Kintore Hydrogen Plant

Environmental Impact Assessment Report
Chapter 3: Consideration of Alternatives

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Qualifications

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Summary

It is a requirement of the EIA Regulations 2017 that the developer must outline any reasonable alternatives that have been studied and the reasons for selecting the preferred option with a comparison of environmental effects. This chapter explains how the proposed development location was chosen in the vicinity of Kintore Substation to provide its grid connection. It goes on to explain how the design has evolved to respond to the findings of the EIA process and feedback from stakeholder consultation.

1 Introduction

1.1 Approach

1.1.1 Regulation 5(2)(d) of the EIA Regulations requires an Environmental Impact Assessment Report (EIAR) to include "*a description of the reasonable alternatives studied by the developer, which are relevant to the development and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment*".

1.1.2 Kintore Hydrogen has employed a staged decision-making process to arrive at the proposed development location and design, taking into account findings of EIA work and stakeholder feedback from pre-application consultation.

1.1.3 In the first stage, Kintore Hydrogen has identified fundamental requirements arising from the project definition which guide the selection of a broad area for locating the proposed development, and then specific sites within that area for the main development elements: hydrogen production, electricity grid connection, gas grid connection and water supply.

1.1.4 In the second stage, Kintore Hydrogen has then considered specific aspects of design, scale, technology and opportunities for environmental enhancement for the development on the identified site.

1.1.5 Through these two stages, there are five main aspects in which Kintore Hydrogen has considered alternatives:

- the location of the Kintore Hydrogen Plant site and associated infrastructure;
- within that location, the overall masterplan layout and scale of buildings and equipment for the electrolysis plant element;
- the choice of technology or design for specific items of infrastructure and equipment;
- options for retaining and enhancing areas of habitat, landscaping and heritage assets, plus new habitat creation; and
- means of access to each part of the proposed development in construction and operation.

1.1.6 The following sections of this chapter explain each of these in further detail.

1.2 Scope in relation to PPC Permitting

1.2.1 The relative technical and environmental merits of various technology options in Kintore Hydrogen plant, including electrolysis of water to produce hydrogen, water treatment, cooling, and gas treatment for transmission will be subject to a requirement for detailed justification of 'Best Available Techniques' (BAT) under the Pollution Prevention and Control (PPC) permitting regime administered by the Scottish Environment Protection Agency (SEPA).

1.2.2 Application of BAT will need to be demonstrated and approved by SEPA in order for the hydrogen plant to receive a PPC Permit for operation. Guidance for this from SEPA is under development: initial guidance has been issued as in March 2024 as 'Guidance on Emerging Techniques (GET) for hydrogen production by electrolysis of water'.

1.2.3 Kintore Hydrogen has taken this emerging guidance into account in the design of the proposed development. In view of the controls over application of BAT provided by the PPC Permitting regime (and the need to retain scope to apply the best available technology, which is likely to be emerging for each phase of the development), the Planning Permission in Principle application reserves optionality over some technology choices. These are discussed where applicable in the consideration of alternatives for EIA, but noting that determination of BAT for these matters would be confirmed in the PPC Permit application in due course.

2 Consideration of Alternatives

2.1 Project imperatives and location

2.1.1 The purpose of Kintore Hydrogen Plant is to produce hydrogen using water and renewable electricity at a scale to make a significant contribution to Scotland's hydrogen production targets. This hydrogen production process and the policy drivers for it are explained further in Chapter 2: Project Description and Site Setting.

2.1.2 The fundamental requirements of the hydrogen production process are sufficient supplies of water and electricity and a route to transmit the hydrogen for use. All three elements are essential, but to utilise up to 3 GW of electricity for hydrogen production as proposed, there must be available capacity at a 400 kV substation on the backbone high voltage transmission network.

2.1.3 Kintore Hydrogen has taken a structured approach to select the proposed development site. The initial, broadest area of search was within North East Scotland, illustrated as Region A in Figure 2.1. This region is identified as the optimum for hydrogen production from the perspective of electricity grid balancing, due in part to the abundant on- and offshore wind power being connected in this region and the limited electricity transmission capacity to areas of higher demand in the UK. Guidance in this respect has been taken from National Grid Energy System Operator (ESO)'s 'Beyond 2030' strategy[1] for the energy system and from the DESNZ Second Hydrogen Allocation Round (HAR2) Application Guidance Document[2], from which Figure 2.1 is taken.

2.1.4 Within the North East region, Kintore Hydrogen has then considered a number of 400 kV substation locations as possible areas for project development. These are shown on Figure 2.2 overleaf. For each, the proximity to the National Gas National Transmission System (NTS) network for hydrogen export and to water sources was evaluated. A GIS-based screening approach was also used to identify significant environmental constraints (such as nationally- or internationally-designated sites of ecological, heritage or landscape protection), and the landscape character and level of existing development was considered.

