Report prepared for Rogate Parish Council Shale Gas Working Party re. UKOG plc application SDNP/16/04679/CM

PROPOSED HYDROCARBON EXPLORATORY BOREHOLE: MARKWELLS WOOD W. MARDEN, HANTS. UKOG (GB)

COMMENTS ON ENVIRONMENTAL STATEMENT AND GROUNDWATER RISK ASSESSMENT BY HYDROCK CONSULTANTS LTD ON BEHALF OF UKOG (GB).

1. GENERAL.

1.1. The planning application relates to site MWI at Markwells Wood, S. Holt Farm, Rowlands Castle, PO66EL Ref. Dg 161482/001 (APP A). An exploratory borehole was drilled in 2010/11 In PEDL 138 by Northern Petroleum, with initial tests during 2012.
The proposed development comprises 2 phases: -

Phase 1. Construction of a horizontal "side-track" extension from MWI, with well-tests to assess commercial viability of the resource.

Phase2. Dependant on the outcome of Phase 1:- 3 additional wells off the same pad; each comprising a vertical and horizontal component. Provision is also made for a vertical water-injection well.

It is anticipated that the site will be in operation for 20 years.

1.2. The site lies 7km east of Horndean on the SW flank of the S Downs, within the South Downs National Park in a dry valley location approx. 110m AMSL.

1.3. All operations will be in accordance with (1) EA Groundwater Protection, Principals and Practice (GP3) Aug 2013 (2) DEC Onshore Oil and Gas Exploration, Regulatory and Best Practice, Dec 2015 and (3) EA Onshore Oil and Gas Sector Guidance 2016

1.4. Issues to Consider, identified by Hydrock:-

- an interpretation of the hydrogeological conditions that characterise the area within reasonable influence of the drilling proposals;
- Identification of aquifers and groundwater resources that may be put at risk;
- a review of site surface operations and their potential effect on the water environment;
- a review of the proposed sub-surface drilling and associated operations, their potential to affect groundwater resources and proposed mitigation measures; and
- well abandonment proposals to ensure that no long term effects will be experienced.

2. GEOLOGY AND GROUNDWATER FLOW.

2.1. The main components of the geological succession are shown in Fig.1, based on the

lithological records for MWI and reproduced from Tables 3.1 -3.2 of the Hydrock Groundwater Risk Assessment of Sept 2016 (wwwhydrock.com) The upper 576m of the sequence includes 2 principal aquifers: the Chalk comprising 412m of fissured soft limestone, and 87m of permeable sandstones of the Upper and Lower Greensand formations.

2.2. The Chalk and Lower Greensand aquifers have been assessed by Hydrock as in hydraulic continuity, implying that the intervening Gault Clay is not impermeable and would not therefore function as a protective barrier to the migration of hydrocarbons.

2.3. The main target horizons for oil and gas extraction lie within the Cornbrash and Great Oolite formations; logged in MW. I at between 1658 and 1755m b.g.l.

2.4. Groundwater flow is controlled by the local geological structure, characterised by the Chichester syncline and Portsdown anticline (Fig.2). Storage in the aquifer is replenished by rainfall throughout the S. Downs, and in the area NE of the Chichester Syncline, rainfall infiltration reaching the water table will be subject to a general S to SW flow path, taking it below the axis of the syncline to emerge on the Havant/(Bedhampton springline; a straight line distance of approximately 8km (Fig.3) With a mean water table level of approx. 30m AOD and the spring line close to sea level, this would give a hydraulic gradient of about 1 in 270 (or approx. 3.7m/km compared with the Applicant's figure of 1.6m/km).

2.5 It is therefore possible to discern a pathway from a hydrocarbon leakage source at the exploratory borehole site, via a network of fractures and solution fissures, to its outfall at the springs – a strategic public water supply source with a rated average discharge of 144Ml/day.

3. **GROUNDWATER RISK ASSESSMENT.**

3.1. Any deep drilling operation involving penetration of an aquifer can present a threat to the quality of the constituent body of groundwater. And in the case of MW.I Hydrock acknowledge that there is a risk of contamination by drilling fluids, recovered hydrocarbons and stored materials; and as explained in the consultant's Executive Summary, the purpose of the risk assessment is to show how any of the adverse effects can be mitigated to the extent that all perceived risks are "reduced to an acceptably low level".

3.2. The conclusion from this statement must be that the degree of risk is unknown; and even allowing for mitigation measures, a risk of some degree will remain, one that may be acceptable to the applicant but not necessarily to the host community.

