Firethorn – October 2022 Bioregional response to applicant most recent commentary

Docs reviewed:

- "NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" pdf
- "Response to Bioregional comments. AMJ 30.06" pdf

"Response to Bioregional comments. AMJ 30.06" pdf			
Topic	**Issue requiring scrutiny**	**Found in document**	**Bioregional suggestion to Cherwell's cost & viability consultants**
Separation of non-carbon-related "additional" costs	Bioregional had queried why foundations and permeable finishes were treated as abnormal or enhancements. Applicant responded: "Standard Foundations are included in the build cost. Extra over costs for deeper foundations to isolated locations has been excluded and deemed included in the 10% contingency allowance as agreed between RLF and G&T. Non-permeable finishes are the standard hard surface treatment. Permeable finishes … [have] additional cost. The introduction of permeable finishes is to reduce surface water discharge into the local water-courses."	"Response to Bioregional comments. AMJ 30.06" Page 2	Ensure the permeable finishes/foundations are not treated as part of the cost uplift for Future Homes Standard or Zero Carbon. Confirm with Cherwell whether the permeable finish is necessary to comply with any other local planning policy requirements. If it is not, consider omitting that cost for sensitivity testing. Discuss with applicant whether those are really "abnormal" costs. Do they arise from local plan policy, or would they be incurred by any development on this site? Could they be reduced or avoided by changing site layout? Although unrelated to carbon, we note that such measures to improve water quality at local watercourses is a generally positive step for other aspects of sustainability. The cost of permeable finishes could therefore be treated: • Either as part of the base build • Or as a separate 'non-carbon-related sustainability add-on'.
	Costs for rainwater/greywater recycling are mentioned. Bioregional previously highlighted that these are not related to carbon reduction and	"Response to Bioregional	Ensure the rainwater/greywater costs are not only added for Future Homes Standard or Zero Carbon scenarios.

	queried and whether these were included in the base build, FHS or ZC spec. Applicant responded "The costs are easily identifiable for omission for sensitivity testing if required."	comments. AMJ 30.06" Page 2	Confirm with Cherwell whether rainwater / greywater recycling are necessary to comply with any other local planning policy requirements. If it is not, then this cost should be omitted for sensitivity testing. Side note: rainwater/greywater is a very positive step for general sustainability / climate adaptation as this is a water-stressed area. It should be encouraged if possible but there should be clarity that this is not part of the requirements for carbon or future homes. If included, it should be treated: • Either as part of the base build • Or as a separate 'non-carbon-related sustainability add-on'.
	Bioregional had queried what was meant by "up to 5% of dwellings to have passive ventilation" (e.g. would this just mean 'openable windows') and whether the 'abnormal' passive ventilation costs were counted only within the Future Homes or TZC scenarios. Applicant responded "Passive Ventilation is independent of the FHS/ TZC scenarios and stated separately" but did not clarify the meaning.	"Response to Bioregional comments. AMJ 30.06" Page 2	Query with applicant what is meant by "passive ventilation" e.g. does it just mean opening windows and if so, why was this treated as additional? Once the meaning is clarified by applicant, confirm with Cherwell whether the "passive ventilation" is necessary to comply with any other local planning policy requirements. If it is not, then check to ensure that this cost is separately stated and can be omitted for sensitivity testing.
	Bioregional had queried why lifts were only added as a cost for the 'affordable' and not the 'private sale' and why these were abnormal. Applicant responded: "Lifts apply to both private and affordable, albeit there was a computational error on the previous issue to the affordable units which has since been rectified. Lifts are not always a standard requirement and is dependent on local policy, hence why the lifts cost allowances have been stated separately … It was confirmed to both RLF and G&T that lifts would be required by the local planning authority. The lifts allowances are	"Response to Bioregional comments. AMJ 30.06" Page 3	Check to ensure that lifts are correctly accounted for across all homes, not just 'affordable' segment Double check with Cherwell that lifts are truly a local plan requirement and whether this can be waived or reduced for sensitivity testing (e.g. perhaps to cover part rather than all of the homes?) Check to ensure that these are counted as a separate local plan policy requirement, not only in the Future Homes or zero carbon related costs.

