



International  
Specialised  
Skills  
Institute



# BUILDING WITH EARTH

IN REMOTE ARID REGIONS

An International Specialised Skills Institute  
Fellowship.

**CLARE KENNEDY**

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# i. ACKNOWLEDGEMENTS

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The Fellow would like to thank the following individuals and organisations who generously gave their time and their expertise to assist, advise and guide her throughout her George Alexander Foundation Fellowship.

## Awarding Body – International Specialised Skills Institute (ISS Institute)

The ISS Institute exists to foster an aspirational, skilled and smart Australia by cultivating the mastery and knowledge of talented Australians through international research Fellowships.

The International Specialised Skills Institute (ISS Institute) is proud of its heritage. The organisation was founded over 25 years ago by Sir James Gobbo AC CVO QC, former Governor of Victoria, to encourage investment in the development of Australia's specialised skills. Its international Fellowship program supports a large number of Australians and international leaders across a broad cross-section of industries to undertake applied research that will benefit economic development through vocational training, industry innovation and advancement. To date, over 350 Australian and international Fellows have undertaken Fellowships facilitated through ISS Institute. The program encourages mutual and shared learning, leadership and communities of practice.

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- » Preparing a detailed report for distribution to government departments, industry and educational institutions
- » Recommending improvements to accredited educational courses
- » Delivering training activities including workshops, conferences and forums.

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The Fellow sincerely thanks The George Alexander Foundation for providing funding support for the ISS Institute and for this Fellowship. In 1972, George Alexander AM (1910 - 2008) set up an independent philanthropic Foundation as a way of sharing his wealth and giving back to the community. Today, the main focus of The George Alexander Foundation is access to education for promising young people, particularly students with financial need and those from rural and remote areas.

The George Alexander Foundation (GAF) Scholarship and Fellowship Programs form the core of the foundation's work, operating in partnership with major tertiary institutions, while our Fellowships and other Education grants provide a variety of other unique and challenging educational experiences. George Alexander believed in the notion of 'planting seeds and hoping they grow into pretty big trees'. The programs supported by the Foundation endeavour to support this ideal and as GAF students graduate and go on to contribute to the community, George's legacy and spirit lives on through their achievements. George Alexander came to Australia as a child migrant, and went on to become a mechanic, an entrepreneur and a businessman and later, a generous philanthropist, who held that you do not own the possessions you have, 'you're just minding them'. This philosophy guided him to give during his lifetime and to hope that through his example, he might inspire others to do the same.

## Personal Acknowledgements

The fellow would like to personally acknowledge the following people for their assistance over the course of this fellowship

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- » Mark Goldman for taking care of us in Taos

# 1. EXECUTIVE SUMMARY

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Thousands of Australians live in the remote arid regions that make up two thirds of this country. In these places there are limited materials with which to build, labour is difficult to source and maintaining housing is difficult to manage. Unlike those of us living near the coast, this arid population has little choice when it comes to their type of housing. They are reliant on imported materials and building systems which often do not suit their place, its climate or their culture.

This fellowship explores the possibility of using commonly found locally available materials - namely earth and stone - to build in arid regions. In similar climate zones overseas, particularly the south-west region of the USA where this fellowship took place, there is a variety of low skill simple methods of building to suit desert extremes. These methods are under utilised in Australia. So popular are these forms of construction in the US that dotted across the entire region are different earth building research organisations dedicated to finding suitable forms of housing for those living in the surrounding areas.

The fellow, Clare Kennedy, is an Australian architect specialising in the use of local materials in construction. Her Brisbane based practice - Five Mile Radius - researches, prototypes and builds using different indigenous Australian resources. The practice is testing the environmental, cultural, social and economic impacts of this approach, believing that as we go forward we need to find more localised, and culturally appropriate ways of building that work for our diverse Australian climate.

During September and October of 2017, Clare spent 6 weeks touring California, Arizona, Utah, New Mexico and Texas researching their earth construction culture. Her trip began with a 1 week course at the California Earth Institute and finished in Santa Fe at America's annual earth construction conference - Earth

USA. Alongside this Clare visited exemplary pieces of earthen architecture and visited earthen research organisations, university departments and architectural specialist practices. Her research was broken down into three major categories:-

- » earthen organisations,
- » earthen materials and techniques, and
- » earthen passive design principles.

Clare learned that there are material techniques available applicable here in Australia to instigate more localised forms of construction suitable to our arid climate zones. Rammed earth, adobe brick, rock masonry and earthen paints have all been used to great effect abroad, and the earthen organisations that advocate for these construction systems offer support to ensure their continuation. For this reason, alongside purely material research, Clare's fellowship looked at the workings of these American earthen organisations, gaining an understanding of the business structure and funding strategies that helps to keep them operational.

Following the USA fellowship Clare is now sharing her findings through speaking engagements as well as the publication of a book and an article to accompany this report. She intends to build prototype buildings in Australian deserts that will reference the findings of this fellowship, while growing Five Mile Radius into a larger organisation for researching available Australian construction materials similar to those organisations visited during her time in America.

