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## GRIFFITH UNIVERSITY STUDY FINDS MULTIPLE OPPORTUNITIES FOR ZEOLITE-BASED GREENHOUSE GAS MITIGATION

Emerging mineral processing technology company, Zeotech Limited (ASX: ZEO, "Zeotech" or "The Company"), is pleased to advise Griffith University ("Griffith") has completed a 3-month Extended Carbon Market Scoping Study<sup>1</sup> ("the Study"), which formed part of the Company's comprehensive dual-stream agricultural product development program ("the Program") currently underway at the university.

The Study was strategically tailored to commence at the beginning of the Program to identify additional opportunities for materials-based greenhouse gas (GHG) mitigation, made possible with Zeotech's proprietary mineral processing technology for the low-cost production of manufactured zeolites.

### HIGHLIGHTS

- Griffith's 'Extended Carbon Market Scoping Study' finds manufactured zeolites have the potential to contribute to climate change mitigation for the three major greenhouse gases (GHG) - carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)
- The Study identified an additional seven prospective opportunities for manufactured zeolites to achieve potential climate change mitigation outcomes, driven by the Company's low-cost proprietary mineral processing technology
- Zeotech has engaged Griffith to prepare a targeted proposal to further investigate the commercial prospects of two high potential opportunities in landfill methane mitigation and calculating fertiliser GHG offsets
- Methane is the second most significant GHG with a 100-year global warming potential 28 times greater than CO<sub>2</sub> and landfill methane releases just under 1 Gt of atmospheric CO<sub>2</sub>-e p.a.
- An active manufactured zeolite layer could function to intercept and destroy methane emitted from the underlying refuse within landfill sites
- Chemical fertiliser production is one of the most GHG intensive processes globally. Further, Nitrous Oxide is produced when nitrogen fertilisers are applied to soils. Nitrous Oxide is the third most significant GHG with a 100-year global warming potential 265 times greater than CO<sub>2</sub>

Griffith University, School of Environment and Science | Australian Rivers Institute, Dr. Chris Pratt commented:

*"Griffith's extended carbon markets scoping study confirms manufactured zeolites have the potential to play a significant role in materials-based greenhouse gas mitigation. Methane emissions remain a critical sustainability challenge and working on developing zeolite centric solutions to achieve this is an exciting and important opportunity"*

<sup>1</sup> ASX Release 08/11/2021 "Zeotech to Develop Products for Carbon Markets in Collaboration with Griffith University"

*"The team at Griffith has also commenced the soil carbon trials, which form part of Zeotech's agricultural product development program, and we look forward to further investigating GHG mitigation solutions utilising Zeotech's low-cost manufactured zeolites."*

Zeotech, Managing Director Peter Zardo added:

*"Zeotech has taken a portfolio approach in developing opportunities that leverage the Company's proprietary mineral processing technology to address sustainability challenges, and our work with Griffith underpins this focus."*

*"I recently met with the team at Griffith on campus and feel confident the capabilities and expertise we have on our projects will deliver on Zeotech's objectives and enable the Company to make a tangible contribution in developing GHG mitigation solutions."*

### **Griffith University 'Extended Carbon Markets Scoping Study'**

The Study was undertaken to investigate further opportunities for materials-based GHG mitigation, made possible through the use of Zeotech's low-cost proprietary mineral processing technology. The Study found that manufactured zeolites have the potential to contribute to mitigation of the three main GHGs of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). The work undertaken by Griffith identified seven (7) additional opportunities and ranked them on a scale of 'readiness and value proposition of testing'.

1. Zeolite application to landfill cover soils to mitigate methane emissions
2. Calculating fertiliser GHG offsets by replacing conventional fertilisers with zeolites
3. In vitro testing on methane reduction potential of zeolites as a livestock feed
4. Engineered wetlands to mitigate wastewater methane and nitrous oxide emissions (following on from opportunity #1)
5. Incorporating zeolites into methane oxidation technologies for coal mines
6. Zeolites in livestock housing to suppress ammonia emissions
7. Using zeolites to catalyse the crystallisation of inorganic carbonate minerals

The Company has engaged Griffith to prepare a proposal to carry out further research on the two highest-ranking opportunities of landfill methane mitigation and fertiliser greenhouse gas offsets. The short-term projects, which will run parallel with the existing Program, will aim to establish the commercial feasibility and market readiness of each opportunity.

