire Core Strategy housing. Therefore, an undertaking from DIO to follow the Strategy and any resulting identified need for adaptive management will be adequate as a strategic initiative to address the small additional contribution made by ABP. Contributions would need to be on a pro-rata basis in relation to

the probable contribution to the impact such that approximately 80% of any mitigation would need to be provided by Wiltshire Council and c. 20% by the MOD.

8.5 The approach of the Wiltshire Council Mitigation Strategy is to monitor both visitor pressure and stone curlew populations throughout the plan period and respond to any identified negative correlation between the two through a range of potential mechanisms. However, it will be extremely difficult to categorically conclude that increased recreation is linked to plot failure and mechanisms do not necessarily need to involve the creation of new stone curlew plots on SPTA; there is already a considerable surplus of stone curlew plots on SPTA compared to the number of nesting pairs which implies that creating more plots will not necessarily have any effect on the population. The surplus of plots also provides 'buffering' for the stone curlew population on SPTA in that if for any reason a plot is not particularly suitable in a given season (whether due to vegetation growth, disturbance or other reasons) there are other plots available. The stone curlew population at Salisbury Plain is currently at 'favourable conservation status' with the latest data from 2015 for the Wessex stone curlew project identifying a very good year for the Salisbury Plain population, with productivity at around 0.77 (the highest since 2003).

8.6 Measures associated with Wiltshire Council's Mitigation Strategy include:

- Ongoing monitoring of the stone curlew breeding success on Salisbury Plain through the Wessex Stone Curlew Project;
- Increasing the suitability of farmland outside SPTA to stone curlew (this would be an action delivered through parties other than DIO);
- Investigation of opportunities to influence recreational visitors;
- Updated visitor surveys. (including the follow-up survey, undertaken in summer 2015, ref G)
- Improving communication to residents and recreational visitors regarding the sensitivities of the stone curlew populations on SPTA;
- Adaptive management of stone curlew areas to respond to specific matters regarding breeding success (which are often unrelated to disturbance) and enable time and plot-specific initiatives to improve overall plot success and ensure that (irrespective of effects on particular plots) the overall plot resource for stone curlew on SPTA remains viable; and
- Creation of a forum for discussion of the Mitigation Strategy including Natural England, DIO, Wiltshire Council and RSPB.

8.7 As detailed within the Wiltshire Council Mitigation Strategy, the survey of access patterns on Salisbury Plain found that the proportion of the local population using SPTA decreased with distance; decreasingly rapidly between 0-4km but remaining relatively constant between 4-15km. It should be noted however that although the locations of most SFA housing are some distance from the SPA (with no SFA housing located in very close proximity[6]) they are closer than any housing proposed under the Core Strategy:

- Ludgershall SFA site is 2.8km from the SPA;
- Larkhill SFA site is 1.5km from the SAC/SPA;
- Bulford SFA site is 1.3km from the SPA.

8.8 The Mitigation Strategy itself does not appear to have a set quantitative element and there is therefore no reason why it could not be extended to cover the housing proposed as part of

[6] Conventionally defined in planning guidance as five minutes or 400m

ABP. Nonetheless, as the MOD housing will be closer than anything proposed under the Core Strategy, MOD will deliver additional bespoke aspects beyond the Mitigation Strategy:

- Following an assessment of publicly accessible walking routes and open areas in the vicinity of the proposed SFA housing sites at Larkhill, Bulford and Ludgershall (and subsequently Upavon Garrison), MOD will implement a Recreational Access Action Plan (see Annex C). This details the measures that will be taken on the ground at each site to increase and improve the existing path and open space network, enhancing local access for service personnel, their families and the wider public so they are less inclined to visit the SPA. This will link to the provision of a network of open and play spaces within the SFA sites which have been developed in line with Wiltshire Council's *Open Space Study: Draft Report on Typologies and Standards* (December 2014). The amount of space being provided on each SFA site is above that ratio required, to further reduce the likelihood of service personnel and their families visiting SPTA for recreation. The above improvements and linkages to local access have been discussed and agreed with Wiltshire Council.

- As part of the Action Plan, MOD will develop Welcome packs for new residents to educate them about the sensitivity of Salisbury Plain and to promote the access routes around the SFA, encouraging access away from the SPA. Other methods of influencing access and providing education on the conservation value/ sensitivity of the site will also be investigated.

- The DIO Stone Curlew Management Plan (ref C) has been reviewed and updated and includes measures to improve the attractiveness of the plots to the birds and to maximize the number that are suitable (for example by influencing the timing of vegetation removal) and further investigating the feasibility of providing more stone curlew plots in the west of SPTA. These measures will ensure that there are sufficient suitable plots to maintain and if possible increase the overall stone curlew population.

8.9 Achieving these measures (particularly relating to the stone curlew plot management, provision of attractive semi-natural accessible green space on the SFA developments and strengthening of current access around with the SFA sites) in the next five years would provide further precautionary comfort that a likely significant effect on the SPA would not result from ABP.

8.10 DIOs commitment to delivering these mitigation measures is set out in the Environmental Commitments for Salisbury Plain Masterplan (9th September 2014) which states: '*DIO will work with Wiltshire Council and Natural England to address the potential impact of increased recreational pressure from Army Basing on Stone Curlew and will develop a range of additional mitigation measures beyond the Wiltshire Council Stone Curlew Mitigation Strategy. As well as updating the MOD Stone Curlew Management Plan, these measures may include provision of additional recreational green space close to/ within SFA sites; development of walking/ cycle routes to encourage use away from sensitive parts of the training area; continuing adaptive management and exploring measures to positively influence recreational access (particularly for dog walking) on SPTA'.*

Water Resources

8.11 Both MOD and Public Water Supplies (PWS) across Salisbury Plain are abstracted from groundwater sources within the catchment of the River Avon SAC. Whilst the garrisons and SFA at Tidworth and Perham Down are served by licensed Veolia abstractions, the garrisons and some existing SFA at Larkhill, Bulford and Upavon are supplied by (currently) unlicensed MOD groundwater abstractions. The Army Basing Programme is expected to lead to a projected demand increase of approximately 94m^3 (0.094 Ml) per day at Larkhill garrison. At Bulford garrison, on-going leakage reduction work means that the ABP demand will not lead to any increase in abstraction requirement when compared to the 2012-15 baseline. Overall, abstraction at Bulford is estimated to reduce by approximately 23m^3/day. Both sites are served by currently un-licensed MOD sources..

8.12 The new SFA developments at Larkhill and Bulford will be supplied by Wessex Water as Statutory Undertaker (SU); the new SFA at Ludgershall and Tidworth will be serviced by Veolia Water. Both companies already have established Water Resource Management Plans in place and have confirmed that they can supply the additional MOD requirements.