	independent of the FHS/ TZC scenarios and are stated separately."		
Feasibility of ASHP for all home types	Bioregional had queried why some homes (flats) appeared to be using direct electric heating (with some PV) instead of ASHP which would be likely to provide more efficient energy, carbon and bill savings. The applicant had stated it might not be always possible to use ASHP and we had queried in what situation this might be. Applicant responded: "The use of ASHP, and the ancillary infrastructure associated with heat pump technology (low temperature radiators, thermal stores etc) needs to consider space standards within the dwelling, external space for mounting technology, and whole lifecycle impact of the technology (and ancillary infrastructure) selected."		Air source heat-pumps are a common technology used throughout the building industry in new build homes of all typologies. Put simply, there are no use cases where heat pumps are not appropriate, and often, the optimum technology within new build properties. In terms of the specific issues raised by the applicant: 1. Low temperature radiators are simply radiators, but in principle must be larger than radiators which operate at higher temperatures to deliver the same heat output. However, for modern energy efficient homes with reasonable fabric performance, the radiators sizes required are very small due to the low heat loss. We have never seen "radiator space" as an issue raised before in energy-efficient homes. 2. The thermal store requirement is for a standard DHW cylinder. This is as per a typical condensing boiler – however, this is only in the case where the heat pump is located at the flat level. (See point 3) 3. A more common solution in multi-residential buildings is for ASHP units on the roof, with a LTHW[1] distribution within the building feeding HIUs[2] at the unit level. In this solution, the flat can be laid out as per a system boiler, with no low temperature radiators or thermal storage. Rooftop ASHP would reduce the area available for solar PV, but this may be balanced by the 60-70% reduction in electricity needed to run ASHP compared to direct electric. There may not even be a decrease in actual PV delivery unless the entire roof of every flatted block was proposed to be covered in ASHP. Additionally, the residents will always gain the energy bill savings benefit of ASHP because it reduces their actual electricity use, whereas they will only gain the

[1] Low Temperature Hot Water
[2] Heat Interface Unit

		benefit of PV if they are using the electricity at the time the PV is producing it (often not the case as households tend to use less energy during the middle of sunny days). 4. Please see CIBSE AM16 for an overview of heat-pump installation approaches within multi-residential buildings 5. The life-cycle impacts of a heat-pump are vastly less than any other technology, due to the high efficiency and significant reductions in life-time operational energy use
	In response to our query about energy cost impacts from using direct electric heating in some homes instead of ASHP, applicant responded: "In addition, domestic energy costs need to also consider existing heating tariffs established within exemplar development in the Bicester area to ensure equitable energy costs within the geography".	Heat-pumps offer the lowest cost of heating to home-owners in new builds. Running costs would be around one-third to one-quarter of a direct electric heat system, or around 10-15% lower than a gas boiler. See also point (3) in the previous row where we discuss the fact that ASHP is more likely to deliver certain energy bill reductions to residents thanks to its energy use reduction, compared to solar PV which will not help residents with direct electric heaters reduce their heating bills because PV generation tends to be largely during hotter sunnier periods and the middle of the day (while the bulk of most households' energy use is in the early morning, evening, and winter). Additionally, residents in a block of flats will only get energy bill benefits from PV on their own roofs if there is a special arrangement in place whereby the 'owner' of the PV (typically the freeholder) arranges to sell the electricity cheaply directly to residents and/or discount residents' energy bills if profit is made by selling PV energy to the grid. Although we are aware of the existing district heating/CHP heat network system in the exemplar development, we are not aware of a planning requirement to make new Bicester developments' energy running costs unnecessarily high simply to match those of the existing exemplar development, when there are technologies and opportunities to give the new development a different energy system that is cheaper to run as well as lower carbon. We understand the heat network has quite a high standing charge to occupants of the existing exemplar, which might be improved by