2.1.5 From this exercise, Kintore Substation emerged as the clear preference due to the balance of constraints and best satisfying the project imperatives identified in paragraph 2.1.2: the substation (currently being expanded) can provide the 3 GW electricity supply capacity, there is proximity to two National Gas NTS pipelines and there is proximity to a more than sufficient non-saline water supply from the River Don. The consented expansion of Kintore Substation is currently under construction and is due for completion in 2026.

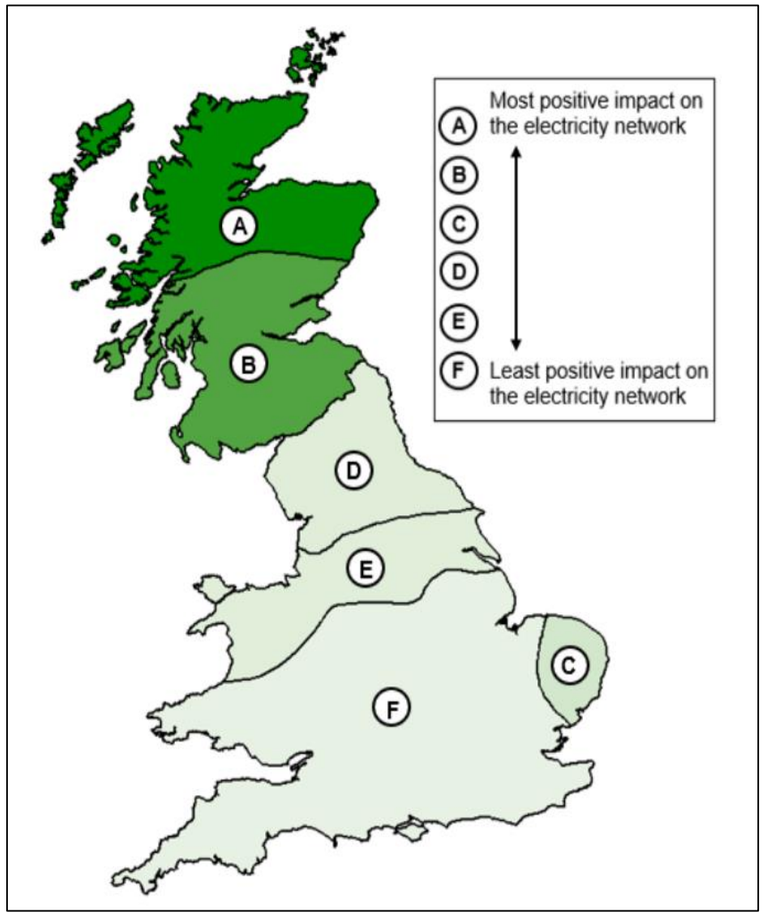

Figure 2.1: Impact of the location of low carbon hydrogen production on the electricity system in Great Britain – reproduced from page 54 of the HAR2 Guidance

