DWD

HIVE AGGREGATES

Retford Circular Economy Project

Need and Alternatives Assessment

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EXECUTIVE SUMMARY

This Need and Alternatives Assessment sets out and summarises the detailed analysis carried out by Lound Hive Limited ('Hive'), part of Hive Aggregates, prior to and since undertaking to develop the Retford Circular Economy Project ('RCEP').

The RCEP proposes to extract, process and export pulverised fuel ash ('PFA') from a former landfill site near Retford, Nottinghamshire (the 'RCEP Site'). The PFA would be sold into the building products industry as a sustainable, low carbon cement replacement. It is proposed to extract the PFA in phases over around a 22-year period at a rate of approximately 300,000 tonnes per annum.

This report has been produced in response to, amongst other things, consultation comments from the local community that:

- query the carbon impact of cement and the benefits and support of PFA use;
- assert that there are different decarbonisation pathways for the cement industry; and
- contend that there are alternative sites that mean that the RCEP is not needed.

This report addresses these queries and strongly refutes these assertions, using numerous empirical sources and published evidence, contextualised further with the latest government policy and industry feedback.

1.0 INTRODUCTION

1.1 This Need and Alternatives Assessment sets out and summarises the analysis carried out by Lound Hive Limited (the 'Applicant' or 'Hive'), part of Hive Aggregates and the wider Hive Energy Group, both prior to and since undertaking to develop the Retford Circular Economy Project ('RCEP').

1.2 The RCEP proposes to extract, process and export pulverised fuel ash ('PFA') from a former disposal site near Retford, Nottinghamshire (the 'RCEP Site'). The RCEP is also referred to collectively as the 'Proposed Development'.

1.3 The PFA would be sold into the building products industry as a sustainable, low carbon cement replacement product. The material results in 93% lower carbon dioxide emissions than average Portland Cement[1] in the UK and can either partially or fully replace it in a cement mixes[2].

RCEP overview

1.4 It is proposed to extract the PFA in phases over around a circa 22-year period at a rate of approximately 300,000 tonnes per annum. The Proposed Development takes a measured and considerate approach to the extraction of PFA and restoration of the RCEP Site, which has been informed by ongoing engagement with local stakeholders.

1.5 The RCEP would deliver a wide range of benefits, including:

- Supporting the sustainable growth and diversity of mineral extraction in Nottinghamshire by maximising the use of its secondary mineral resource.
- Provide a significant long-term supply of PFA, a mineral of national importance for which there is a recognised shortage. The RCEP alone could provide a substantial contribution to UK supply.

[1] The current carbon intensity of Portland Cement (using the assumptions set out in the Greenhouse Gas Emissions chapter of the Environmental Statement ('ES') that accompanied Hive's planning application (Chapter 15, Volume 1 of the ES, February 2023) is 0.812tCO2e/T, which is obtained from a recently validated Environmental Performance Declaration produced by the Mineral Products Association. The whole life carbon intensity of the RCEP PFA as calculated in the assessment is 57.0kgCO2e/T, hence around 93% lower.

[2] Geopolymer and alkali activated cements can comprise 95% PFA and 5% activator, with zero Portland Cement required; these novel cements can therefore result in 90% carbon dioxide reductions when compared to Portland Cement. Source: https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete. There is also the potential to partially replace Portland Cement in more traditional cement mixes at up to 70%, with such mixes used in the USA and UK at present (known as 'High Volume Fly Ash Cement' or 'HVFA Cement'). Source: http://www.ukqaa.org.uk/information/faqs/.

- Make a positive contribution towards the decarbonisation of the cement and concrete industry and support the transition towards a low carbon economy.
- Deliver a high-quality restoration scheme which is sensitive to and seeks to enhance the adjacent Sutton and Lound Gravel Pits Site of Special Scientific Interest ('SSSI').
- Deliver economic and social benefits through the generation of employment opportunities, including the potential for over 90 jobs on the site and in the local supply chain.

1.6 Hive submitted a planning application for the RCEP in March 2023, which is currently being determined by Nottinghamshire County Council ('NCC'). The location of the RCEP Site is shown in **Appendix 1** to this report.

PFA Explained

1.7 PFA is the by-product from the burning of coal in power stations. The material has certain mineral qualities that mean it can be used to replace Portland Cement fully or partially, also known as a supplementary cementitious material or 'SCM'. However, only the highest quality PFA can be used for this purpose, including that proven to be available at the RCEP Site.

1.8 The use of SCMs like PFA is already established practice. SCMs are used widely in concrete manufacturing, where they offer a feasible solution to partially substitute Portland cement[3].

1.9 PFA is a pozzolanic material. Other examples of pozzolanic materials are volcanic ash, pumice, burnt clay and opaline shale. Pozzolanic materials have been added to concrete mixes for millennia. The Romans constructed large buildings and aqueducts using concrete blends containing volcanic pumices found in neighbouring territories including Pozzuoli (Naples), from which the name pozzolan originated.

1.10 There is significant and growing demand for high-quality PFA in the UK; however, the domestic supply is inherently finite following the UK Government's decision to close all coal-fired power stations by 2025 with similar decisions being made across the European Union ('EU'). This is why Hive is proposing to extract the material from a former disposal site; because without projects like the RCEP, this domestic supply of PFA will be lost.

1.11 The availability of cement replacement quality PFA in the UK is currently in the thousands of tonnes; however, the underlying demand is in the millions of tonnes. This has been confirmed to Hive

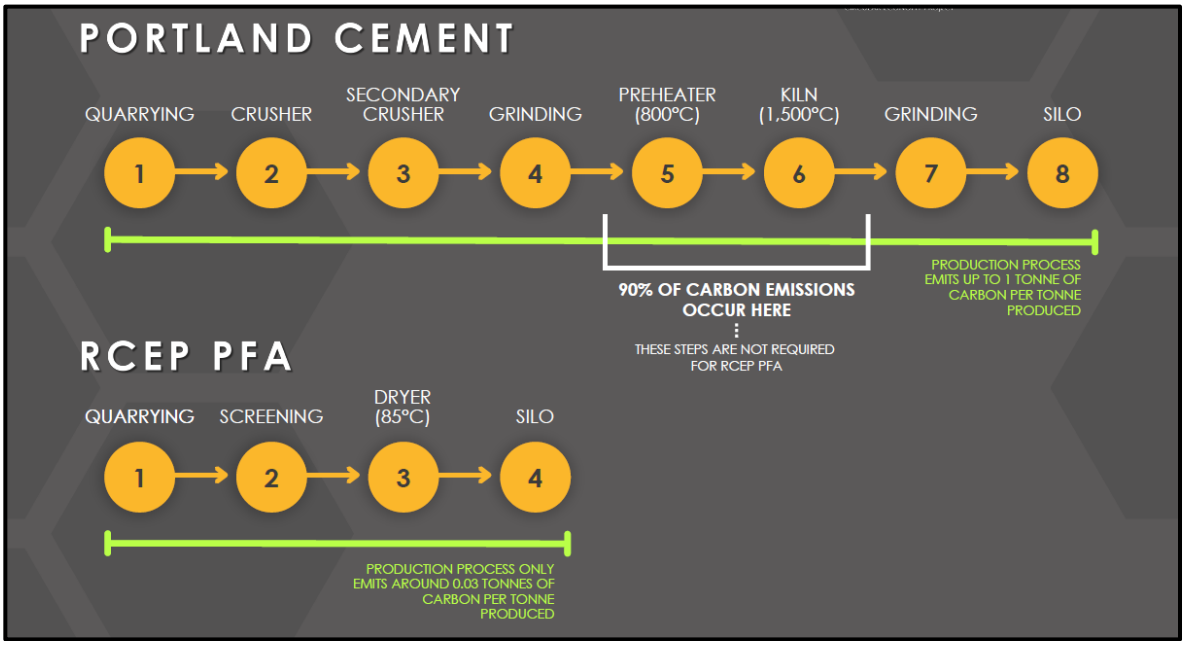
[3] https://www.cisl.cam.ac.uk/files/sectoral_case_study_cement.pdf

through discussions with industry, as demonstrated by some of the feedback included at **Appendix 2** to this report.

1.12 The UK Quality Ash Association ('UKQAA') confirms that 1 tonne of PFA can replace 0.86 tonnes of carbon dioxide when it replaces Portland Cement[4], and Chatham House confirms similar at around 0.83 tonnes[5]. The savings are partly due to the intrinsic chemistry of the raw materials used to manufacture Portland cement and partly because PFA, unlike Portland Cement, does not need to be kilned, as it has already been through a thermal process in the power station furnace where it was produced. The intrinsic carbon disadvantages of Portland Cement production are described more in section 3.

1.13 The production process of both Portland Cement and RCEP PFA are summarised in Figure 1.1 below. PFA from the RCEP Site avoids 90% of the carbon emissions associated with Portland Cement, just by virtue of already going through a thermal process.

Figure 1.1 – RCEP PFA production and carbon savings versus Portland Cement



[4]http://www.ukqaa.org.uk/wp-content/uploads/UKQAA_SECONDARY_MATERIAL.pdf
[5]https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete

Industry feedback

1.14 Hive has spent a significant amount of time talking to the cement industry and suppliers of industrial by-products like PFA, including all the main cement producers in the UK. This has informed Hive's decision to pursue the development of PFA resources and the RCEP itself.

1.15 Amongst the feedback provided, the following principles regarding cement replacement materials like PFA were repeated time and time again:

- The supply needs to be **consistent, reliable and available in large quantities** (i.e. millions of tonnes).
- There are only two materials that (i) **do not require further significant processing** (i.e. significant heat treatment and kilning) and (ii) **have historically been available in significant enough quantities**.
- These materials are **PFA and ground granulated blast furnace slag ('GGBFS')**.

1.16 The support from industry for the RCEP and confirmation of the above is evidenced in the letters included at **Appendix 2** to this report.

Content, purpose, and structure of this report

1.17 The purpose of this report is to set out the need that exists for the RCEP in response to the growing need to decarbonise the cement industry as it seeks to achieve the legally binding commitment to 'Net Zero' greenhouse gas ('GHG') emissions by 2050.

1.18 It has been produced to support the RCEP planning application and address consultee comments from some members of the local community, which can be summarised as follows:

- the carbon impact of cement and carbon dioxide saving benefits of PFA as a SCM have been overstated;
- there are alternative or better ways to address carbon dioxide emissions in the cement industry; and
- there are alternatives to the RCEP Site itself.

1.19 This report should be read alongside the other documents submitted as part of the RCEP planning application, including the Planning Statement which sets out how the RCEP has taken account of and complies with the national and local planning policy.

1.20 The remainder of this report is structured as follows:

- Section 2 – 'Key planning policy' provides an overview of key national and local planning policy relating to the supply of PFA and minerals, and in relation to reducing carbon emissions.
- Section 3 – 'Cement industry overview' explains the scale of the UK and global cement industry, its carbon dioxide emissions, and the need to reach Net Zero by 2050.
- Section 4 – 'Decarbonising the cement industry' considers the vital role PFA from former disposal sites, like the RCEP Site, can play in decarbonising the cement industry, and also considers other potential decarbonisation options;
- Section 5 – 'RCEP and alternative sites' assesses the RCEP Site against known PFA deposits, and also nearby mineral extraction sites and cement plants; and
- Section 6 – 'Summary and conclusions' to close the report.

2.0 KEY PLANNING POLICY

2.1 This section sets out key planning policy relating to PFA and the supply of minerals (note: PFA is classed as a 'mineral' for planning purposes).

2.2 It is important to set the planning policy context for minerals at local and national level, including the importance attached to PFA, before moving onto considering PFA as a cement replacement product and establishing the importance of extraction from former disposal sites in sections 3 and 4 of this report.

Key planning policy

2.3 The RCEP is currently at the planning application stage, therefore planning policy is the first consideration (in policy terms) when analysing need and alternatives.

