Sustaining housing through planned maintenance in remote central Australia

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ABSTRACT

Once housing is constructed, its sustainability depends on the efficacy of property maintenance. In remote Indigenous communities in Australia, responsive or reactive approaches to property maintenance dominate over planned and preventive attention, leaving housing in various states of disrepair. This article describes an alternative and exceptional approach taken on the remote Anangu Pitjantjatjara Yankunytjatjara (APY) Lands in South Australia, where housing benefits from a planned maintenance program combined with an environmental health program. By documenting an approach that is succeeding in this wider context, this article shows the commonplace situation of poorly maintained social housing is entirely interruptible. Through detailed empirical analysis of program datasets, interviews, and ethnographic fieldwork, it describes the expert, systematic, and attentive work required to sustain functional housing in the wider context of undersupply, crowding, and challenging environmental conditions. We argue for the necessity of planned maintenance approaches as an essential component of sustainable housing, both to extend the life of housing assets and to ensure householder health and wellbeing.

KEY WORDS: maintenance, sustainability, housing quality, Indigenous housing policy, healthy housing

Introduction

The concept of sustainability is prominent in social housing policy rhetoric, in part because it appears irrefutably virtuous. Yet definitions of sustainability are often undefined or uninterrogated, written into government policies and industry rating schemes as lists of principles, standards or critical success criteria that do not clarify how to manage inevitable tensions between financial, environmental, and occupant-centred goals (Wiesel et al., 2012; Chan & Adabre, 2019). Where the construction and design sectors provide definitions for sustainable housing, these typically focus on front-end design standards and construction materials (Green Building Council, 2016; NatHERS, 2021; UK Government, 2000). Limited consideration is given to what is required once occupancy begins and houses inexorably start to disassemble. With sustainability an enabling platitude, and its connection to maintenance left unspecified, another seeming inevitability takes hold: public housing is impossible to proactively maintain, because of the 'unsustainable' expense this would incur.

In line with emergent accounts of the importance of maintenance and repair to eke further life from public housing infrastructures, we argue that housing's materiality is dynamic and entropic, making housing a process, not simply a product (Go-Sam, 2008; Minnery et al., 2000). Exploring sustainability as a concept that is centrally focused on performance and impact *over time*, this article argues that sustainable housing must be understood *a posteriori*, in terms of the functional performance of the house and its key amenities post-occupancy. Such issues as the design of fittings and fixtures and selection of material are critical for longevity and maintenance. Relatedly, we argue that sustainable housing depends on adequate ongoing property maintenance, which in turn requires a combination of sustained policy and practice attentiveness. If the natural inclination of infrastructure is toward

‘disassembly’, then sustaining housing function demands dedicated and regular correction (Grealy, 2021). Yet, while there is a growing international literature recognising the importance of infrastructural care and repair (Graham & Thrift, 2007; Arrigoitia, 2015; Mattern 2018; De Coss-Corzo, 2020), and housing as an infrastructure of care (Power & Mee, 2020; Desroches & Poland, 2021), little empirical research details the systems of provisioning that enable effective interventions. Close attention to the dependence of sustainability on planned repairs and maintenance regimes is scant.

Responding to this gap, this article analyses the property maintenance program undertaken by the South Australian Housing Authority (hereafter ‘Housing SA’) and the environmental health program undertaken by Nganampa Health Council (NHC) for Indigenous housing on the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands of South Australia (SA). In so doing, it contributes to housing studies debates on three fronts. First, it challenges prevailing uses of the term ‘sustainability’ as it pertains to housing to suggest that sustainable housing cannot be achieved without a proactive maintenance regime to check the degradation of existing buildings (Gianfrate et al., 2017). Our research finds that such an R&M regime must be systematic in its planning, attentive to detail, delivered by individuals with appropriate expertise, articulated to design and construction processes, funded recurrently, responsive to householder and community requirements, and must consider the technical requirements of the building and its location (Pholeros and Phibbs, 2012; Kim et al., 2016). If these features are present, then they may protect assets over time, reduce future expenditure, and support the health and wellbeing of householders by sustaining housing quality (Fien & Charlesworth, 2011; Priemus, 2005).

Second, by showing how this can be achieved in the demanding context of remote area service delivery in Indigenous Australia, we challenge the normalisation of responsive or reactive maintenance as the default arrangement for living within funding means (or living within mean funding). This arrangement is typically tacit. An Australian policy document which declares that proactive maintenance of public housing is undesirable cannot be found, while exhortations for such to be in place abound (Commonwealth of Australia, 2017; NTG, 2022). Its practical absence on the ground can nonetheless be traced in commissions of inquiry and procedural hearings, where tenant testimony of missing or erratic repairs convey business as usual in public housing R&M.[1] Given that adequate government funding for public housing supply and maintenance is being phased out in Australia and elsewhere (Leone & Carroll, 2010), examples which reveal the cost efficiency of proactive R&M are essential.

By documenting the detailed attention which make dedicated repairs and maintenance possible, in contexts usually described as impossible to efficiently service, we illustrate potential applications to a diverse range of sites. Our findings are relevant to jurisdictions where governments continue to play significant roles in public and community housing. Indigenous housing in Aotearoa/New Zealand and Turtle Island/Canada share similar challenges related to housing function and quality (Riva et al., 2021; Waldegrave et al., 2013), the cost and logistics of remote delivery (Agrawal & Zoe, 2021), and the relationship between adequate housing and health and wellbeing (Christensen, 2016; Webster, 2015).

Third, this article contributes a unique analysis of planned maintenance and environmental health programs working in concert to sustain housing. The health focus and emphasis on proactive maintenance on the APY Lands reflects long term policy activation by Indigenous

organisations, insisting that living conditions and people's health and wellbeing are intimately linked (Tedmanson, 2016; Lea, 2008). We identify the value of design and construction teams' familiarity with a maintenance program and typical housing repair issues, which enables such knowledge to be integrated into more robust hardware design. More broadly, we argue for the necessity of paying detailed and ongoing attention paid to the contextual factors that affect the impact of a maintenance program—such as the condition of existing stock, contractor availability, environmental factors, and so on—on the health and wellbeing of householders. Such detailed and ongoing attention is the difference between sustainability rhetoric and residents' wellbeing over time.

Literature and Policy Review

The concept of sustainability is both flexible and contested (Vos, 2007; Kates et al., 2005). Critics note that 'thin' definitions of sustainability can gloss over questions of inequality (Vos, 2007; Chan & Adabre, 2020), suggesting sustainability should also encompass issues of affordability and access over time (Yates et al., 2008). Maldonado et al. (2020) draw a distinction between *sostensible* and *sustenable*, 'the former connoting a capacity to be maintained over time, the latter a sense of being reasonable' (p. 465). Anything can be sustained, in theory, but there is a gap between determining what technical action is required for a particular outcome and guaranteeing that such action is adequately funded, or that it is reasonable to expect it to be funded (Crabtree & Hes, 2009). In remote Australia, this sustainability question intermittently adopts an existential significance, concerning the 'viability' of remote Indigenous communities, given the difficulty of ensuring housing, education, and infrastructural supports; reducing unemployment and mass incarceration; and of guaranteeing health and safety under climate change (Stafford Smith et al., 2008). Housing

in such contexts faces challenges of inconsistent funding, associated undersupply and crowding, environmental factors that place buildings and infrastructure under additional pressure, and sporadic maintenance (Ali et al. 2018; Standen et al. 2020). As a result, what is sustained is predominantly substandard government-provided Indigenous housing, constructed with limited attention to the quality of materials and inadequate maintenance over time (Habibis et al., 2019; Brackertz & Wilkinson, 2017; Bailie & Wayte, 2006).