3.3 Side-track drilling will be confined to levels at least 1000m below the base of any aquifer; with 2 cemented layers of steel casing remaining in situ. There is also a "potentially significant risk" of fluids being lost into the aquifers via the network of fissures.

3.4. The executive summary also includes the statement that "the risk will in part be mitigated by conventional methods such as the installation of aggregate to seal the fissures and by the use of clean water and inert additives, including bentonite" They add that the

most important mitigation will be achieved by casing out the more permeable part of the upper Chalk before drilling through lower levels of the aquifer.

Our concern here is that most levels of the Upper and Middle Chalk can be heavily fractured and can also act as conduits for contaminants. The Consultants also state in the Exec. Summary that "there is no risk of aquifer contamination by hydrocarbons during the drilling process because, by the time any such hydrocarbons are encountered, all aquifer horizons will have been cased out and cemented in." Unfortunately, because of the brittle nature of the Chalk, the drilling process also creates an 'over – break' annulus or zone of fractured rock surrounding the borehole and this can provide a pathway for contaminants to by-pass the grouted (cemented) sections and migrate throughout the aquifer. I am not aware of any means by which the Applicant could achieve total isolation of the aquifer from such sources of contamination.

4. WATER RESOURCE IMPLICATIONS.

4.1. We know enough of the hydrogeology of the area to support the view that an escape of hydrocarbon contaminants at depth from the MW.1 site could present a material risk to the groundwater resource supporting the public supply source at the Havant and Bedhampton Springs. And the Applicant's Consultant's implicitly acknowledge such a risk but with the proviso that this could in some way be reduced or mitigated. But with the development planned for a period of 20 years, this is ample time for corrosion and failure of the borehole casings and protective seals.

4.2. Many failures will be at depth and could remain undetected by the mainly surface-based monitoring system , possibly for periods of weeks or months – too late for effective remedial action. And once contaminated, a groundwater source must be regarded as, for all practical purposes, lost indefinitely.

4.3. The Havant/Bedhampton Springs are a strategic public water supply source operated by Portsmouth Water Co, and an assessment by the Environment Agency in July 2013 using a 4-scenario classification of a water company's level of water stress (Table 1) has rated Portsmouth as "moderately stressed" under current conditions and also scenarios 2 and 4, and" seriously stressed " under scenarios 1 & 3. What is of special significance however is that all other water companies in the SE Region, including South East Water, Southern Water and Thames, have been rated as <u>seriously</u> stressed under <u>all</u> scenarios. This has a particular bearing on Portsmouth's situation because, whereas in past years water companies formulated their 5 – 25 year Water Resource Management Plans on the basis of a degree of inter-action and mutual support arrangements with neighbouring companies in times of drought or supply shortages; the latest guidance from Government, recognising the future impact of demand growth and climate change, calls for much closer co-operation between neighbouring companies; invoking a regional or even national context for future water resource management plans, commencing with WRMP19 now in preparation. As a net contributor, Portsmouth will almost certainly feature as a key element in the regional management of our water resources and public supply strategy. The threat to Havant and Bedhampton should therefore be assessed with this in mind. We should also prepare for the possibility that successful development of the MW.I site will encourage further applications for additional pads; adding to the threat to groundwater quality .

TABLE 1
ENVIRONMENT AGENCY WATER STRESS SCENARIOS.
JULY 2013.

SCENARIO	WATER CONSUMPTION	CLIMATE CHANGE IMPACT
1	HIGH	SEVERE
2	HIGH	MODERATE
3	LOW	SEVERE
4	LOW	MODERATE

4.4. Any assessment of the possible impact of the current application should also take into account what any substantial contamination of the Chalk aquifer could also mean for the environmental quality of soils and any surface bodies of water in the vicinity of MWI.

4.5. The EA has also made clear that groundwater quality must be protected from potentially polluting operations, and under its Groundwater Protection Principles and Practice, Nov. 2012, opposes any development that may pollute "aquifers of high value" – a provision which must certainly apply to the Markwells situation; and there are no benefits that can be set against the environmental, economic and social risks to the host community.

4.6. The proposal also calls for a complex and sophisticated regulation strategy that cannot, under any circumstances, accommodate short cuts or relaxation of environmental quality or public health standards. And it also pre-supposes that the regulators have the requisite staffing levels and resources to monitor, supervise and where necessary, enforce compliance.