### **Manufactured zeolite application to landfill cover soils to mitigate methane emissions**

Landfilling of domestic waste is a significant source of methane (CH<sub>4</sub>) emissions, releasing just under 1 Gt of atmospheric CO<sub>2</sub>-e (carbon dioxide equivalent) per annum. Methane (CH<sub>4</sub>) is the second most significant GHG, with a global warming potential (GWP) **28 times greater** than carbon dioxide (CO<sub>2</sub>) over a 100-year period<sup>2</sup>. Despite advancements in applications where methane gas can be used for energy, recovery efficiency is typically less than 60%<sup>3</sup>, resulting in unrecovered gas passing through the overlying capping soils.

Given zeolites' high gas exchange and high surface area properties, their application to landfill cover soils could significantly boost baseline CH<sub>4</sub> oxidation rates.

<sup>2</sup> IPCC. Climate Change (2014): Synthesis Report, IPCC, Geneva, Switzerland

<sup>3</sup> Abbasi, S. A. The myth and the reality of energy recovery from municipal solid waste (2018)

The exceptionally high surface area of manufactured zeolites presents a prospective opportunity to harness these advanced materials for climate change abatement. The application of a layer of manufactured zeolites to cover soils could offer ideal habitats for a group of bacteria termed ‘methanotrophs’. These bacteria are specialist methane consumers and can oxidise the powerful GHG into water and carbon dioxide. Whilst the latter is a GHG, it has significantly less GWP.

In addition to stimulating biological CH<sub>4</sub> oxidation, zeolites applied to landfill cover soils could also catalyse chemical CH<sub>4</sub> oxidation. It has been identified that manufactured zeolites exhibit exceptionally effective CH<sub>4</sub> oxidation potential, noting that they may hold the key to substantive climate change abatement.<sup>4</sup>

The volume of zeolite addition required to increase the CH<sub>4</sub> oxidation of landfill cover soils is an important consideration. The thickness of landfill cover soils varies widely. However, research indicates a very thin active layer is responsible for oxidation<sup>5</sup>. This is encouraging as it implies relatively small volumes of zeolite additions may be required to be effective. An active manufactured zeolite layer could function to intercept and destroy methane emitted from the underlying refuse, as shown below.



(image) Mitch Diamond, The Image Bank via Getty Images

The blue highlight line indicates where an active manufactured zeolite layer could function to intercept and destroy methane emitted from the underlying refuse.

<sup>4</sup> Jackson, R. B.; Solomon, E. I.; Canadell, J. G.; Cargnello, M. and Field, C. B. Methane removal and atmospheric restoration. *Nature Sustainability*. 2019, 2(6): 436-438. 10.1038/s41893-019-0299-x

<sup>5</sup> Pratt, C.; Walcroft, A. S.; Deslippe, J. and Tate, K. R. CH<sub>4</sub>/CO<sub>2</sub> ratios indicate highly efficient methane oxidation by a pumice landfill cover-soil. *Waste Management*. 2013, 33(2): 412-419. <https://doi.org/10.1016/j.wasman.2012.10.020>

Combined with manufactured zeolite's potential for improving gas exchange rates within the soil matrix, it may be possible to significantly increase the methane oxidation capacity of landfill cover soils. In addition to climate change abatement potential, the application to landfill cover soils could offer further co-benefits from the suppression of dangerous and nuisance gas accumulation and boost prospects of re-purposing closed-off landfill sites for other applications, such as recreational use or ecological habitat restoration.

Eligible landfill gas projects can earn Australian Carbon Credit Units (ACCUs) for the reduction of methane emitted, measured in carbon dioxide equivalent (CO<sub>2</sub>-e). This would allow for every one tonne of net methane abatement calculated for the project (project abatement less baseline abatement) to equate to 28 tonnes of CO<sub>2</sub>-e, or potentially 28 ACCUs.

### **Assessing fertiliser GHG offsets by utilising manufactured zeolites as a fertiliser delivery platform**

Production of chemical fertilisers is one of the most GHG intensive processes on a global scale<sup>6</sup>. Food production is responsible for approximately one quarter of the world's GHG emissions<sup>7</sup> and the planet's growing population and food consumption will require food production to increase by 70% by 2050<sup>8</sup>.

When nitrogen fertiliser is applied to the soil, plant uptake can be as little as 35%<sup>9</sup> and much of the fertiliser is leached into waterways or is broken down by microbes in the soil releasing nitrous oxide (N<sub>2</sub>O) into the atmosphere<sup>10</sup>. Nitrous oxide is the third most significant GHG with a GWP **265 times greater** than carbon dioxide (CO<sub>2</sub>) over a 100-year period<sup>11</sup>.