By way of illustration, data collected by the not-for-profit company Healthabitat for approximately 7500 houses surveyed in Indigenous communities across Australia shows that 62 per cent of houses had no working shower, and 40 per cent had no working toilet (Healthabitat, 2021). Brackertz and Wilkinson (2017) describe that in the years 2014-15, 28 per cent of Indigenous Australians over 15 years of age lived in housing with major structural problems, rising to 36 per cent in remote areas. Bailie and Wayte (2006) characterise the shortcomings of remote Indigenous housing in relation to conceptions of 'adequacy' that include 'quality of basic services, materials, facilities and infrastructure; habitability; affordability; accessibility; legal security of tenure; and location and cultural adequacy' (178). Similar issues of housing adequacy, suitability, and structural integrity are represented in research on Indigenous housing in Canada's north. Agrawal and Zoe (2021) describe how Canada's First Nations communities face major quality issues related to plumbing, electrical systems, and mould, while a survey conducted by Riva et al. (2021) showed a significant reduction in thermal discomfort and an increase in perceived control, privacy, and identity for Indigenous residents following rehousing into newly constructed units. Such outcomes represent the normalisation by governments of poor housing in remote communities, sporadically attended to by underfunded repair and maintenance systems (Lea & Pholeros, 2010; GAO 2014).

Housing function is a major social determinant of health (Baker et al., 2016; Ware, 2013). Functional health hardware such as taps, tubs, and toilets, and social factors such as crowding, affordability, and insecure tenure are implicated in high rates of infectious disease, injury, and mental illness (Ali et al., 2018; WHO, 2018; Webster 2015). In Australia, Ali et al. (2018) conducted a narrative literature review and found that insufficient maintenance is associated with gastrointestinal infections, crowding is associated with skin-related diseases and viral conditions, and diarrhoea is associated with inadequate food preparation and storage areas. Foster and Hall (2021) undertook an analysis of 14 datasets comprising information on Northern Territory crowding, dwelling condition, health hardware, and maintenance services to examine the impact of housing on rates of shigellosis, acute rheumatic fever, helminths, and trachoma (see Table 1, 329). Research on hospital admissions and clinical presentations shows a disproportionate impact of these health outcomes on Indigenous children (Kearns et al., 2013; Buntsma et al., 2017). Research investigating Indigenous residents' particular understandings of 'home' also demonstrates the relationship between inadequate housing and mental stress (Andersen et al., 2018; Penfold et al., 2020). Yet while the contribution of poorly maintained and constructed housing to poor health outcomes and inequality is often recognised in public policy, when it comes to good practice, efforts and outcomes have been inconsistent (McKnight & Cowell, 2014).

Property maintenance in social housing takes various approaches. What policy may describe as corrective or reactive maintenance involves repairing or replacing dysfunctional building components, usually in response to tenant reporting. This is distinguished from planned, cyclical, or preventive maintenance, which involves a scheduled program of regular inspections, condition assessment, testing, and/or replacement of worn or failing building

components (Kim et al., 2016). While various reports quantify the financial benefits generated through targeted housing spending for vulnerable people (Audit Commission, 2009), and even identify planned or cyclical maintenance as a priority (Commonwealth of Australia, 2017; Audit Commission, 2010), inadequate attention is given to the details of the labour required to maintain housing at high function. Healthabitat's Housing for Health methodology is an exception (Standen et al., 2020). An effective R&M program attends to the functionality, quality, and serviceability of a building and ensures safety and compliance with statutory obligations. It also facilitates what Healthabitat calls 'healthy living practices' (Torzillo et al., 2008)—the ability to wash oneself and one's children, the ability to remove effluent, and so on. Implemented consistently, attention to functioning health hardware improves health outcomes for residents, in the form of fewer housing related illnesses resulting in hospital separations, among other measures (NSW Health, 2010; WHO, 2018). Reliable property maintenance additionally supports strong relationships with tenants, reducing the rate and associated costs of tenancy turnover (Habibis et al., 2016; van Mossel & Jansen, 2010).

Property maintenance is a standard requirement of management agreements for government supplied Indigenous housing in all Australian jurisdictions. Yet, even allowing for the 'variation, improvision and innovation' that is celebrated in recent repair literature (Graham & Thrift, 2007, p. 6; Mattern 2018), actual programs do not regularly resemble the features of best practice property maintenance (Pholeros & Phibbs, 2012; Minnery et al., 2000). Instead, as in social housing in many international contexts (Powell, 1994; Arrigoitia, 2014), insufficient government subsidy and low rental yields generate budget rationing, restricting the capacity of property maintenance programs to responsive activities and limiting planned programs to essentials such as smoke alarm checks (Pawson et al. 2019; Wiesel et al., 2012).

Non-urgent maintenance is deferred to reduce expenditure (Audit Office of NSW, 2013), in a process which justifies and accelerates the sale of public housing stock (Pawson et al., 2019; Atkinson & Jacobs, 2010).

This can be both costly and inefficient. In a major review of remote Indigenous housing delivery in Australia, median costs of emergency R&M were 75 per cent higher than planned activities; non-emergency responsive activities were 50 per cent more costly; and costs for emergency R&M could be up to 20 times higher than planned R&M (Nous, 2017, pp. 25-26). Travel costs associated with emergency repairs consumed up to 96 per cent of per unit costs, compared with 11 to 37 per cent for planned maintenance. These issues are especially concerning due to the pressure on remote housing providers to manage their portfolios effectively so that existing housing stock is not further reduced by chronic deterioration leading to uninhabitability.

Understanding the attention required for successfully implementing planned maintenance assumes even greater importance given current policy disinterest in funding new public housing to match demand. In Australia, the principal policy framework for Aboriginal and Torres Strait Islander people is "Closing the Gap", a partnership between all levels of government and the Coalition of Aboriginal and Torres Strait Islander Peak Organisations (Australian Government, 2020). Under the first iteration of Closing the Gap, a $5.4 bn investment in remote Indigenous housing under the *National Partnership Agreement on Remote Indigenous Housing* (NPARIH) delivered approximately 11,500 additional liveable houses in remote Australia between 2008 and 2018 (Commonwealth of Australia, 2017). While this major increase in new stock and refurbished housing was associated with a reduction in crowding from 52.1 per cent of households in 2008 to 41.3 per cent in 2014-15,

levels of crowding remain high, while overall funding has since been reduced. The Commonwealth Government's own assessments suggest around 5,500 more homes are required by 2028 to reduce crowding to acceptable levels (Commonwealth of Australia, 2017), but funding commitments are mostly restricted to replacement and/or refurbishment of existing housing (NIAA 2021). The Commonwealth Government has also made it clear that funding has been provided as 'walk away' (non-recurrent) money, discharging its future involvement in remote Indigenous housing provision (Dillon, 2018).

In the sections to follow we outline how preventive maintenance, undertaken in cooperation with Indigenous community controlled health services and focused on the capacity of households to undertake essential healthy living practices, can ensure the longevity of housing while also improving health outcomes for residents (NSW Health, 2010).

Methods and Materials

This research employed a mixed methods approach to examine remote Indigenous housing maintenance. Property maintenance and environmental health program datasets and reports were obtained from both Housing SA and Nganampa Health Council, as each organisation works to maintain houses and their surrounding areas on the APY Lands of South Australia. Housing SA datasets included property maintenance expenditure data over five years, financial reports detailing the distribution of expenditure between the APY Lands and other Indigenous communities in South Australia, a schedule of property maintenance services provided by the head contractor, and raw datasets listing jobs completed by the head contractor from June 2017 to June 2020. This data was imported into SPSS (a statistical software program) and transformed to allow analysis focused on the types of R&M

undertaken, including job type (coded to trade), cost, location, and duration to completion. From Nganampa Health Council we received raw datasets listing jobs completed by their environmental health teams dating back to 2008, and quarterly reports summarising work completed in 2018-2020. Nganampa data were coded in relation to Healthabitat's healthy living practices, a framework that emphasises the impact of functional 'health hardware' to improve householder health outcomes (Torzillo et al., 2008), which has been intermittently incorporated into Indigenous housing policy in Australia for over two decades (NTG, 2020; Commonwealth of Australia, 1999). This sort of comprehensive data on the maintenance works that attend to a particular housing portfolio is rarely represented in housing or policy literature, in part due to inconsistent reporting systems and *ad hoc* engagement with multiple contractors for responsive works.