National Planning Policy Framework

2.4 The National Planning Policy Framework ('NPPF') was adopted in March 2012 and was most recently updated in 2023. It sets out the Government's planning policies for England and how these are to be applied. It contains a number of policies that are pertinent to and specifically support the principle of the RCEP.

2.5 Paragraph 210 confirms that planning policies should (bold and underlining added for emphasis):

*"a) **provide for the extraction of mineral resources of local and national importance**…*

*b) so far as practicable, take account of the contribution that **substitute or secondary and recycled materials and minerals waste** would make to the supply of materials, before considering extraction of primary materials, whilst aiming to **source minerals supplies indigenously**…"*

2.6 On page 72, 'secondary aggregates' are defined as including 'coal derived fly ash', i.e. PFA.

2.7 On page 70, crucially, the NPPF classes 'coal derived fly ash' (another term for PFA) in single use deposits (i.e. resources of pure PFA, like the RCEP) as **'mineral resources of local and national importance'**. Importantly, **no other comparable by-product material benefits from this specific designation in the NPPF**.

2.8 Paragraph 152 states that the planning system should support the transition to a low carbon future in a changing climate by contributing to **radical reductions in greenhouse gas emissions**. This extends to a domestic supply of sustainable building products, such as PFA.

Nottinghamshire Minerals Local Plan (2021-2036)

2.9 The Nottinghamshire Minerals Local Plan ('NMLP') sets out the vision, objectives and planning policies for mineral development across the County covering the period to 2036. A key aim of the NMLP is for minerals to be used as efficiently as possible. This is developed into Strategic Objective SO1 which seeks to improve the efficient use of primary mineral resources partly through increasing the use of alternatives from secondary aggregate sources, such as PFA.

2.10 Policy SP3 (Climate Change) states that all minerals development should help **reduce greenhouse gas emissions and move towards a low-carbon economy**.

2.11 Policy MP5 (Secondary and Recycled Aggregates) supports the principle of development proposals which will **increase the supply of secondary and/or recycled aggregates**. This policy is clearly intended to implement NPPF paragraph 210 described above and is supportive of the principle of PFA extraction.

Nottinghamshire and Nottingham Local Aggregates Assessment

2.12 The Nottinghamshire and Nottingham Local Aggregates Assessment (LAA) is produced annually and sets out:

- Past aggregate sales, number of active quarries and the distribution of the extracted mineral;
- The latest 10 and 3 year average sales data and sales trend commentary; and
- The key issues that could affect the future demand for aggregates over the next plan period.

2.13 The most recent LAA published in December 2022 reports on sand, gravel, sandstone, crushed rock as well as alternate aggregates including Power Station Ash. The LAA does not provides historic sales data for power station ash in Nottinghamshire but notes that three power stations in the County produced around 1.7 million tonne in 2014 and that national sales of such materials has been steadily growing over recent years.

3.0 CEMENT INDUSTRY OVERVIEW

3.1 Cement is the principal ingredient and binding agent in concrete, the most widely consumed material on the planet after water. Cement and concrete are therefore intrinsic to modern society.

3.2 This section of the report provides a summary of the scale and geographic extent of the industry in the UK as well as the diametrically opposed challenges arising from increased global demand and the need to reach Net Zero by 2050.

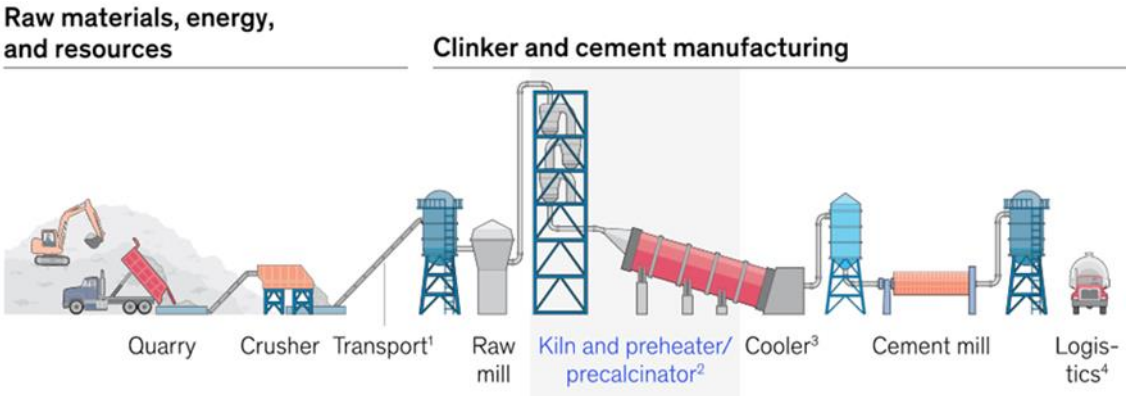
Cement overview

3.3 'Cement' is a generic term that can be applied to group of binder materials used in global construction. Amongst these binders, Portland Cement is the most common type of cement in general use today. It is estimated that 98% of concrete produced globally uses Portland Cement.

3.4 Portland Cement production starts with extracting raw materials, such as limestone, clay, sand, and iron ore, from quarries or mines. The raw materials are mixed into specific proportions and then heated up to approximately 1,450°C in a large rotary kiln. The resultant substance termed 'clinker' is then cooled and milled into to a fine powder and combined with gypsum to create Portland Cement.

3.5 The Portland Cement referred to in this report is classed as 'Ordinary Portland Cement', which generally contains around 95% clinker.

Figure 3.1 – Summary of Portland Cement manufacturing process



3.6 As a fundamental component of concrete, cement plays a crucial role in shaping the buildings and infrastructure globally. In the UK, there were 2.4 million jobs in the construction industry in Q2

2019, 6.6% of all jobs in the UK[6]. In 2018, the construction industry was responsible for 6% of the GDP contributing £117 billion to the UK economy[7]. As such, the UK heavily relies on cement and concrete, and will continue to do so as we pursue sustainable growth in the future.

3.7 According to IBISWorld, the East Midlands is the main region for cement manufacturing within the UK. Tarmac Cement and Lime Ltd, Heidelberg Cement AG, Aggregate Industries and Breedon Cement operate in the region, as it offers good access the necessary raw materials and the national market[8].

Carbon emissions

3.8 Each year, more than 4 billion tonnes of cement (predominantly Portland Cement) is produced globally, accounting for around 8% of global carbon emissions. To put this into perspective, if the cement industry were a country, it would be the third largest carbon emitter in the world with up to 2.8 billion tonnes, surpassed only by China and the US. The UK alone uses around 15 million tonnes of cement annually.

3.9 The monumental need for and use of Portland Cement along with its intrinsic chemistry has significant energy and carbon impacts. In the Portland Cement production process, there are two main sources of carbon dioxide emissions:

- the chemical reaction from the heating of limestone and raw materials; and
- the combustion of fuels, predominantly fossil fuels, to heat the kiln during this process.

3.10 The use of energy accounts for up to approximately 40% of the carbon dioxide emissions, with the remainder being an inevitable product of the chemical reactions which occur when the limestone and raw materials are heated.

Figure 3.2 Illustrative clinker production process

Limestone	→		**Clinker** +	**Carbon Dioxide**
		Heat (*at* 1450°C) *~40% of process carbon dioxide emissions*		~60% *of process carbon emissions*

[6] https://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf
[7] https://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf
[8] https://www.ibisworld.com/united-kingdom/market-research-reports/cement-manufacturing-industry/#:~:text=The%20East%20Midlands%20is%20the,and%20the%20populous%20North%20West.

3.11 The emissions intensity of cement production has increased since 2015 at an average rate of 1.6% per annum worldwide, largely due to increasing clinker-to-cement ratio globally.

3.12 The production of Portland Cement emits around one tonne of carbon for every tonne produced, with some sources estimating that the process can emit up to 1.25 tonnes of carbon per tonne produced[9]. The RCEP planning application uses a significantly more conservative estimate of around 0.81 tonnes of carbon per tonne produced, which was calculated using a recently validated Environmental Product Declaration (EPD) for average UK Portland Cement obtained from the Mineral Products Association[10].

3.13 Interestingly, the EPD already assumes using a small amount of PFA and certain energy efficiencies, hence it could be considered conservative.

Rising demand for cement

3.14 Due to increased demand, the cement sector is facing a significant expansion at a time when emissions need to fall at an unprecedented rate.

3.15 As a result of urbanisation, infrastructure expansion (including that which is required to address climate change), and population growth, the manufacturing of cement has been steadily growing – and will continue to grow. Global cement production is set to increase to over 5 billion tonnes a year over the next 30 years[11]. Rising global population and urbanisation patterns, coupled with economic development, and infrastructure development needs are also expected to increase demand for concrete and cement[12]. To illustrate this, global building floor area is expected to double by 2060 with the addition of 2.4 trillion square feet (230 billion m2) of new floor area to the global building stock. This growth will be equivalent to adding an entire New York City to the world every month for 40 years[13].

3.16 Providing infrastructure to deliver Net Zero 2050 also relies on cement and concrete, whether for wind farm foundations, nuclear power plants or hydroelectric dams etc. The Net Zero Strategy notes that removing fossil fuels will require the transformation of every sector of the global

[9]http://rammedearthconsulting.com/rammed-earth-cement-co2.htm
[10]EPD (2022) Environmental Performance Declaration. UK Average Portland Cement for Mineral Products Association (Valid April 2022 to April 2027)
[11]https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete
[12] https://iea.blob.core.windows.net/assets/cbaa3da1-fd61-4c2a-8719-31538f59b54f/TechnologyRoadmapLowCarbonTransitionintheCementIndustry.pdf
[13] https://www.aceee.org/blog-post/2022/12/low-carbon-cement-could-be-sped-market-climate-law-funds

economy. It means no longer burning fossil fuels for power or heating, and it means new ways of making concrete, cement, and steel[14].

Net Zero

3.17 The UK Government and cement industry has acknowledged the carbon intensive and damaging nature of production and pledged to reduce emissions in accordance with Net Zero 2050[15]. GHG emissions need to fall by around half by 2030 to meet the Paris Agreement goal of keeping global warming to well below two degrees centigrade above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5 degrees centigrade[16]. This scenario is very demanding for the built environment, in that it will require carbon-neutral or carbon-negative construction everywhere from 2030 onwards, which implies the need to rapidly scale up carbon reduction initiatives in the cement industry. As the energy transition continues, advances toward low-emissions materials and the circular economy must also speed progress to Net Zero[17].

3.18 Decarbonising the cement industry cannot be achieved by a single solution; all stages of the production process need to be targeted to reach emissions targets. In the UK, the industry has already delivered a 53% reduction in absolute carbon dioxide emissions since 1990 through, for example, fuel switching and energy efficiency.

3.19 As part of the transition to a Net Zero economy, a 'materials transition' is also necessary, which would involve the implementation of lower-impact ways to produce materials and—crucially—the application of circular-economy principles to optimise the use and reuse of these materials[18]. The Institute of Structural Engineers ('ISC') emphasises that in order to meet the massive demand for cement globally, existing cement alternatives, such as PFA, must be utilised as new SCMs are developed.

3.20 Most recently, the Department for Energy Security and Net Zero released updated National Policy Statements (NPS). In paragraph 4.7.3 of NPS EN-1 (Overarching National Policy Statement for

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf
[15]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651222/cement-decarbonisation-action-plan.pdf
[16] https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered#:~:text=But%20to%20avoid%20the%20worst,and%20ultimately%20reach%20net%20zero.
[17] https://www.mckinsey.com/capabilities/sustainability/our-insights/how-a-materials-transition-can-support-the-net-zero-agenda
[18] https://www.mckinsey.com/capabilities/sustainability/our-insights/how-a-materials-transition-can-support-the-net-zero-agenda

Energy) it states that, *"Projects should look to use modern methods of construction and sustainable design practices such as use of sustainable timber and low carbon concrete[19]".*

3.21 At the time of writing the updated NPS are not formally designated, however, they are expected to be designated policy by the end of the calendar year.