## 2. FELLOWSHIP BACKGROUND

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### 2.1 Aim of the Fellowship.

The aim of this fellowship was to study methods of low skill, low cost construction in the Southwest deserts of the United States that could be of use in parts of Australia with a similar climate. Clare will use the findings of this fellowship to test and promote the suitability of forms of construction observed in the US for an Australian context.

The region of the USA to which Clare traveled is known for:-

- » Sustainable earthen architecture built from local mineral resources.
- » Climatically appropriate design suited to the desert/arid climate.
- » Ancient and historic earthen villages.
- » Exemplary, innovative, environmentally focused architectural practices.
- » World-class contemporary examples of earthen architecture.
- » Leading institutes for earth construction research.
- » Hands on training facilities and workshops.

### 2.2 Fellowship Methodology.

The fellowship took place over a 6-week period with Clare completing -

- » Workshops with Cal Earth Institute in California and Adobe Alliance in Texas.
- » Guided tours of earth and masonry buildings in New Mexico, Utah, Arizona, California and Texas.

- » Formal meetings with prominent architects including Rick Joy Architects and Robert Vint in Tucson.
- » Meetings with Arizona State and Utah University architecture staff.
- » Earth USA - a 4-day earthen conference in Santa Fe.

Clare collected information in three categories

- » The operation of earthen organisations.
- » Different building materials and techniques.
- » Desert environmental design principles.

### 2.3 Timing of the Fellowship.

Clare travelled for 6 weeks in September and October 2017.

### 2.4 Fellow Biography.

Clare is a Queensland based registered Architect and founder of the architectural practice - Five Mile Radius. Clare's work involves the use of locally available materials in construction - developing forms of Australian architecture that respond to our varied climate and resources. The growing practice designs, researches and builds using locally sourced resources and looking for ways to lower the environmental impact of building while offering more meaningful healthy structures for local communities. Clare is a lecturer with the Queensland University

of Technology, a committee member for the Earth Building Association of Australia and an active member of the architectural community in Brisbane.

## Clare Kennedy Bio.

### Qualifications:

- » Board of Architects Queensland (2017) Registered Architect 5237.
- » Masters of Architecture (2012) - QUT Brisbane.
- » Spring Semester Programme (High Distinction) (2011) - Architectural Association London.
- » Bachelor of Design – Architectural Studies (2010) - QUT Brisbane.

### Roles:

- » Five Mile Radius (2015) - Founding Director.
- » Queensland University of Technology (2017-2018) Masters of Architectural - Design Tutor.
- » Architectural Association School of Architectural (2017) Visiting School - Design Tutor, Bangalore, India.
- » Kent School of Architecture (2015) Assistant Lecturer - Canterbury. UK.
- » Designer with various practices including Sangath Institute, Buro Two Architects & CRAB studio.

### Awards, Exhibitions and Publications:-

- » Expanded Discrete States (2018) - Artisans' Gallery, Brisbane.
- » Art In Soil POP Gallery - Brisbane (2017).
- » Disappearing Dialogues - Biknar House, Delhi, India.

- » The Apprenticeship (2016) - Artisans' Gallery, Brisbane.
- » Indian Dirt. (2016) - Garland Magazine.
- » Using what you have. (2016) - The Natural Artisan.
- » Artisanal brick making with Clare Elizabeth Kennedy (2016) - Artisans' Magazine.
- » Brisbane made bricks (2016) - Local Creativity curated by Owen Architecture, Brisbane.
- » Natural Architectural Screens (2016) - The Shape of Things to Come Exhibition, QUT Brisbane.
- » Laurie Baker Brick Genius (2015) - More Margie.
- » Sangath; A Day in the Life of B.V. Doshi's Studio and Garden (2015) - More Margie.



*Clare Kennedy with colleague Tom O'Shea at the Grand Canyon in Arizona, an area renowned for innovative low skill masonry construction.*

## 3. AUSTRALIAN SITUATION

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### 3.1 Current Australian Condition.

Two thirds of Australia is climatically classed as desert/arid. Communities in these remote regions rely heavily on imported construction materials and labour to create their housing. These imported construction methods are often not suited to the extremes of climate or to the social or cultural patterns of the communities for which they are built. The structures are often difficult to customise, hard to maintain and reliant on mechanical systems for heating and cooling. In Australia's deserts our current architectural models are well behind those of other countries.

One solution to this issue could be using locally sourced resources for building. Earth - a material widely available in many remote regions - can be utilised in a number of ways, depending on the type of earth present and the climatic conditions of the site. In many countries, particularly the US, earth is widely recognised as a low cost, low skill, healthy, environmentally friendly and culturally appropriate building material. As yet in Australia we do not have adequate research organisations undergoing prototype projects to foster the widespread use of this resource.

### 3.2 Strength, Weaknesses, Opportunities and Threats.

Below is a SWOT analysis of the potential impacts of using local materials (namely earth) in constructing remote housing in Australia.