We also draw on 11 interviews with stakeholders (SH) including housing and environmental health officers, contractors and tradespeople, and housing and infrastructure professionals.[2] Conducted from July through November 2020, interviews mostly occurred via a virtual platform, were transcribed verbatim by a professional transcription service and entered into the qualitative data analysis software NVivo. Analysis of interview data was conducted according to the 'framework approach' (Ritchie & Spencer, 1994; Gale et al., 2013). Following familiarisation with the transcripts, a thematic framework was developed and agreed upon by the researchers, based on the core topics specified for the larger project (for example, maintenance, data management, employment, climate change) and sub-themes that emerged during the interviews and fieldwork (such as planned and responsive maintenance, budgeting, the feedback loop, and so on).

Analysis of datasets and interviews was augmented by ethnographic fieldwork, involving two visits to the APY Lands in August 2021 and February 2021. This included accompanying a Nganampa Health Council environmental health supervisor as they undertook various duties in and around community houses, such as repair work, removing and installing washing machines, collecting and removing rubbish, testing wastewater, and filling animal troughs. It also involved accompanying Housing SA managers to the APY Lands as they scoped upcoming replacement housing and refurbishment projects, consulted with council members, met with the head contractor's local employees, residents, and other service providers, and travelling with the head contractor to understand the logistics of delivering the maintenance program in context. Such ethnographic participation provided a direct view of program delivery that is more typically mediated in analyses of housing programs by datasets and interviews.

Results and Discussion

Property maintenance on the APY Lands

On the APY Lands, housing maintenance is the responsibility of Housing SA according to a 50-year lease agreement. Houses remain under community ownership, while the lease agreement grants Housing SA the right and responsibility to maintain housing and collect rents. The Aboriginal and Remote Housing section is a discrete unit in Housing SA that coordinates property maintenance on the APY Lands, with its work distinct from the general maintenance and construction program applied to Housing SA properties elsewhere. In other South Australian contexts, the maintenance approach is more typical of social housing maintenance in Australia generally, being reliant on tenant reporting for responsive repairs.

[Figure 1. APY Lands Map. Copyright. Regional Aṉangu Services Aboriginal Corporation]

Figure 1 represents the APY Lands communities included in the maintenance programs undertaken by Housing SA and Nganampa Health Council. Iwantja (Indulkana) is the most eastern of the APY Lands communities, located just west of the Stuart Highway and 55km north of Marla, a major logistical hub for the Housing SA maintenance program. Table 1 represents distances from Marla to each of the APY Lands communities travelling in an east to west direction to convey a sense of the distances involved. Distances from the Stuart Highway to communities in the northwest of the APY Lands (Kalka, Pipalyatjara, Kanpi, Nyapari) are reduced slightly if entering by a northern road. The administrative hub on the APY Lands is located at Umuwa (south of Pukatja), with section managers located in Adelaide, 1300 kilometres to the south.

[Table 1. APY Lands communities.]

Housing SA is responsible for the maintenance of 371 houses across ten communities on the APY Lands (Table 1), servicing a population of approximately 2,276 people (ABS, 2016). Population figures are subject to significant variation due to intra-regional and remote-to-urban mobility, according to seasonal changes, housing availability, and for cultural reasons, but the figures demonstrate the high average occupancy rates of houses. Large numbers of Aṉangu people leave the APY Lands for Alice Springs and coastal South Australian cities, such as Port Augusta and Adelaide, during the summer months, when daily maximum temperatures average over 37°C.

Housing SA's APY Lands property maintenance program involves a single head contractor supervising a team of employees and subcontractors. Under this contract, across a calendar year, each house typically receives ten planned visits. This scheduled program of works includes two air conditioning services, four pest services, an electrical safety assessment, a plumbing maintenance visit, a hot water system check, and a building fabric check. These programmed maintenance services are in addition to responsive maintenance works responding to complaints or emergencies, quality assurance (QA) inspections by the Housing SA maintenance and capital works coordinators (who undertake rotating two-week shifts on the APY Lands), and inspections and tenancy support visits conducted by the Housing SA tenancy management team. Housing SA managers also typically make monthly trips to APY Lands communities to assess housing stock, scope required capital upgrades, attend council meetings, and consult with tenants, contractors, and the Housing SA on-ground coordinators, located in an office at Umuwa. This contrasts with the frequently made critique of bureaucrats compounding spatial disadvantage through governance from afar (Atkinson & Jacobs, 2010).

Supplemental R&M is also undertaken by Nganampa Health Council (NHC). NHC is an Aboriginal community-controlled health organisation that delivers comprehensive primary health care from seven clinics across the APY Lands. Its *Uwankara Palyanyku Kanyintjaku* (UPK) environmental health program involves environmental health worker teams who provide services such as yard maintenance, rubbish removal, hazard reduction, and tree lopping to local organisations such as schools and health clinics (NHC, 2018). Service provision is flexible, rather than operating according to a mandated job sheet, with the focus on maximising the potential for residents to enact healthy living practices, whether that

means fixing a washing machine or clearing a yard. This means day-to-day activities of UPK environmental health workers are responsive while operating within available resources.

The total budget for the Housing SA APY Lands maintenance program in the 2019/2020 financial year was $3,726,237. This equates to an average spend per property of approximately $10,000 per annum, separate to the value of Nganampa Health Council's environmental health program.[3] The program also includes $500,000 allocated to vacancy maintenance, for property refurbishment between tenancies. Due to crowding pressures, this vacancy budget is rarely expended in full, but is rolled over from one financial year to the next and can shift between maintenance categories.

Table 2 details the Housing SA remote housing maintenance budget for the 2019/2020 financial year and the projected budget for the year 2020/2021. It applies to all property maintenance undertaken by the Aboriginal and Remote Housing section across South Australia (not only the APY Lands and 501 houses in total). It indicates that Housing SA apportion most of their budget to planned maintenance, and only one-fifth to one-quarter to responsive work. This is highly unusual for remote housing R&M and aligns with target benchmarks for planned maintenance in general social housing in urban areas (Community Housing Industry Association, 2018). Travel accounts for approximately ten per cent of the budget, which given the cost pressures on remote R&M would likely be significantly higher if not for the planned delivery of works (Nous Group, 2017).

[Table 2. Housing SA maintenance program budget for all remote Aboriginal communities in South Australia (501 houses)]

Planned and responsive maintenance

Housing SA distinguishes between 'planned' and 'responsive' property maintenance:

> [The head contractor] uses this 'stitch in time' approach and it's sort of an aphorism we're using, where if we're continually going into a house and fixing up those things that are failing, then we're hoping that we can lower our responsive callouts. They're our most costly callouts, responsive maintenance. But a planned maintenance [approach], because you're in that community and your trades are going through every house and going around ... we also can achieve more at the same time. (SH1)

Tradespeople working for the head contractor have significant discretion to complete additional jobs while on site, with only larger jobs requiring separate approval by Housing SA. Such discretion is atypical across Australian jurisdictions. Usually, work orders of much lower values require separate approvals by diverse contract superintendents, with associated impacts on travel costs, job completion time, contractor and tenant satisfaction and trust (Grealy, 2021).

The high number of planned visits by licensed tradespeople represented in the programmed schedule of works is a distinctive feature of the APY Lands program. During a programmed visit, a tradesperson not only works according to a technical data sheet relevant to their expertise, but if they notice a job in another trade area that requires completion, they can report this to the Housing SA maintenance coordinator, who will generate a trade-relevant work order. Significant resources are dedicated to proactively 'chasing maintenance' (SP1), because program managers believe this reduces future costs.