3.22 The NPS represents a material consideration in the determination of the planning application and provides insight into the climate initiatives and expectations of the UK Government, who in designating EN-1 are stating that they expect that the civil engineering features (such as foundations, roads, dams, and buildings) in energy developments to use low carbon concrete.

3.23 If the UK fails to invest in decarbonising the cement and concrete industries, it will forego market competitiveness in low-emission manufacturing technologies and solutions. Although improving energy efficiency can help in the short term, the sector must address its inherent process emissions associated with Portland Cement.

[19] https://www.gov.uk/government/publications/overarching-national-policy-statement-for-energy-en-1

4.0 DECABARBONISING THE CEMENT INDUSTRY

4.1 This section sets out the limited options that are available to decarbonise the cement industry, including:

- a summary of the current situation;
- present and future options;
- an analysis of feasibility in the short, medium and long-term; and
- a conclusion regarding the potentially most viable and planning policy compliant route forwards for the UK.

Current situation

4.2 Significant changes in how cement is produced are needed in order to achieve the goals set out in the Paris Agreement on climate change and to achieve the carbon reduction required for Net Zero 2050.

4.3 The Net Zero Strategy[20] states that, *"Removing dirty fossil fuels will require the transformation of every sector of the global economy. It means no longer burning fossil fuels for power or heating; it means new ways of making concrete, cement, steel; it means the end of the petrol and diesel engine".* Although efforts have been undertaken to decarbonise the cement sector, it is widely acknowledged that most relatively straightforward gains, such as fuel switching and energy efficiency, have already been made.

4.4 The next phase of decarbonisation will require more ambition and faster action than efforts to date. Due to the nature of cement production there are a limited number of solutions to reduce emissions to the required level, and these will be required in combination with each other.

Decarbonisation options

4.5 The UK Industrial Decarbonisation Strategy[21] emphasises that although it is not possible to predict the exact mix of technologies that will be required to achieve Net Zero, it is known that there is a need to continue to innovate and develop a broad range of low carbon solutions. This will put the

[20] https://assets.publishing.service.gov.uk/media/6194dfa4d3bf7f0555071b1b/net-zero-strategy-beis.pdf

[21] https://assets.publishing.service.gov.uk/media/6051cd04e90e07527f645f1e/Industrial_Decarbonisation_Strategy_March_2021.pdf

UK in the best possible position to reduce the cost of decarbonisation and maintain the competitiveness of industry[22].

4.6 The UK Government and cement industry acknowledge that there are no 'silver bullets' to decarbonise the cement industry and have therefore highlighted a number of actions. This includes the following from the 'Cement Sector Joint Industry Government Industrial Decarbonisation and Energy Efficiency Roadmap Action Plan[23]' produced jointly by the Department of Business, Energy and Industrial Strategy and the Mineral Products Association:

- 1 – replacing Portland Cement/clinker with SCMs and other lower carbon materials;
- 2 – energy efficiency and using alternatives to fossil fuels for kilning Portland Cement; and
- 3 – carbon capture, utilisation and storage ('CCUS').

Each of the above actions (1-3) are considered in the remainder of this section.

SCMs and lower carbon materials decarbonisation pathway

4.7 As described in section 3 (and in particular Figure 3.2) Portland Cement production causes carbon emissions from two processes: the intrinsic chemical reaction (60%) and fuel sources for kilning (40%). SCMs and other lower carbon materials offer the biggest opportunity around carbon reduction, since they avoid these carbon emissions in the first place.

4.8 The need to make use of the readily available low carbon alternatives, such as PFA, to meet the demand for low carbon cement is essential to ensure carbon emissions are prevented as far as possible. A recent study by Chatham House[24] notes the following regarding replacing Portland Cement with alternative materials like PFA:

- It is not only a very effective solution, but also one that can be deployed cheaply today, as it does not generally require investments in new equipment or changes in fuel sources.
- It is, therefore, especially important to scale up partial replacement in the near term while more radical options are still under development, such as geopolymer or alkali-activated cements.

[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970229/Industrial_Decarbonisation_Strategy_March_2021.pdf
[23] https://assets.publishing.service.gov.uk/media/5a82ad2fed915d74e623711e/cement-decarbonisation-action-plan.pdf
[24] https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete

- Geopolymer or alkali-activated cements, which use by-products like PFA and/or GGBFS, and do not require Portland Cement, can have embodied energy and carbon footprints that are up to 80-90% lower.

4.9 It is for the reasons set out above that replacing Portland Cement with SCMs like PFA form a significant part of the UK Government and industry strategy to decarbonise the cement sector, and why the same is true in Europe and the US. Although, as previously stated, significantly more needs to be done.

4.10 The UK Industrial Decarbonisation Strategy emphasises that although we cannot predict the exact mix of technologies that will get industry to net zero, we know we need to innovate and develop a broad range of low carbon technologies to reduce the cost of decarbonisation[25]. The Global Cement and Concrete Association 2050 Roadmap to Net Zero[26] demonstrates that as industrial sectors increasingly decarbonise, industrial by-products, such as 'fresh' supplies of PFA and GBBFS are likely to become less available for use in construction. However, novel approaches to reusing previously untapped industrial wastes, such as extracting PFA from former disposal sites, can significantly extend the availability of certain SCMs[27].

4.11 Industry feedback gathered by Hive has signalled that the cement industry in the UK has recently seen a reversion to using less sustainable materials, i.e. using more Portland Cement, as PFA and GGBFS have become less available due to the closure of coal-fired power stations and reduced output from steel works. The current EPD for average UK Portland Cement obtained from the Mineral Products Association, referred to earlier in this report, contains just 1% PFA replacement for clinker.

4.12 There is therefore still considerable scope for improvement in clinker substitution and replacement, as evidenced by the target set by the 2018 Technology Roadmap for low carbon transition in the cement industry of reaching an average global replacement ratio 0.60 by 2050[28]. The UK Government's own policy and research, and the aforementioned study by Chatham House, propose increasing supply.

[26] https://gccassociation.org/concretefuture/wp-content/uploads/2021/10/GCCA-Concrete-Future-Roadmap-Document-AW.pdf
[27] https://gccassociation.org/concretefuture/wp-content/uploads/2022/10/GCCA-Concrete-Future-Roadmap-Document-AW-2022.pdf
[28] https://www.wbcsd.org/contentwbc/download/4586/61682/1

4.13 The Chatham House report[29] states that the following actions are required, amongst other things, to increase the supply of SCMs and achieve the deep decarbonisation that is necessary:

- Encourage the reprocessing of waste from former disposal sites. These supplies can be huge in scale.
- Increase the availability of traditional SCMs, i.e. PFA and GGBFS, in the short-term (the next 10-20 years).
- Optimise the efficiency of cement use in concrete. The industry will need to invest in additional extraction sites and equipment to scale up the use of SCMs.
- Increase clinker replacement by 40% to achieve the realised global clinker to cement ratio of 0.60 by 2050, set out in the 2018 Technology Roadmap[30], requiring roughly 2 billion tonnes of SCMs to be consumed globally by 2050.
- Increase availability of traditional SCMs through targeted regulation and policy, as has been seen in the UK where former PFA disposal sites like the RCEP Site are designated by the Government as nationally important mineral resources.

4.14 Figure 4.1 below is an extract from the UK Government Net Zero Strategy[31] that demonstrates the current timelines for technology development in various industries relative to the current market share of low carbon technology in each sector. Known as the Sectoral S curve, the graph demonstrates emergence, diffusion, and reconfiguration of new technology across various sectors. In this economic model, the emergence of new technology encourages policy making which drives forward the deployment and eventually reduces cost and improves performance. As technology develops and deployment increases, other sectors are driven by the new opportunities within these emerging markets. The key point to note from this figure is how early in the curve cement currently features, and the scale of development required to decarbonise this industry.

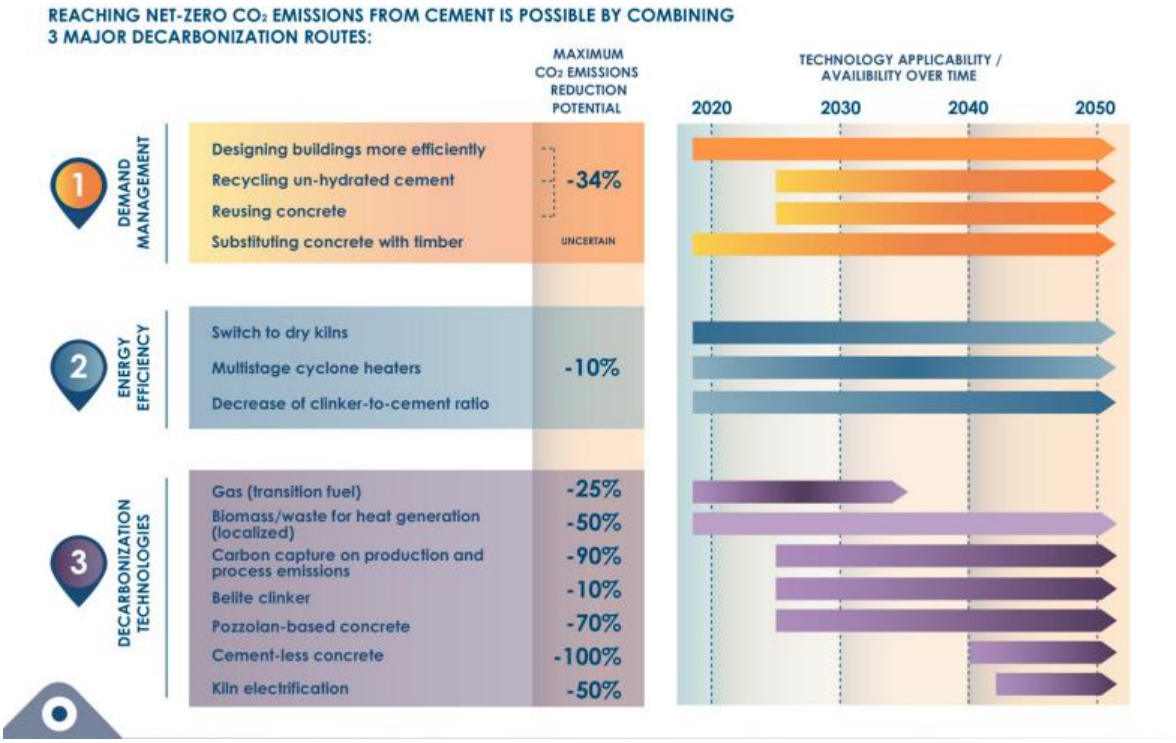
4.15 Figure 4.1 below from the Energy Transitions Commission outlines the pathway and various contributors that will be needed for the decarbonisation of the cement industry and their respective applicability and availability through the Net Zero Transition. As seen in the decarbonisation technologies below, pozzolan based concrete and cement-less concrete, both of

[29]https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete
[30] https://iea.blob.core.windows.net/assets/cbaa3da1-fd61-4c2a-8719
31538f59b54f/TechnologyRoadmapLowCarbonTransitionintheCementIndustry.pdf

which can contain large quantities of PFA, will achieve some of the highest CO_2 emission reductions at 70% and 100% respectively[32].

4.16 The figure of 90% CO_2 reduction for carbon capture is not comparable, because as stated in the diagram, this reduction only relates to production and process emissions; the reductions are lessened once accounting for emissions generated from the carbon capture process itself, and the construction of the carbon transport and storage pipeline network.

Figure 4.1: Decarbonisation Routes to meet Net Zero



Pulverised Fuel Ash

4.17 PFA is the most widely available and used SCM in concrete globally, due largely to its significant availability historically as a by-product from the burning of coal in power stations. PFA, like GGBFS, has also already been through a thermal process, meaning that it does not require kilning/high temperatures like Portland Cement and some other SCMs.

4.18 Its use in cement means:

- beneficially reusing a waste by-product, thereby positively contributing to the circular economy; and
- significant carbon savings, as set out earlier in this report.