			adding more properties to the heat network, this would not be improved at all by having residents at Firethorn use direct electric heating (which is not a heat network technology). In fact, a rooftop ASHP system with distribution shared between the flats would be more suitable for later connection to an expanded heat network if that were planned. Finally: We do not make any comment on whether the ASHP on flats is more or less expensive for the developer to implement compared to direct electric + rooftop PV. We would have to defer to Cherwell's costs consultant for this – but we emphasise that if this is assessed then it should be on the basis of a shared rooftop system with distribution to heat interface units in flats, not a separate ASHP unit per flat, as the former is a more sensible and typical industry solution in our experience.
Labour costs	We had queried why fabric cost uplift for FHS and zero carbon was so high compared to other sources' estimates (Govt official, and Currie/Brown). Applicant responded "The recent change in the Building Regulations and the FHS places (correctly) a greater emphasis on quality in construction, and the need to measure, verification and reporting (MVR) … The additional quality and MVR requirements increase labour costs to ensure meeting the standards. The impact of these need to be considered in more detailed modelling with every project."		The FHS is currently not in operation, and hence doesn't form a material requirement on the development here. The updated Part L has some slight changes to the process to which developers approach air pressure testing – particularly insisting that each dwelling is tested, rather than a single test dwelling which then proves build standards. This will add a small cost. However, we aren't clear what MVR processes the applicant is referring to. It would be helpful for them to document these processes and their expected costs in relation to the new obligations.
Labour costs	Applicant stated "Labour inflation responds to a wider range of variables beyond that of asset cost inflation, including skills availability (from design through to construction), labour intensity in construction, resource availability, and regional salary variables to name a few. The impact of labour inflation needs to be considered within the	"Response to Bioregional comments. AMJ 30.06" Page 4	Recommend that Cherwell's cost consultants check the cost of labour for gas boiler (base build) versus ASHP or direct electric. Ensure that any economies of scale are accounted for in the quotes being acquired for all energy-related uplifts. E.g. Can heat pump labour costs be reduced by having the same company do whole land packages or whole development while already on site?

	context of project geography. Labour costs increase year on year."		For rooftop PV, ensure the costs for scaffolding are not double-counted e.g. can the PV installation be done when scaffolding is already up for other reasons e.g. roof and window installation? As the applicant has assumed increased labour costs due to inflation, check there is also an inflationary uplift assumed to the sale or rental value of the homes. If allowed within the standard viability assessment procedure, we should also aim to ensure the assessment considers any local/regional recent uplift to the value of homes, especially the value of larger homes with gardens that has trended upwards since the pandemic, and any evidence available on higher values of energy-efficient homes.
Offset cost	Because the applicant's carbon calculation figures were internally inconsistent, Bioregional asked for clarification about whether the CO2 per-annum tonnage before addition of PV is 490 tonnes or 460 tonnes. Bioregional noted that "If the 460 is incorrect, that means that the estimated offset cost of £543,600 is also incorrect". The applicant responded: "The 490 tonnes per annum is based on SAP10.2 emission factor of 0.136kgCO2/KWh." We are happy with this carbon factor as it is also close to the BEIS estimated grid carbon intensity for 2022. We presume this means that the figure of 490 was the correct figure before PV addition. This means the applicant's carbon cost calculation was incorrect. The applicant's suggests a carbon price of £60/tonne. We presume this is to reflect the London Plan carbon offset cost set several years ago, which no longer reflects the national valuation of carbon.	"Response to Bioregional comments. AMJ 30.06" Page 5	Sensitivity-test a range of carbon offset prices (as per our calculations a, b, c, d and e, in the left column) to see what amount might be reasonable. Ask Cherwell to roughly estimate what it would cost them to deliver carbon saving projects to save the same amount of carbon (we estimate 2,968 tonnes of carbon across a 30 year period). This should ideally be done with additional PV installations or transitioning other homes from fossil fuel to heat pump or heat networks, but could include afforestation schemes if backed by verified Woodland Carbon Code credits from forests within the District that would make the savings within the 30 years (price enquiries can be made at Carbon Store UK – looking at the scale of carbon savings claimed by other projects on this site, we estimate that it may take about 24ha of woodland to sequester 2968 tonnes of carbon within a 30 year period). If Cherwell has a way to deliver the required 2,968 tonnes saving at a cost of £60/tonne or less, then offset total cost option e) could be used as this reflects £60/tonne over the 30 years. However, we suspect that the £60/tonne price is unlikely to be enough for Cherwell to spend on measurable, verified carbon saving projects.