Table 3 represents the number of housing maintenance jobs undertaken by each trade type, for the approximately 371 houses subject to the program over 2017-2020. Eleven different trade types are reported in the data. Plumbing works accounted for the highest average number of jobs across the period, constituting over 20 per cent of housing maintenance jobs in any year. This includes internal work related to sinks, bath, showers and laundries, taps, toilets, and sewer drains, and external work related to guttering, stormwater, hot water systems, and rainwater tanks. All maintenance jobs incurred travel costs, given the remote locations of houses. The data shows that, on average, approximately ten maintenance work orders were completed for each travel work order, demonstrating the relative efficiency of the planned approach.

[Table 3. Number of jobs by trade over the period 2017-2020 for 371 APY Lands properties]

Even a planned maintenance program as extensive as that designed by Housing SA for APY Lands housing requires responsive maintenance works. Housing hardware breaks down or malfunctions without warning between planned maintenance checks. Housing SA uses a spectrum of 1 to 5 to prioritise responsive work orders according to required fix times. Most responsive work orders are raised as a P-2 (attend within two days) or P-5 (30 days), however in practice most P-5 maintenance work is addressed within two weeks, given the two-week shifts of contracted tradespeople. This practice has further reduced travel costs and created work practice efficiencies.

Housing management arrangements

Housing SA's Aboriginal and Remote Housing section is responsible for both remote Indigenous housing maintenance and capital works. This proximity has generated important lessons about sustainable housing design and material function over time:

> When we were just doing construction, you'd finish, you'd walk away. We'd go back at the end of the 12-month defect liability period, we'd look in the house, we'd talk about how the house has performed. We tick. We go away … Whereas now, we're constantly going back into housing, seeing how they perform, seeing how they're used, seeing what's breaking and failing constantly. (SH1)

This generates an important 'feedback loop', from humble to significant integrations. For example, a common failure point is shower rails yielding from bathroom walls and ceilings. The integration of the capital works and maintenance teams means housing upgrades now ensure that wall studs are appropriately located such that shower rails can be more securely attached. To reduce backflow into wet areas, subfloor piping includes multiple direct exits as built-in redundancy for any blockages. In delivering the maintenance program, the contractor is asked, 'Can you capture what's missing on a house?' (SH1), to identify hardware subject to repeated failures. This in turn leads to research and development with local manufacturers, such as for new window and door security screens, demonstrating Housing SA's recognition that the design of fixtures and fittings and the selection of materials are critical for housing longevity and subsequent pressures on maintenance.

[Figure 2. APY Lands new house.]

As noted, the head contractor provides multi-trade services to Housing SA through a combination of employees and subcontractors under a seven-year contract with both Housing SA and the Department of Infrastructure and Transport. Under earlier models, multiple

tradespeople with similar expertise were employed by different companies to undertake work in the same community simultaneously, creating travel inefficiencies and diluting responsibility for hardware failures. For example, under the former arrangement a contractor could avoid liability for unsatisfactory work: '"Oh no. That was the other electrician. That's his fault." Whereas, now there's just one. If there's anything wrong, [Housing SA] just come to us' (SH5).

Both Housing SA and the head contractor spoke positively of their relationship, including the proactive approach the head contractor has assumed in relation to housing failure.

> We've got a really good relationship with our contractor... he works with us. It's a partnership. Whereas a lot of other maintenance contracts, it's an "us and them" approach. We see him as the doing arm. If he's not successful, then we're not successful as well. (SH1)

From the head contractor's perspective, the positive relationship was dependent on the government agency's clear understanding of what is required to deliver remote area R&M. This mutual understanding saw the head contractor involved in forward planning of the programmed maintenance schedule and afforded greater autonomy to undertake the work as needed and as possible for maximum efficiencies, given challenges related to weather and climate, employment, and time-intensive work programs.

Hardware failures and reporting maintenance

Common hardware failures in APY Lands housing include electrical faults, air conditioner malfunction or breakdown, damaged and broken doors and door handles, missing screen doors and windows, blocked toilets, septic tank corrosion, and appliance failure, especially

stoves. Table 4 shows the total cost of works for each trade type in 2019. While not undertaken as frequently as plumbing works, general maintenance work is the costliest category, accounting for a third of the total cost. Plumbing is the second most expensive work type, accounting for one quarter of total expenditure. Under 11 per cent of the total cost of maintenance was spent on travel.

[Table 4. Total cost of works undertaken on the APY Lands by trade for 2019]

Hardware failures were attributed to myriad factors such as the hardness of water, the dusty arid landscape, and the presence of insects, rodents, and other animals, domesticated and feral (Healthabitat, 2022). Some hardware failure was also attributed to the neglect of repairs and maintenance under previous regimens. Inattention to minor issues can contribute to subsequent major damage, as one respondent described of a full bathroom refurbishment:

> We're probably up to $50,000/$60,000 worth of repair work which probably originally started off as a $2,000 job. Now it's a $50,000 job. So, it's just that going in and looking and addressing little issues … That's the key for the remote stuff because when it becomes big, *it's big*. (SH2)

Crowding was also identified as a cause of accelerated wear and tear, highlighting the burden on property maintenance and its limited capacity to rectify housing shortages:

> So, if we've got overcrowding at 49 per cent, it doesn't matter what [we] design in a house, we're always going to have high failure points. The septics are always going to be under extreme pressure. When you've got fifteen people in a house that's really designed for six or seven, your solar hot water service is always going to be running cold very quickly... Everything in the house is going to be stressed to the maximum capacity. (SH1)

While tenants in urban public housing across the state tend to formally lodge requests for R&M via a Housing SA phone-in system, the difficulty for some Anangu residents to report maintenance issues in English also informs the current model. Rather than tenants initiating requests themselves, the highest reporting avenue is via Housing SA tenancy practitioners attending houses and speaking to people directly. Such a proactive approach captures housing failures that are otherwise unreported. Similarly, if an environmental health worker from Nganampa Health Council encounters an issue they are not licensed to fix or lack the time to address, they too can put in a maintenance request to Housing SA—as can disability services officers, other health professionals, and, as we have shown, the trade contractors themselves. In relation to emergency repairs, or where a delay is anticipated, an environmental health worker might step in: 'Often, it's just easier to fix it myself, rather than wait for Housing to come out. If you've got an issue which is a real health problem, you can't wait' (SH7). In turn, Housing SA tenancy practitioners will raise issues with Nganampa Health Council, where these relate to cleanliness outside the house but within the fence line. In sum, supplementing mainstream reporting procedures for requesting housing repairs are myriad less formal, more relational, mechanisms.

Maintenance and environmental health

Extensive as it is, Housing SA's planned maintenance program is not exhaustive. Prioritisation is given to works that impact most directly on safety and health inside the house, including electrical, plumbing, air conditioning, and pest control works. Nganampa Health Council environmental health workers undertake preventive and responsive work that does not typically require licensed tradespeople, 'such as unblocking drains, fitting mirrors in

bathrooms, maintaining yards, repairing washing machines, washing houses, and removing rubbish' (SH8). At the request of residents, environmental health workers will leave a trailer in residents' yards, which can be filled with rubbish for delivery to the tip. The program also dispenses parasitic control drugs to dogs between specialist vet visits, ensures water troughs are full to prevent animals entering communities, provides firewood for cultural business, slashes grass, and undertakes various public health work as required, such as testing wastewater and distributing domestic products (detergents and cleaning agents, for instance).

Work conducted by the NHC environmental health team operating in the west of the APY Lands (Kalka, Pipalyatjara, Kanpi, Nyapari) is summarised in Table 5. During the financial year 2019-2020, this team undertook 317 discrete jobs, which are coded to Healthabitat's healthy living practices (HLPs).

[Table 5. Nganampa environmental health work distribution by HLPs (west team)]

Because the work of the environmental health program extends beyond the fence into the community, a range of other work types were undertaken. Across the 2019-2020 period, work completed by the team operating in the west of the APY Lands included additional jobs summarised in Table 6.