4.19 The use of PFA provides opportunity for developers and businesses to reduce the 'upstream emissions' associated with construction and development. For instance, the Energy and Carbon Footprint Report that was produced for the Tideway Tunnel Development Consent Order in 2013 estimated a total carbon footprint in the decarbonised scenario of approximately 838,000 tCO_2e with the principal impact being the greenhouse gas (GHG) emissions arising from the construction of the infrastructure, in particular embodied carbon in manufacturing of materials. The carbon in these materials equates to approximately 84% of the total emissions.

4.20 It is noted that within the submitted Environmental Statement it was originally predicted that the concrete mix for the tunnel segments and base plugs of the shafts would contain a maximum of 25% cement replacement – such as PFA or GGBFS. However, the Tideway Climate Related Financial Disclosure Report 2020/21 stated through consultation with the designers it has been possible to achieve up to 75% PFA in the base plugs and between 25% and 45% GGBFS in the tunnel segments whilst still meeting the performance specification. The carbon savings have not yet been calculated by the main works contractor but are expected to be significant.

4.21 Furthermore, policy requirements for the implementation of SMCs continues to emerge both domestically and internationally. In the UK, the concrete for London's Crossrail project is required to have a minimum cement-replacement content of 50%. In the United Arab Emirates all major infrastructure projects are required to use cements that contain at least 60% PFA or GGBFS, since 2015[33].

4.22 In addition to the above, PFA can also make cement and concrete stronger, which has significant benefits in structures like dams and flood defences, amongst other things. The Institute of Physics ('IOP') has undertaken several characteristic studies on cement alternatives. The findings of these studies conclude that PFA concrete had greater strength, durability and workability than Ordinary Portland Cement[34].

[33] https://www.chathamhouse.org/2018/06/making-concrete-change-innovation-low-carbon-cement-and-concrete
[34] https://iopscience.iop.org/article/10.1088/1755-1315/357/1/012010/pdf

Ground granulated blast furnace slag

4.23 GGBFS is also a widely used SCM; similarly to PFA it has historically been available in large quantities due to the volume of steel production in the UK and globally.

4.24 It is also a waste and has its own quality standard. It is manufactured through the process of rapidly quenching molten slag produced during steel/iron making. This granulated material is ground down to powder form and acts with hydraulic properties when combined with water. The IOP advises that GGBFS is a suitable alternative to Portland Cement, but is not as strong as PFA or other SCMs such as silica fume. GGBFS is however more resistant to chloride penetration than PFA, but not more workable[35]. Therefore, GGBFS is more suitable for development within seawater, such as platforms for wind power.

4.25 While GGBFS has beneficial applications, it is also plagued by domestic supply issues due to the closure and lower output of steel works[36]. Through conversations with industry bodies and business Hive understands that within the UK GGBFS is now being imported from Japan and China. The possibility of importing large quantities of high quality PFA from nations that are still burning coal has also been considered by some operators, however the same issues are relevant.

4.26 The above is also somewhat academic given that the use of domestically available mineral products, as opposed to imports, is specifically supported by the NPPF[37], which states at paragraph 210 that supplies of minerals should be sourced indigenously where available, as set out in section 2 of this report.

4.27 GGBFS also, importantly, does not benefit from the significant, domestic former disposal site resource that applies to PFA in the UK. The aforementioned study by the UK Government indicates that in 2017 GGBFS reserves were around 1 million tonnes only (likely now significantly more depleted or fully consumed), whereas the PFA landfill resource in the UK is up to around 100 million tonnes[38]. This factor, i.e. availability providing a potentially longer-term supply, is unique to PFA in the UK; no other comparable material is available in such quantities, which goes some way to

[35] https://iopscience.iop.org/article/10.1088/1755-1315/357/1/012010/pdf
[36]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/660888/fly-ash-blast-furnace-slag-cement-manufacturing.pdf
[37]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1182995/NPPF_Sept_23.pdf
[38]http://www.ukqaa.org.uk/wp-content/uploads/UKQAA_SECONDARY_MATERIAL.pdf

demonstrating why PFA contained in former disposal sites (or 'single use deposits') is classed by the NPPF as a mineral resource of national importance.

4.28 The above GGBFS supply issues are echoed in a recent study[39] produced by the Institute of Structural Engineers, which concludes that GGBFS is a limited and constrained resource that is almost fully utilised globally, and no references were found (by those carrying out the study) to demonstrate significant useable GGBFS stockpiles, unlike PFA.

4.29 The study therefore concludes that any local increase in the amount of clinker substituted with imported GGBFS is unlikely to decrease global carbon emissions. Furthermore, that alternative options exist for reducing clinker usage and thus reducing global carbon emissions. It is not inconceivable to consider that these alternatives could and should include PFA from former disposal sites.

Other SCMs and lower carbon materials

4.30 There are other SCMs and lower carbon materials; however, these are either not available in large enough volumes in the UK, do not benefit from the necessary properties to replace Portland Cement in large enough quantities, and/or require significant kilning/heating/calcination and associated carbon emissions. As mentioned previously, PFA and GGBFS are the only recognised SCMs that have historically been available in the large enough quantities in the UK and do not require further, significant thermal treatment.

4.31 Calcined clay (or 'metakaolin') is a possible alternative, for example; however, after quarrying it needs to be calcined, which means heating it to around 650°C and 750°C degrees centigrade[40], similar to the chemical reaction required when heating limestone to produce clinker. The Global Cement and Concrete Association (GGCA) finds that the need to activate metakaolin through heating the raw material to relatively high temperatures make its production a more costly and carbon intensive exercise that other SCMs such as PFA. More problematically, the use of metakaolin can increase water demand during concrete production by over 20% unless suitable water-reducing admixtures are used[41].

[39] https://www.istructe.org/resources/guidance/efficient-use-of-ggbs-in-reducing-global-emissions/
[40] https://gccassociation.org/cement-and-concrete-innovation/clinker-substitutes/calcined-clays/#:~:text=Calcined%20clay%20%E2%80%93%20or%20metakaolin%20%E2%80%93%20is,waste%20and%20oil%20sands%20tailings.
[41] https://gccassociation.org/cement-and-concrete-innovation/clinker-substitutes/calcined-clays/#:~:text=Calcined%20clay%20%E2%80%93%20or%20metakaolin%20%E2%80%93%20is,waste%20and%20oil%20sands%20tailings.

4.32 Silica fume is another possible SCM. It is a by-product from the production of elemental silicon or alloys containing silicon in electric arc furnaces. Although very strong, it has a significant water demand and often requires water-reducing admixtures when used in concrete. For these reasons, cements containing silica fume are more rarely produced than those containing other pozzolanic industrial by-products, such as PFA or natural pozzolans, its use being restricted to high-strength applications[42]. It is also not available in sufficient quantities in the UK to provide for the level of Portland Cement replacement that is required and is often significantly more expensive that both PFA and Portland Cement.

Energy efficiency and using alternatives to fossil fuels

4.33 The UK Government's cement sector industrial decarbonisation and energy efficiency action plan (2017, p21)[43] identifies that 'the majority of energy efficiency savings that can be made have already been implemented by the UK cement sector' and that 'some actions, particularly related to fuel switching, might make cement manufacture less energy and electrically efficient'.

4.34 Cement works are continuing to explore the use of alternative fuels. Due to the high temperatures involved, a range of non-recyclable waste streams are potentially available including secondary liquid fuels, scrap tyres, paper, packaging and household waste, meat and bone meal and sewage sludge pellets. These displace some of the fossil fuels used by the industry[44].

4.35 They are at most a partial solution since the fuel demands are substantial and non-recyclable waste streams are declining nationally, due to the context of increasing national recycling rates[45] and the demand for waste streams from consented and operational energy from waste power plants (an example being the 500,000tpa EMERGE facility being built at Ratcliffe-on-Soar by Uniper). Large quantities of waste are also in demand for sustainable aviation fuel manufacturing (pursuant to the UK Government's published Jet Zero Strategy).

4.36 Hydrogen can only substitute fossil fuels at cement sites at significant percentages with a major redesign of their burner, and the availability and infrastructure for green and blue hydrogen is

[42] https://gccassociation.org/cement-and-concrete-innovation/clinker-substitutes/silica-fume/
[43] https://www.gov.uk/government/publications/industrial-decarbonisation-and-energy-efficiency-action-plans
[44] https://www.cemex.co.uk/alternativefuels.aspx
[45] The UK Government's Resources and waste strategy for England (2018, p79) explains that "Greater waste prevention, reuse and a 65% municipal waste recycling rate, delivered through policies in this Strategy, will mean that municipal residual waste is expected to decrease to around 20.0 Mtpa by 2035". Available at: https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

currently limited[46]. As such the GCCA 2050 Cement and Concrete Industry Roadmap does not indicate renewable hydrogen playing a significant role in the decarbonising the cement industry in the near future and forecast hydrogen playing a small role for the industry from 2040 onwards. [47]

4.37 To conclude, increasing energy efficiency and using alternatives to fossil fuels offer limited opportunities at present to decarbonise cement production, due to nil, low or declining availability of alternative fuels, impacts on efficiency, and because they do not solve the problem of the carbon released when the raw materials are heated and kilned, i.e. where the vast majority of emissions originate.

Carbon capture, utilisation and storage

4.38 A potential method of decarbonising the cement industry is the deployment of CCUS, and it is acknowledged that the contribution of CCUS to decarbonising the cement industry could be significant.

4.39 It must be noted however that the development of technologies such as CCUS could take a number of decades[48]. Accordingly, the UK Government committed to 20 years of funding to deliver CCUS at scale and specific projects are emerging; however, as explained below there are a number of obstacles facing deployment of CCUS.

4.40 The Net Zero Strategy[49] outlines that the industrial CCUS will assist in the decarbonisation of the cement industry; however, CCUS is not currently investable for most industrial sectors as deployment costs are higher than the current carbon price can support, and businesses are unable to pass these through to consumers.

4.41 At present one cement works (Padeswood) has been confirmed for government revenue support under its CCUS business model, being part of the track-1 Hynet cluster. The associated carbon capture pipeline (Hynet Carbon Dioxide Pipeline) does not yet have development consent (i.e. planning and land powers)[50] and its construction and operation are therefore some years away.

[46] https://www.dnv.com/article/why-is-the-cement-industry-labelled-hard-to-abate241192#:~:text=Hydrogen%20and%20the%20cement%20industry,Technology%20Readiness%20Level%20(TRL).
[47] https://gccassociation.org/concretefuture/wp-content/uploads/2022/10/GCCA-Concrete-Future-Roadmap-Document-AW-2022.pdf
[48] https://www.mckinsey.com/industries/chemicals/our-insights/laying-the-foundation-for-zero-carbon-cement
[49] https://assets.publishing.service.gov.uk/media/6194dfa4d3bf7f0555071b1b/net-zero-strategy-beis.pdf
[50] https://infrastructure.planninginspectorate.gov.uk/projects/wales/hynet-carbon-dioxide-pipeline/

4.42 Furthermore, the recent 'Skidmore Review'[51] produced for the UK Government noted that connecting 'dispersed' cement production plants to the future carbon capture network, such as the five plants located in the Peak District which collectively emit millions of tonnes of GHG emissions annually, will be very challenging. Specifically, the document states that:

"At an evidence roundtable for the Review, we heard that it was, and will continue to be, very challenging for dispersed sites *to connect into the CCUS network, exacerbated by a lack of non-pipeline transport options such as shipping of CO2."*

4.43 The Skidmore Review also states that leading CCUS stakeholders such as the CCSA and Shell believe the lack of a clear route for deployment of CCS beyond Track 1 clusters, and phase 1 projects within these clusters, could damage the UK's progress[52]. They have also said that the lack of clarity around clusters beyond Track 1, and a plan beyond 2030, is supressing investor action due to significant uncertainty on future demand.