8.13 The Wessex Basin Groundwater Model has previously been developed for the catchment by AMEC FW for the Environment Agency and Wessex Water to inform the Wessex Water licence discussions and Water Resource Management Plan. To inform the impacts of the ABP programme, MOD commissioned AMEC FW to undertake a number of new rounds of groundwater assessments (September 2014- January 2016) to assess the potential effects of different ABP options on the hydrology of the SAC.

8.14 At a meeting of the ABP Hydrological Sub-Group on 24th February 2016 NE advised that MOD need not assess the standalone or in-combination impacts of the existing MoD abstractions and discharges at this stage. This is due to the large amount of work (including development of the Water Management Strategy outlined later) which MOD has undertaken and agreed with all statutory bodies in the lead up to this assessment, which will enables these impacts to be addressed. Further assessment will be required at a later stage and prior to removal of MOD's current exemption from certain licence requirements). In view of this the Groundwater Model was re-run in March 2016 to inform this HRA and to focus specifically on the standalone hydrological impacts of the ABP uplift on the 'Full Licence' condition and closure of Larkhill STW and to develop mitigation options (see Annex G).

8.15 The Full Licence Scenario (Run 296) which is used as the basis from which all other options are assessed includes all Wessex Water and other abstractions/discharges that are considered important by the regulators. Runs included in the latest March 2016 work are detailed below:

- Run 296- the Full Licence run (pre-ABP) against which other runs are compared;
- Run 297- the Full Licence plus ABP (potable uplift + closure of Larkhill STW soakaway) which is presented for reference to highlight the change in impacts as a result of the mitigation options that are presented in Runs 307 and 308;
- Run 307- the first alternative ABP mitigation option which includes a 934 m^3/d reduction in MOD's abstraction at Larkhill to offset the maximum loss of discharge to ground from the closure of Larkhill STW;
- Run 308- the second alternative ABP option which includes a cumulative reduction in abstraction of 934 m^3/d at Larkhill (reduced by 580 m^3/d) and Round O (reduced by 354 m^3/d) to offset the maximum loss of discharge to ground from Larkhill STW.

8.16 The groundwater modelling (Annex G) indicates that the ABP changes (Run 297) will have a relatively low impact compared to current levels with a potential reduction in flow of -0.05 to -0.5 ml/day at all flow regimes on the Avon upstream of Ratfyn STW. Similar potential impacts on flow are also demonstrated along the length of the Till. Downstream of Ratfyn STW the flows are improved as a result of the relocated discharge from Larkhill and the overall increase in discharge following ABP.

8.17 To mitigate for the effects of ABP on river flows resulting from the loss of discharge to ground at Larkhill STW, MOD will reduce net abstraction from the Round O and Larkhill boreholes, and increase reliance on Wessex Water supplies within existing licence conditions. It should be noted that Wessex Water's current Full Licence amount has headroom to cater for back-up supply volumes to MOD and that this Full Licence amount is included in the model runs.

8.18 Wessex Water is currently installing an upgraded regional water distribution grid under the AMP 6 programme to ensure future security of supply for the Salisbury Plain area. According to their adopted (June 2014) Water Resource Management Plan, Wessex Water expects to

have a net surplus of c. 50 Ml/day (50,000 m^3 per day) throughout the period until at least 2040. This would be more than enough to meet existing demand, planned development and all ABP requirements.

8.19 Wessex Water has confirmed there is sufficient mains supply available to feed to Larkhill Camp and that the existing connection is able to provide up to 100% of the camp's potable requirement. At Bulford, there is no existing mains connection; Wessex Water has confirmed that it can provide up to 100% of the camp's potable supply with a new link from Allington and a potential secondary connection from the existing Canadian Estate SFA.

8.20 The two mitigation options (Runs 307 and 308) are based on a maximum daily requirement from Wessex Water of up to 934 m^3/d; this figure will be further refined in the WMS and agreed by the Regulatory Hydrology Steering Group. The impacts of both mitigation scenarios have been modelled against the pre-ABP baseline (Run 296) and show the following:

- Run 307: At Q30- Q95 there is an increase in flow on the River Avon upstream of Ratfyn STW from reducing the Larkhill abstraction. At Q30 there is still reduced flow on the River Till (-0.05 to -0.5 Ml/d); however this impact reduces at lower flow percentiles (Q50- Q95). This shows that the Till, perhaps unsurprisingly as a winterbourne, is much better connected to the aquifer at times of higher water levels than lower water levels;

- Run 308: By reducing the abstraction at Round O and reducing abstraction at Larkhill by a smaller amount, it is possible to improve flows on both the Till and the Avon upstream of Ratfyn (though the improvement upstream of Ratfyn STW will be less that Run 307). This option provides additional benefit to the smaller Till over the larger, less vulnerable River Avon.

8.21 Further details are given in AMEC FW Briefing Note on Alternative Army Basing Scenarios, January 2016 (see Annex G).

8.22 In summary both mitigation options provide an improvement in flow compared to pre ABP conditions. In addition, both scenarios result in improved flows in the Avon across the flow duration curve. Scenario 1 does still have a small negative impact on the Till at higher water levels and flows, with scenario 2 providing small improvements to flows in the Till at higher water levels but less flow improvement to the Avon. The groundwater model concludes that scenario 1 would result in negligible, but negative, impact on flows in the Till whereas scenario 2 would result in negligible, but positive, impact on flows in the Till. Both options would result in positive impact on flows in the River Avon both upstream and downstream of Ratfyn STW.

8.23 Based on the model runs scenario 2, a cumulative reduction in abstraction of up to 934 m^3/d, will be implemented, with Larkhill borehole being reduced by up to 580 m^3/d and Round O borehole being reduced by up to 354 m^3/d.

8.24 To ensure no impacts on the integrity of the SAC from ABP, the MOD has committed that water will not be abstracted above current levels (as defined by the recent maximum monthly peak volume) from the MOD boreholes supplying Larkhill and Bulford, and secondly that the Larkhill STW soakaway will not be turned off, until such time as the Wessex Water secondary supplies are secured and operational. The detail of the proposed Wessex supply volumes and the point at which MOD abstractions will be reduced is detailed in the Water Management Strategy and will be kept under review by the ABP Hydrology Steering group until such time as MOD abstractions are Licensed (see DIO Commitment in Annex H).

8.25 In addition to the above mitigation, the WMS details a series of elements which are programmed to be implemented over the next 4 years to 2020, or longer by prior agreement:

- Since 2007/8, leakage reduction, coupled with efficiency measures, has reduced the total Water Into Supply by approximately 17% at Larkhill and 51% at Bulford. Additional leakage reduction measures have the potential to reduce abstraction requirements still further.

However, it is recognised that this may not result in a similar drop in consumption or impact on the river system as any below-ground leakage is assumed by the Regulators to return to the aquifer.

