ASX ANNOUNCEMENT

ASX: QEM

21 July 2020

Outstanding oil yields achieved in extraction test work

- **Oil extraction test results from the Julia Creek resource confirm oil yields up to 181 kg per tonne, which is 218% on those reported under Modified Fischer Assay (MFA)**
- **Oil yields consistently over 175% of Modified Fischer Assay oil yield for a range of varying test conditions**
- **The increase in oil yields is made possible with the addition of a solvent, which would be derived directly from the oil stream produced from the Julia Creek resource and therefore be exceptionally cost effective**
- **Oil analysis work to be completed to characterise oil produced**
- **Test work currently being completed for vanadium extraction rates within the shale portions of the Julia Creek resource**

QEM Limited (ASX: QEM) **("QEM" or "Company")** is pleased to announce highly successful results from recent independent test work at its 100%-owned Julia Creek vanadium and oil shale project in North Queensland. The Project currently hosts a JORC resource of 2,760Mt with an average V_2O_5 content of 0.30% and a 3C Contingent Oil Resource of 783 MMbbls with an average oil yield of 53 litres per tonne (refer to ASX announcement dated 14 October 2019*).

The test work was designed to investigate the potential to increase oil yields from the oil shale portions of the Julia Creek deposit through the addition of a solvent during extraction processing. The test work indicates that substantially higher oil yields are possible at Julia Creek, compared to extraction processing without solvent, such as direct retorting.

These impressive results provide greater clarity and flexibility for QEM to implement a balanced vanadium versus oil shale recovery strategy, which is a crucial factor in minimising capital cost expenditure, minimising operating costs and maximising profit margins.

QEM Managing Director Gavin Loyden said he was delighted with the oil results, which marked a key milestone towards commercialisation of the Julia Creek project.

"The tests produced oil yields substantially higher than our previous oil extraction test work (Ref: QEM Announcement 17th July 2019), laying the groundwork for a significant improvement to the processing and extraction methods for the oil shale and vanadium ore body," Mr Loyden said.

"We will now build on this strong momentum by conducting further optimisation tests and engineering design. Our task now is to determine the optimum processing and extraction method, which balances

and maximises the returns we can make from both vanadium and the hydrocarbons available at Julia Creek".

"With fuel security a very important and growing national security issue, we expect that domestic sources of quality hydrocarbon supply are likely to be more highly valued in the future, as Australia seeks to develop a more resilient economy, post COVID-19 and reduce its reliance on imported fuel supplies."

Figure 1: Oil produced from Solvent Extraction of QEM oil shale

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Oil Extraction Testing

The Company engaged HRL Technology Group in Melbourne (HRL) to conduct an extensive program which included oil extraction testing using a solvent. HRL, which is a NATA-accredited laboratory company, has a depth of knowledge gained over many years and has previously completed projects for various oil shale developers in Australia.

The hydrocarbon solvent used in the extraction testing can be derived directly from the produced oil stream. The solvent additionally acts as a hydrogen donor which converts the kerogen to product oil with higher yield and quality than conventional technologies. The solvent is regenerated and re-used within the process, so this reagent is likely to be exceptionally cost efficient.

Specific outcomes from the extraction testing activities included:

- The oil yields determined for the base case solvent extraction tests at 450°C were 16.7 to 18.1 % dry basis for the OSU shale and about 14.7% for the OSL shale;
- The oil yields for the solvent extraction tests are about double those for Fischer Assay Tests;
- The oil yields were relatively consistent for a range of varying test conditions;

Sample Details

Testing focused on samples from a single location within the QEM oil shale resources. A 10kg crushed sample from each of the upper and lower shale bands (OSU and OSL) were provided by QEM from previously reported drillhole QEM2017.

Drill Hole	Easting	Northing	Elevation (m)	Depth (m)
QEM017	597941.96	7709036.66	141.59	84

Samples were milled to a nominal top size of 212µm using a vibratory mill to facilitate subsequent chemical analysis and oil extraction testing.

Test Methodology

The solvent extraction testing involved heating a slurry of oil shale and solvent in a batch autoclave at high pressure and a temperature typically in the range of 400°C to 450°C. Under these supercritical conditions the kerogen in the shale is converted to liquid and gaseous products. The solvent acts as a hydrogen donor solvent which assists the kerogen conversion.

The oil yield from solvent extraction tests is impacted by a range of factors including temperature, residence time, particle size, feed material properties, solids loading and solids / solvent ratio. The intention for the solvent extraction test program was to demonstrate the effectiveness of solvent extraction for QEM's oil shale rather than optimising the different test conditions.

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Test Matrix

The following table details a high-level summary of the different factors investigated in the test work:

Test	Objective	Sample	Temp	Residence Time	Shale Mass	Shale Particle Size	Solvent	Solvent Mass
			°C	mins	g			g
0	Check system operation	OSU	450	15	8	-212 µm	Solvent A	16
1	High temperature	OSU	450	15	8	-212 µm	Solvent A	16
2	Mixed Solvent	OSU	450	15	8	-212 µm	80:20 Solvent B / Solvent A	16
3B	Coarse Shale	OSU	450	15	8	-600 µm to 2mm	Solvent A	16
4	Solvent A- blank	-	450	15	-	-	Solvent A	24
5	Increased Shale Loading	OSU	450	15	12	-600 µm to 2mm	Solvent A	12
6	Low temperature	OSU	400	15	12	-212 µm	Solvent A	12
7	High residence time	OSU	450	45	12	-212 µm	Solvent A	12
8	Varied Mixed Solvent Ratio	OSU	450	15	12	-212 µm	90:10 Solvent B / Solvent A	12
9	Test second sample	OSL	450	15	12	-212 µm	Solvent A	12
10	Low temperature	OSL	400	15	12	-212 µm	Solvent A	12

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Test Results

As detailed below, the oil recovery test results highlighted that using a solvent consistently produced an oil yield which is **double** the yield of a Modified Fischer Assay (MFA) for both the OSU and OSL.