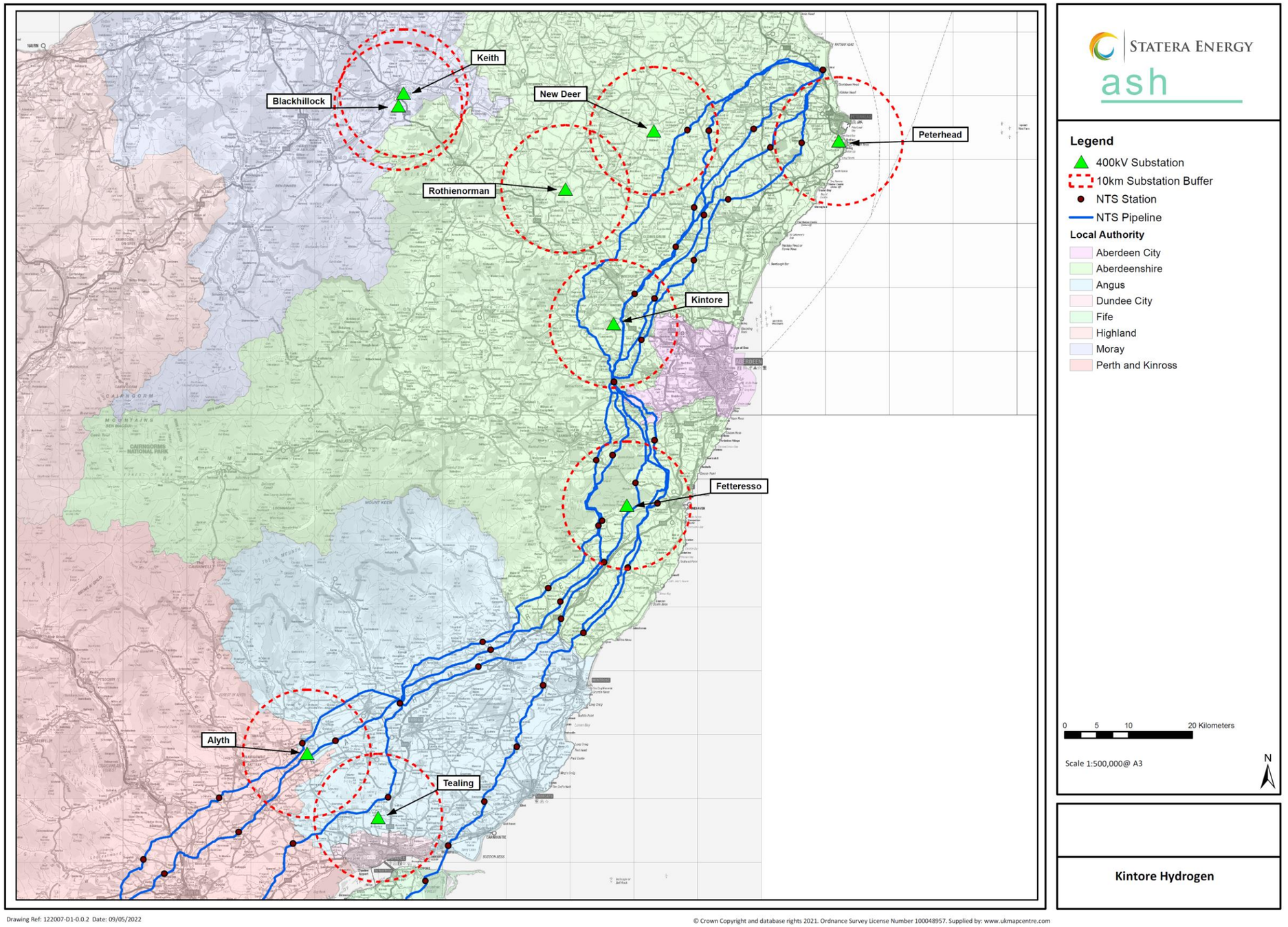

Figure 2.2: Hydrogen Plant substation and gas grid connection locations considered

2.2 Development site locations around Kintore Substation

2.2.1 When considering potential development site locations within the area around Kintore Substation, areas within which brownfield or agricultural land may be available have been reviewed by Kintore Hydrogen.

2.2.2 The proposed main electrolysis plant site that has been selected is immediately adjacent to the expanded substation, providing the shortest grid connection, minimising the trenching for underground cables and avoiding any need for new overhead power lines. The site topography is favourable to development, providing the opportunity to locate the majority of the electrolysis plant buildings and equipment tucked behind the site's central ridge, between it and the woodland to the north, which has been strongly advantageous for minimising landscape and visual impacts. Being on land as close as possible to the substation keeps the area of energy infrastructure development localised.

2.2.3 Other possible locations for the electrolysis plant in the area around Kintore Substation are more open in aspect, with greater potential for views of the development, and would extend the area of energy infrastructure development (together with the existing substation and the other existing and proposed battery storage projects) further into the generally rural setting.

2.2.4 Kintore Hydrogen considered a location around 0.5 km further east on the other side of the B977, broadly around the location of the above-ground installation (gas connection point) proposed for the development, as a possible alternative for the main electrolysis plant. However, this was found to be a much more open site with likely greater visual and landscape character impact from the proposed development and was further from Kintore Substation. In addition, an area of Ancient Woodland, existing overhead power line pylons and an existing pig farm were constraints to an efficient development layout.

2.2.5 Kintore Hydrogen also considered areas of brownfield land in industrial/commercial parks in the vicinity of Kintore Substation, such as Kirkwood commercial park. However, none were found that had brownfield land of sufficient size for the development (being largely occupied by existing businesses) and all were further from either the gas, electricity or water supply connection points.

2.3 Grid, gas and water connections

2.3.1 As noted above, the selected site location is adjacent to the (expanded) Kintore Substation and enables an underground cable connection of minimal length to be constructed between the sites.

2.3.2 With respect to water supply, the River Don is the closest water source that provides sufficient supply capacity for the electrolysis process. Alternative minor burns in the area would not provide the necessary supply capacity. Groundwater abstraction has not been considered by Kintore Hydrogen as sufficient aquifer capacity is not available, discussed in Chapter 13: Soils, Geology and the Water Environment.