- Consumption reduction will be maximised by a series of water efficiency, demand management and infrastructure improvements. Whilst the per-capita consumption for service personnel in on-camp Single Living Accommodation (SLA) is relatively modest at 83 litres per person per day, the per-capita consumption for service families (at 150 litres per person per day) is above the national average of 135 litres. The measures below will seek to reduce consumption rates:
    - Constructing all new build to the latest building standards;
    - Reviewing MOD supply infrastructure to improve flexibility, including taking water from other MOD sources across SPTA;
    - Introducing tighter controls on water losses that currently occur on the garrisons (e.g. by replacing leaking fittings); and
    - Retrofitting water efficient technology into existing buildings.

Desmoulin's Whorl Snail

8.26 Desmoulin's Whorl Snail's are a designated feature of the River Avon SAC and occupy fen, marsh and swamp communities in the wider floodplain. They require a water table close to the surface so that the ground remains wet all year, i.e. never drying out, so that, even in high summer, water will rise when the soil is trodden. Desmoulin's Whorl Snail are known to occur on a number of terrestrial areas as outlined in ref H.

8.27 The Site Units with the greatest potential to be affected by ABP are 23 and 24 in the vicinity of West Amesbury, with snails having been recorded in an area of fen, marsh and swamp in unit 23 and on bankside vegetation associated with ditches in unit 24. Site Unit 23 is detailed as Unfavourable- recovering and Site Unit 24 Favourable with works undertaken to restore the ditch habitat for Desmoulin in 2008/09 with a 2010 survey identifying an abundant snail population along the ditch.

8.28 The Wessex Basin Groundwater Model (March 2016) and specifically figures 10 and 14, shows that both the mitigation scenarios (Runs 307 and 308) result in negligible change to groundwater levels close to the River Avon SAC and Units 23 and 24. The model also demonstrates that even if the potential drawdown in groundwater resulting from closure of the Larkhill STW were to extend towards these sites it would be on the edge of the range illustrated (less than 0.01m). This level of groundwater reduction is outside of the range which NE have advised could cause an impact on the suitable habitat for this species. In addition, any impacts on groundwater would be offset by increases in river flows from the mitigation scenarios as these snail areas are adjacent to the river and/or connected ditches and water levels are also affected by the discharging boundary of the river itself.

8.29 In view of the above there will be no significant impacts on Desmoulins as a result of ABP subject to scenario 2 being implemented.

Water Quality

8.30 ABP will see a net impact of approximately 3,100 additional people (service personnel and families) based at Larkhill, and approximately 1,200 at Bulford. Whilst sewage from the existing Bulford SFA and from the camp is handled by Wessex Water at Ratfyn STW on the River Avon, foul flows from Larkhill are handled at the MOD Larkhill STW, which discharges to a soakaway. Larkhill STW lies within the Stonehenge World Heritage Site (WHS) and removal of all MOD STW infrastructure is a stated objective in Historic England's recently updated WHS Management Plan. There would therefore be considerable difficulty in obtaining

approval to upgrade or extend the STW, which is currently operating close to capacity and is nearing the end of its operational life (see Annex F).

8.31 With the closure of Larkhill STW, foul flows from a population of approximately 6,800 (ABP uplift at Larkhill/ Bulford and those currently connected to Larkhill STW) will be transferred to Ratfyn. Larkhill, Bulford and Ludgershall SFA developments have all been designed with SuDs to ensure all surface water discharges to ground through soakaways, rather than being discharged to the STW.

8.32 The current proposed timeline for the ABP development is detailed below with dates at which flows to Ratfyn STW are expected to increase. Please note the programme is inherently subject to change, but shows a gradual increase in flows from 2016- 2020:

- Jul 16 – Aug 17: Main development works start at Larkhill garrison, with construction of new pipework to connect the garrison and SFA to Ratfyn STW. However, no flows are expected.
- Jun 16 – Jun 17: construction of new pipework to connect Bulford SFA to Ratfyn STW. However, no flows are expected.
- Sept 17: Foul flows from Larkhill camp will be diverted to Ratfyn STW, allowing Larkhill STW and soakaway to be demolished.
- Nov 17: First 100 SFA at Larkhill occupied; flows to Ratfyn will commence.
- Feb 18: First 100 SFA at Bulford occupied; flows to Ratfyn will commence.
- Jun – Aug 19: Majority of personnel and families (approx. 90%) relocate to Salisbury Plain. Flows from camps and SFA will approach their expected final volumes.

8.33 In 2015 Kelda Water undertook an assessment of the Waste Water Treatment Options for Bulford and Larkhill (see Annex E). This concluded that the option to close Larkhill STW and connect the garrisons and SFA from both sites to the Wessex Water mains sewage network provided considerable cost-benefit over the principal alternative option of building a new STW at Larkhill. However, subsequent environmental assessment established that changing the discharge of final effluent from the surface soakaway at Larkhill to a point source on the River Avon SAC has observable impacts on both water quality (through a loss of groundwater attenuation of Phosphorous) and water quantity (through the loss of the supporting impacts on the Avon and Till from the Larkhill soakaway..

8.34 The SAC currently exceeds the phosphorus targets set out in Natural England's Supplementary advice to the European Site Conservation Objectives (ref J). This failure has prompted development of the River Avon Nutrient Management Plan (NMP), issued 30th April 2015 (ref D). Current reactive phosphate levels between the Nine Mile confluence and Salisbury are between 0.07 and 0.1mg/l (70-98 ppb); the NMP aims to reduce this to 0.05mg/l (50 ppb). The NMP aims to stop the deterioration in condition of the SAC and restore it to Favourable condition in line with the Statutory requirements of the EU Habitats Directive and the Water Framework Directive by reducing both consented (point source) and diffuse phosphate discharge. The recommendation is Section D5 of the NMP states *'Additional connections to STWs should continue to be made, as long as discharges are within existing consented headroom and the development does not compromise the deliverability of the NMP.'*

8.35 The EA and NE assessed the additional 'worst case' flows to Ratfyn from ABP in September 2015 and calculated an increase in discharge of 933 g Total P/day (see WMS Appendix F for email correspondence confirming calculation, 25th September 2015). Following this assessment the figure was revised down to 737g P/day to reflect changes to the expected military population; it is against this figure the previous HRA (December 2015) was assessed. This figure has been reduced further to 686 g P/ day (see WMS Appendix F for the calculation) to take into account the confirmed Code for Sustainable Homes (CfSH) Code 4 water use standards in the new SFA.

8.36 Although the increase would be within Wessex Water's existing, permitted discharge limits at Ratfyn, NE considers that this additional input will make it harder to deliver the NMP targets (see WMS Appendix F). Even though the NMP would remain 'just deliverable', NE concluded that the MOD should *'include measures to reduce or offset the additional P load discharged to the River Avon from MOD growth to reduce uncertainty on whether the project will compromise deliverability of the SAC conservation objectives.'*

8.37 MOD *could* make the case for not having to offset the additional 686 g P/ day, since even the original 0.933 kg P/day would not *technically* compromise the deliverability of the NMP. Wessex Water has confirmed that it can accommodate the additional ABP load within its existing permitted capacity at Ratfyn, and considers that the NMP takes this Permitted headroom fully into account. However, the ABP Masterplan HRA (and subsequent project-level HRAs) have to conclude with confidence that the activity will **not** have a negative impact on the SAC. Rendering delivery of the NMP more difficult by sending all flows to Ratfyn would make it harder for MOD to conclude this with confidence, especially in light of the currently sub-optimal condition of the SAC . In addition, as a government department, MOD has a statutory duty to protect and enhance protected habitats.