Using the applicant's suggested per-tonne price, we calculate:
490 tonnes minus 158 tonnes = 332 tonnes.
332 * £60 = £19,920 annual tonnes
30 years * £19,920 = **£597,600 total offset payment.**

Alternatively we have calculated a range of alternative carbon offset total costs using BEIS Green Book Energy & Carbon Valuations to apply the anticipated grid carbon reductions over the 30 year lifespan. Starting with 490 tonnes in 2022, minus a 38% energy saving from the PV (158 tonnes), then applying grid carbon reductions over the 30 year period, we estimate that the development would emit 2,968 tonnes of carbon across the 30 year period. The BEIS data also offers a 'low', 'central' and 'medium' value per tonne of carbon. These values rise by about 1.5% year-on-year through to 2050. Choices can be made about whether to use low, central or high value, and whether to use the 2022 value throughout or use future years' values for future years' carbon emissions.
Depending on which cost per tonne of carbon is used, the total offset cost taking into account grid decarbonisation could be:

a. **£819,868** if we start with the 2022 'central' value per tonne of carbon (£248) rising in each year across the 30 years to match the BEIS value increase of +1.02% YOY.
b. (Or **£409,934** if we do the same but starting with the BEIS 2022 'low' value of carbon)

If we are correct in that assumption, we believe the reasonable total offset cost would be option c) (**£737,172**) which uses the 2022 official national value of carbon per tonne and takes into account grid carbon reductions.

However, sensitivity testing could also explore a 'low' option of d) (£368,586) and a medium option of b) (£409,934). These are explained to the left. Both are defensible as they both take into account grid decarbonisation and both still use BEIS carbon values, but the 'low' value rather than the 'central' value.

	c. **£737,172** if we apply grid carbon reductions but keep the 2022 'central' carbon per-tonne £ valuation throughout (NOT applying BEIS annual carbon valuation increases for future years' carbon emissions). d. (Or **£368,586** if starting with the BEIS 'low' value of carbon) e. **£178,095** if we apply grid carbon reductions but we start with Stantec's original suggested price of £60/tonne (coped from London policy; now out of date).	
Cost sources	On heat pumps vs gas boilers, applicant has said: "Costs are from 2017 - Has Bioregional allowed for 5 years worth of inflation?" "G&T cannot locate the revised cost 'falling to £8,335 in 2022' in the cited paper. Please can Bioregional provide the relevant extract?" "The gas connection £1,280 is an infra cost not build cost (in the G&T Order of Cost) therefore the combi boiler cost for terraced is £4,327, resulting in a £4,079 uplift for the ASHP connection (when excl. electrical infra upgrade of £187 which is incl. in the infra costs not build costs)"	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770783/2nd_UK_Cost_Optimal_Report.pdf • Page 38 (which is actually the 41st page of the PDF) gives per-element costs for ASHP system (and other systems) for a single unit of various house types in 2015, 2016 and 2017. We summed all the elements of a 2017 ASHP system which gives £8593, and then we applied a cost reduction to reflect the % cost improvement cited in the same report Table 5.9 (page 42, which is actually the 45th page of the PDF). The cost in 2022 is stated to be 97% of the 2017 price, which gives £8,335. • We did not adjust for inflation as we are not costs professionals with access to inflation data – we must defer to Cherwell's cost professionals to take that step. • Whether the gas and electrical connection costs are included in infrastructure or build costs, the gas connection costs should be excluded from the 'FHS' and 'zero carbon' scenarios either way.