2.3.3 The reach of the River Don south-east of Kintore, between the town and Hatton of Fintray, has been considered by Kintore Hydrogen for the intake and outfall location. This area provides the shortest distance for the water pipeline connection between the electrolysis plant and intake/outfall through farm land, avoiding the built-up areas of Kintore. The hydrological conditions of this reach of the river have been confirmed as suitable to provide the water supply by SEPA through the granting of a CAR licence for the full abstraction capacity.

2.3.4 Alternative sections of the River Don further upstream, west of the main electrolysis plant around the Kemnay area (instead of east at Kintore), were also initially considered because a pipeline route in this direction would not need to cross the A96 or railway. However, there is insufficient river flow capacity for the necessary abstraction volume at these locations further upstream, due to tributaries joining the river around the area of Kintore town.

2.3.5 Along the selected reach south east of Kintore, specific locations for the intake/outfall and pumping station have been considered on the basis of a number of factors: avoiding development of the pumping station in the flood plain; availability of access from the existing road network; a suitable crossing point of the railway; avoiding direct impacts on designated heritage assets; avoiding habitats of higher ecological value than farmland; and avoiding the more productive fishing lies.

2.3.6 The combination of these considerations has led Kintore Hydrogen to revise the proposed location of the intake/outfall and pumping station around 200 m eastwards, compared to the location initially studied at the EIA Scoping stage. This enables construction of the pumping station south of the railway, in a location avoiding the former Aberdeenshire Canal Scheduled Monument, and reduces the need for large construction plant to cross the railway. It also responds to feedback from the fishing community about the location of the most productive fishing lies and helps to avoid these.

2.3.7 From the intake and outfall point, two alternatives for the water pipeline route have been studied by Kintore Hydrogen, which were shown at EIA Scoping stage: one across farmland and one largely following minor public roads. The road option has subsequently been discounted on the basis of causing substantially greater disruption to transport and access for residents during construction and presenting greater

engineering challenges. As the pipeline route can be fully restored to agricultural use after trenching during the construction stage, causing no long term impact, this is the preferred option. This also provides a generally more direct route, minimising the length of pipeline and hence duration of construction works and materials used for the pipes.

2.3.8 Two alternatives for the hydrogen pipeline route and connection point to the National Gas network have been studied by Kintore Hydrogen. The route shown at EIA Scoping stage remains the preferred option, establishing a connection point south of the B977 and east of the electrolysis plant site where there are two existing National Gas pipelines. This requires a hydrogen pipeline length of approximately 2.2 km. The alternative considered was a route south to the existing National Gas compressor station at Garlogie, making the connection for hydrogen export at the compressor station. However, this has been discounted on the basis of requiring a much longer hydrogen pipeline route (around 8.3 km as the crow flies), which would need to pass through the Dunecht House Garden and Designated Landscape and require construction work in proximity to the Loch of Skene SPA/SSSI/Ramsar site.

2.4 Electrolysis plant masterplan

2.4.1 Within the selected site for the electrolysis plant, a range of potential plant layouts have been considered by Kintore Hydrogen. These were informed by an environmental site opportunities and constraints workshop held early in the EIA process between the EIA team, Kintore Hydrogen's front-end engineering design advisors (Worley) and architects (HRI Munroe). Following the initial workshop on 12 October 2023, site masterplanning and engineering design involved continued environmental specialist input as alternative design options were iteratively considered.

2.4.2 Key environmental design principles established through the initial workshop were:

- retention of higher-value habitat along and north of Dewsford Burn, in the north part of the site (outside the farmed area);
- retention of existing stands of trees in the centre of the site, tree/hedgerows at the site perimeter and badger setts insofar as possible;
- retention of the standing stone Scheduled Monument with a protective buffer to avoid direct impact or disturbance;
- making best use of the site topography for visual screening, including through control of building locations and heights relative to existing ground level;
- providing space for comprehensive landscaping and habitat enhancement within the site;
- consideration of construction and operational site access locations with respect to junction safety on the B977; and
- consideration of specific equipment locations and design with respect to potential for noise or air pollutant impacts to sensitive receptors outside the site.

2.4.3 Further detail of the site masterplan evolution and design principles from an architectural and landscaping perspective is given in the Design Principles Statement accompanying the planning application.

2.4.4 Figure 2.3 shows one early alternative considered for engineering design, as an illustration of design evolution that has subsequently taken place as further alternatives were studied. This early design met engineering requirements, retained the standing stone Scheduled Monument, and largely avoided development in habitat north of Dewsford Burn. However, it involved creating a single development platform across the majority of the site and did not enable best use of the existing topography nor retention of the central wooded areas to visually screen the development.