8.38 The 'IROPI' (Imperative Reasons of Over-riding Public Interest) clause cannot be invoked since MOD has a viable alternative of building a new STW outside the World Heritage Site with discharge to ground, rather than increasing the direct nutrient loading in the Avon.

8.39 To positively conclude this HRA and to enable Wiltshire Council to positively determine the project-level HRAs for ABP developments at Bulford and Larkhill, MOD has developed a Phosphorous Action Plan as part of the WMS to offset, as far as reasonably practicable, the additional currently-estimated 686g/ day of Phosphorous that will be discharged into the River Avon system from Q3 2017 onwards as a result of the Army Basing Programme developments:

- MOD will work with Wessex Water to keep the estimated ABP phosphate loading into the River Avon from Ratfyn STW under review. The figure will be updated whenever new information is received, to help ensure that the right target reduction is being worked towards. Measures that could affect the figure going forward include more accurate data on measured flow (given that some figures in the current Phosphorous calculation are estimated); revision to the target Phosphorous figure for the SAC Conservation objectives and/or longer-term changes to final effluent concentrations brought about by technological changes at Ratfyn STW.

- MOD will provide direct funding to Natural England for a Catchment-Sensitive Farming Officer, from FY 16/17 until FY 20/21, when the ABP programme ends. 2020. This post will develop working relationship with farmers on both MOD and non-MOD land in the River Avon catchment, in order to identify potential improvements to farming practices, and to assist them in obtaining Stewardship and other funding to address diffuse phosphorous inputs into the river. As part of this, MOD will provide funding as required for the CSF officer to procure targeted 'Farmscoper' assessments in support of the programme.

- MOD will continue to support the ongoing EA/ NE Sediment programme to identify tracks and training infrastructure on MOD land (including areas subject to more intensive agricultural management) that could be providing a pathway for silt to enter the river. Where the study identifies significant sediment pathways, MOD will undertake appropriate measures (in agreement with the CSF officer) to reduce or eliminate direct runoff. The possibility of sampling for phosphate levels in these sediment sources will also be investigated.

- MOD will also make additional Capital funding available (up to a total of £50k per annum) from FY 17/18 to FY 20/21 inclusive, to provide an alternative funding stream supporting direct improvement measures. This funding will help farmers make smaller-scale

infrastructure improvements that could bring rapid results, although it is not intended to replace Stewardship funding, which is likely to involve much larger sums and potential changes to agricultural practices. The funding will be targeted primarily at MOD tenant farmers; however MOD will investigate if current funding rules allow funding to be used on non-MOD land in the catchment.

- Working with the CSF officer, MOD and its industry partners will also investigate point-source pollution from un-sewered MOD-owned buildings in the catchment; e.g. from failing septic tanks or drainage mis-connections. Repairs will then be undertaken as required.

- MOD will monitor progress of the CSF phosphate reduction measures on a regular basis in conjunction with NE. If the expected phosphate offset is not reasonably on track to be at least largely met (e.g. ≥80% of the target figure) by Spring/summer 2018 (after 2 years of the programme), MOD will then investigate a more comprehensive programme of reforms to Schedule 1 MOD land in the Avon Valley and other areas close to water bodies with direct pollutant linkages to the river. This programme will quantify the shortfall in Phosphorous reduction and then implement effective measures to further reduce diffuse and small-scale point inputs. Measures could involve either reducing the intensity of agricultural production, for example reversion from arable to low-intensity grazing or, in extreme circumstances, taking land out of agricultural production altogether, e.g. by reverting it to wetland habitat. Since this latter measure may affect the viability of some farm businesses, MOD would look to work with farmers in the first instance to change land use, rather than buy out agricultural tenancies

8.40 The success of the above measures will be monitored on at least a six-monthly basis by the regulatory Hydrology Steering Group (see paragraph 8.44).

8.41 The above measures are considered necessary to mitigate P inputs to the Avon until the next water industry Asset Management Programme (AMP 7) period, which starts in April 2020. At this point, enhanced P stripping technology at Ratfyn and other STWs on the Avon *may* be sanctioned. Currently, Ratfyn STW has P stripping in place which reduces the total P concentration in the final effluent to around 0.7mg/l (700ppb) against a consent limit of 1mg/l (1000ppb). Current trials across England are looking at a range of technologies that could potentially reduce P levels in final effluent to around 0.1mg/l (100ppb).

Water Management Strategy

8.42 Kelda Water Services has been appointed to produce a 25-year Integrated Water Management Strategy (WMS) for the military sites being developed under the Army Basing Programme. The WMS, which is required as a Planning Condition being placed on the ABP developments, will manage the current and future impacts of increased military presence on Salisbury Plain on the water environment, particularly but not exclusively related to impacts on flow and water quality targets in the River Avon SAC. The WRMP will have regard for the DIO's planned leakage reductions and efficiency improvements, the expected licensing of MOD abstractions after 2019 and targets set by the Habitats Directive, Water Framework Directive and River Avon NMP. The WMS will provide the overall strategy and mechanism to implement the water resource and quality measures detailed in this HRA

8.43 The Planning Condition being placed on ABP developments on Salisbury Plain currently states:

"The development hereby permitted shall not be occupied until such time as a Water Management Strategy that includes the following components has been submitted to, and approved in writing by, the local planning authority. Where necessary, the Strategy shall make reference to, and be an integral part of, the wider Army Basing Programme developments and the existing MoD water network. Development shall be carried out in compete accordance with the Strategy approved as part of this condition to include:

a) Details of water abstraction volumes, specific abstraction sources, where water will be discharged and leakage rates. This should include detailing any abstraction conditions and how these conditions will be met, also identifying the link between abstractions and discharge to meet licence and permit conditions.

b) Where possible, an overall assessment of individual and combined environmental impacts relating to water resources and how any impacts will be mitigated.

c) Details of any required mitigation or infrastructure improvements to the water abstraction/ supply or foul drainage network that have been identified in the overall assessment carried out as part of this Water Management Strategy, or that have been identified by other relevant studies.

d) Any specific water management requirements/ mitigation for the developments hereby permitted."

8.44 The draft WMS was supplied to Natural England, the Environment Agency and Wiltshire Council in February 2016 with feedback received from Natural England and the Environment Agency in February 2016. The updated document will be available in April 2016.

8.45 The MOD intends to use the Hydrology Steering Group (formally known as the Masterplan Hydrology Stakeholder Sub-Group) to continue dialogue with Natural England, the Environment Agency and Wiltshire Council over progress with hydrological issues and to monitor the performance of the Water Management Strategy and delivery of associated improvements.