#### **Strengths**

- » Resource availability.
- » Qualified designers.
- » Industry interest and support.
- » Potential for innovative forms of housing construction.
- » Environmentally friendly.
- » Low Cost.

#### **Weaknesses**

- » Isolated geographic locations.
- » Lack of knowledge.
- » Lack of historic precedent.
- » Climate extremes.
- » Labour costs / issues.

## Opportunities

- » Potential university engagement.
- » Expand on current trends into eco housing.
- » Volunteer participation in learning new skills.
- » Appropriate resources available.

## Threats

- » Build costs.
- » Climatic extremes.
- » Industry pessimism.
- » Imported materials.
- » Feasibility.
- » Building Code issues.

## 3.3 Skill Enhancement Identification.

Clare's fellowship research focused on three main areas:-

- » Earthen organisations - how do US businesses specialising in earthen construction operate?
- » Materials and techniques - what types of building materials are appropriate and utilised in US desert climates and how are these prepared and constructed?
- » Environmental design - how does earthen architecture in the US deserts respond to local climatic and environmental conditions.

## 4. SKILLS ENHANCEMENT & KNOWLEDGE ACQUISITION AREAS.

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### Skill Enhancement 1 - Earthen organisations.

How do organisations specialising in earthen construction operate?.

Analyse:-

- » Organisational structure.
- » Organisation aims.
- » Organisational foundation.
- » Premise and operations.
- » Funding strategies.

Action:-

- » Visit earthen organisations and discuss structures.
- » Research online content relating to organisations.

### Skill Enhancement 2 - Materials and techniques.

What types of building materials are used in desert climates and how are these prepared and constructed?

Study areas include -

- » Materials and structure.
- » Building skill requirements.
- » Material and labour costs.
- » Material durability and maintenance.
- » Planning and spatial organisation.
- » Economic impact.
- » Cultural value.
- » Health and Wellbeing.
- » Customisation.

Action:-

- » Visit and document key projects.
- » Speak with architects and historical organisations.
- » Complete workshops / conferences.

## Skill Enhancement 3 - Environmental design.

How does earthen architecture respond to local climatic and environmental conditions including:-

- » Material life cycle considerations.
- » Passive ventilation.
- » Thermal Mass.
- » Shading.
- » Evaporative cooling.

Action:-

- » Visit and document key projects.
- » Speak with architects and historical organisations.
- » Complete workshops / conferences.

## 5. INTERNATIONAL EXPERIENCE AND DISCOVERY.

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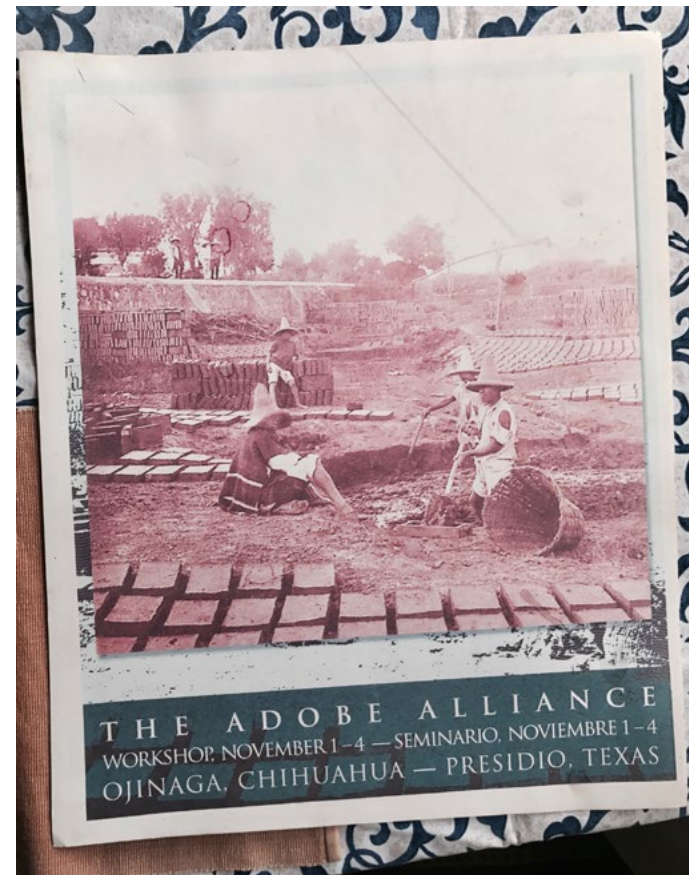
### Skill Enhancement 1 - Earthen organisations.

#### **Organisational structure.**

A total of 7 organisations as well as one conference dedicated to forms of earth construction were visited. These organisations generally exhibited one of two business structures, operating either as a stand alone non-profit organisation or a specialised program from within a university department. Both these situations place some limitations on the organisation, and this could impede the financial capacity of the organisations to grow, expand their research and compete with other more commercial building enterprises.