The unique properties of manufactured zeolites and research to date present potentially significant GHG mitigation opportunities for the application of zeolites to soils as nitrogen-carrying slow-release fertiliser. The aim of the research is to establish whether a GHG offset benefit could arise from granulating the Company's manufactured zeolite with conventional fertilisers to offer a more effective, efficient, and sustainable platform for plant nutrient delivery. A more efficient slow-release platform has the potential to utilise less fertiliser input without compromising yield, resulting in enhanced on-farm economics and improved environmental and biodiversity outcomes.

The proposed research is strongly aligned with the existing dual-stream program and would seek to establish the carbon footprint of a potential Zeotech agri-product compared to conventional fertiliser applications. Further, it is anticipated that additional on-farm benefits may arise from decreased conventional fertiliser costs, improved soil moisture retention, increased soil carbon protection, decreased soil acidification and eutrophication prevention.

This announcement has been approved by the Board.

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<sup>6</sup> Tallaksen, J. Nitrogen fertilizers manufactured using wind power: greenhouse gas and energy balance of community-scale ammonia production. *Journal of Cleaner Production* (2015)

<sup>7</sup> Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*

<sup>8</sup> Whitfield, S., Challinor, A. J. & Rees, R. M. Frontiers in Climate Smart Food Systems: Outlining the Research Space. *Front. Sustain. Food Syst.* 2, 1–5 (2018).

<sup>9</sup> <https://ourworldindata.org/fertilizers#nearly-two-thirds-of-applied-nitrogen-is-not-used-by-our-crops>

<sup>10</sup> Paungfoo-Lonhienne C., Redding M., Pratt C., Wang W. Plant growth promoting rhizobacteria increase the efficiency of fertilisers while reducing nitrogen loss. *Journal of Environmental Management*, 233 (2019)

<sup>11</sup> <http://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme/global-warming-potentials>

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## About Zeotech

Zeotech Limited (ASX: ZEO) is a team of dedicated people, working together to build a future focused company, leveraging proprietary technology for the low-cost production of advanced materials 'manufactured zeolites' to deliver solutions aimed at addressing sustainability challenges.

## About Zeolites

Manufactured zeolites are aluminosilicate minerals with a sponge-like structure, made up of tiny pores (frameworks) that make them useful as catalysts or ultrafine filters. They are commonly known as molecular sieves and can be designed to selectively adsorb molecules or ions dependant on their unique construction.

Zeolites play an important role in a cleaner and safer environment.

- zeolites are an effective substitute for harmful phosphates in powder detergent, now banned in many parts of the world because of blue green algae toxicity in waterways;
- as catalysts, zeolites increase process efficiencies = decrease in energy consumption;
- zeolites can act as solid acids and reduce the need for more corrosive liquid acids;
- zeolites adsorbent capabilities see them widely used in water treatment i.e., heavy metal removal including those produced by nuclear fission; and
- as redox catalyst sorbents, zeolites can help remove exhaust gases and CFC's.

## Forward-looking Statements

This release may contain certain forward-looking statements with respect to matters including but not limited to the financial condition, results of operations and business of Zeotech and certainty of the plans and objectives of Zeotech with respect to these items.

These forward-looking statements are not historical facts but rather are based on Zeotech current expectations, estimates and projections about the industry in which Zeotech operates, and its beliefs and assumptions.

Words such as "anticipates," "expects," "intends," "plans," "believes," "seeks," "estimates", "guidance" and similar expressions are intended to identify forward looking statements and should be considered an at-risk statement.

Such statements are subject to certain risks and uncertainties, particularly those risks or uncertainties inherent in the process of developing technology and in the endeavour of building a business around such products and services.

These statements are not guarantees of future performance and are subject to known and unknown risks, uncertainties, and other factors, some of which are beyond the control of Zeotech, are difficult to predict and could cause actual results to differ materially from those expressed or forecasted in the forward-looking statements.

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Zeotech cautions shareholders and prospective shareholders not to place undue reliance on these forward-looking statements, which reflect the view of Zeotech only as of the date of this release. The forward-looking statements made in this announcement relate only to events as of the date on which the statements are made. Zeotech will not undertake any obligation to release publicly any revisions or updates to these forward-looking statements to reflect events, circumstances or unanticipated events occurring after the date of this announcement except as required by law or by any appropriate regulatory authority.



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