Cost sources	"Bioregional has cited a 248 paged paper and G&T is struggling to identify the extracted cost data. Please can Bioregional provide the relevant information in order for G&T to review?" "Has Bioregional allowed for labour and material inflation since 2019?"	"Response to Bioregional comments. AMJ 30.06" Page 7	Bioregional cited the pages in the documents named, in our previous commentary that is also repeated in the same "AMJ 30.06" pdf where this applicant comment was made. The cited FHS document is 32 pages and the Currie/Brown Cornwall Council document is 38 pages. The longer document cited is a Currie/Brown report on behalf of HM govt. The documents and page references once again are: Future Homes Standard Impact Assessment: (Table 5, page 16 – total cost is £2560 for a semi-detached house, minus the WWHR cost that is wrapped up in this figure but is not a fabric measure – thus deduct £400/WWHR element cost as detailed in Table B.1, page 30) Currie and Browne/Etude cost modelling for Cornwall Council: Page 22. We had not attempted to estimate changes in costs for inflation– we would defer to Cherwell's appointed costs professionals to apply an inflation uplift to the figures provided to bring them up to the same 'cost year' as was used by the applicant, for comparability. However, in a subsequent response to an applicant comment within this note, we have made a very rough estimate of inflation uplifts based on Bank of England inflation calculator (not specific to construction costs).

"NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" pdf			
Topic	**Issue requiring scrutiny**	**Found in document**	**Bioregional suggestion to Cherwell's cost & viability consultants**
Costs and planning powers	Applicant quotes a cost of £9,341,000 to build to the FHS standard (on top of the base build cost). Divided across a maximum number of 530 homes, we calculate that this would work out at ~£17.6k per home (or £19.7-20.9k/home if there are only 447-474 homes as later stated in paragraph 5.1 - 5.2) – of which £6150 for fabric (table, page 12) and £1770 for airtightness (table, page 13). Firstly we would point out that there should be no uplift for airtightness for the FHS, as the airtightness standard in the FHS notional specification is identical to that of the 2013 and 2021 building regs. Applicant says that "The documentation for the FHS recognises the increased costs and states that 'the options increase the costs for the home builders and so we propose to remove the ability of local planning authorities to set higher energy efficiency standards than those in the Building Regulations.'" The latter part of this statement is not relevant given that after a strong negative consultation response to the idea of removing local authorities powers, it was confirmed in the FHS Consultation Response that "All levels of Government have a role to play in meeting the net zero target ... Local authorities have a unique combination of powers ... local knowledge ... and democratic accountability ... We recognise that there is a need ... to provide developers with the confidence that they need to invest in the skills and supply chains ... To provide some certainty in the immediate term, *the Government will not amend the Planning and Energy Act 2008, which means that local planning authorities will retain powers to set local energy efficiency standards for new homes.*" It is true that the FHS Consultation recognised that the FHS would involve additional costs to developers, but this was estimated (FHS Impact Assessment October 2019) to be more like £2470 for fabric (Table 5 'Option 1', average home, minus £400 for WWHR which is not actually	"NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" Page 3 Para 3.5 – 3.6 (& page 12, total of fabric costs)	Remove £1770 airtightness cost uplift in the FHS scenario – this should be constant with the base build. Adjust 'site prelims' to match (as 'site prelims' are shown as a fixed % in relation to all other build costs). Cherwell's cost consultants to truth-check all of the costs per fabric and heat system element, at a reasonable economy of scale to represent the large scale of development at Firethorn. Cherwell's cost consultants to double-check the inflation uplift estimates made by Bioregional as detailed in the left column of this table. If Bioregional's inflation uplift estimates are reasonable, Cherwell's cost consultants to examine the government cost data sources provided by Bioregional to ascertain: • Whether there is evidence of whether labour was included in those or not (Bioregional has attempted to ascertain this but could not find a clear answer – this might be clearer to a cost consultant in reading the methodology appendices) • What is the reason for the discrepancies between govt estimates

included in the eventual FHS spec), plus the cost of a heat pump system. The fabric figures vary by home type (see Table 5 in that report). The heat pump system was not separately costed in that Impact Assessment, but has been costed in a separate Govt report earlier the same year. That earlier report Table 5.5 estimates that a heat pump system excluding grid connection would be £8,406 in a terraced house or £7,217 in a flat, compared to a gas boiler system cost (excluding gas connection) of £4,327 or £3,558 in homes and flats respectively. The uplift for a heat pump system would therefore be £4079 in a house or £3659 in a flat. These uplifts shrink to £2,986 and £2,432 respectively when taking into account the cost of electric grid connection vs gas grid connection.