[Table 6. Nganampa community-based environmental health work (west team)]

The focus on environmental health emphasises an ecological understanding of what is required to effect healthy living practices.

> We always said you've got to take a broad frontal approach ... to ensure that when people were at home, they could wash their kid. That relies on the bore working, it relies on the delivery, the pipes. It relies on the taps not falling off, their capacity to buy a towel in the store and the soap and the shampoo ... the house has got to be designed, constructed, supervised; there's got to be money for maintenance; there's got to be a store that can supply the essentials. (SH8)

Nganampa Health Council respondents emphasised the relationship between the house and the yard as central to the UPK program. Buffel grass, an introduced species, is rife across the APY Lands (Read et al., 2020). Its removal from yards reduces indoor crowding by increasing the utility of yard areas and is also an important fire hazard reduction activity.

Housing SA supplies stoves, evaporative air conditioning units, and (until recently) water tanks, but not whitegoods, including fridges and washing machines. To fill this gap, a UPK supervisor sources washing machines for residents from discarded units at the international tourist destination of Yulara (nearby Uluru). These are not always fully functional but can be stripped for parts to repair broken machines in people's houses. This supervisor has a running list of washing machines in APY Lands houses that require repairs or replacement, because they have stopped working, are leaking or are too noisy. While smaller in scale than Housing SA's property maintenance program, Nganampa's environmental health program complements these works while emphasising the health conferring function of housing.

Sustainable Repairs and Maintenance

Together, the Housing SA and Nganampa Health Council programs promote a conception of functional housing that prioritises housing's health-conferring capacity. Housing is

understood as a process that must be augmented through ongoing attention and as extending beyond the four walls to include the yard, the community, and the impact of hardware failure on crowding in adjacent properties (Hall et al., 2020; Memmott et al., 2006). Their work demonstrates how planned maintenance can sustain functional housing against its entropic tendencies in the most demanding contexts. While sustainability is now an uncontroversial ambition for housing policy, guaranteeing ongoing functionality in remote Indigenous housing through adequate ongoing property maintenance is rarely achieved in practice (Grealy & Lea, 2021). Key factors underpinning the efficacy of the Housing SA maintenance program include the planned program works, the housing management arrangements, flexible reporting procedures, and the multi-trade contract. Nganampa Health Council's environmental health program complements the Housing SA program, by taking a holistic view of householder health and wellbeing that attends to work outside the house and beyond the fence line.

There are lessons here for policy makers and practitioners in other contexts. We have identified an exemplary model of a planned and responsive R&M program as a key strategy for extending the lifespan, habitability, and amenity of existing housing. Aspects of this approach can be straightforwardly replicated in social housing portfolios elsewhere. Planned and cyclical maintenance by housing officers reduces the likelihood of discovering major hardware failures and their associated emergency costs (Nous Group, 2017). The well-established relationship between housing and health (WHO, 2018; WHO, 2020) means that effective early interventions in key failure points in health hardware will assist in extending the habitability of housing stock and alleviate the health impacts of crowding. For further health and wellbeing gains, environmental health programs that operate inside and outside the fence line are also needed.

To emulate such dividends elsewhere requires assured funding, contracts of appropriate length, an adequate volume of work, planning to distribute that work across a scheduled period, skilled labour, and careful administration. Housing SA has secured additional gains through the feedback loop established between its remote maintenance and construction programs and the standardisation of housing hardware.

Conclusion

Successful planned maintenance with supportive public health servicing is not simply an effect of, nor confined to, remote or even Australian Indigenous contexts. However, to support sustainable housing rather than buck-passing over neglect, programs must be properly resourced. The programs outlined here in many respects represent best practice under current constraints, including that of ongoing housing shortages, where questions of future sustainability are also questions of maintaining existing stock, of repair, and the anticipation of infrastructural degradation. In remote Indigenous communities in Australia, where there is little evidence of any likely increase in housing supply in the short- to medium-term, the most effective way to reduce the health impacts of crowding and improve householder wellbeing is to ensure ongoing housing performance through planned maintenance approaches that reduce the likelihood of major and prolonged disrepair.

Sustaining houses means sustaining attention to the routines required to maintain such housing. In remote Australia and elsewhere, there remains significant potential to guarantee sustainable housing through strategic partnerships and assertive and planned R&M strategies. Such programs may increase upfront expenditure but can reduce the health and

social costs of inadequate housing. Attentiveness to the uncharismatic details required to make R&M work should be prioritised in sustainability advocacy, contra the conventional emphasis on front-end construction standards and materials. In showing that this is feasible even with extreme distances and environmental pressures, our analysis should embolden policy makers regarding the gains to be achieved by implementing planned maintenance programs, for remote Indigenous housing and social housing in general.

Notes

[1] See for example *Various Applicants from Santa Teresa v Chief Executive Officer (Housing) [2019] NTCAT 7 (27 February 2019)*, (2019). Available at https://www.hrlc.org.au/human-rights-case-summaries/2019/6/24/nt-civil-and-administrative-tribunal-awards-compensation-to-aboriginal-tenants-for-uninhabitable-housing (accessed 7 March 2022).

2 Throughout this article, interviewees have been anonymised and interview material is referenced by stakeholder code (for example SH1).

3 It is not possible to say if this figure exceeds industry norms as each jurisdiction reports maintenance expenditure differently (Nous Group, 2017, p.11). The Australian Capital Territory expends approximately $40m on planned and reactive maintenance for 11,600 dwellings in the capital city of Canberra, yielding an average of $3,362 per dwelling in 2014/15 figures (ACT Auditor General, 2016, p.13, 30). Canberra also has twice the volume of housing stock per 1000 tenants than Australian averages, reducing wear and tear from crowding (p.66). An analysis of the costs of servicing remote area housing suggests metropolitan public housing costs are multiplied by a factor of 1.4 to 4.5 in remote areas (Nous Group, 2017, p. 13).

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Table 1. Housing in APY Lands communities subject to Housing SA property maintenance, 2019-2020

Community	Housing SA Properties	Population (ABS Census)	Distance by road to Marla, SA (km)
Iwantja (Indulkana)	56	256	55
Mimili	53	243	117
Kaltjiti (Fregon)	48	220	194
Yunyarinyi (Kenmore Park)	6	-	207
Pukatja (Ernabella)	76	412	242
Amata	65	455	383
Nyapari	11	72	484
Kanpi	13	35	495
Pipalyatjara	28	189	604
Kalka	15	92	607
Total	371	1974	339 (avg.)

Table 2. Housing SA maintenance program budget for all Aboriginal communities in South Australia (501 houses)

	2019/2020		2020/2021	
	$	**%**	**$**	**%**
Responsive	1,300,000	25.7	1,300,000	20.8
Planned	2,600,000	51.3	3,700,000	56.2
Homelands	200,000	4.0	200,000	3.2
Vacancies	500,000	9.9	505,000	8.0
Travel	460,000	9.1	550,000	8.8
Total	5,060,000	100	6,255,000	100

Table 3. Number of jobs by trade over the period 2017-2020 for 371 APY Lands properties

Trade	Jobs per year										
	2017		2018		2019		2020		Total		
	No.	%	No.	%	No.	%	No.	%	No.	%	Yearly Average
Plumbing	1411	21.6	2785	23.7	2685	25.3	4483	46.6	11364	29.5	2835.8
General	1234	18.9	1401	11.9	2667	25.1	1702	17.7	7004	18.2	1622.5
Electrical	1038	15.9	2620	22.3	1364	12.8	908	9.4	5930	15.4	1481.8
Travel	686	10.5	1625	13.9	1208	11.4	1382	14.4	4901	12.7	1225.3
Air Conditioning	895	13.7	1750	14.9	1626	15.3	449	4.7	4720	12.3	1179.5
Pest Control	1066	16.3	1085	9.3	618	5.8	374	3.9	3143	8.2	785.8
Waste Management	2	0.0	287	2.4	216	2.0	185	1.9	690	1.8	172.5
Building	186	2.9	163	1.4	139	1.3	87	0.9	575	1.5	143.8
Painting	0	0.0	1	0.0	86	0.8	40	0.4	127	0.3	31.8
Cleaning	3	0.0	11	0.1	12	0.1	8	0.1	34	0.1	8.5
Fire Safety	0	0.0	1	0.0	3	0.0	0	0.0	4	0.0	1.0
Total	6521	100	11729	100	10624	100	9618	100	38492	100	