Summary

Rear access from Bulford Garrison to SPTA

- A project-specific HRA completed in January 2015 assessed no likely significant impacts for Salisbury Plain SAC & SPA and River Avon SAC once the mitigation measures were considered;
- Mitigation included sensitive design of track infrastructure (e.g. avoiding direct land take within the Salisbury Plain SAC/ SPA, positioning of the washdown to the north of the Nine-Mile River and provision of a clear span bridge), production of a CEMP to minimise risk of pollution entering the Nine-Mile River and enhancement of habitats within the river corridor.

Recreational pressure

- An in-combination recreational pressure/ disturbance impact on the stone curlew population of Salisbury Plain SPA due to SFA was identified when considered with the housing to be delivered under the Wiltshire Core Strategy.
- Wiltshire Council's Salisbury Plain Mitigation Strategy has been considered adequate to address the issue with respect to the Wiltshire Core Strategy housing, and therefore this Strategy will be followed on a pro-rata basis for the small contribution made by ABP.
- However due to the proximity of the ABP housing to the SPA, MOD will deliver the following aspects beyond the Mitigation Strategy:
    - DIO will implement the measures detailed in the Recreational Access Action Plan to promote and where required strengthen the existing network of informal permissive access routes around the SFA sites, in order to create a viable alternative to accessing SPTA for recreation and dog walking.
    - As part of the Action Plan welcome packs will be issued to new residents to educate them about the sensitivity of Salisbury Plain, promote the access routes around the SFA and encourage access away from the SPA;
    - The DIO Stone Curlew Management Plan has been reviewed and updated and includes measures to improve the attractiveness of the plots to the birds and to maximise the number that are suitable (for example by increasing vegetation removal) and further investigating the feasibility of delivering the DIO's ongoing objective to provide more stone curlew plots in the west of SPTA.

Water Resources

- Groundwater modelling indicates that ABP-related abstraction and the closure of Larkhill STW soakaway will have a small but noticeable impact on flows in the River Avon upstream of Ratfyn and along the length of the Till. To mitigate these impacts the following measures will be implemented:
    - A cumulative reduction in abstraction of up to 934 m^3/d will be implemented, with Larkhill borehole being reduced by up to 580 m^3/d and Round O borehole being reduced by up to 354 m^3/d;
    - The additional demand will be met through the provision of secondary potable supplies from Wessex Water within existing licence conditions. Wessex has confirmed that it can provide up to 100% of required demand at both sites;
    - To ensure that ABP has no net impact on the integrity of the SAC, abstractions will not exceed recent peak monthly volumes and the Larkhill STW soakaway will not be turned off until an agreement has been finalised with Wessex Water and the infrastructure is in place to supply enough mains water to offset the uplift and loss of the soakaway volume.
- Additional monitoring, leakage reduction and efficiency measures will continue to be implemented, in line with the WMS.

Desmoulin's Whorl Snail

- The Wessex Basin Groundwater Model (March 2016) shows Runs 307 and 308 result in negligible change to groundwater levels close to the River Avon SAC areas that support Desmoulin's Whorl Snail and therefore no significant impacts as a result of ABP are predicted subject to the Run 308 being implemented

Water Quality

- ABP will lead to an increase in service personnel and families at Larkhill and Bulford which will lead to a potential water quality impact on the River Avon SAC from increased wastewater flows and diversion of existing flows from MOD's Larkhill STW to Wessex Waters Ratfyn STW;
- The latest figures show an increase in discharge of 686 g P/ day to the River Avon SAC from Ratfyn as a result of ABP. The increase would be within Wessex Water's existing, permitted discharge limits at Ratfyn, however P levels are already outside recommended levels for SAC rivers and NE have stated that in their opinion this additional input will make it harder to deliver the NMP targets;
- MOD will implement the following measures to offset, as far as reasonably practicable, the additional Phosphorous that will be discharged into the River Avon system from Q3 2017 onwards as a result of the Army Basing Programme developments:
    - MOD will work with Wessex Water to keep the estimated ABP phosphate loading into the River Avon from Ratfyn STW under review;
    - MOD will provide direct funding to Natural England for a Catchment Sensitive Farming officer post for up to 5 years for the River Avon catchment;
    - MOD will continue to support the ongoing EA/ NE Sediment programme;
    - MOD will also make additional Capital funding available (up to a total of £50k per annum) from FY 17/18 to FY 20/21 inclusive to provide an alternative funding stream supporting direct improvement measures;
    - Working with the CSF office, MOD and its industry partners will also investigate point source pollution from un-sewered MOD buildings in the catchment;
    - MOD will monitor progress of the CSF phosphate reduction measures on a regular basis in conjunction with NE, and if targets are not being met by Spring/ Summer 2018 MOD will investigate a more comprehensive programme of reforms.

8.46 The above water resource and water quality measures will be delivered through a 25 year Integrated Water Management Strategy to cover the military sites being developed as part of the ABP. The performance of the WRMP and delivery of Catchment Sensitive Farming will be monitored by the Hydrology Steering Group.

9. After mitigation, what are the likely residual effects of the proposal on the international nature conservation interests for which the site(s) is designated?

9.1 There is considered to be no likely significant impact on Salisbury Plain SAC and SPA provided the measures outlined above and in Annexes A and B are implemented.

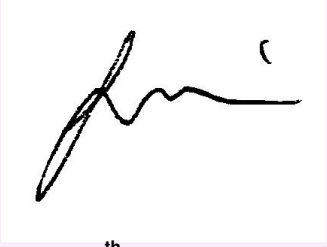
9.2 There is considered to be no likely significant impact on River Avon SAC provided the measures outlined above and in Annexes A and B are implemented.

10. Is further Appropriate Assessment Required?

10.1 The MOD's decision is that because significant effects will be avoided and/or mitigated, Appropriate Assessment is not required for this project.

<table>
<tr><td colspan="2">MOD Formal Record of HRA Decisions</td></tr>
<tr><td colspan="2">Consultation
Natural England, Wiltshire Council and the Environment Agency have been engaged throughout the development of the Salisbury Plain Masterplan (published in June 2014) and were consulted on the Masterplan documents, including the Overarching Environmental Appraisal and the subsequent Masterplan HRA, published in October 2014. Consultation is ongoing with the statutory consultees, including via the ABP Hydrology sub-group meeting, the last meeting of which was held on 24th February 2016 and at which NE advised that the focus should be on ABP impacts alone. As outlined, consultation will continue through the development of the Water Management Strategy and associated initiatives.</td></tr>
<tr><td colspan="2">MOD Decision: Judgement of Likely Significant Effects (JLSE)
The MOD's decision is that the PP, as proposed, <u>is not</u> likely to have a significant effect on the conservation objectives.</td></tr>
<tr><td colspan="2">MOD ENVIRONMENTAL ADVISER AUTHORISATION:</td></tr>
<tr><td>Prepared by:
Chris Meddins (MCIEEM), WYG
Contact no: 02920 829200