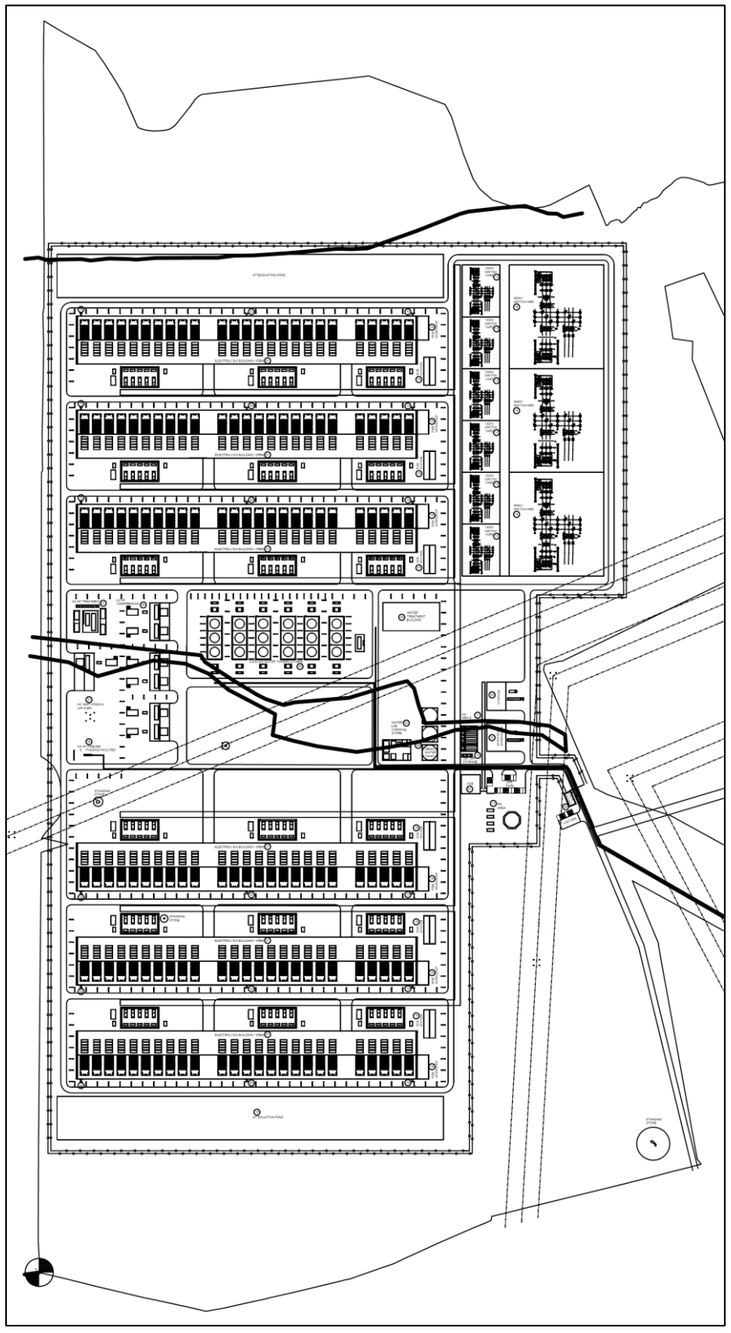

Figure 2.3: Early masterplan alternative considered

2.4.5 Figure 2.4 shows a revised illustrative masterplan design, one of a number of feasible variations from which the Planning Parameters Plan for the proposed development (shown in Figure 2.4 of Chapter 2) has been derived. Compared to the earlier engineering design alternative, several aspects of the illustrative masterplans and ultimately the proposed Planning Parameters Plan were refined to better meet the environmental design objectives set out above.

2.4.6 The proposed Planning Parameters Plan retains the topography and vegetation of the site's central ridgeline with its existing wooded area and other habitat. Together with other retained habitat and proposed further habitat creation within the site, this maintains connectivity between ecological areas, including enabling the majority of badger setts to be retained.

2.4.7 It locates the majority of buildings and equipment to the north of the central ridge, adopting a more compact layout in that area, which has reduced the visibility and potential landscape character impact of these aspects. In addition, instead of a single development platform and electrolysis plant buildings of up to a uniform height as initially designed, a graduated control of building heights was introduced through the development parameters as defined in Chapter 2.