#### **Organisational aims.**

The aims/objectives of the various institutes varied, however they all had in common the desired use of local materials in construction. Other aims included exploration in low cost housing; building responses to desert climate; connections to landscape; and the economic impact and advantages of using local labour and materials. Another key focus was methods of preserving historic building techniques through the continued use of traditional methodologies.



*The Adobe Alliance is a non-profit organisation founded to promote and teach adobe brick making in Presidio, Texas where the knowledge of previous generations is under threat.*

## Organisation foundation.

Interestingly most of the organisations visited were founded by a single visionary who inspired a group of people with their ideologies and methods. In the case of Cal Earth in California and Taliesin West in Arizona the founder has passed away and the organisations are now run by like-minded people operating under the same ethical and operational guidelines. Cal Earth was founded by Iranian earthbag expert Nader Khalili. Renowned architect Frank Lloyd Wright formed Taliesin West as a school to teach students, among other things, methods of responding to desert climates. The Earthship Academy in New Mexico was formed by Mike Reynolds, known world wide for his Earthship buildings.

## Premise and operations.

All of the earthen organisations visited had a physical headquarters showcasing the building techniques explored. Often these were in remote locations and have become well known tourist destinations within the surrounding region. These centres included display structures, information centres, workshop spaces, sleeping spaces for students, community spaces, staff offices and gift shops. They were often both places for ongoing research and design work as well as places for the public to visit and students to come and learn new techniques. At times it seemed that maintaining these remote locations had become difficult and tiring for staff, draining resources from the organisations core imperative.



*Cal Earth runs monthly open days at their headquarters in Hesperia California, inviting the public to tour display houses, take part in building workshops or speak with design consultants about potential projects.*

### Funding strategies.

Funding for the organisations varied. Educational institutions such as Design Build Bluff in Utah and Taliesin West in Arizona receive funding from universities from tuition and grants. Though usually reliable as a source of income, this situation can sometimes put pressure and limitations on the scope of work of the organisation. Educational programs provided a portion of the funding for private non-profit organisations. Cal Earth and the Earthship Academy both hold private workshops and sell guides relating to their respective techniques. Other sources of consistent income include public building tours, membership fees and conference tickets.

Less reliable forms of income come from professional fees for design services, and grants and donations for ongoing research. Across all the organisations visited there was a sense that repeated workshops, although good for stable income, became tiring for staff who were more committed to researching new techniques.



## Skill Enhancement 2 - Materials and techniques.

### Materials and structure.

Below is a table of the major materials and structural systems used in the buildings visited.

Building	Local Materials	Structure
Cal Earth	Earth filled sand bags, chicken wire, fired bricks.	Laid in courses to form a vault or dome.
Mary Coulter Buildings	Rock masonry, timber beams, rasses.	Stacked masonry. Timber roof covered with grasses.
Taliesin West.	Rock masonry, cement.	Rock and cement cast in formwork.
Noah Purifoy Museum.	Recycled waste materials.	Different compositions from found recycled materials.
Earthship Academy.	Rammed earth, car tires.	House built below ground using earth rammed into car tires to form a retaining wall. Green roof above.
Simone Swann House.	Adobe brick, mud mortar, mud render, local organic matter.	Stacked adobe brick with mud mortar and a vaulted roof.

Image left: Design Build Bluff in Utah operates under the University of Utah's architecture faculty. Each year students from the school travel to Bluff to build a home for a member of the community. Janet, pictured here with program coordinator Arsushi Yamaoto, had her house built by students using earth and recycled materials.

Building	Local Materials	Structure
Taos Pueblos.	Adobe brick, mud render, local organic matter, timber beams.	Stacked adobe brick with mud mortar and a timber roof structure covered with mud and grasses.
Cliff Dwellings.	Rock masonry, mud mortar.	Stacked masonry with mud mortar.
Design Build - Bluff.	Rammed earth, recycled materials.	Rammed earth wall, recycled steel overhead roof.



Ancient Cliff Dwellings in Utah made from rock masonry and mud mortar.



The rock masonry made from local stone and cement at Taliesin West.



Adobe brick vaults made from local materials at the Simone Swan house in Presidio Texas.

### **Building skill requirements.**

All of the buildings visited had relatively simple construction methods. Cal Earth's earthbag domes can be built by one or two unskilled people. Adobe bricks can be made onsite by small teams using limited machinery. The rock masonry used at Taliesin West was designed to be quick to construct.

More difficult tasks, such as testing earth mixtures or designing roof structures, often require the initial input of a more highly skilled professional able to educate others in the community. Generally speaking organisations promoting earth construction offered hands-on courses in their building techniques as well as literature explaining the processes. These organisations are without exception keen to share their techniques with others, believing that such low skill low cost forms of housing should be available to all.



Cal Earth's technique of laying sacks of dry earth to form a domed structure was developed as disaster relief housing. This technique is very quick to learn and structurally robust.