The current 3C Contingent Oil Resource of 783 MMbbls at an average oil yield of 53 litres per tonne is reported applying a Modified Fischer Assay. This assay method is the standardised laboratory test to determine oil yield from oil shale. It simulates the amount of oil yield possible through the application of high temperatures in pyrolysis or retorting, with no use of a solvent. As such, the results achieved through using a solvent detailed below are reported as a percentage of the Modified Fischer Assay oil yield.

Parameter	**Run 1**	**Run 2**	**Run 3B**	**Run 5**	**Run 6**	**Run 7**	**Run 8**	**Run 9**	**Run 10**
Percentage Yields (% dry basis)									
Oil yield	16.7	13.4	15.6	18.1	15.5	14.5	9.5	14.8	13.4
Gas yield	2.6	4.2	3.0	3.3	1.7	5.6	3.3	3.2	0.5
Water yield	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solids residue yield	79.8	82.4	81.4	78.6	82.8	79.9	87.3	82.0	86.1
Shale conversion	20.2	17.6	18.6	21.4	17.2	20.1	12.7	18.0	13.9
Oil yield (kg/tonne dry basis)	167.4	134.1	156.3	180.8	154.9	145.1	95.0	147.5	134.1
% of MFA Oil Yield	202	162	188	218	187	175	114	208	189
Modified Fischer Assay (MFA) oil yield (kg/tonne)	OSU shale – 83 kg/tonne							OSL Shale – 71 kg/tonne	

A further pleasing outcome from the test work was that utilising coarse feed (test 3) did not significantly impact on the extraction efficiency. The particle size will be important for commercial process with respect to the shale preparation as well as slurry flow and heat transfer characteristics.

The Company is extremely pleased with the results of the test work which clearly demonstrate the effectiveness of solvent extraction for QEM's oil shale.

QEM Limited
Level 11, 216 St Georges Terrace
Perth WA 6000 Australia

John Foley Chairman
Gavin Loyden Managing Director
Daniel Harris Non-Executive Director
David Fitch Non-Executive Director

www.qldem.com.au
info@qldem.com.au
+61(0) 8 9481 0389

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Next steps – Oil Extraction Testing

With the highly encouraging results, the Company will immediately seek to complete:

- Evaluation of oil quality from solvent extraction tests;
- Additional tests with different samples from the Julia Creek resource to demonstrate the test outcomes across the resource;
- Optimisation trials to investigate given parameters in more detail;
- Engineering and costing activities to develop and evaluate the extraction process, including assessing economic viability.

Vanadium Extraction Testing

The Company is currently awaiting final results for extraction efficiencies for vanadium achieved from acid leach tests of shale ash feeds produced under different conditions and looks forward to reporting these when available.

- ENDS -

This announcement was authorised for release on the ASX by the Board of QEM Limited.

*The information in this announcement that relates to the mineral resource and contingent resource estimates for the Company's Julia Creek Project was first reported by the Company in its IPO prospectus dated 20 August 2018 and supplementary prospectus dated 12 September 2018 (together, the "Prospectus") and the subsequent resource upgrade announcement ("Resource Upgrade") dated 14 October 2019. The Company confirms that it is not aware of any new information or data that materially affects the information included in the Prospectus and Resource Upgrade, and in the case of estimates of Mineral Resources and Contingent Resources, that all material assumptions and technical parameters underpinning the estimates in the Prospectus and Resource Upgrade continue to apply and have not materially changed.

For further information, please contact:

Gavin Loyden
Managing Director
P: +61 7 3303 0161
E: gavin@qldem.com.au

Shane Murphy
FTI Consulting
Investor Relations
P: +61 420 945 291
E: shane.murphy@fticonsulting.com

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ABOUT QEM

QEM Limited (ASX: QEM) is a publicly listed company which is focussed on the exploration and development of its flagship Julia Creek Project, covering 250km^2 in the Julia Creek area of North Western Queensland.

The Julia Creek vanadium / oil shale project is a unique world class resource with the potential to deliver innovative energy solutions, through the production of energy fuels and vanadium pentoxide. QEM strives to become a leading producer of liquid fuels and in response to a global vanadium deficit, also aims to become a global supplier of high-quality vanadium pentoxide, to both the nascent energy storage sector and the Australian steel industry.

This globally significant JORC (2012) Mineral Resource of 2,760 Mt @ 0.30% V2O5 is one of the single largest ASX listed vanadium resources and represents a significant opportunity for development.

The tenements form part of the vast Toolebuc Formation, which is recognised as one of the largest deposits of vanadium and oil shale in the world and located less than 16km east of the township of Julia Creek. In close proximity to all major infrastructure and services, the project is intersected by the main infrastructure corridor of the Flinders Highway and Great Northern Railway, connecting Mt Isa to Townsville.

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