2.4.8 This comprises a 16 m height limit for the main electrolysis buildings in the north of the site, which is reduced to 14 m south of the ridge where buildings are less visually screened by the landform; and where the site rises to The Knock prominence on its central-western edge, two zoned height limits for buildings and equipment of 128 m and 134 m aOD are imposed, to keep these to no greater than the peak existing ground level which is around 136 m aOD. Collectively, these design refinements, compared to earlier alternatives, are advantageous in better utilising the site's existing topography and trees to minimise the visibility of the proposed development.

2.4.9 Within the zoning of the overall layout of the electrolysis plant site, further alternatives for locations of key equipment such as compressors and hydrogen ground flare, drainage design and access junctions have also been studied, as set out in the following sections.

2.4.10 The proposed operational access junction has also been revised, moving it further east, in response to feedback from public consultation as discussed further below.

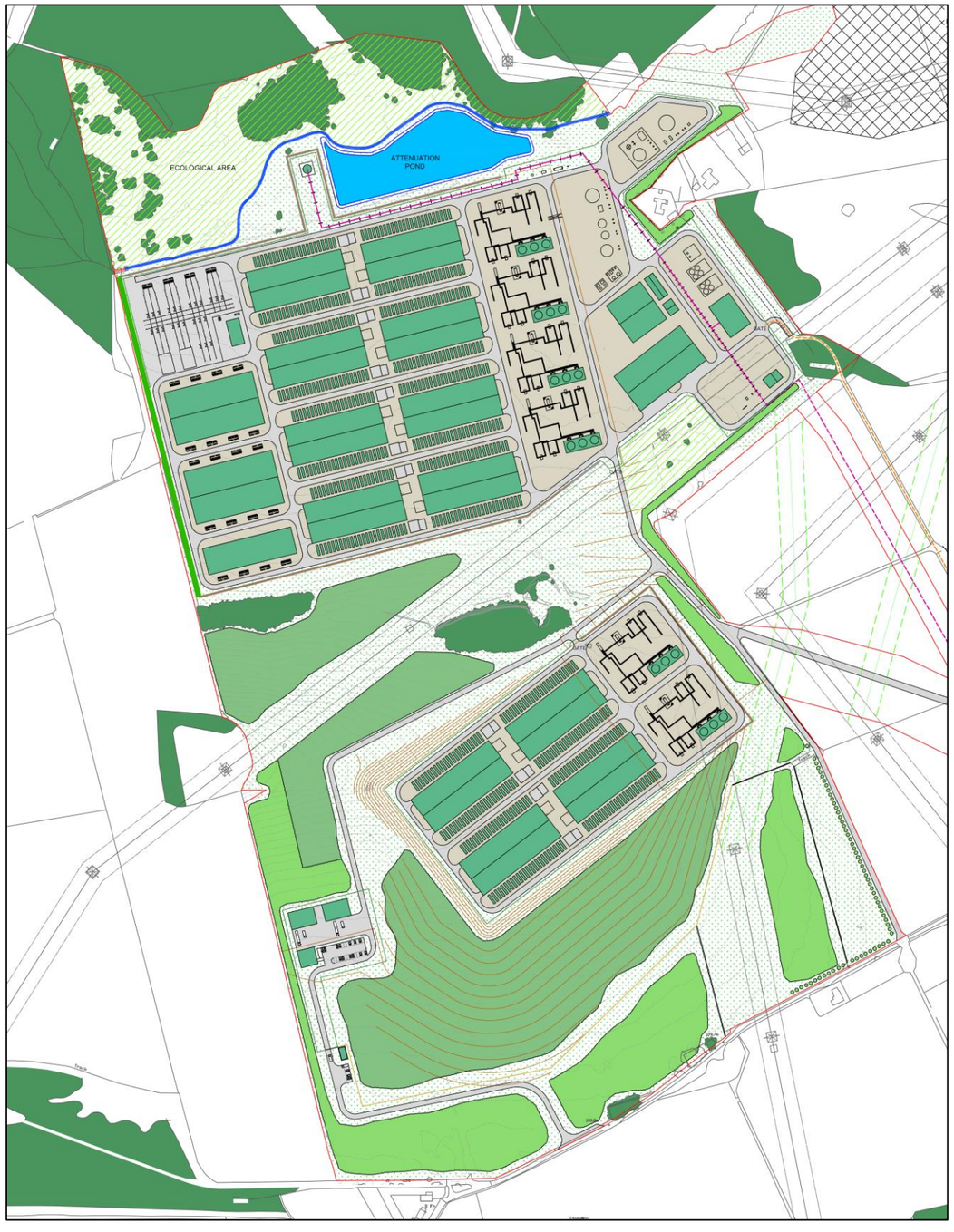

Figure 2.4: Illustration of a refined masterplan option

2.5 Design and technology options

2.5.1 As noted in the introduction, technology for production of hydrogen by electrolysis is under development and Kintore Hydrogen will need to demonstrate the use of BAT to SEPA for its operational PPC Permit. For the Planning Permission in Principle application, Kintore Hydrogen must therefore retain appropriate flexibility in the choices of specific technologies, equipment design and suppliers. This necessary flexibility is encompassed within a Rochdale Envelope of design parameters for the EIA.