Dr Sue Jordan (AIEMA) DIO
Contact no: 01980 674867</td><td>Authorised by:
Julie Swain (MCIEEM), DIO
Contact no: 01980 674608</td></tr>
<tr><td>Signature:
 

Date: 21st March 2016</td><td>Signature:
 
Date: 25th March 2016</td></tr>
</table>

Annex A -Technical Consideration

SPA / SAC / Ramsar Site Feature	**Conservation Objective / Favourable Condition Attribute**	**Potential Hazards** of the plan or project	**Avoidance and Mitigating Factors or Measures** (if appropriate)	**Probability, Magnitude, Likely Duration and Reversibility** of residual impacts	**In Combination Effects** (if appropriate)	**Conclusion**
Salisbury Plain SPA: Stone Curlew	**Disturbance & predation.** **Food availability.** **Extent & distribution of habitat.** **No of breeding pairs.** **Productivity**	**Recreational disturbance in combination with the Wiltshire Core Strategy**	**DIO will implement the measures detailed in the Recreational Access Action Plan to promote and where required strengthen the existing network of informal permissive access routes around the SFA sites, in order to create a viable alternative to accessing SPTA for recreation and dog walking.** **As part of the Action Plan, MOD will develop 'Welcome' packs for issue to new residents to educate them about the sensitivity of Salisbury Plain and to promote the access routes around the SFA and to encourage access away from the SPA.** **DIO Stone Curlew Management Plan reviewed and updated to increase attractiveness of stone curlew plots and investigate the feasibility of expanding population to the west of the SPTA.** **Adaptive management of all stone curlew plots and nesting areas on SPTA in order to respond to specific matters regarding breeding success and ensure overall plot resource for stone curlew on SPTA remains viable** **Participate appropriately in Wiltshire Councils Salisbury Plain Mitigation Strategy.** **Provision of a network of open spaces within the SFA sites which has been developed in line with Wiltshire Council's *Open Space Study: Draft Report on***	**Nil, providing measures outlined are followed.**	**None. All other developments account for effects on this feature.**	**No likely significant effect.**

SPA / SAC / Ramsar Site Feature	**Conservation Objective / Favourable Condition Attribute**	**Potential Hazards** of the plan or project	**Avoidance and Mitigating Factors or Measures** (if appropriate)	**Probability, Magnitude, Likely Duration and Reversibility** of residual impacts	**In Combination Effects** (if appropriate)	**Conclusion**
			Typologies and Standards **(12 December 2014) that is above the ratio required within the document, to further reduce the likelihood of service personnel and their families visiting the SPTA for recreation.**			
Salisbury Plain SPA: Hen Harrier	**Extent & distribution of habitat Disturbance**	**None. No impacts on important roosting sites.**	**N/A**	**N/A**	**No impacts on this species have been highlighted in previous assessments or are known from other planned projects.**	**No likely significant effect.**
Salisbury Plain SPA: Quail	**Extent & distribution of habitat Disturbance**	**None. No impact on important nesting sites.**	**N/A**	**N/A**	**No impacts on this species have been highlighted in previous assessments or are known from other planned projects.**	**No likely significant effect.**
Salisbury Plain SPA: Hobby	**Disturbance & predation. Food availability. Extent & distribution of habitat. No of breeding pairs. Productivity.**	**None. No impact on important nesting sites or lone trees.**	**N/A**	**N/A**	**Feeding range and nesting sites not assessed as detrimentally impacted by other plans or projects or known from other planned projects.**	**No likely significant effect.**
Salisbury Plain SAC: Semi-natural dry grasslands & scrubland facies on calcareous substrates (*Festuco-Brometalia*) important orchid site	**No loss of current grassland Richness of positive indicator species. Little or weed free. Scrub encroachment free Status as focal area for Marsh**	**None . No loss of calcareous grassland due to this proposal.**	**N/A**	**N/A**	**None. None known from other planned projects.**	**No likely significant effect.**

SPA / SAC / Ramsar Site Feature	**Conservation Objective / Favourable Condition Attribute**	**Potential Hazards** of the plan or project	**Avoidance and Mitigating Factors or Measures** (if appropriate)	**Probability, Magnitude, Likely Duration and Reversibility** of residual impacts	**In Combination Effects** (if appropriate)	**Conclusion**
	fritillary					
Salisbury Plain SAC: *Juniperus communis* formations on heaths or calcareous grasslands	**Mix of grassland & scattered, open Juniper scrub Ability to regenerate**	**None. No juniper will be affected by this proposal.**	**N/A**	**N/A**	**No impacts on juniper from other projects have been identified or are known.**	**No likely significant effect.**
Salisbury Plain SAC: Marsh fritillary butterfly *Euphydryas (Eurodryas, Hypordryas) aurina*	**Un-fragmented nature/distribution of habitat (grassland) Long & structured grassland sward Distribution/freq of food & host plant Devil's bit Scabious *Succisa pratensis***	**None. No suitable habitat will be affected by this proposal.**	**N/A**	**N/A**	**None. All other developments account for effects on this feature. None known from other planned projects.**	**No likely significant effect.**
River Avon SAC: All features	**Habitat Functioning: Water flow dependent attributes** Maximum acceptable percentage deviations from	**Reduced flow below flow targets**	**To offset the reduction in discharge due to the closure of Larkhill STW a cumulative reduction in abstraction of up to 934 m^3/d will be implemented at Larkhill borehole (reduced by up to 580 m^3/d) and Round O borehole (reduced by up to 354 m^3/d). The reduced abstraction will be met through an increased reliance on Wessex Water supply, within existing licence conditions, who have confirmed sufficient**	**Nil increase due to ABP, providing measures outlined are followed.**	**Current MOD abstraction to be assessed at a later stage as agreed with NE**	**No likely significant effect as a result of ABP**

SPA / SAC / Ramsar Site Feature	Conservation Objective / Favourable Condition Attribute	Potential Hazards of the plan or project	Avoidance and Mitigating Factors or Measures (if appropriate)	Probability, Magnitude, Likely Duration and Reversibility of residual impacts	In Combination Effects (if appropriate)	Conclusion
	daily naturalised flows throughout the river (from ref H): <Qn50 flows– 15% Qn50-Qn95 flows – 10% >Qn95 flows– 5-10% (5% on winterbourne section of River Till)		**mains supply.** **To ensure no impacts on the integrity of the SAC from ABP, the MOD has committed that water will not be abstracted above current levels (as defined by the recent maximum monthly peak volume) from the MOD boreholes supplying Larkhill and Bulford and the Larkhill STW soakaway will not be turned off, until such time as the Wessex Water secondary supplies are secured and operational. The detail of the proposed Wessex supply volumes and the point at which MOD abstractions will be reduced is detailed in the Water Management Strategy and will be kept under review by the ABP Hydrology Steering group until such time as MOD abstractions are Licensed.** **Additional measures to run concurrently to ABP include:** • **Infrastructure leakage reduction will be implemented by 2017.** • **Constructing all new build to the latest building standards;** • **Introducing tighter controls on waste of water that currently occurs on the garrisons;** • **Retrofitting water efficient technology into existing buildings.** **Production of a 25 year Water Management Strategy to manage the current and future impacts of increased military presence from the garrisons and SFA on the water environment.**			