4.44 Whilst it is acknowledged that CCUS has the potential to capture 90% of emissions at a site level (i.e. production and process) the emissions involved in constructing and powering carbon capture facilities require consideration, and organisations such as Friends of the Earth point to the limitations of CCUS – including that it could stifle technological innovation.

4.45 Most recently, at COP28, United States Special Presidential Envoy for Climate, John Kerry, expressed his concern for the reliance on carbon capture technology, stressing that CCUS could not, on its own, solve the emissions problem[53]. EU Climate Commissioner, Wopke Hoekstra, further stated that carbon capture and storage was *"a minor part of the solution space"* and that we cannot 'CCS ourselves out of the problem'[54].

4.46 It is therefore clearly inappropriate to rely entirely on CCUS to decarbonise the cement industry, particularly as there could be a 20 year or more wait for it to be implemented at scale in the UK, given the significant difficulty and costs in connecting dispersed cement production plants in rural areas.

[51]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1128689/mission-zero-independent-review.pdf
[52] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1128689/mission-zero-independent-review.pdf
[53] https://www.politico.eu/article/us-climate-envoy-john-kerry-cop28-climate-summit-talks-carbon-capture-fossil-fuels-greenhouse-gases-emissions-global-warming/
[54] https://www.politico.eu/article/us-climate-envoy-john-kerry-cop28-climate-summit-talks-carbon-capture-fossil-fuels-greenhouse-gases-emissions-global-warming/

Conclusion

4.47 Having reviewed the aforementioned literature, it is considered that one of the most sustainable and viable options for the UK to achieve further carbon reductions in the cement sector is to extract PFA from historic disposal sites, which is supported by planning policy at local and national level.

4.48 PFA is the only SCM that is sufficiently consistent (available in pure PFA landfills in the UK, i.e. not mixed with other materials) and found in high enough quantities to provide the millions of tonnes of carbon reduction that are required. Furthermore, it would actually prevent a significant amount of carbon emissions where PFA replaces Portland Cement, unlike CCUS, where the carbon is still generated. The quantities of available PFA mean that it has a longer-term future working alongside CCUS in the UK, and, very importantly, it is the most viable and planning policy compliant measure to provide significant further carbon savings in the short to medium-term, i.e. in the 20-year window, possibly longer, that the UK Government has stated will be required to implement CCUS[55].

4.49 The above, i.e. a somewhat combined strategy, is consistent with the UK Government Industrial Decarbonisation Strategy (2021), which highlights that the technical options for the cement sector (particularly those cement plants that are located away from carbon injection points) are:

- building onshore pipelines or other transportation to facilitate CCUS; and
- focus on innovation and switching to green cement (e.g. using alternatives to Portland Cement)[56].

4.50 Furthermore, while in 2009 the Cement Technology Roadmap[57] identified four levers for reducing emissions, including thermal and electric efficiency, alternative fuels, clinker substitution, and carbon capture and storage, it is becoming apparent that the use of SCMs as partial clinker substitutes is the strategy with the lowest economic and performance impacts to cement and concrete production[58]. A recent investigation commissioned by the United Nations Environmental Program Sustainable Building and Climate Initiative (UNEP-SBCI)[59] identified clinker substitution

[55] https://www.theguardian.com/environment/2023/mar/30/government-gambles-on-carbon-capture-and-storage-tech-despite-scientists-doubts

[56] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970229/Industrial_Decarbonisation_Strategy_March_2021.pdf

[57] WBCSD, IEA, Cement Technology Roadmap 2009: Carbon emissions reductions up to 2050, 2009.

[58] https://eprints.whiterose.ac.uk/146768/1/Juenger%20et%20al.%202019%20-%20SCMs%20review%20for%20ICCC%202019.pdf

[59] K.L. Scrivener, V.M. John, E.M. Gartner, Eco-efficient cements: Potential economically viable solutions for a low-CO2 cement-based materials industry, Cem. Concr. Res. 114 (2018) 2-26.doi:10.1016/j.cemconres.2018.03.015.

and concrete mixture proportioning as the most favourable carbon reduction levers for the industry.

4.51 Moreover, it remains that the decarbonisation technologies should not be preference over one another in a climate emergency. Figure 4.1 from the Energy Transitions Commission[60] outlines the pathway and various contributors that will be needed for the decarbonisation of the cement industry and their respective applicability and availability through the Net Zero Transition.

4.52 Figure 4.1 also demonstrates three major decarbonisation routes in order to achieve Net Zero. Notably, the technology and applicability for decreasing the clinker to cement ratio through substitutes such as PFA is available now where as many decarbonation technologies such as CCUS are still not yet readily available.

[60] https://www.energy-transitions.org/wp-content/uploads/2020/08/ETC_MissionPossible_FullReport.pdf

5.0 INCREASING THE UK SUPPLY OF PFA

5.1 Sections 2, 3 and 4 of this report have established the importance of SCMs and extracting PFA from former disposal sites in the UK for use in the cement sector. This section now sets out:

- a potential supply requirement scenario for domestically sourced PFA, referencing some of the aforementioned documents and studies; and
- the action that would be required to increase the domestic supply of PFA from historic disposal sites to meet certain supply scenarios for Portland Cement replacement.

Action required

5.2 Sufficiently opening up the UK's PFA resource would require production from multiple former disposal sites, in turn requiring multiple planning permissions to extract and process the deposits.

5.3 The following demonstrates the size of the task:

- if PFA is to replace just 20% of cement consumption in the UK there will need to be a consistent supply of around 3 million tonnes (of PFA) per annum (note: this is on the basis that the UK uses around 15 million tonnes of cement annually); and
- this figure rises to 6 million tonnes per annum if the target of 40% replacement, as referred to above, is to be met.

5.4 These volumes will require constant production from multiple sites.

5.5 To put this into perspective, in order to achieve the 40% replacement scenario, there would be a requirement for 20x PFA production sites – each producing a volume of 300,000 tonnes per annum.

6.0 RCEP AND ALTERNATIVE SITES

6.1 Having established the limited options to decarbonise the cement sector in the UK and the need to extract from PFA landfill deposits; this section considers the RCEP Site relative to other PFA deposits and cement works in the UK.

6.2 The principal aim of this section is to consider the planning / environmental designations and considerations relevant to the RCEP Site in relation to other PFA disposal sites and nearby mineral reserves. The analysis has been carried out by Chartered Town Planners at DWD, who are specialists in the field and submitted the RCEP planning application on behalf of Hive.

6.3 Importantly, it should be noted that there is no statutory or defined national policy requirement to carry out an 'alternative site assessment' or similar as recognised in the Bramley appeal decision[61].

6.4 Furthermore, *a* recent High Court judgement on the challenge to the grant of the A57 DCO concluded that, *"There is no general principle of law that the existence of alternative sites inevitably becomes a mandatory material consideration in any case where a proposed development would cause adverse effects[62]".*

6.5 Most importantly, in the current state of climate emergency and evident need for PFA, as demonstrated by this study, any suitable alternative sites identified in this assessment, should also be developed in accordance with local and national policy in order to meet demand.

Assessment scope

6.6 The assessment considers a range of recognised planning and environmental criteria, including environmental designations, flood risk, highway access, planning allocations, and potential availability.

6.7 These alternatives are not replacements for the RCEP Site since there is a demonstrable need for all accessible PFA deposits in the UK to be developed in order to meet the challenging climate change objectives set out in this report. Notwithstanding this, in order to achieve the 40%

[61] Bramley, Hampshire APP/H1705/W/22/3304561 ('Bramley') - 45MW solar farm and battery storage allowed 13th February 2023

[62] Peak District and South Yorkshire Branch of the Campaign to Protect Rural England v Secretary of State for Transport v National Highways Limited [2023] EWHC 2917 – Approved Judgement for Development Consent Order for the A57 Link Roads Scheme

replacement scenario, set out in section 5 of this report, there would need to be 20x PFA production sites at a production volume of 300,000 tonnes per annum.

6.8 Note that there are only 17 potential alternative PFA sites considered in this section, meaning that some sites would arguably need to produce more than 300,000 tonnes per annum. This may also be advisable given that the vast majority of the resource would need to be mobilised as quickly as possible to be available in the approximate 20-year window before CCUS is intended to be widely deployed in the UK.

6.9 The potential alternative PFA sites have been suggested by consultees in the local community around the RCEP Site and were also taken from research carried out by DWD, including pending planning applications and the UKQAA's own list. It is not known if they are all commercially viable; existence of a planning permission does not equate to viability, and it is known that some of these sites are facing pressures for alternative forms of development. For example, the Thorpe Marsh site is subject to a pending planning application with Doncaster Council for a battery energy storage system to be built and no removal of PFA during the battery's lifetime.

6.10 The assessment also considers four cement works within a 50-mile radius of the RCEP Site. These are considered in order to demonstrate the production status quo for cementitious materials and what will likely continue at current levels if PFA deposits are not extracted from at the required scale.

RCEP Site

6.11 The main challenges from the local community in relation to the RCEP Site include the following non-exhaustive reasons:

- it is located within the countryside (as defined by the Bassetlaw Core Strategy & Development Management Policies DPD);
- it is located adjacent to the Sutton and Lound Gravel Pits SSSI that forms part of the Idle Valley Nature Reserve;
- there are isolated residential properties located close to the site boundary; and
- the village of Lound is located approximately 400 m to the north and the village of Sutton-cum-Lound located approximately 380 m to the north west.

6.12 It should also be noted that, in terms of benefits (not exhaustive), the RCEP Site has direct access to the A638, meaning that minor roads through local villages do not need to be used; there is a

legacy of minerals and industrial development in the area, with the RCEP able to make use of some of the remaining infrastructure; and PFA from the RCEP Site is of proven high quality.

Assessment summary

6.13 The assessment set out in **Appendix 3** to this report demonstrates that the alternative sites are subject to one or a combination of the following:

- located within or in close proximity to a nature reserve and/or cultural heritage asset;
- do not benefit from a direct access to an A-road, meaning that minor roads would need to be used;
- located immediately adjacent to or in close proximity to residential properties; and/or
- subject to development proposals or strategic policies that are not deemed compatible with long-term PFA extraction.

6.14 It is also important to note that many mineral and PFA deposits are located in countryside locations, with many of these also located within the Green Belt. This is commonplace for mineral extraction sites.

6.15 Many of the alternative sites suggested by consultees in the local community are significantly more constrained than the RCEP Site, particularly when considering designated sites. This includes numerous alternative sites actually being designated as SSSIs and nature reserves/wildlife sites themselves, and others located immediately adjacent to designated sites with the highest level of international protection, e.g. Special Protection Areas ('SPA'), Special Areas of Conservation ('SAC') and RAMSAR sites.

6.16 To illustrate this from the alternative sites assessed in Appendix 3:

- The Longannet PFA site (in Scotland), which has been proposed by some consultees in the local community as a more suitable location than the RCEP Site, is entirely located with the Firth of Forth SSSI.
- The Cottam PFA site (in Nottinghamshire), also proposed by some consultees in the local community as a more suitable location than the RCEP Site is largely designated as a Local Wildlife Site (around 50%), located close to the village of Cottam and immediately adjacent to a residential property; there is no A-road access (although train exports may be possible); and the site is proposed for redevelopment for different uses, including residential properties as part of the 'Cottam Priority Regeneration Area' in Bassetlaw planning policy.

- The Kingsnorth site (in Kent), also proposed by some consultees in the local community as a more suitable location than the RCEP Site, is surrounded by and immediately adjacent to the Medway Estuary and Marshes SPA, Medway Estuary and Marshes Ramsar Site, and Medway Estuary and Marshes SSSI.

6.17 It is also notable that when considering existing cement plants located closest to the RCEP Site, they are almost exclusively located within the Peak District National Park and/or immediately adjacent to nationally and internationally protected sites. Furthermore, the cement plants are all either located immediately adjacent or close to residential properties and/or tourist accommodation.