2.5.2 Consideration of alternatives has been used to help define the parameters of that envelope.

Electrolysis and substation technology

2.5.3 Two different electrolysis technologies have been considered: proton exchange membrane (PEM, also known as polymer electrolyte membrane) and alkaline processes, described further in Chapter 2. Kintore Hydrogen may use either or a combination of these in different phases of the development. Similarly, two different technologies for on-site electrical export infrastructure have been considered: use of either air-insulated substation (AIS) or gas-insulated substation (GIS) equipment.

2.5.4 There are options with these technologies for equipment either to be housed within buildings or designed as freestanding external plant, which affects the space required and the visibility and appearance. There are advantages and disadvantages to each: buildings offer greater scope for sensitive architectural treatment to minimise visual impact but have greater massing than freestanding equipment. GIS requires sulphur hexafluoride as the insulating gas, which has a high global warming potential should it leak, but this risk is strictly managed under the F-Gas Regulations (detailed in Chapter 12: Climate Change). Either buildings or custom enclosures for specific equipment can be used to mitigate noise impacts where required.

2.5.5 The EIA has not identified a need to select one technology choice to mitigate significant adverse effects, nor a decisive advantage to one choice or the other; accordingly, and in line with the need to demonstrate BAT at a later stage, the Rochdale Envelope has been defined to encompass the combination of available technology options at this stage.

Hydrogen flaring

2.5.6 At the EIA Scoping stage it was anticipated that the proposed development design would include cold venting of small quantities of hydrogen when required. However, further design work and engagement with SEPA indicated that an enclosed ground flare is the preferred solution. This is primarily on the grounds of safety but also avoids

the (minor) potential global warming impact from any direct hydrogen release without flaring.

2.5.7 Two alternatives for flare design and two alternatives for flare location have been studied, in combination defining the corners of an envelope of flare size and a site area zoned for it on the Planning Parameters Plan. The outcomes of this assessment are detailed in Chapter 11: Air Quality. This has shown that design solutions within the Rochdale Envelope would avoid significant adverse effects. The specifics of flare design and operation would be regulated by the PPC Permit.

Compressor noise mitigation

2.5.8 Design and location alternatives within the electrolysis plant site have been studied for the hydrogen export compressors to determine the best solution for mitigating noise from this equipment. Different locations within the site were not found to materially affect noise levels at sensitive receptors, as the distance to the off-site receptors and effect of intervening landform or buildings was not much changed by different locations within the site.

2.5.9 The preferred alternative for compressor noise mitigation has therefore been through identifying a source noise level which would not cause significant adverse effects at sensitive receptors, with this to be achieved through a combination of at-source noise reduction in the compressor design and enclosure in a noise-attenuating structure. The outcomes of the noise assessment and mitigation measures are detailed in Chapter 10: Noise and Vibration.

Cooling system

2.5.10 Three technology and design alternatives for the electrolysis plant cooling system have been considered: a ‘dry’ (fin-fan coolers), ‘hybrid’ or ‘wet’ (fully evaporative cooling) system. A dry system was discounted due to having high capital cost, power requirement and potential noise levels associated with the fan-driven cooling approach. A fully evaporative wet system could utilise the plant’s water supply including water treatment plant effluent and provides a more energy-efficient cooling system; however, it would lead to visible water vapour plumes in around 90% of meteorological conditions over a typical year, which would substantially extend the visual impact of the proposed development.

2.5.11 A hybrid system, as described in Chapter 2, has therefore been selected as offering the best balance between cooling system energy efficiency, plume visibility and noise.

2.5.12 A once-through river water cooling system with return of cooling water to the Don was not considered by Kintore Hydrogen due to the significantly greater water volume (entailing larger pipelines and pumps) and elevated return temperature of discharge to the river that this would entail.

Drainage

2.5.13 Alternative conceptual designs for the clean surface water drainage system have been studied, considering the potential solutions to attenuate the runoff rate (via ponds or tanks) and the discharge point(s) to ground or existing watercourses.