Table 4. Total cost of works undertaken on the APY Lands by trade for 2019 (371 houses)

Trade	2019		
	2019 Costs	Yearly Cost (%)	Avg. house cost
Air Conditioning	$472,493.02	12.77	$1273.57
Building	$24,479.04	0.66	$65.98
Cleaning	$33,165.92	0.90	$89.40
Electrical	$391,745.36	10.59	$1055.92
General	$1,204,342.01	32.56	$3246.20
Painting	$69,857.03	1.89	$188.29
Pest Control	$86,625.88	2.34	$233.49
Plumbing	$935,766.57	25.30	$2522.28
Travel	$393,180.78	10.63	$1059.79
Waste Management	$87,730.98	2.37	$236.47
Total Yearly Cost	$3,699,386.59	100.00	$9971.39

Note: The total costs are different to those costs cited above as the data is derived from calendar year costs rather than financial year costs.

Table 5. Nganampa environmental health jobs~~work~~ distribution by HLPs (west team)

Healthy Living Practice (HLP)	Jobs completed (2019-2020)
Safety	13
1. Washing people	27
2. Washing clothes and bedding	73
3. Removing wastewater safely	49
4. Improving nutrition	22
5. Reducing the impacts of overcrowding	55
6. Reducing the negative effects of insects, animals and vermin	24
7. Reducing the health impacts of dust	0
8. Controlling the temperature of the living environment	36
9. Reducing hazards that cause trauma	18
Total	317

Table 6: Nganampa community-based environmental health work (west team)

Job Type	**Jobs completed (2019-2020)**
Cemetery (prepare sites and dig graves)	10
Community infrastructure	10
Cockroach treatment	5
Pressure clean building areas	11
Window repairs	1
Door and door lock repairs	11
Firewood collection and distribution	27
Stock trough maintenance	15
Rubbish trailer delivery and removal	17
Sampling main supplies for SA Water	4
Total	111

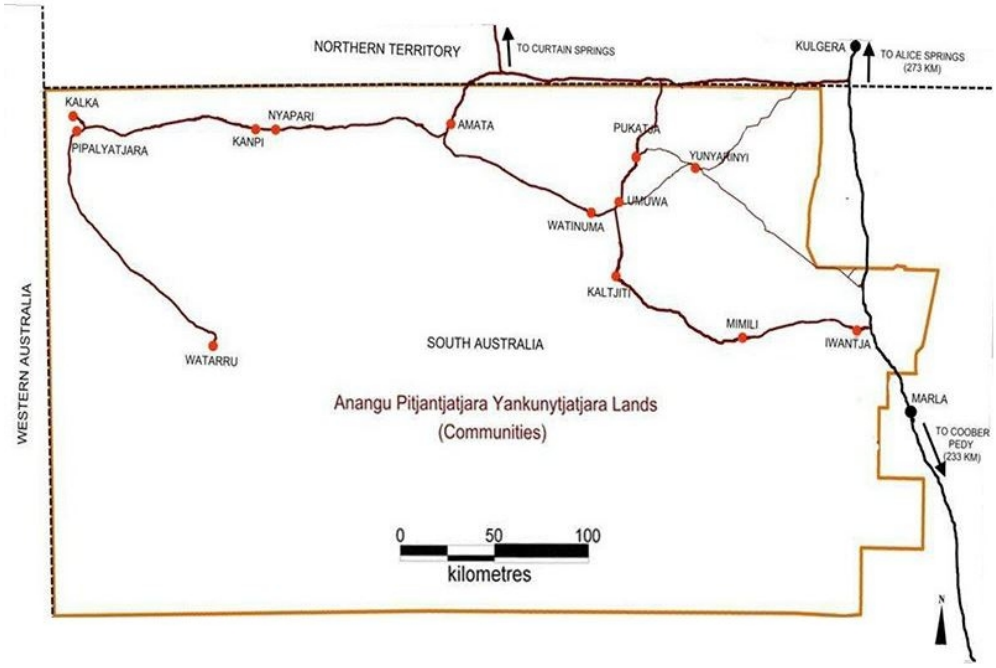

Figure 1. APY Lands Map. Copyright. Regional Anangu Services Aboriginal Corporation

142x97mm (144 x 144 DPI)

Figure 2. APY Lands new house.

1422x800mm (72 x 72 DPI)

Response to Referee 1

This article was originally submitted on 19.7.2021 (CHOS-2021-0316) and we undertook revisions based on your advice. It was resubmitted on 25.8.2021 and we received reports from three reviewers on 21.1.2022, which have informed subsequent major revisions. We would like to sincerely thank the three anonymous reviewers for their labour, consideration, and constructive feedback. This has helped to extensively refine the article's argument and analysis.

A track changed version of the article is supplied, together with a clean version. The revisions made across two review rounds include:

- Clarification of the article's framing, including revision of the title and abstract, and reassessment of the literature cited. Revisions have highlighted the article's engagement with and relevance to literature on repair and maintenance. This has included engaging with the distinctions and overlap between sustainability and maintenance as key concepts.
- Expanding the article's engagement with international literature to demonstrate the relevance of the study and findings to an international audience. Initially, this included increased explicit engagement with concepts such as sustainability and repair, and relevant previous studies. Following receipt of referees' reports, we have conducted further literature searches on the suggested topics of 'housing in remote areas, housing quality, and the struggles of Indigenous people' and sought to engage with this literature throughout the article and outline the implications of the study for international readers.
- Clarification of the article's contribution to housing studies literature and policy. The engagement with sustainability literature has not been removed, as we consider this an important contribution to Australian discourse on remote Indigenous housing, specifically for framing planned maintenance programs as necessary for long-term house function, contra the usual emphasis on front-end construction standards and materials. However, it has been shortened and we have also sought to complicate the temporal dimension of sustainability by emphasising the active process of sustaining housing, through maintenance. In doing so, we draw attention to the way the discourse of sustainable housing diminishes the importance of constant and ongoing attention to combat housing's disassembly, irrespective of original construction techniques and materials.
- Highlighting the original policy contribution as the demonstration of the advantages of planned and preventive (rather than responsive) housing maintenance programs and the combination of property management and environmental health approaches. The article also argues that meaningful—in the sense of both being both actionable and effective—policy recommendations, depend on empirical investigation and detailed description of policy delivery on the ground.
- Additional description of the methods employed in the study to generate the results, specifying research questions and highlighting the complementary approaches of statistical analysis, interviews, and ethnographic fieldwork.
- Amendments to the conclusion regarding the generalisability of the study and potential policy transfer for policy makers and practitioners elsewhere.

Below I summarise the revisions made according to feedback specifically from Referee 1.

Referee 1

- The results presented do not align with the introduction/literature review and general framing of the paper. The framing and upfront sections of the paper talk about sustainable housing but what you are focused on is sustaining housing. You pivot to 'sustaining housing' in the later sections of this paper. While you rightly note that sustainable housing typically focuses on energy/carbon outcomes, you do not provide a clear enough link to the role of maintenance, and you do not return to the idea of sustainable housing in your results or later discussion. I would remove the discussion on sustainable housing and instead focus on delivering minimum quality and performance in housing and the idea of 'sustaining housing' which is what your results are focused on.

  - This was a useful comment for us to reassess the opening section and overall argument. Rather than remove the discussion on sustainable housing, we have shortened it and sought to clarify the relationship between sustainable housing, sustaining housing, and maintenance in the early sections of the paper.