The heat system figures are from cost year 2017 and the fabric figures are from cost year 2019. If we apply an inflationary uplift from those respective years to September 2022 (Bank of England inflation calculator shows that 2022 represents a 19.7% since 2017 or 14.8% since 2019) the uplift figures per home would be as follows, to the nearest £10:

- Mid terrace house: **£6950** excluding electricity/gas grid connection costs, or £5640 including connection costs
- Unweighted average of all house types: **£7850** excluding grid connections) or £6540 including connections
- Flats: **£4640** (excluding grid connection) or £3140 including connections.

The reports note that these are for a medium sized house builder with a reasonably efficient design/supply chain, but recognise that these could fluctuate by +/-30% depending on location, procurement approach and details of the home product. However, even if we assume that the applicant has the worst case efficiency (which is unlikely) causing a 30% increase, the costs would then range from approximate a 4 – 10k uplift (depending on type of home and whether infrastructure is included) – not anywhere near the £17-£21k per home that is quoted by the applicant. See appendix provided with this note.

We note that neither of the cost reports we have cited are completely clear about whether labour is included in their analysis, however the report we quoted for heating system costs does state that "The capital and applicant's estimates, even after inflation has been applied, and which is likely to be the more reasonable estimate.

	cost data was sourced from a combination of recent tenders for relevant projects and first principles cost planning; drawing on published materials, costs and labour rates for relevant trades". This would seem to imply that those figures may include labour.		
Type of energy improvement measure	Applicant states "Homes built to FHS do not achieve the target carbon dioxide emissions savings required by the Council's policies on TZC homes and therefore to increase the fabric energy efficiency it has been necessary to include the use of additional technology such as wastewater heat recovery systems and solar PV." This is a misleading statement as wastewater heat recovery and PV would not increase the fabric energy efficiency as these are not fabric measures. Fabric measures refers only to the fabric of the building that helps to retain heat (or prevent solar gain). These other measures would help improve overall energy/carbon performance, but not fabric efficiency.	"NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" Page 3, para 4.1	No action to take – just making this note to help clarify what is or isn't a fabric efficiency measure.
Number of homes & spec of different types / phases of home	Paragraphs 4.6 – 5.3 note a quite confusing and apparently contradictory range of number of home units and spec of those units. • Paragraph 4.6 says there are 530 homes (including 451 with ASHP and 79 with direct electric heating), all with water consumption of 110 litres/person/day, and using SAP10.2 carbon emissions factor (136gCO2/kwh) – this scenario was apparently used for the Applicant's estimated carbon offset figure • Paragraph 5.1 says the actual energy statement includes only 474 dwellings, all with ASHP and 80L/P/D water consumption, and that their electricity carbon emissions factor would be "reduced … in line with the Government's projections for 2025" (that factor is not stated here but it should be 125g/kWh) • Paragraph 5.2 states that additional sensitivity analysis has also been conducted in Appendix B for "447 units built to FHS with line one (titled phase 1) being based on ASHP … [and] line two (titled phase 2) is based on 474 units all electric panel heaters". Both of these "lines/phases" have "110 litres per person per day water consumption and a carbon emission factor for electricity defined in SAP 10.2." Naming these two parts "phase 1" and "phase 2" implies that they are two phases of the same scheme which	"NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" Para 4.6 – 5.3	Ensure that the carbon emissions cost calculation is based on the same scenario as the energy statement – in terms of number of homes, spec of those homes (water consumption; heat system, other energy features e.g. WWHR etc), and electricity carbon factor that is being used in the calculation. Otherwise, if the carbon offset calculation is based on 530 homes but the buildings' fabric and heating systems are based on 474 homes, this risks either overestimating the cost of carbon offset or underestimating the cost of building features. The water consumption is not a direct requirement of the Future Homes Standard or True Zero Carbon standard, however if the water efficiency figure