6.18 To illustrate this:

- The Hope Cement Works, the largest single producer of Portland Cement in the UK by capacity, is subject to numerous sensitivities, including being located within the Peak District National Park, partly overlapping the Dirlow Rake and Pindale SSSI, immediately adjacent to the South Lee Meadows SSSI, immediately adjacent to the Grey Ditch Scheduled Monument, and located in close proximity to residential properties.
- The South Ferriby Cement Works, currently closed but previously producing around 1 million tonnes of Portland Cement per annum, is located immediately adjacent to the Humber Estuary SPA, SCA, RAMSAR and SSSI. It is also located immediately adjacent to the village of South Ferriby.

6.19 The above demonstrates that the availability of minerals and the landscape are influenced by an area's geology, so the highest quality minerals are often found in places with high landscape value. As a result, there is a strong correlation between mineral siting and environmental designation meaning that the alternative sites are almost exclusively subject to the same or comparable sensitivities and constraints as the RCEP Site.

6.20 This is not to say that such sensitivities and constraints are not important or should be disregarded; quite the opposite, hence why Hive has acknowledged them throughout its planning application and carried out an extensive Environmental Impact Assessment ('EIA') and proposed extensive mitigation measures and controls.

6.21 However, it is demonstrably the case that:

- if sites located in proximity to designated assets, in the countryside and/or in proximity to residential properties were ruled out, then every single site on the list in **Appendix 3** would be ruled out, along with many more mineral extraction sites in the UK; and

- clearly, with careful management and mitigation, mineral extraction and processing sites are able to operate in the countryside and co-exist with nature and operate in some of the most sensitive environments in the UK (e.g. the Peak District National Park), some of which are arguably significantly more sensitive than the RCEP Site.

6.22 The assessment considers three alternative PFA stockpiles within Nottinghamshire and identified that, in term of their continued availability and use:

- The Cottam PFA site is currently closed and proposed for alternative development, including residential. Hive has enquired about the availability of this site for PFA extraction, including development of a long-term processing plant, and has been informed that it is not currently available.
- The West Burton PFA site is currently extracting PFA; however, its long-term future is in doubt due to proposals for a fusion reactor at the site. Hive has also enquired about the availability of this site for PFA extraction, including development of a long-term processing plant, and has been informed that it is not currently available.
- The Ratcliffe PFA site is currently understood to be extracting PFA; remaining deposits are estimated to be around 1 million tonnes of PFA, meaning it is not a long-term option.

6.23 The above means that the supply of PFA within Nottinghamshire is threatened. It is also notable that there are currently no known cement replacement quality supplies of PFA from within Nottinghamshire, which, to realise, would require a (i) large supply (millions of tonnes) and (ii) long-term, guaranteed source of PFA to justify the capital expenditure on processing plant (many millions of £ pounds). It is notable that there is no subsidy regime for PFA extraction, and it therefore has to be commercially viable, and the high quality and large resource at the RCEP Site is considered to be commercially viable.

6.24 The findings of this assessment demonstrate that all sites are equally or more constrained than the RCEPE Site and show why minerals related planning policy places great importance on the need to work minerals where they are found, whilst managing and mitigating impacts; and why it is so important to plan for the future and ensure that sufficient planning permissions are granted to ensure supply, including secondary mineral/PFA supplies in Nottinghamshire.

7.0 SUMMARY AND CONCLUSION

7.1 Hive submitted a planning application for the RCEP in March 2023, which is currently being determined by NCC.

7.2 This report has been produced in response to comments from consultees in the local community querying the carbon impact of cement and the benefits and support for PFA use and asserting that there are different decarbonisation pathways for the cement industry or alternative sites that mean that the RCEP is not needed.

7.3 This report addresses the queries and strongly refutes the assertions made, using numerous empirical sources and published evidence, contextualised further with the latest government policy and industry feedback. It finds, in summary, that:

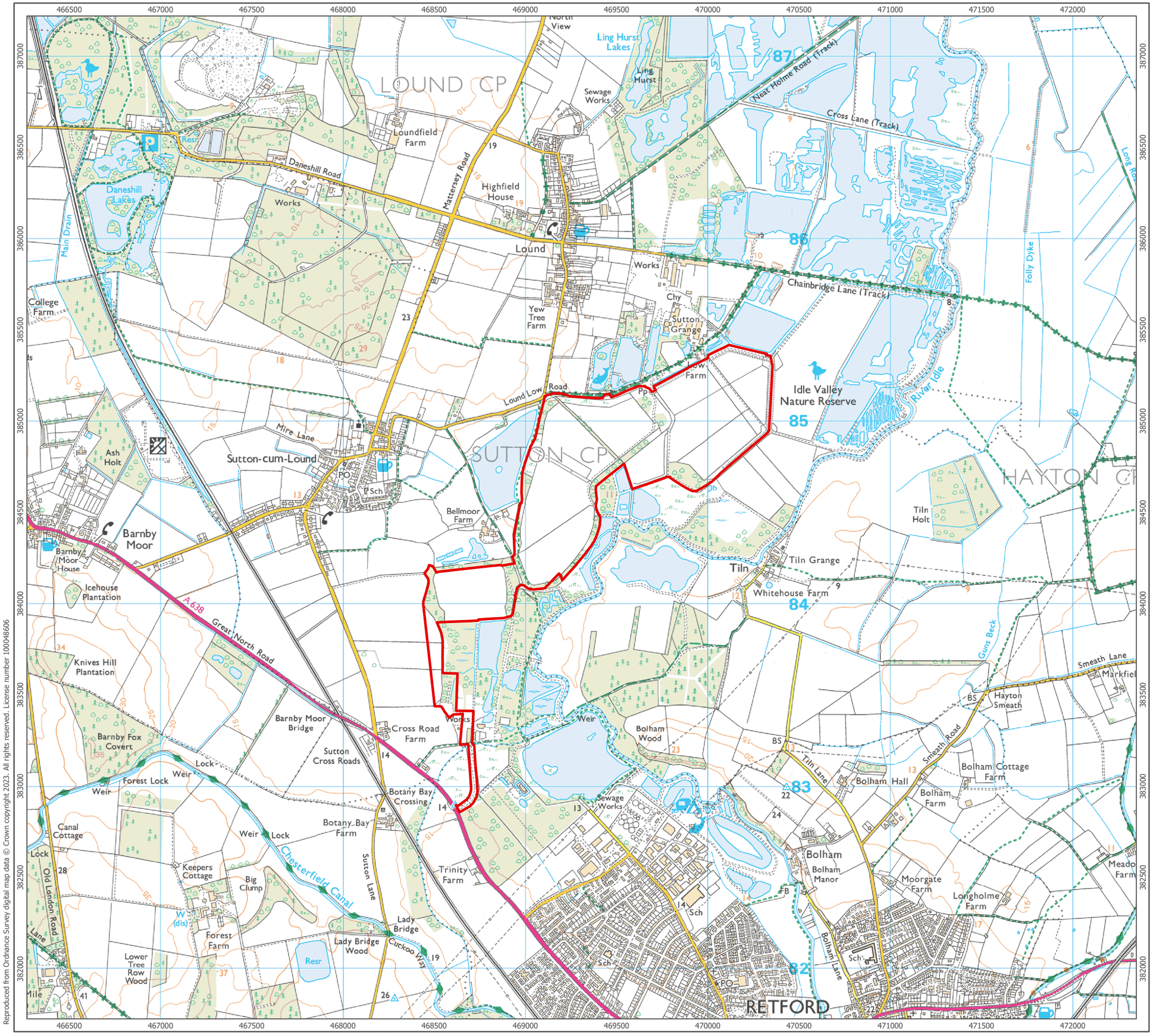
- The carbon emissions from the cement industry are undeniable and very significant at almost one tonne of carbon for every tonne of Portland Cement produced.
- The UK Government is proposing a significant reduction in carbon emissions.
- The demand for cement is growing and there are limited options to decarbonise the industry, due largely to the nature of the material and the chemical reaction that is required to produce it. The replacement of the clinker component of cement with SCMs, such as PFA, is the one of the only recognised ways to actually prevent a large portion of the emissions.
- There is a significant need for traditional SCMs, such as PFA, over the next 20 years or more both before CCUS is fully adopted and to work in tandem with it.
- PFA is the only material that is domestically available in large enough quantities to provide the carbon reduction that is required now. The PFA resource in the UK therefore needs to be beneficially used at scale, with numerous new extraction and processing sites required. PFA is a finite resource and is specifically defined in the NPPF as a type of secondary aggregate that local plan policies must support. The NPPF also classes PFA from former disposal sites as a nationally important mineral resource. Unsurprisingly therefore, Policy MP5 of the NMLP supports the principle of development proposals which will increase the supply of secondary and/or recycled aggregates, such as PFA.
- The RCEP comprises a nationally significant scale of resource at around 6.6 million tonnes, which is capable of saving over 5 million tonnes of carbon. The RCEP Site comprises a high-

quality source, and can be developed in a sensitive way, using modern technologies such as low energy drying.

- The alternative PFA extraction sites in the UK are subject to the same and/or comparable sensitivities and constraints as the RCEP Site and are unlikely to all be commercially viable.

7.4 The final conclusion therefore is that the need to extract from the RCEP Site has been demonstrated and reasonable alternatives have been considered.

APPENDIX 1: SITE LOCATION PLAN



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Y:\GIS\Environment\4092 Lound Ash Extraction\4092 Lound Ash Extraction.aprx\4092-REP-072 Site Location Plan

HIVE AGGREGATES

ARCUS

Site Boundary

1:20,000 Scale @ A3

0 0.5 1 km NORTH

Produced By: HG	Ref: 4092-REP-072
Checked By: EB	Date: 16/02/2023

Site Location Plan

Retford Circular Economy Project

APPENDIX 2: SUPPORT LETTERS

CEMBLEND

Cemblend Ltd
Swan House Business Centre
Bosworth Hall Estate
Market Bosworth
Nuneaton
Warwickshire
CV13 0LJ

4th April 2023

Joel Marshall
Principal Planning Officer
Nottinghamshire County Council
Policy, Planning, and Corporate Services
County Hall
West Bridgford
Nottingham
NG2 7QP

PLANNING APPLICATION ES/4518 – EXTRACTION, PROCESSING AND EXPORT OF PULVERISED FUEL ASH FROM FORMER ASH DISPOSAL LAGOONS AND THEIR PROGRESSIVE RESTORATION – SOUTH OF LOUND, RETFORD, DN22 8SG

I am writing to register my support for the above planning application based on the following reasons:

- This project will generate economic benefits in the local and wider area through the creation of approximately 20 new full-time jobs at the site and work and jobs created in the local supply chains.
- Pulverised Fuel Ash (PFA) from a former landfill site is a sustainable component in the production of cement, reducing demand for primary raw materials.
- PFA provides a partial alternative to traditional cement, helping to reduce carbon emissions and supporting the decarbonisation of the building products industry.
- This project is expected to save upwards of 5 million tonnes of carbon across its lifetime, reducing greenhouse gas emissions and helping the UK achieve its key climate targets.
- For every tonne of PFA used in place of traditional cement, approximately 0.8 tonnes of carbon will be saved.
- Replacing cement will form a significant element of the Net Zero 2050 strategy at both a country and business level.
- Further processing of recovered PFA would increase its possible uses in the manufacturing of concrete products.

CEMBLEND

Cemblend Ltd
Swan House Business Centre
Bosworth Hall Estate
Market Bosworth
Nuneaton
Warwickshire
CV13 0LJ

- The British Standards for cement and concrete are currently being changed to incorporate 'novel' low carbon cements and recovered PFA is a known component of some 'novel' cements.

- This project will improve local biodiversity by restoring the site to improved habitats that complement the Idle Valley Nature Reserve.