SPA / SAC / Ramsar Site Feature	Conservation Objective / Favourable Condition Attribute	Potential Hazards of the plan or project	Avoidance and Mitigating Factors or Measures (if appropriate)	Probability, Magnitude, Likely Duration and Reversibility of residual impacts	In Combination Effects (if appropriate)	Conclusion
			Review of performance and delivery of mitigation with NE, EA and Wiltshire Council through the Masterplan Hydrology Stakeholder Sub-Group.			
River Avon SAC: All features	**Habitat Functioning: Water quality dependent attributes** **Total Reactive Phosphorous** (annual average concentration of 0.06mg/l in Upper Avon & 0.1mg/l in Lower Avon (from ref H) **Suspended Solids** No unnaturally high loads - <=10mgl l-1 for reaches of the river classified as chalk stream in character or that should contain salmon under conditions of high environmental quality <=25 mgl l-1 for all other reaches (Units 8, 9, 11, 34 & 35). In addition, no drop in class from existing situation (from ref	**Reduced water quality**	**MOD will implement the following measures to offset, as far as reasonably practicable, the additional Phosphorous that will be discharged into the River Avon system from Q3 2017 onwards as a result of the Army Basing Programme developments:** • **MOD will work with Wessex Water to keep the estimated ABP phosphate loading into the River Avon from Ratfyn STW under review;** • **MOD will provide direct funding to Natural England for a Catchment Sensitive Farming officer post for up to 5 years for the River Avon catchment;** • **MOD will continue to support the ongoing EA/ NE Sediment programme;** • **MOD will also make additional Capital funding available (up to a total of £50k per annum) from Spring 2017 to Spring 2021 inclusive to provide an alternative funding stream supporting direct improvement measures;** • **Working with the CSF office, MOD and its industry partners will also investigate point source pollution from un-sewered MOD buildings in the catchment;** • **MOD will monitor progress of the CSF phosphate reduction measures on a regular basis in conjunction with NE, and if targets are not being**	**Nil increase due to ABP, providing measures outlined are followed.** **It should be noted the River Avon SAC currently exceeds the phosphorus targets set out in Natural England's Supplementary advice to the European Site Conservation Objectives (ref J) without the additional ABP input. This failure prompted development of the NMP to implement the requirements to reduce P impacts in the river under the Habitats and Water Framework Directive.**	**The offsetting of the additional Phosphorous has been provided to reduce uncertainty on whether the project will compromise deliverability of the SAC conservation objectives.** **Additional developments are required to comply with the Nutrient Management Plan (ref D) which has been developed to facilitate development in the catchment in a manner compliant with the requirements of the Habitat Regulations, whilst securing that existing consented activities do not adversely effect the integrity of the River Avon SAC.**	**No likely significant effect as a result of ABP.**

SPA / SAC / Ramsar Site Feature	Conservation Objective / Favourable Condition Attribute	Potential Hazards of the plan or project	Avoidance and Mitigating Factors or Measures (if appropriate)	Probability, Magnitude, Likely Duration and Reversibility of residual impacts	In Combination Effects (if appropriate)	Conclusion
	H)		**met by Spring/ Summer 2018 MOD will investigate a more comprehensive programme of reforms.** **Production of a 25 year Water Management Strategy to manage the current and future impacts of increased military presence from the garrisons and SFA on the water environment** **Review of performance and delivery of mitigation with NE, EA and Wiltshire Council through the Masterplan Hydrology Stakeholder Sub-Group.**			
River Avon SAC: Desmoulin Whorl Snail	**Ground Moisture levels**- ground moisture levels should be 2,3 or 4 (from ref H) **Vegetation composition:** negative indicators or waterlogging or frying out- not more than 10% (occasional on the DAFOR scale) replacement of preferred dominant species of wetter or drier conditions There should be no reduction in population level from that recorded by the Avon Valley survey 1994-5 and Ian Killleen survey	**Changes to habitat through drying out by drawdown of groundwater or disconnection with river.**	**To offset the reduction in discharge due to the closure of Larkhill STW a cumulative reduction in abstraction of up to 934 m^3/d will be implemented at Larkhill borehole (reduced by up to 580 m^3/d) and Round O borehole (reduced by up to 354 m^3/d). The reduced abstraction will be met through an increased reliance on Wessex Water supply, within existing licence conditions, who have confirmed sufficient mains supply.** **To ensure no impacts on the integrity of the SAC from ABP, the MOD has committed that water will not be abstracted above current levels (as defined by the recent maximum monthly peak volume) from the MOD boreholes supplying Larkhill and Bulford and the Larkhill STW soakaway will not be turned off, until such time as the Wessex Water secondary supplies are secured and operational. The detail of the proposed Wessex supply volumes and the point at which MOD abstractions will be reduced is detailed in the Water Management Strategy and will be kept under review by**	**Nil increase due to ABP, providing measures outlined are followed.**	**Current MOD abstraction to be assessed at a later stage as agreed with NE**	**No likely significant effect as a result of ABP**

SPA / SAC / Ramsar Site Feature	**Conservation Objective / Favourable Condition Attribute**	**Potential Hazards** of the plan or project	**Avoidance and Mitigating Factors or Measures** (if appropriate)	**Probability, Magnitude, Likely Duration and Reversibility** of residual impacts	**In Combination Effects** (if appropriate)	**Conclusion**
	1996 (ref H)		**the ABP Hydrology Steering group until such time as MOD abstractions are Licensed.**			