4.7. Further development of UK oil and gas would also be at odds with our commitment to comply with the inter-governmental agreement to restrict carbon emission rates in line with the 2050 global warming control limits. If so we understand that there are already more than sufficient reserves in hand to meet future needs.

5. CONCLUSIONS AND RECOMMENDATIONS.

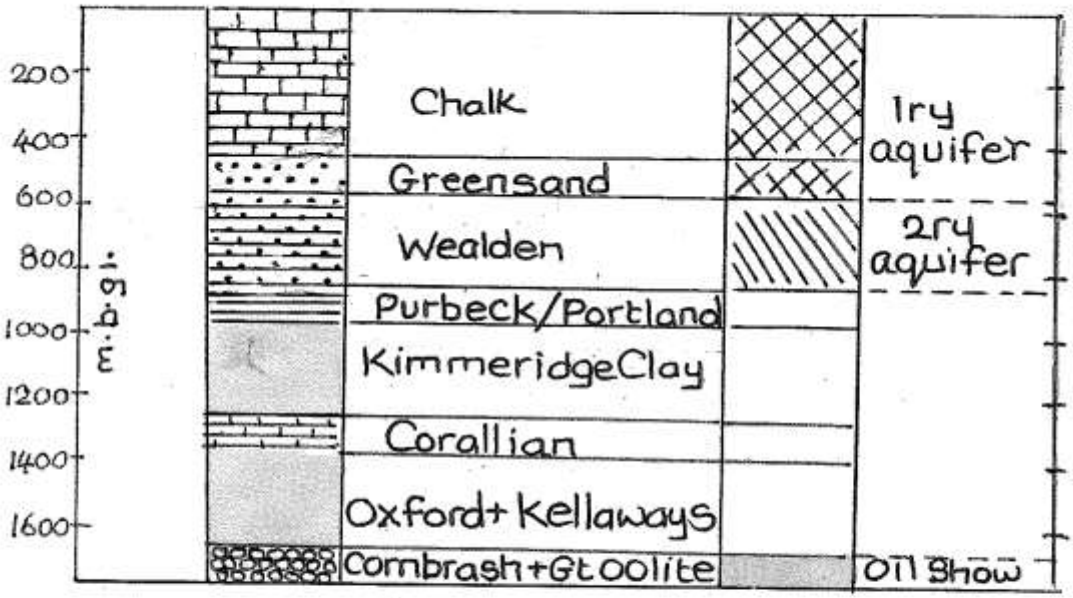
Notwithstanding the Applicant's commitment to measures for aquifer protection, we are not persuaded that the development of hydrocarbon fuels at this site can be effected without detriment to local groundwater resources and strategic public supply sources. It would therefore be important to have the views of the water company.

The foregoing comments are made on the assumption that neither phase of the proposed development will involve pressure injection of fluids or hydraulic fracturing of any of the constituent geological formations.

G.D.Warren
14.10.2016.

Fig·1

MW·1 STRATIGRAPHY.



Fig·2

SOUTH DOWNS. DIAG. SECT.