*The Adobe Alliance in Texas runs brickmaking workshops from their learning center in Marfa.*

### **Material and Labour costs.**

Low skill construction techniques using local materials such as earth or stone generally require plenty of physical labour such as harvesting and processing earth, forming bricks or ramming walls. Material costs however are reasonably low and so it is usually the preferred form of construction for owner builders who are looking for low cost housing solutions. Some earth organisations in the US offer machinery for hire or sale which can help to lower labour costs, and this becomes especially advantageous when entire communities are looking to build using the same construction technique.

### **Material durability and maintenance.**

All buildings require maintenance, and one of the benefits of using a local material in construction is the relative ease of repair and maintenance as required. In remote locations it can be difficult to obtain and maintain imported materials so locally sourced building materials provide the best option. Building owners need ready access to educational literature, tools and trades that can assist with their ongoing maintenance.

When choosing the best form of construction for a specific climate it is imperative to consider durability. For instance in California's seismic zone, Cal Earth advocates for domed structures that can withstand severe earthquakes. In other areas, where there is more rain or water run off, earth buildings are built on high brick or stone plinths to prevent ground water infiltrating the structure.

### **Planning and spatial organisation.**

Another benefit of a low skill, low cost construction is the ability for different cultural groups to plan their own settlements and create spatial arrangements that depart from more standardised ideas of urban planning.

In places such as Cal Earth houses are clustered around central

*In Tucson, Arizona adobe brick buildings are traditionally lifted on an stone plinth, protecting the adobe from running water.*



courtyards, allowing families to come together in outdoor areas then retreat to their more private interior spaces. In Taos Pueblo houses have developed over three levels, allowing all within to share a common outlook. Cliff dwellings in Utah are built into cliffs providing both shelter and security to the inhabitants. Not all cultural communities thrive in conventionally planned settlements, and using local materials help to provide the capacity for a community to decide upon their own best fit spatial arrangements.



*Using adobe brick as a primary material, Taos Pueblo developed a town plan based on cultural values, spiritual beliefs and surveillance requirements.*

### **Economic Impact.**

A huge advantage of building with local materials using local labour is the positive economic impact for the surrounding region. In towns such as Santa Fe in New Mexico earth construction is so popular that there is an entire economy based around it. Builders, designers, suppliers, real estate agents, hoteliers and homeowners all value earth construction so highly that it helps to provide a stable economy with profits redistributed locally.

### **Cultural Value.**

When communities use local materials and labour the buildings take on a local style and the community develops a cohesive pride of place. The people are proud of their environment and visitors appreciate this and ask questions about the unique setting. Local materials foster a sense of personal identity. In places such as Taos, New Mexico, so desired are the original low cost Adobe houses that they now sell for considerably more than similarly sized buildings made from more contemporary materials.



*Houses in Taos made from low cost Adobe brick have become the most desirable and fashionable form of construction.*

### **Customisation.**

Low skill, low cost forms of construction give homeowners an opportunity to personalise the designs themselves. Often you can see examples of occupants crafting embellishments or motifs on their walls, or adapting floor plans to suit individual family arrangements. This customisation, when there is little variety available in affordable commercial building solutions, creates interest, pride and self worth within remote communities.



*At Cal Earth each building is customised using earth and wall paints made from local clay.*

## Health and Wellbeing.

Building with natural materials, like earth, stone and timber has a positive impact on the health and wellbeing of a building's occupants. Earth and masonry do not create any harmful air pollutants, unlike paint and other forms of commercial composite materials. Mud is often mixed with other natural materials such as cow dung or plant fibers to enhance its antibacterial properties. The psychological benefit of living in a building connected to the landscape is easy to observe, and in towns such as Marfa or Santa Fe, the real estate and tourism industries often market their adobe brick homes as healthy homes, great for both the physical and mental wellbeing of occupants.

*Made entirely from local clay, the Simone Swan house is a healthy, breathable structure with a material connection to its landscape and place.*



## Skill Enhancement 3 - Environmental Design.

### Material life cycle considerations.

Natural building materials are often easy to recycle when deconstructing a building, or they can simply be returned to the land from whence they came. This awareness of the full life cycle of a material from its source to its end use is an increasingly popular component of a sustainable building approach.

Using earth and other locally sourced building materials also reduces the final embodied energy of a building which is otherwise increased as a result of transporting commercial building materials to the site, and the intensive manufacturing processes involved in these commercial materials. Greenhouse gas emissions released during construction are concomitantly reduced, and negligible.

### Passive Ventilation.

Climatic extremes of desert living require well ventilated buildings that encourage air flow even when there is little wind outside. Air conditioning is costly to run and often remote communities are not linked to a major power source. Natural ventilation is crucial for the occupants' comfort. Interesting strategies were observed at Cal Earth where low openings captured incoming air which then rises within the structure to escape out of high level openings. This system creates a constant exchange of air in the interior spaces reducing heat and removing stagnant air. Other strategies observed were even simpler. At the Simone Swan House in Presidio Texas, vaulted ceilings were tremendously high allowing hot air to rise leaving a layer of cooler air below.