Yours sincerely,

[redacted]

[redacted]
Director
Cemblend Ltd

Joel Marshall
Principal Planning Officer
Nottinghamshire County Council
Policy, Planning, and Corporate Services
County Hall
West Bridgford
Nottingham
NG2 7QP

May 15th, 2023

PLANNING APPLICATION ES/4518 – EXTRACTION, PROCESSING AND EXPORT OF PULVERISED FUEL ASH FROM FORMER ASH DISPOSAL LAGOONS AND THEIR PROGRESSIVE RESTORATION – SOUTH OF LOUND, RETFORD, DN22 8SG

Dear Mr Marshall,

Climate change is universally recognised as an existential threat and the journey to net-zero is therefore a hugely important challenge to countries, communities and companies around the world.

The cement industry in general and Cemex in particular are, as a consequence, pursuing a wide range of initiatives and innovative strategies to play their part in radically reducing the amount of CO2 produced as an inevitable result of their manufacturing operations.

By the very nature of the chemical reaction taking place to produce cement, CO2 is produced. The challenge is to reduce the amount of CO2 in every tonne of cement manufactured. For some time the industry has actively pursued and developed the use of alternative fuels which have substantially displaced traditional fossil fuels and thus reduced CO2 emissions.

The use of alternative and decarbonated raw materials in cement manufacture will allow further significant reductions in CO2 for every tonne of cement and the introduction and recycling of materials such as pulverised fuel ash (pfa) can play an important role in this process.

It is estimated that the project at Lound could save upwards of five million tonnes of carbon across its lifetime and thus make a significant contribution on the road to net-zero.

In conclusion, I would urge you to consider this most important aspect of these proposals when assessing this application.

Yours sincerely,

[redacted]

CEMEX EMEA Region
VP Corporate Affairs, Sustainability & ERM
Phone: [redacted]
[redacted]
cemex.com

Our Ref :

4 April 2023

Joel Marshall
Principal Planning Officer
Nottinghamshire County Council
Policy, Planning, and Corporate Services
County Hall
West Bridgford
Nottingham
NG2 7QP

PLANNING APPLICATION ES/4518 – EXTRACTION, PROCESSING AND EXPORT OF PULVERISED FUEL ASH FROM FORMER ASH DISPOSAL LAGOONS AND THEIR PROGRESSIVE RESTORATION – SOUTH OF LOUND, RETFORD, DN22 8SG

Dear Joel

I am writing in support of the above planning application.

As a major local employer, experienced earthworks operator and large consumer of cementitious materials we have full awareness of the local benefits, operational impacts and major requirement for the product to be created here.

The scheme stands to create 20-30 jobs for the local area, and the potential to offer training, development and apprenticeships to several young people or those wishing to upskill. The jobs will be created across the full spectrum of employment, providing wider benefits to the local towns and villages. It will also bring wider benefits through utilising the local supply chain for ancillary services including plant maintenance, servicing, and supplies to welfare.

PFA is an important resource, and a waste product. It offsets the requirement for primary materials within the concrete. Its benefits in lowering the carbon impact of cement are well understood and publicised and increasingly project specifiers are requiring the use of PFA within concrete mixes in order to assist construction projects in achieving net zero carbon targets. The availability of sufficient high quality PFA to support this is a key limitation. This project will directly address this.

The proposed extraction is to be undertaken at a low rate of production with progressive restoration. Much of the transport is using conveyors, and operating behind screening. This methodology is best practise to mitigate potential impacts on the surrounding area. On completion, the current artificial raised banks are removed with the site returning back to original natural levels, with biodiversity gains to enhance the adjacent nature reserve.

Yours Sincerely
Fox (Owmby) Limited

[redacted]

[redacted]
Director

Fox (Owmby) Limited

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Lincolnshire LN8 2BU
Tel 01673 878444 Fax 01673 878644
Email office@foxowmby.com
www.foxowmby.com

Registered No: 804642 England

Hargreaves Logistics | West Terrace | Esh Winning | Durham | DH7 9PT
T. 0191 373 4485 | F. 0191 373 3777
www.hsgplc.co.uk

Date: 10th May 2023
Planning Application ES /4518

Joel Marshall
Development Management
Place Department
Nottingham County Council
County Hall, Loughborough Road
West Bridgford
Nottingham
NG2 7QP

Dear Joel Marshall,

LOUND HIVE LIMITED – PLANNING APPLICATION FOR THE EXTRACTION, PROCESSING AND EXPORT OF PULVERISED FUEL ASH FROM FORMER DISPOSAL LAGOONS TO THE SOUTH OF LOUND, RETFORD, DN22 8SG.

The reason for this letter is to support the planning application ES / 4518 made by Hive Aggregates for the extraction, processing, and export of Pulverised Fuel Ash in Lound.

Hargreaves Group offer a range of industrial services, should Hive Aggregates be successful in their application Hargreaves Services intend to work closely with Hive Aggregates to provide related services involved in the supply chain of this application. Hargreaves already operates a significant amount of bulk haulage services within this area, upon successful application working closely with Hive would allow Hargreaves Services to continue offer secure well-paid employment within the area and potentially new employment opportunities.

The integration of exported Pulverised Fuel Ash from this site would also integrate into existing transport networks reducing emitted emissions from operations supporting drive towards 2050 net Zero. The integration of these volumes also offers an opportunity to reduce overall traffic movements as better efficiency is found.

Hargreaves recognise the importance of sustainable building materials which this development offer reducing the overall impact of critical infrastructure and building products This coupled with sustainability advantages found within the supply chain mean this development offers a substantial number of benefits to both internal and external stake holders.

Kind Regards
[redacted]
Commercial Director Hargreaves Logistics.

Power Minerals Ltd. Wrens Court 46 South Parade Sutton Coldfield B72 1QY
Tel: +44 (0)121 321 3416 | sales@powerminerals.co.uk | powerminerals.co.uk

6th June 2023

Joel Marshall
Principal Planning Officer
Nottinghamshire County Council
Policy, Planning, and Corporate Services
County Hall
West Bridgford
Nottingham
NG2 7QP

PLANNING APPLICATION ES/4518 – EXTRACTION, PROCESSING AND EXPORT OF PULVERISED FUEL ASH FROM FORMER ASH DISPOSAL LAGOONS AND THEIR PROGRESSIVE RESTORATION – SOUTH OF LOUND, RETFORD, DN22 8SG

I am writing on behalf of Power Minerals Limited ('PML') in support of the Retford Circular Economy Project ('RCEP'), which will provide a valuable source of low carbon cement replacement material for many years to come.

As the UK's leading independent supplier of power station ash products, PML is at the forefront of exciting developments that are transforming the energy industry. Owned by power giant EP Power Minerals GmbH, PML sits at the center of an international and UK-wide network that expertly guides quality ash supplies to major projects across the construction, housing and infrastructure sectors.

We understand the pulverised fuel ash ('PFA') at the RCEP site is very high quality. This level of quality and consistency lends itself perfectly to providing a cement replacement product with minimal processing and energy. We have decades of experience in making this judgement.

As a supplier to the cement and concrete industry our customers have set out road maps to net zero – one of the technology levers to pull is the increase use of low carbon cement alternatives – of which PFA is a vital ingredient for our customers to meet these goals.

The UK, although no longer producing fresh PFA in sufficient volumes, benefits from significant domestic PFA reserves in legacy deposits. A number of projects like the RCEP will be required to facilitate the mineral products industry in meeting its targets of net-zero.

The RCEP and resources like it are nationally valuable assets that should be used beneficially without delay.

Yours sincerely,

[redacted]

Sales & Technical Director
Power Minerals Limited.

APPENDIX 3: ALTERNATIVE PFA STOCKPILE SITES AND NEARBY MINERAL QUARRIES

Site	General comments	Designations and potential development feasibility constraints
Longannet PFA Site	Restored Valleyfield Ash Lagoon adjacent to the sea to the east of the power station Countryside, coastal, with some industrial elements	• Whole site designated as the Firth of Forth SSSI • Immediately adjacent to the First of Forth Special Protection Area ('SPA') • Immediately adjacent to the First of Forth Ramsar Site • High Risk of Surface Water flooding, medium risk of coastal flooding • Residential properties within 100m
Cockenzie PFA Site	Restored Former lagoons located on the coast to the southwest of the power station Countryside, coastal, with some industrial elements	• Adjacent to Firth of Forth SPA, SSSI, Ramsar along the coast and the Outer Firth of Forth and St Andrews Bay Complex SPA • Situated between two towns: Port Seton and Prestonpans • High likelihood of coastal flooding within the site • Areas of high and medium likelihood of river flooding within the site • Areas of high and medium surface water flooding within the site
Kilroot PFA Site	Operational Power station currently exporting ash. Lagoons adjacent to coast on the power station site Countryside, with some industrial elements	• SSSI and Ramsar site to immediate southwest of the site • At risk of flooding from a nearby River • Residential area located 240m to the east. • Outer Belfast Lough Area of Special Scientific Interest and Ramsar site 400m southwest • Local Wildlife Site is adjacent to the site
Lynemouth PFA Site	Largely restored Ash lagoons to south of power station, Countryside, with some industrial elements	• Grade I Listed church adjacent to the site as well as three Grade II Listed headstones and tombs. • Located 200m from Cresswell and Newbiggin Shores SSSI • Located 250m from Northumbria Coast SSSI • Located 250m from Northumbria Coast Ramsar Site • Site located immediately adjacent to residential properties. • According to the Northumberland Development Plan, the land lies within a Nature Improvement Area, Southeast Northumberland Wildlife Network and Coastal Mitigation Service Area

Site	General comments	Designations and potential development feasibility constraints
Ferrybridge PFA Site	Ash disposal lagoons located to the north of former Power Station Countryside (Green Belt), with some rural elements	• Green Belt. • Located 150m from residential properties. • Ferrybridge golf course is adjacent to the west of the Site. • 220m from nearest listed Building (Grade 2). • 770m north of Ferrybridge Scheduled Monument. • 850m south of Fairburn and Newton Ings SSSI. • 1.2km southeast of Well Wood Local Nature Reserve. • 1.5km from Fairburn Ings Local Nature Reserve. • River Aire bounds the eastern boundary – the site is mostly in Flood Zone 3 with some parts of the land located within Flood Zone 2. • Planning application for the development of general industrial (B2 use class) and storage and distribution (B8 use class) employment floorspace has been submitted in 2023 under ref: 23/00100/FUL.
Eggborough PFA Site	Part restored Gale Common site located to southwest of power station Countryside (Green Belt), with some industrial elements	• Green Belt. • Adjacent to three parcels of ancient woodland. • 670m west of a scheduled monument. • Flood Zone 1 adjacent to Flood Zone 2 to the north. • 300m east of a locally important landscape area. • Immediately adjacent to residential properties. • No A-road access. • Existing planning permission in place for the extraction of PFA at the Gale Common disposal site, therefore the site unlikely to be available to Hive. • Note that permission granted here is for the export of 1 million tonnes per annum with no A-road access.
Drax PFA Site	Majority restored Barlow Mound to the west of the power station Countryside, with some industrial elements	• Outdoor Ted children's play and educational centre immediately adjacent to the site. • Skylark Centre nature reserve immediately adjacent to the site. • Located within Flood Zone 1 and surrounded by Flood Zone 3. • Camblesforth village close to the west of the site. • Grade I and Grade II Listed Buildings1km to the southwest. 2.2km to the south west of River Derwent SSSI Boundary. • Site may contain biomass ash and may not be of sufficient quality.
Fiddlers Ferry PFA Site	Currently exporting ash Countryside (Green Belt), with some industrial elements	• Green Belt • Golf course and recreation area located immediately to the north. • Located 3.5km northeast of the Mersey Estuary SSSI. • River Mersey bounds the south of the site. • Nearest listed building is 1.3km to the south. • Nearest residential areas are located 610m to the north and 1.3km to the south. • Local Nature Reserve 400m to the south. • Proposed for residential development and public amenity space, not compatible with long-term PFA extraction. • Southern part of the site located within the Overall Spatial Strategy Green Belt and Strategic Green Links.