	would bring the total to 921 homes, far more than the originally stated 530.		(80L/P/D) is used then it will bring down the carbon emissions figure very slightly but may increase the build cost figure significantly for low-flow fittings, appliances etc.
Spec for fabric measures beyond FHS	On air permeability, the applicant states that "it is the additional cost of air tightness standards to achieve TZC homes which are significant and therefore … this will substantially increase the viability gap [compared to using technology such as PV and WWHR]". This implies that although their proposed "ultra low energy" scenario spec also has improvements to U-values (insulation, glazing etc), it is the airtightness that mostly causes the sudden jump to £42k/unit rather than £19k/unit (cost uplift from base build). The air permeability target in Table 2 for the "ultra-low energy demand standard" is very good (1m^3/m^2/Hr@50Pa, compared to 5m^3/m^2/Hr@50Pa correctly stated for all of the Building Regulations standards – 2013, 2021 and FHS). This 'ultra low energy' air permeability would indeed be very close to the Passivhaus target (0.6m^3/m^2/Hr@50Pa) However, with air permeability there are often diminishing returns for the more extreme end of the airtightness range. We wonder whether a significant fabric improvement could have been made without quite such an extreme cost uplift by improving the air permeability to a less drastic extent – say 2 or 3m^3/m^2/Hr@50Pa.	"NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" Page 8, Table 2	Cherwell cost consultants to truth-check the cost difference between an airtightness of 2-3m3/m2/Hr@50Pa as opposed to an airtightness of 1m3/m2/Hr@50Pa.
Spec for fabric measures in FHS	For ULES (ultra low energy standard) to reach the targeted very high airtightness: Applicant assumes that 'additional sealing activity' will take a full 3 weeks of labour from 3 operatives + labourer + supervision. (between the first and second fix) This is a significant part of the cost uplift and therefore should be checked. For FHS: Applicant allows for £1770 of "Additional preparation/ supervision to achieve an improved [airtightness] rating compared to current	"NOTE IN RESPONSE TO CHERWELL'S LETTER OF 21 JULY 2022" Page 13	Cherwell cost consultant to investigate whether an air permeability target of 1m^3/m^2/Hr@50Pa does really take a full 3 weeks of labour from 3 operatives + labourer Remove the £1770 air tightness uplift cost from FHS scenario, as there is in fact no change in air tightness spec between the 2013 regs and FHS. (Adjust site

	standards" despite acknowledging that in fact "the rating is constant between the 2013 regs and FHS". While the assumption that there is an ambition for improved airtightness, this should not be part of the assumed cost for the FHS as this is not part of the FHS notional spec.	prelims to reflect this cost removal, as site prelims is treated as a constant % in relation to build costs).
Missing features from 2013 spec	"Triple glazing" is treated as a separate element that only applies to FHS and TZC. Significant costs are applied for this. But no glazing or glazing cost at all has been specified for the 2013 base build. (All glazing this should really have been treated as part of the "Fabric" category rather than having 'triple glazing' as a separate category).	IMPORTANT: Must add a cost for normal glazing (assume double) in the 2013 base build.
Unidentified costs	"Site prelims" is always assumed at 13.5% of each section. This means that "site prelims" for FHS and TZC are always significantly higher because these specs have higher materials & labour costs. Is this reasonable or would many of the site prelims not in fact scale with the build costs? Surely many of the site prelims would be constant across all scenarios or at least not scale directly as a fixed %? Additionally, in the categories of air permeability, ventilation, space heating, and xxx, "site prelims" is only added to the "extra" costs above building regs. However in the 'fabric' category, "site prelims" is added to the 2013 base build too. Why is this – surely the base build will always have site prelims too? (we accept there would be no 'site prelims' for the 2013 base build in the categories of WWHR, PV and triple glazing, as these categories do not apply to the 2013 spec).	Cherwell's cost consultants to investigate what is included in site prelims and take a professional decision about: • whether it is reasonable to assume these will always scale directly as a % in proportion to the higher material/labour costs in the FHS and TZC scenarios • whether 'site prelims' should be always added to the 2013 base build cost for all building elements, not added only to the FHS and TZC extra costs (Bioregional cannot take a view on this as we are not familiar with what is a standard assumption, but would suspect that at least some of the site prelims would be constant).