*At Cal Earth, structures are designed to allow breeze to enter the interior through low openings. This warm air then rises internally and escapes through high openings creating constant air flow within the space.*

## **Thermal Mass.**

Earth can be used to keep a building cool without the need for air conditioning. Earth and stone can have high thermal mass, meaning they hold the ambient atmospheric temperature for a long time. With the correct orientation and roof overhang you allow winter sun to directly fall onto mud and stone surfaces, heating them up during the day so that they release that heat at night and keep the space warm. Conversely, in summer, using orientation, screens and roof overhangs helps to screen buildings from the hot sun so the mud and stone can retain some of their cooler overnight temperature.



*The recycled iron roof of this house by Design Build Bluff in Utah keeps the sun off the rammed earth structure below. The earth stays cool despite the extreme desert temperatures which moderates the home's internal temperature.*

## Shading.

In desert environments the provision of outdoor shaded space away from extreme direct sun is crucial. Screens can be made from smaller plant varieties or from recycled materials. These are often community gathering spaces for use during the day.



*Artist Noah Purifoy has created a series of desert shade structures using found materials from the desert.*

## Evaporative cooling.

Water and plants help keep spaces passively cool. This was particularly evident at Earthship Academy where a greenhouse ran the length of the structure. Recycled water is misted onto the plants promoting their growth while causing evaporative cooling of the building's internal environments. In Taliesin West Frank Lloyd Wright placed ponds and pools near window openings for the same reason. Air is cooled as it crosses over the waterbody and enters the space. The relaxation benefits of enjoying the planting further enhances the occupants' comfort.



*Greenhouses within the buildings at the Earthship Academy keep interior spaces cool by evaporative cooling of the space.*

## 6. CONSIDERATIONS AND RECOMMENDATIONS

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Considerations and recommendations are listed in point form with respect to each skill enhancement area.

### Earthen Organisations.

In Australia we have a great need for centres for earthen construction, and we can learn a great deal from analysing the successes and difficulties faced by organisations in America.

- » Business Structure: Non-profit and university structures can place limitations on growth and expansion of a business. Instead consider establishing new Australian organisations as social enterprises, able to generate a profit, but with a responsible agenda. Funding is key to an organisation's success, and non-profit and university based business structures seemed, at times, to limit the potential growth of an organisation by reducing its appeal to potential business investors.
- » Staff satisfaction: Repeated educational programs such as hands-on workshops, though important, become tiring for staff. Instead methods of concurrently disseminating information should be sought - such as video and online content - that can reach wider audiences. Organisations must have time to continue researching and testing new forms of building. Repeated workshops which simply rehash outdated research should be discouraged.
- » Leadership: Organisations need to survive changes in leadership and develop freely rather than with a narrow reliance on the vision of a single founder alone. Diverse forms of collaboration between like-minded people need to be fostered in order to share both research findings and responsibility.
- » Physical Headquarters: Physical headquarters accessible to the public must be easy for staff to manage and maintain. Display buildings are a very successful form of generating public engagement, and these should be encouraged. The headquarters should also be considered as a tourist destination, with a positive impact on the surrounding region.

### Materials and techniques.

From the diverse range of buildings and organisations visited it is possible to deduce a list of building aims and objectives that could be used by Australian designers to create successful forms of remote housing here. These design aims include:-

- » Use local materials where possible.
- » Favour simple, low skill construction techniques.
- » Consider appropriate structural systems based on locally available materials and climatic conditions.
- » Consider the labour required, and where labour isn't readily available consider sourcing simple machinery to assist.
- » Design for durability.
- » Educate all members of the community on building maintenance.
- » Provide opportunity for locals to make individual design decisions.
- » Allow for non-conventional urban planning arrangements.
- » Analyse the potential positive economic impact of using local materials and skills.

- » Foster community pride by allowing for the development of unique settlements using local materials.
- » Promote healthy buildings that breathe and are connected to the land.

### **Environmental Design.**

The following is a list of key design principles relating to environmental design, climate control and sustainability as discovered on the fellowship.

- » Consider the full life span of materials used, including the environmental impact of their harvesting and their disposal.
- » Design for passive ventilation at all times of the year. ALL interior spaces need natural ventilation.
- » Do not rely on mechanical heating or cooling systems.
- » Design and orientate correctly for thermal mass opportunities taking into consideration daily and annual sun migration patterns. Site masonry in places that receive winter sun but will be shaded from summer sun.
- » Provide adequate outdoor shading using lightweight (preferably ventilated) natural or recycled materials.
- » Consider including plants or ponds in places to provide evaporative cooling for internal spaces.

# 7. KNOWLEDGE TRANSFER AND DISSEMINATION.

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The following is a list of intended dissemination methods following the fellowship:-

## Short Term

- » Public lectures on fellowship outcomes to be given at Queensland University of Technology; Foolsap Studio Melbourne; Earth Building Association of Australia annual conference; and Five Mile Radius' quarterly events.
- » Production of a short book of images from the trip with captions relating to design principles discovered. This will be released through Clare's organisation Five Mile Radius and sold online as a means of helping to fund research into new forms of building.
- » An article written by Clare for Australian architectural media (publication TBA) outlining the fellowship's findings with key information.