2.5.14 The preferred conceptual solution is described in Appendix 13.3: Drainage Impact Assessment. This comprises discharge via an attenuation pond to Dewsford Burn for runoff from the northern part of the site and discharge via attenuation pond to a ground soakaway for the southern part of the site. The split solution allows gravity-fed drainage aligned with the site topography, enables surface attenuation ponds to be incorporated in the landscaping and habitat design, and reduces the scale of attenuation required to ensure greenfield runoff flows to each discharge point are not exceeded.

2.6 Landscaping and habitat

2.6.1 The electrolysis plant illustrative masterplans and resulting Planning Parameters Plan have been iterated to maximise retention of existing habitat alongside space for additional landscaping and habitat creation, to be provided as described in the Design Principles Statement and Outline Biodiversity Enhancement and Management Plan submitted with the planning application.

2.6.2 Alternatives considered were development further north within the site or greater development south of the central ridgeline. Although locating more of the development further north could potentially further reduce visual impact, this would mean loss of the higher-value habitat area north of Dewsford Burn and has therefore not been proposed. The site layout evolution to reduce the need for buildings in the southern half of the site has been discussed above, and this has enabled greater room for screening planting in the south.

2.6.3 Designs with a physical impact on the standing stone Scheduled Monument have not been considered due to its protected status. The outline landscaping plan has incorporated landscaping planting sensitive to its setting and also facilitates retention of two cattle rubbing stones of possible heritage interest (one relocated within the landscaping area).

2.6.4 Where the area delimited for electrolysis plant development in the Planning Parameters Plan is adjacent to Dewsford Burn, two alternatives have been considered.

2.6.5 Walkover hydrological and ecological survey indicates the likelihood that Dewsford Burn has been canalised (artificially straightened) in the past at this location, probably as part of improvement works to drain farmland.

2.6.6 The burn could be retained in its current configuration, delimiting the northern edge of the built development (aside from the hydrogen flare, which could be north with a bridge over the burn). This would have the advantage of minimising hydrological disturbance.

2.6.7 Alternatively, the burn could be re-meandered with a more naturalistic course to the north of its current channel. This would offer the opportunity to provide further habitat enhancement in this area, where there are surface water dependent ecosystems, and would avoid any development north of the burn.

2.6.8 There are advantages and disadvantages to each. At this stage, both options are retained in the Planning Permission in Principle application and assessed within the Rochdale Envelope for the EIA, subject to further hydrological study of feasibility and engagement with SEPA.

2.6.9 Beyond the electrolysis plant development site, where crossings of watercourses and woodland by the electricity export cables, water pipelines or hydrogen pipeline (and machinery access for their construction) are required, alternative approaches to crossing works have been studied. These can include open-cut trenching, use of temporary watercourse diversions or culverts, temporary span bridges, or use of 'trenchless' techniques such as horizontal directional drilling. The environmentally preferred alternative will be identified for construction based on the sensitivity of the watercourse or woodland habitat. Watercourse crossings and their condition are set out in the Crossing Schedule at Appendix 13.4.

2.7 Access

2.7.1 Alternatives for temporary construction access and permanent operational access have been considered in the EIA process and proposed development design.

2.7.2 As noted above, various access routes for construction of the water intake/outfall have been considered and the location of this was adjusted for access among other reasons. This enables access routes both north and south of the railway, using existing crossings, from the B977 (The Rushlach Road) and from the B979. This has the benefit of reducing potential disruption to road users and has been informed by discussion of railway crossing use with Network Rail.

2.7.3 Several locations along the B977 between Kintore Substation and Leylodge have been considered for the construction access junction. The location has been revised subsequent to the EIA Scoping stage, being selected on a straight stretch of this road which provides sufficient visibility at the proposed junction for highway safety. Access direct from the B977 is required to accommodate vehicles with large indivisible loads during construction.

2.7.4 Several locations along the unclassified road off the B977 at Leylodge have been considered for the permanent operational access. This road is preferred as it provides direct access into the electrolysis plant site rather than crossing farm land (necessary for the route of the temporary construction access), reducing the land required permanently and impact to farming. Within this stretch of road, an option at the south-west of the electrolysis plant site was considered but discounted due to being beyond the limit of the public highway; and an option at the south-east of the electrolysis plant site was considered but discounted as the access road would cause a greater impact to the setting of the standing stone Scheduled Monument. An option located more centrally on the southern site boundary has therefore been preferred.

References

[1] National Grid ESO (2024): Beyond 2030. [Online] https://www.nationalgrideso.com/future-energy/beyond-2030, accessed 09/04/24

[2] DESNZ (2023): Second Hydrogen Allocation Round (HAR2) Application Guidance Document. [Online] https://assets.publishing.service.gov.uk/media/6604269ee8c442001a220374/hydrogen-application-round-2-application-guidance.pdf, accessed 22/07/24