Appendix – Bioregional estimates of cost uplifts by element, with sources

Heating system cost data is from:	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770783/2nd_UK_Cost_Optimal_Report.pdf						
	Note: This document is not completely clear about whether labour costs are fully considered within the analysis, but it does note that "The capital cost data was sourced from a combination of recent tenders for relevant projects and first principles cost planning; drawing on published materials, costs and labour rates for relevant trades". This would seem to imply that these figures include labour/installation costs.						
	It also notes that the costs are based on a "medium sized housebuilder using traditional (i.e. masonry) construction methods and with reasonably efficient supply chain, design development and construction processes". Therefore larger economies of scale might result in improved costs. It recognises that costs may vary by geography and by changes in the availability of different skills.						
				2017 - Terraced house			2017 - Flat
Combi gas	Combi 30kW			£1,307			£1,264
	Radiators			£747			£640
	Pipework			£2,273			£1,654
	TOTAL - ex supply			£ 4,327			£3,558
	Gas supply			£ 1,280			£1,414
	TOTAL - incl supply			£ 5,607			£4,972
For inflationary uplift data source, see below	Gas - excluding supply, with inflationary uplift			£ 5,179			£ 4,259
	Gas - including supply, with inflationary uplift			£ 6,712			£ 5,951
ASHP	ASHP 5kw			£ 3,828			£ 3,696
	Cylinder (150L house; 120L flat)			£ 1,120			£ 1,067
	Radiators (large)			£ 934			£ 800

	Pipework			£2,524			£1,654
	TOTAL - ex infra			*£8,406*			*£7,217*
	Increased elec infrastructure & base			£187			£187
	TOTAL - incl infra			£8,593			£7,404
For inflationary uplift source figures, see below	ASHP - excluding supply, with inflationary uplift			£10,062			£7,217
	ASHP - including supply, with inflationary uplift			£10,286			£7,404
ASHP vs gas difference	Excluding supply / infra (2017 figures)			£4,079			£3,659
	Including supply / infra (2017 figures)			£2,986			£2,432
For inflationary uplift source figures, see below	Excluding supply / infra (with inflationary uplift)			£4,883			£2,958
	Including supply / infra (with inflationary uplift)			£3,574			£1,453
Inflation 2017 - 22 (source below)	2017 - Sept 2022	19.7%					
https://www.bankofengland.co.uk/monetary-policy/inflation/inflation-calculator	2019 - Sept 2022	14.8%					
Fabric cost uplifts	Note: This document does not state whether or not the capital costs include labour costs. As per the doc referenced above for heat systems, it notes that these costs are for a "medium sized housebuilder using traditional (i.e. masonry) construction methods and with a reasonably efficient supply chain, design development and construction processes" and that the costs could vary +/- 30% according to location, procurement strategy, and detail of housing product.						

	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/836925/REQUEST.pdf	2019 - Detached	2019 - Semi detached	2019 - Mid terrace	2019 AVERAGE ALL HOUSES		2019 - Flat
	"Part L 2020 Option 1" (Future homes fabric + WWHR)	£4,200	£2,560	£2,200	£2,987		£2,070
	WWHR cost to deduct (as this is not part of the indicative FHS spec)	£400	£400	£400	£400		£600
	Future homes fabric only ("Part L 2020 Option 1")	£3,800	£2,160	£1,800	£2,587		£1,470
	With inflation 2019 - 22	£4,362	£2,480	£2,066	£2,969		£1,688
				Mid terrace	AVERAGE ALL HOUSES		Flat
	Excluding infrastructure - 2017+2019			£5,879	£6,666		£5,129
	Including infrastructure - 2017+2019			£4,786	£5,573		£3,902
	Excluding infrastructure - with inflation uplift			£6,949	£7,852		£4,646
	Including infrastructure - with inflation uplift			£5,641	£6,544		£3,140
	Excluding infrastructure - with inflation - minus 30% variation			£4,864	£5,496		£3,252
	Including infrastructure - with inflation - minus 30% variation			£3,948	£4,581		£2,198
	Excluding infrastructure - with inflation - plus 30% variation			£9,034	£10,208		£6,039
	Including infrastructure - with inflation - plus 30% variation			£7,333	£8,507		£4,082

FHS total (FABRIC + HEAT PUMP)