- Given this, the title needs revision. It could be 'Sustaining housing...' Also, the use of APY in the title does not give readers a clear indication of what that means.

  - The title has been revised.

- The abstract feels like it starts part way through a conversation. It needs to be much shorter and sharper in the writing and present the clear broader context and research gap, what you did and what the key implications are, including for an international audience.

  - The abstract has been rewritten to more clearly state what the article does and its implications.

- The introduction section should be rewritten as per my earlier comment. If you are going to stick with the sustainable housing concept you need to provide more details and review some of your key assumptions which do not hold up in the wider literature. I would also remove the summary of your findings from the introduction as to me it created more questions given I did not find strong alignment with the earlier paragraphs.

  - The introduction has been rewritten, revising references and the inclusion of the findings.

- While the literature review does at times touch on wider international research it did so superficially and I would like to see much deeper engagement with the international research and context so it is clear how your paper is contributing to that and why it would be relevant for an international reader. It should also provide more evidence around issues of poor quality housing and implications on liveability/health etc.

  - The literature review has incorporated more extensive engagement with international literature to demonstrate the article's contribution (especially literature from comparable national contexts such as Canada and New Zealand), in particular in relation to questions of housing quality and health implications.

- Your methods state you are providing data from South Australia but that you also had in the larger project data from two other states. If you had that data why is it not included? If you didn't have the same data for those other states why not? You also focus on one case study where a proactive approach is implemented but don't have a case study where it is reactive so it is hard to know how much of what you find is due to the proactive nature. I think some limitations should be touched on. I would also like to see some more information about the houses such as type of design, construction etc. The results and discussion are largely ok, although the $10,000 per year maintenance fee seems quite high but there is not much discussion about that. It was also not clear if the environmental health work was part of that cost or separate? I think towards the end of the discussion you need to do more to relate this back to a wider context. How could this be implemented for other social housing or in other countries? Or is this just relevant for remote communities? Link back to the literature review more.

  - The $10,000 figure relates to the Housing SA program only and this has been clarified. Effort has been made to relate findings back to the larger context and its implications for remote

housing management elsewhere. An image of a new APY Lands house has been included for reference to house style and construction. The brief references to the larger project confused the discussion in this article and have been removed.

- Conclusion section is missing.
  - We have revised the final section and included a conclusion subtitle.

We thank you for your consideration of this submission and look forward to hearing back from you.

Response to Referee 2

This article was originally submitted on 19.7.2021 (CHOS-2021-0316) and we undertook revisions based on your advice. It was resubmitted on 25.8.2021 and we received reports from three reviewers on 21.1.2022, which have informed subsequent major revisions. We would like to sincerely thank the three anonymous reviewers for their labour, consideration, and constructive feedback. This has helped to extensively refine the article's argument and analysis.

A track changed version of the article is supplied, together with a clean version. The revisions made across two review rounds include:

- Clarification of the article's framing, including revision of the title and abstract, and reassessment of the literature cited. Revisions have highlighted the article's engagement with and relevance to literature on repair and maintenance. This has included engaging with the distinctions and overlap between sustainability and maintenance as key concepts.
- Expanding the article's engagement with international literature to demonstrate the relevance of the study and findings to an international audience. Initially, this included increased explicit engagement with concepts such as sustainability and repair, and relevant previous studies. Following receipt of referees' reports, we have conducted further literature searches on the suggested topics of 'housing in remote areas, housing quality, and the struggles of Indigenous people' and sought to engage with this literature throughout the article and outline the implications of the study for international readers.
- Clarification of the article's contribution to housing studies literature and policy. The engagement with sustainability literature has not been removed, as we consider this an important contribution to Australian discourse on remote Indigenous housing, specifically for framing planned maintenance programs as necessary for long-term house function, contra the usual emphasis on front-end construction standards and materials. However, it has been shortened and we have also sought to complicate the temporal dimension of sustainability by emphasising the active process of sustaining housing, through maintenance. In doing so, we draw attention to the way the discourse of sustainable housing diminishes the importance of constant and ongoing attention to combat housing's disassembly, irrespective of original construction techniques and materials.
- Highlighting the original policy contribution as the demonstration of the advantages of planned and preventive (rather than responsive) housing maintenance programs and the combination of property management and environmental health approaches. The article also argues that meaningful—in the sense of both being both actionable and effective—policy recommendations, depend on empirical investigation and detailed description of policy delivery on the ground.
- Additional description of the methods employed in the study to generate the results, specifying research questions and highlighting the complementary approaches of statistical analysis, interviews, and ethnographic fieldwork.
- Amendments to the conclusion regarding the generalisability of the study and potential policy transfer for policy makers and practitioners elsewhere.

Below I summarise the revisions made according to feedback specifically from Referee 2.

Referee 2

- This paper covers territory within the Housing Studies remit but its publishability in the journal is questionable since it fails to mount a convincing case as an original contribution to the international housing studies literature. Right from the start, in the obscurity of its title, the paper is minimising its chances of publication (and also making it hard to secure reviewers). Since there is a massive literature on the concept of 'sustainability' the inclusion of this word in the title could be a bit of a hostage to fortune. 'Maintaining attention' is fine in the sense that it embodies an argument of the paper, but this isn't clear without actually reading it. The paper's remit would be much clearer if the title referred to 'maintaining housing'.

- The title has been revised in response to this suggestion and the feedback from Referee 1.

- The key premise of the paper is the need to contest an official rhetoric that allegedly argues that planned maintenance is 'discretionary'. The NSW Audit Office reference provided to support this (cited as a 'for example') doesn't really do so, in my opinion. The foundational UK policy literature on social housing management (in particular reports published in the 1990s and 2000s by the Audit Commission) in fact argues strongly that planned maintenance should be prioritised over responsive or reactive repairs - on value for money grounds. I suspect that the CHIA NSW reference cited on p14 is influenced by that perspective. I don't think the problem is 'policy arguments that rationalise inattention or neglect', it is more a case that in Australia the business model for social housing (at least for public housing) is fundamentally flawed due to wilful political disinterest. If the paper's contentions in this respect are in fact straw persons, then its overall logic is badly weakened.

- We have clarified our argument about this point. It was less our key premise to contest any official rhetoric than to demonstrate the empirical gains of preventive maintenance. We agree that the need for preventive maintenance is cited by various reports, including on cost grounds, and have included relevant citations. We suggest that despite this, comprehensive and well-funded preventive maintenance programs are rare in practice in Australian public housing. This rarity underpins the significance of the APY Lands case study.

- The account of housing R&M practice in remote Indigenous communities of South Australia is an interesting but rather detailed case study of housing management practice in a remote Indigenous community context. And while some attempt is made to analyse the financial implications of such practice, this would need to be carried through in far greater depth to provide a convincing basis for the claim that the APY R&M model is generalisable across social housing in Australia (let alone internationally). An associated concern is that the research questions (1, 3 and 4, in any case) are of such breadth that it's hard to imagine how they could be properly addressed on the basis of a small scale case study in an unusual setting.

- We don’t consider that the case study must be straightforwardly generalisable in order that it merit analysis in this article. The characterisation that it is ‘rather detailed’ signals our effort to demonstrate to readers multiple components of the program, some of which might be appropriated into program design elsewhere. This detail indicates that academic journal articles can represent policies and programs in specific contexts that might be of interest to researchers and policy makers elsewhere, but also demonstrates that it an unrealistic expectation that this genre should outline exactly how such programs might be translated and implemented in other places. Such policy translation work depends on engagement with specific historical, geographical, demographic, and political circumstances, such as we have attempted to show for the APY Lands.

- For publishability in this journal the conclusions would also need to speak to an international audience.

- We have revised the conclusion and sought to draw on international literature and speak to an international audience more fully throughout.

We thank you for your consideration of this submission and look forward to hearing back from you.