Annex B – Summary of Avoidance and/or Mitigation Measures

Avoidance or Mitigation Measures	How will the measure avoid or reduce adverse impacts on the site	How, by whom and when will the measure be secured and implemented	Degree of confidence in likely success	If/how the measures will be monitored, and, should mitigation failure be identified, how that failure will be rectified
Design of the Nine Mile River crossing includes clear span bridge (retaining channel and bank side vegetation), track at ground level through floodplain, minimised track width through floodplain, CEMP, floodplain construction during summer months, incorporation of wash down to north of river crossing (SPTA) and spill control precautions contained within Range Standing Orders.	Protection of water quality in the River Avon SAC	DIO, designers, construction contractors and military are all responsible for delivery. Timetable for delivery will be immediately prior to the Nine Mile River crossing from Bulford garrison becoming operational	High	Both DIO and the military would be responsible for monitoring implementation. If procedures were not being properly followed this would be remediated by the military enforcing strict adherence to existing standing orders and if necessary introducing more stringent standing orders.
Participate appropriately in Wiltshire Council's Salisbury Plain Mitigation Strategy for the Core Strategy.	Addressing the in combination recreational pressure impact	Ongoing from 2015, to be delivered collectively by DIO, Wiltshire Council, Natural England and RSPB (Wiltshire Council leading)	High	Monitored collectively by DIO, Wiltshire Council, Natural England and RSPB as this is not a purely MOD initiative but is being led by Wiltshire Council. If this ceases to function for any reason MOD would be in the best position of any contributory organisation to address its own contribution to stone curlew disturbance through management of land.
Provision of a network of open and play spaces within the SFA sites which have been developed in line with Wiltshire Council's *Open Space Study: Draft Report on Typologies and Standards* (December 2014). The amount of space being provided is above that ratio required within the document, to further reduce the likelihood of service personnel and their families visiting the SPA for recreation.	Addressing the in combination recreational pressure impact	At the time of delivery of each SFA site. Construction/ landscaping contractor responsible for delivery. WYG responsible for design work.	High	Monitored by DIO. Other initiatives included (e.g. access management) if the greenspace proved to be ineffective.
DIO will implement the measures detailed in the Recreational	Addressing the in combination recreational pressure impact	From 2016 by DIO- secured through inclusion of the Recreational Access	High	Monitored by DIO through success of stone curlew populations and

Avoidance or Mitigation Measures	How will the measure avoid or reduce adverse impacts on the site	How, by whom and when will the measure be secured and implemented	Degree of confidence in likely success	If/how the measures will be monitored, and, should mitigation failure be identified, how that failure will be rectified
Access Action Plan to promote and where required strengthen the existing network of informal permissive access routes around the SFA sites, in order to create a viable alternative to accessing SPTA for recreation and dog walking.		Action Plan in the S106 agreement		visitor surveys. Additional access management if proved to be ineffective.
As part of the Action Plan, MOD will develop 'Welcome' packs for issue to new residents to educate them about the sensitivity of Salisbury Plain and to promote the access routes around the SFA and to encourage access away from the SPA.	Addressing the in combination recreational pressure impact	From 2016 by DIO- secured through inclusion of the Recreational Access Action Plan in the S106 agreement	High	N/a
The DIO Stone Curlew Management Plan has been reviewed and updated and includes measures to improve the attractiveness of plots to the birds and to maximise the number that are suitable and further investigating the feasibility of providing more stone curlew plots in the west of SPTA.	Addressing the in combination recreational pressure impact	From 2015 by DIO.	High	DIO staff monitor stone curlew with RSPB. Should plot management not be sufficient this can be enhanced. Success of plots is considered as part of monitoring and management plan.
Cumulative reduction in abstraction of up to 934 m^3/d will be implemented at Larkhill borehole (reduced by up to 580 m^3/d) and Round O borehole (reduced by up to 354 m^3/d). The reduced abstraction will be met through an increased reliance on Wessex Water supply.	Addressing the impacts of ABP on river flows due to the increased abstraction and reduction in groundwater discharge as a result of the closure of Larkhill STW	To ensure no impacts from ABP MOD will not close the Larkhill STW or carry out additional abstraction above current figures until an agreement has been finalised with Wessex Water and infrastructure is in place to supply mains water to allow the abstraction reductions	High	Monitored by DIO; continued dialogue with NE, EA and Wiltshire Council using the Masterplan Hydrology Stakeholder Sub-Group.
Water efficiency and consumption improvements across the MOD sites including reduction in leakage, new construction to modern build,	Reducing demand and therefore MOD abstraction requirements	Linked to delivery of new developments. Delivered by DIO and appointed construction companies	High	Monitored by DIO; continued dialogue with NE, EA and Wiltshire Council using the Masterplan Hydrology Stakeholder Sub-Group.

Avoidance or Mitigation Measures	How will the measure avoid or reduce adverse impacts on the site	How, by whom and when will the measure be secured and implemented	Degree of confidence in likely success	If/how the measures will be monitored, and, should mitigation failure be identified, how that failure will be rectified
review of supply infrastructure to improve flexibility, tighter controls on the waste of water and retrofitting of water efficient technology.				
Direct funding to Natural England of a Catchment Sensitive Farming Officer for up to 5 years to cover the River Avon catchment.	Identify measures to reduce diffuse inputs into the River Avon and protect water quality in the River Avon SAC	Direct funding by MOD to Natural England; details to be agreed and a contract set in place prior to connection of additional flows to Ratfyn STW. Included as part of the WMS Planning Condition and S106 agreement	High	Dependent on details of role but role and delivery discussed regularly with continued dialogue with NE, EA and Wiltshire Council using the Masterplan Hydrology Stakeholder Sub-Group. MOD will monitor progress and if expected phosphate offset is not reasonably on track to be met, the MOD will investigate a more comprehensive programme of reforms to Schedule 1 MOD land in the Avon Valley and other areas close to water bodies with direct pollutant linkages to the river to implement effective measures to further reduce the phosphorous shortfall.
Continued support of Sediment Pathways Project, in association with Natural England and the Environment Agency.	Identify bespoke mitigation to reduce the main pathways for pollutant related run-off into the River Avon and protect water quality in the River Avon SAC	DIO, Natural England and Environment Agency. Phase 2 appointed in 2016	Medium	Monitored by DIO, Natural England and Environment Agency
Additional capital funding (up to a total of £50k per annum) from Spring 2017 to Spring 2021 inclusive.	To provide an alternative funding stream supporting direct improvement measures to reduce diffuse inputs into the River Avon and protect water quality in the River Avon SAC	Funding by MOD with details in place prior to connection of additional flows to Ratfyn STW	High	Monitored by DIO; continued dialogue with NE, EA and Wiltshire Council using the Masterplan Hydrology Stakeholder Sub-Group.
Production of a 25 year Water Management Strategy to deliver all the water resource and water quality measures being developed as part of the ABP.	Delivery mechanism for all water resource and water quality measures; required as part of a planning condition applied to ABP development	Kelda Water Services appointed with delivery draft supplied in February 2016; production and delivery required as part of a planning condition to ABP development. Updated plan based on NE and EA comments in April 2016. Included as part of the WMS Planning Condition	High	Monitored by DIO; continued dialogue with NE, EA and Wiltshire Council using the Masterplan Hydrology Stakeholder Sub-Group.
Hydrology Steering Group	Monitor and review MOD delivery of measures	Ongoing as part of MOD Hydrology	High	Monitored by DIO, Natural England,

Avoidance or Mitigation Measures	How will the measure avoid or reduce adverse impacts on the site	How, by whom and when will the measure be secured and implemented	Degree of confidence in likely success	If/how the measures will be monitored, and, should mitigation failure be identified, how that failure will be rectified
(formally known as the Masterplan Hydrology Stakeholder Sub-Group) to continue dialogue with Natural England, the Environment Agency and Wiltshire Council over progress with hydrological issues and to monitor and review the performance of the Water Management Strategy and delivery of associated improvements.	detailed within the WMS	sub group and forming part of WMS Planning Condition		Environment Agency and Wiltshire Council