## Longer term

- » The fellow will initiate the construction of prototype projects in Australian deserts using materials explored through Clare's practice Five Mile Radius. The aim of these projects is to uncover, test and promote new forms of desert living. These prototype projects will examine the use of
  - » The use of earth building in desert regions
  - » Low skill building techniques and education
  - » Maintenance and durability in remote Australia
  - » Building code relating to earth construction in Australia

- » Passive ventilation and cooling strategies in extreme environments
- » New space planning models suited to cultural patterns and community building
- » Consultation with local community groups and government organisations on types of housing suited to remote regions, with a view to creating new models. Across Australia there are a number of housing organisations that examine different forms of desert occupation. The fellow aims to actively seek out these organisations, sharing the findings of this fellowship and looking for partnerships that might assist in new models of housing.
- » Assist in, and advocate for, the development of a local material institute in Australia. The fellow plans to develop her organisation Five Mile Radius to become a hands on, collaborative research center for local materials in Australian building including earth. The activities of this institute are modeled on overseas institutes visited by the fellow on this fellowship and on previous trips abroad.

## 8. REFERENCES – Reading List

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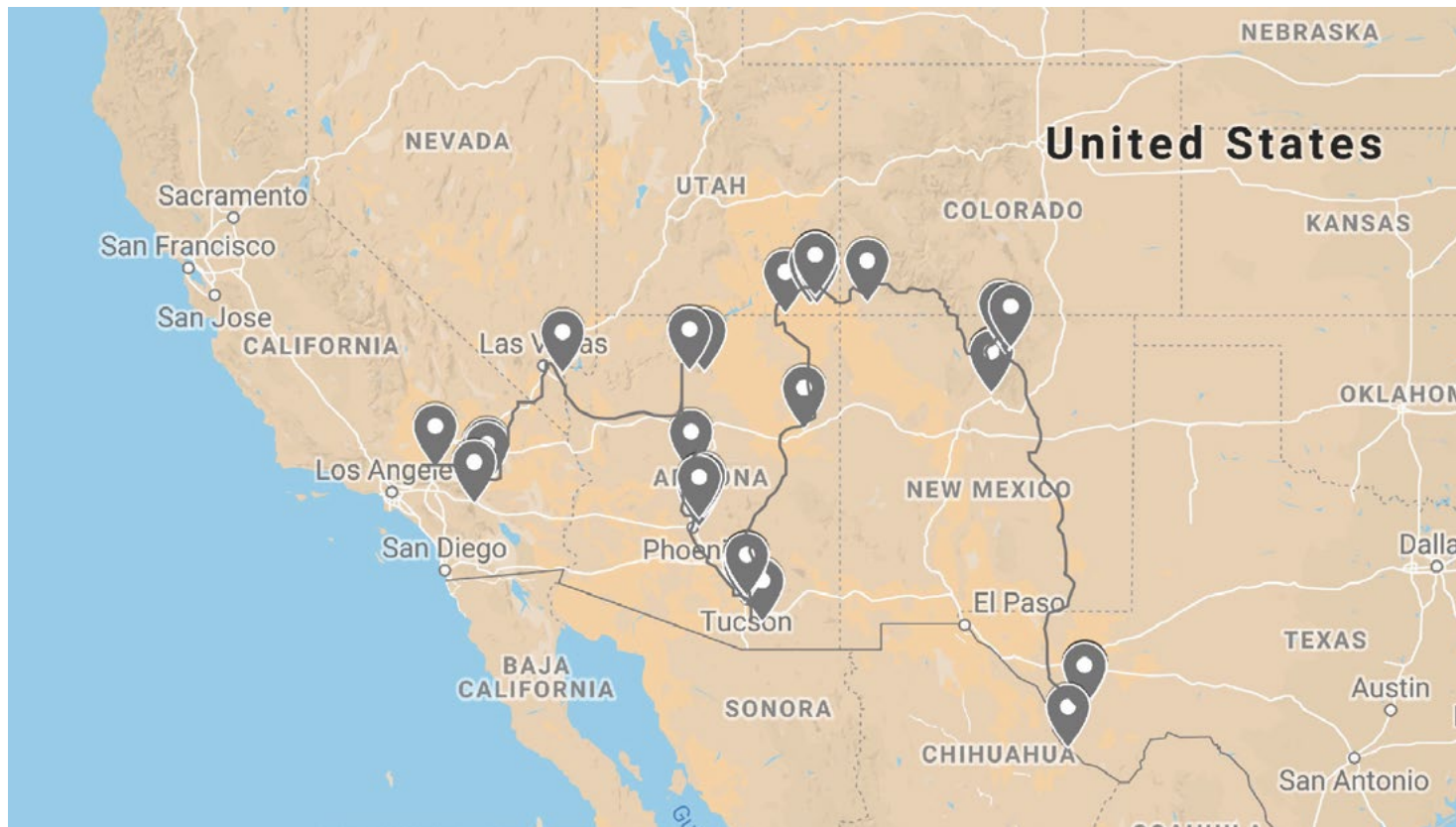
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## 9. APPENDICES




### Appendix 1 - Itinerary of fellowship.

Please find below a list of places visited by the fellow including the activities undertaken at each destination.