Response to Referee 3

This article was originally submitted on 19.7.2021 (CHOS-2021-0316) and we undertook revisions based on your advice. It was resubmitted on 25.8.2021 and we received reports from three reviewers on 21.1.2022, which have informed subsequent major revisions. We would like to sincerely thank the three anonymous reviewers for their labour, consideration, and constructive feedback. This has helped to extensively refine the article's argument and analysis.

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- Expanding the article's engagement with international literature to demonstrate the relevance of the study and findings to an international audience. Initially, this included increased explicit engagement with concepts such as sustainability and repair, and relevant previous studies. Following receipt of referees' reports, we have conducted further literature searches on the suggested topics of 'housing in remote areas, housing quality, and the struggles of Indigenous people' and sought to engage with this literature throughout the article and outline the implications of the study for international readers.
- Clarification of the article's contribution to housing studies literature and policy. The engagement with sustainability literature has not been removed, as we consider this an important contribution to Australian discourse on remote Indigenous housing, specifically for framing planned maintenance programs as necessary for long-term house function, contra the usual emphasis on front-end construction standards and materials. However, it has been shortened and we have also sought to complicate the temporal dimension of sustainability by emphasising the active process of sustaining housing, through maintenance. In doing so, we draw attention to the way the discourse of sustainable housing diminishes the importance of constant and ongoing attention to combat housing's disassembly, irrespective of original construction techniques and materials.
- Highlighting the original policy contribution as the demonstration of the advantages of planned and preventive (rather than responsive) housing maintenance programs and the combination of property management and environmental health approaches. The article also argues that meaningful—in the sense of both being both actionable and effective—policy recommendations, depend on empirical investigation and detailed description of policy delivery on the ground.
- Additional description of the methods employed in the study to generate the results, specifying research questions and highlighting the complementary approaches of statistical analysis, interviews, and ethnographic fieldwork.
- Amendments to the conclusion regarding the generalisability of the study and potential policy transfer for policy makers and practitioners elsewhere.

Below I summarise the revisions made according to feedback specifically from Referee 3.

Referee 3

An important paper due to lack of knowledge in Indigenous housing management field. I have made 30 recommendations or suggestions for improvement to value add to paper.

- What about the link to design and procurement? (p.3 [as numbered in PDF, incl. title page])
    - Phrasing added here and elsewhere to acknowledge the relevance of design and procurement to sustainable housing.
- Need to define this term 'responsive maintenance' here. It will improve sense of sentence. (p.3)
    - Phrase ‘or reactive’ added here to convey meaning. Responsive is defined in more detail in contrast to planned maintenance in the following section.
- Sense of sentence construction needs improving. (p.4)
    - The sentence has been rewritten and split into two sentences for clarity.
- This point goes back to design and design choices. Need to be clear than design of fittings and fixtures and selection of material is critical for longevity and maintenance. (p.5)
    - Included point about the importance of design and selection of fixtures and fittings to maintenance program, in the *Housing management arrangements* subsection.
- Give geographic and methodological context. (p.5)
    - Details of context of Healthabitat’s dataset added.
- Suggest make reference to his more recent papers on 'Closing the Gap'. (p.8)
    - Recent (Australian Government 2020) Closing the Gap report already cited. Further references and Commonwealth funding and maintenance added.
- This needs to be referenced and with more context, perhaps in a footnote. (p.9)
    - Reference provided.
- Suggest cross reference to James Davidson et al AHURI report on 'social capitals'. (p.10)
    - Reference added earlier in paper.
- Are these coded as SH? (p.10)
    - Explanatory phrasing added in brackets
- The number of properties in this Table and the population needs to be referenced to a year! Give time context on the table. (p.12)
    - Table 1 revised to include year, total figures for properties, population, and average distance.
- Is this the 'planned visits' described later? (p.13)
    - Added ‘planned’ to confirm
- Does this include painting? Do 'checks' include actual R&M? Suggest list cyclical maintenance regime mentioned earlier. (p.14)
    - The planned maintenance program does not include painting so this has not been listed.
- Can you include numbers of housing units involved? (p.14)
    - Included in title to updated table.
- Any data on dollar size (cost range) of large versus small job? (p.15)
    - We did not analyse data in detail in relation to dividing jobs into large and small jobs.
- Can this be contextualized by stating the total number of properties involved? Alternatively state no. of properties for a one-year period if that's all that is known. (p.16)
    - Phrasing added to indicate relatively consistent number of houses subject to the program over this time period. This is give or take a couple of hours, depending on the number of house fires and declarations of houses beyond economic repair.
- A footnote on the architectural detailing of this feature would be useful to understand how vermin entry is achieved. (p.17)
    - I presume this refers to how vermin entry is prevented rather than achieved? This is quite tangential to the text.
- Are there any negative aspects to this contractual arrangement e.g. inflated prices by Head Contractor? (p.18)

- In our interviews with Housing SA staff, they were consistently positive about this arrangement and considered that it was an effective arrangement and value for money. There is no control program for comparison for costing of works so inflation of costing is possible but not an expressed concern of government in this case.

- Any quantitative data on these items? Frequency? (p.18)

- Our partners indicated their preference to not include data of this kind in this study. Discourse on remote Indigenous housing dysfunction regularly highlights housing hardware failures as the fault of Indigenous tenants. Consideration of the rates of failure for specific hardware, such as stoves, requires more detailed examination of the factors underpinning design and procurement decisions, which are informed by issues with legacy housing (what fits?), tenant preference (what is desired?), and availability (what can be purchased, or manufactured for a small run?), as well as the social context (such as issues with energy security, disconnection, and the use of stoves as heating devices, accelerating their failure).

- A more detailed discussion on the nature of these problems would be in order to understand the unique nature of remote living and design challenges. (p.19)

- We have identified remoteness where it is a factor impacting on program delivery and added citations to relevant literature throughout the article.

- Who is this cohort of interviewees? Tenants? (p.19)

- This is clarified above.

- Any recommendation on this problem? (p.20)

- Sentence added to clarify the impact of proactive investigation of housing failures through tenancy services.

- Please add comment on lack of response to Dust category. Is there a need to incorporate a recommendation here? Does any response happen by other agencies? (p.21)

- This is a minor issues that we don't consider this requires further explanation for space reasons.

- This table is not in this manuscript! Please add. (p.21/Table 6)

- Table 6 added to submission.

- Say why buffel grass is relevant to health! What is the point of the argument here? How does it reduce yard utility? (p.22)

- Sentence rewritten for clarity. Measures to reduce crowding are relevant to improved health outcomes. Reference added.

- I suggest a footnote or additional sentence in the text to explain this 'loaded' phrase to the reader. (p.23)

- I have added another reference here about the history of Indigenous housing policy in Australia, which emphasises how 'politics' and the short-termism of political cycles undermines sustained attention and funding of remote housing.

- Perhaps comment on the necessity for a regional scale of operation to achieve economic and resource sustainability. Promote as a regional approach for different remote cultural blocs. (p.24)

- Added a sentence to make this point.

- I suggest re-phrasing this sentence to make it stronger as a concluding point and to build better off the introduction on 'sustainability'. (p.25)

- Sentence rewritten to clarify argument about sustainability discourse being made.

- Map is too detailed and complex. Suggest a simplified schematic map to illustrate key analytic points. (p.33/Figure 1)

- New map from Regional Anangu Services Aboriginal Corporation found.

- What is year? Time context please. (Table 1)

- Year added

- Add last row at end of table. Include: Totals of each column and Average kilometres.

Is it worth including a column:- "Are no. of people per home if assumed hypothtical equal distribution'. And discuss. (Table 2)

- Row and information added

- Explain context better of where this budget spent. (Table 2)
  - Title amended to clarify context
- For [x] properties in APY lands. (Table 3)
  - Title amended to clarify context
- (Numbers of housng units = ...) (Table 4)
  - Title amended to clarify number of houses
- Insert totals for Average per house. (Table 4)
  - Row and figures added.
- Jobs (Table 5)
  - Title amended

We thank you for your consideration of this submission and look forward to hearing back from you.