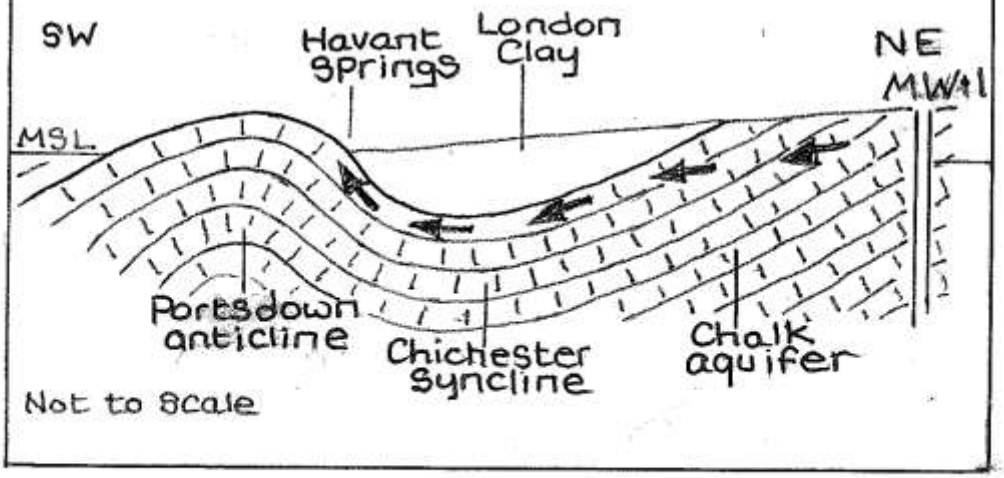
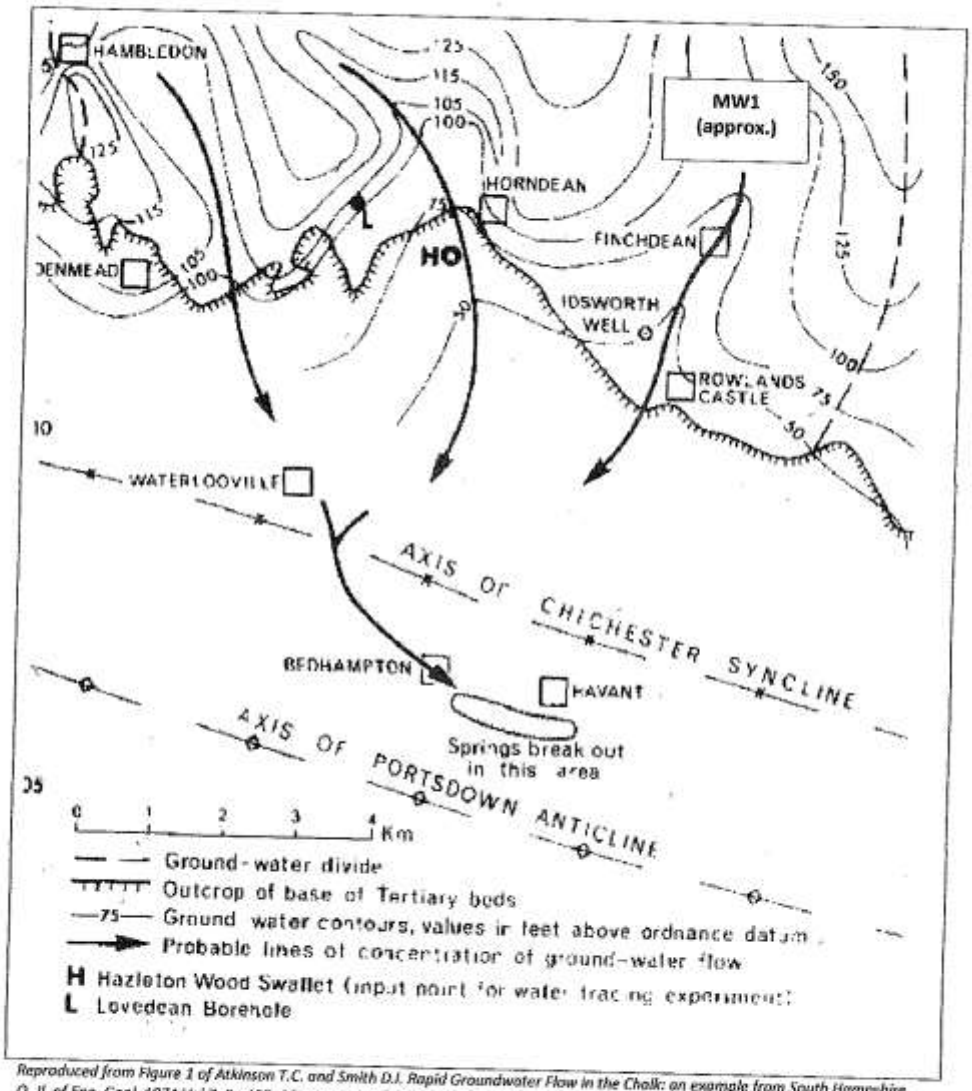


Fig 3

Figure 2: Groundwater Flow in the Chalk



Reproduced from Figure 1 of Atkinson T.C. and Smith D.I. Rapid Groundwater Flow in the Chalk: an example from South Hampshire. Q. Jl. of Eng. Geol. 1974 Vol 7. Pp 197 -205.Countour levels refer to the height of groundwater above ordnance datum, and are not topographical contours.

As per Figure 2, groundwater recharged from rainfall on the Chalk outcrop west of the site is considered to flow towards the Havant and Bedhampton Springs. The springs emerge where the Upper Chalk aquifer crops out at its junction with the Reading Clay near Bedhampton. The 1974 paper by Atkinson & Smith quotes earlier work by Day (1964), wherein preferential flowpaths towards the springs were identified and it may be noted that the Markwells Wood site is not on one of these flowpaths.