Site	General comments	Designations and potential development feasibility constraints
		• Some PFA is currently being extracted from the site and it is not available to Hive.
West Burton PFA Site	Operational power station currently exporting ash Countryside, with some industrial elements	• Residential properties within 200m. • Site is 1.6km from Lea Marsh SSSI. • Scheduled Monument to the south of the site and two Grade II listed buildings found to the north. • Bounded by the River Trent to the east. • West and northwest of the site is located within Flood Zone 3 • PFA is currently being extracted from the site. • Remote from the strategic road network (4.33km at its nearest point). • Long-term availability is doubtful because the site is proposed for a fusion reactor. • Hive has already approached the owner; it is not known to be available due to the potential development proposals. • PFA also known to be variable quality and lower quality than the RCEP.
Cottam PFA Site	Largely restored Ash disposal area located within and to north of power station site Countryside, with some industrial elements	• Site is situated within Flood Zone 2 and 3. • Large part of the site, around 50%, is designated as a Local Wildlife Site. • Village of Cottam located close to the west. • Residential property located immediately to the west. • Closest heritage sites are Grade I and Grade II Listed Buildings found 1km to the south west of the site. • Site located 2.6km to the east of Ashton's Meadow SSSI. • Bassetlaw District Council Policies Map shows that there is an area of land to the north of the power station designated as Locally Important Open Space. • Site is proposed for redevelopment for different uses, including residential properties, as part of the 'Cottam Priority Regeneration Area' in Bassetlaw planning policy; not compatible with long-term PFA extraction. • Site is more remote from the strategic road network 6.33km at its nearest point.
Ratcliffe-on-Soar PFA Site	Operational – currently exporting ash Countryside (Green Belt), with some industrial elements	• Green Belt. • Closest residential area is to the immediate north. • 1.3km to the east of Lockington Marshes SSSI. • 690m to the north east of a Scheduled Monument. • Closest heritage Site is 675m to the north of the site. • PFA is currently being extracted from the site and it is not available in the long-term to Hive.

Site	General comments	Designations and potential development feasibility constraints
		• PFA reserves less than 1 million tonnes with fresh supplies soon to end; not a long-term supply option.
Rugeley PFA Site	Partially restored Ash lagoons immediately to east of power station Countryside, edge of settlement	• Immediately adjacent to a dense residential area. • Areas of the site which fall within Flood Zone 2. • To the north of the Site the land is located within Flood Zone 3. • Closest heritage assets is a Grade II Listed Building to the west of the site. • Outline planning permission for a sustainable and innovative mixed-use neighbourhood, unlikely to be available for or compatible with long-term PFA extraction.
Didcot PFA Site	Restored Main ash lagoons 5km to the north near Radley Countryside (Green Belt), with some industrial elements	• Green Belt. • Immediately adjacent to residential properties. • Contains the Nuneham Courtenay Registered Park and Garden. • Immediately adjacent to Listed Building. • Immediately adjacent to Radley Lakes Nature Reserve. • Located immediately adjacent to 'Settlement site E of Goose Acre Farm' Scheduled Monument. • Located near the Culham Brake SSSI to the north of the Site. • Located within Flood Zone 2 and 3. • 3.3km from the North Wessex Downs AONB.
Aberthaw PFA Site	Large ash mound to east of power station – very prominent and visible Countryside, coastal, with some industrial elements	• Adjacent to East Aberthaw Coast SSSI. • Adjacent to East Aberthaw village. • Site is bounded by the sea to the south and therefore is at high risk of coastal flooding. • Hive has already approached owner – it is not available at present – significant uncertainty due to regeneration proposals and potential incompatibility. • PFA mixed with salt water, causing potential processing problems.
Tilbury PFA Site	Operational - currently exporting ash Partially restored area to east of power plant Countryside (Green Belt), coastal, with some industrial elements	• Green Belt. • Mucking Flats and Marshes SSSI 400m east. • Thames Estuary and Marshes Ramsar Site 400m east. • Located adjacent to residential property and 150m from further properties. • Listed Building to the north of the site and Schedule Monument to the west. • Majority of the Site is located within Flood Risk Zone 3 Surrounded by Local Natural Reserves. • Designated as Primary Industrial and Commercial Area in the Thurrock Core Strategy and Policies for Management of Development; potentially incompatible with long-term PFA extraction. • PFA is currently being extracted from the site and it is not available to Hive.

Site	General comments	Designations and potential development feasibility constraints
Kingsnorth PFA Site	Restored Main ash lagoons located to northeast of former power station Countryside, coastal, with some industrial elements	• Site surrounded by the Medway Estuary and Marshes SPA. • Site surrounded by the Medway Estuary and Marshes Ramsar Site. • Site surrounded by the Medway Estuary and Marshes SSSI. • River Medway is located adjacent to the southern boundary. • Site is primarily located within Flood Zone 3. • Surrounding areas have been sterilised by industrial/logistics development. • PFA potentially mixed with salt water, causing major processing issue. • Hive has enquired about site availability with no success.
Thorpe Marsh PFA Site	Thorpe Marsh Ash Fields Marsh Lane Barnby Dun Doncaster DN3 1ET Ash lagoons adjacent to the derelict Thrope Marsh Power Station Countryside, with some industrial elements	• Located immediately adjacent to the Thorpe Marsh Nature Reserve. • Residential property within 150m. • Site is located primarily in Flood Zone 3 and partly in Flood Zone 2. • Site is surrounded by a Water Storage Area. • Located 4.2km from Shirley Pool SSSI and Owston Hay Meadows SSSI. • South east of the site there are two Grade II Listed Buildings and one Grade II* Listed Building. • According to the Doncaster Local Plan 2015 - 2035 the Site is allocated in the Countryside Policy Area. • Site is the subject of a planning application to extract 600k tonnes of PFA, after which it will be sterilise by a battery storage facility; this is a small amount of PFA and not enough production for long-term impact in terms of emissions reduction. • Hive has tried to secure the site and it is not available. • Site is remote from the strategic road network.
Hope Cement Works	1.5 million tonnes production capacity Countryside, National Park	• Located within the Peak District National Park. • Partly overlaps the Dirlow Rake and Pindale SSSI. • Immediately adjacent to the South Lee Meadows SSSI. • Immediately adjacent to the Grey Ditch Scheduled Monument. • Numerous other SSSIs and constraints in the surrounding area. • Immediately adjacent to numerous Listed Buildings. • Immediately adjacent to numerous residential properties, caravan sites and amenity uses. • Closest residential area located 200m to the south. • Caravan park located 340m to the south east.
Tunstead Cement Works	1 million tonnes capacity Countryside, National Park	• Immediately adjacent to numerous residential properties. • Large part of the site located within the Peak District National Park. • Further residential properties within 100m. • Immediately adjacent to the Wye Valley SSSI. • Peak District Dales SPA 100m to east. • Immediately adjacent to Listed Building and Scheduled Monument.

Site	General comments	Designations and potential development feasibility constraints
Buxton Cement Works	1 million tonnes capacity Countryside, prominent location	• Immediately adjacent to numerous residential properties. • Located adjacent to numerous Scheduled Monuments and Listed Buildings. • 7.6km to the east of the Peak District National Park. • 700m to the east of the Holland Moss SSSI. • 880m north west of Grade 2 listed Building. • Opposite a Local Wildlife Site and 500m of another wildlife site.
South Ferriby Cement Works	1 million tonnes production capacity Countryside, currently closed	• Immediately adjacent to the Humber Estuary SPA. • Immediately adjacent to the Humber Estuary SCA. • Immediately adjacent to the Humber Estuary Ramsar. • Immediately adjacent to the Humber Estuary SSSI. • Immediately adjacent to the village of South Ferriby and residential properties.

APPENDIX 4 ALTERNATIVE SITE RED LINE BOUNDARIES

Longannet PFA Site

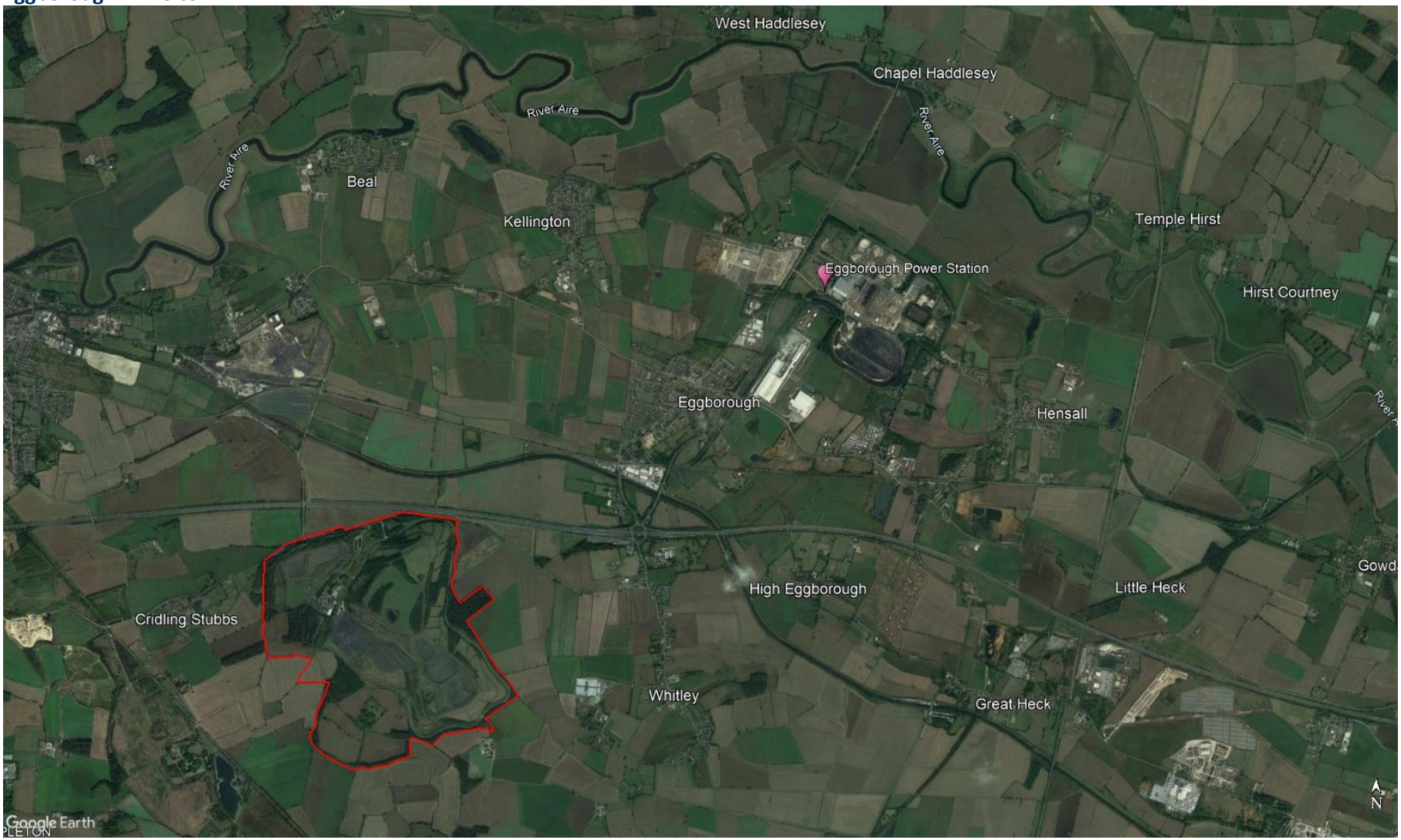
Cockenzie PFA Site

Kilroot PFA Site

Lynemouth PFA Site

Ferrybridge PFA Site

Eggborough PFA Site



Drax PFA Site

Fiddlers Ferry PFA Site

West Burton PFA Site

Cottam PFA Site

Ratcliffe-on-Soar PFA Site

Rugeley PFA Site

Didcot PFA Site

Aberthaw PFA Site

Tilbury PFA Site

Kingsnorth PFA Site

Thorpe Marsh PFA Site

Hope Cement Works

Tunstead Cement Works

Buxton Cement Works

South Ferriby Cement Works