Map of route.

No.	What	Where	About	Activity	
1	Cal-Earth Institute	Hesperia, California	Earth building institute specialising in superadobe	Workshop - Architectural ceramics	
2	Institute of Mentalphysics	Joshua Tree, California	Rock masonry campus by Frank Lloyd Wright	Photo documentation	
3	Noah Purifoy Outdoor Desert Art Museum	Joshua Tree, California	Outdoor museum of sculptures made from waste	Photo documentation and research	

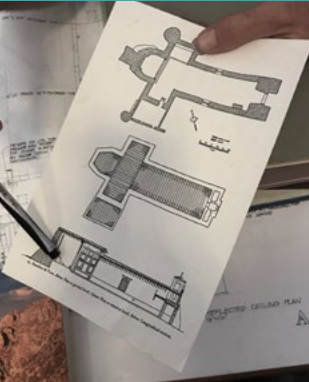


4	Andrea Zittel Planar Pavillons	Joshua Tree, California	Sculptural experient into desert living	Photo documentation and research	
5	Palm Springs Art Museum	Palm Springs, California	Art Museum with native american craft	Photo documentation	
6	Hoover Dam	Hoover Dam, Nervada	Art deco dam	Photo documentation	




7	Mary Coulter Desert Watchtower	Grand Canyon, Nevada	1932 stone building informed by native american indian culture	Photo documentation and research	
8	Mary Coulter Hopi House	Grand Canyon, Nevada	1905 stone building informed by native american indian culture	Photo documentation and research	
9	Mary Coulter Lookout Studio	Grand Canyon, Nevada	1914 stone building informed by native american indian culture	Photo documentation and research	

10	Arcosanti	Prescot, Nevada	Concrete utopian settlement begun by Paolo Soleri	Photo documentation and research	
11	Arizona State Art Museum	Phoenix, Arizona	Antoine Predock university building	Photo documentation	
12	Taliesin West	Scottsdale, Arizona	Frank Lloyd Wright architecture school	Photo documentation and research	

13	Crosanti Originals	Phoenix, Arizona	Phoenix branch of Arcosanti	Photo documentation and research	
14	Sustainable Built Environments at the University of Arizona	Tucson, Arizona	University building using sustainable design principles	Photo documentation and tour	
15	Rick Joy and Associates	Tucson, Arizona	Workplace of Rick Joy and Associates	Photo documentation and office tour	




16	Empire Ranch	Pima County, Arizona	Adobe brick ranch under restoration	Photo documentation and conversation	
17	San Xavier del Bec Mission	Tucson, Arizona	1797 adobe church	Photo documentation	
18	La Casa Cordova	Tucson, Arizona	Oldest adobe home in downtown Tucson	Photo documentation and research	

19	Bob Vint and Associates	Tucson, Arizona	Office of architect Bob Vint, adobe heritage specialist	Meeting	
20	Mary Coulter Painted Desert Inn	Petrified Forest National Park, Arizona	National park centre	Photo documentation	
21	Monument Valley	Monument Valley, Utah	Monument in the Navajo Nation Reservation	Photo documentation	




22	Design Build Bluff	Bluff, Utah	Design and build school under The University of Utah's College of Architecture + Planning department	Photo documentation, research and presentation	
23	Janet's house	Bluff, Utah	Student project by Design Build Bluff	Photo documentation and research	
24	Cliff Dwelling in Bluff	Bluff, Utah	Ancestral Puebloan cliff dwelling	Photo documentation	



25	Rammed Earth house	Bluff, Utah	Student project by Design Build Bluff	Photo documentation and research	
26	Cow Canyon Trading Post	Bluff, Utah	Store and gallery	Photo documentation	
27	Bluff Fort	Bluff, Utah	Museum featuring traditional building techniques	Photo documentation	

28	Cliff Dwellings Mesa Verde	Mesa Verde, Colorado	Ancestral Puebloan cliff dwellings	Photo documentation and research	
29	Santa Fe Townscape	Santa Fe, New Mexico	Adobe and stucco townscape	Photo documentation and research	
30	Earth USA annual conference	Santa Fe, New Mexico	3 day earth building conference	Photo documentation, lectures and research.	

31	San Francisco De Asis Church	Taos, New Mexico	1772 Spanish Mission Church painted by Georgia O'Keeffe	Photo documentation and research	
32	Taos Townscape	Taos, New Mexico	Adobe and stucco townscape	Photo documentation and research	
33	Taos workshop with Mark Goldman	Taos, New Mexico	Design build school for adobe low tech environmental design	Presentation	

34	Earthship Academy	Taos, New Mexico	Earthship display and training centre initiated by Mike Reynolds	Photo documentation and research	
35	Taos Pueblo	Taos, New Mexico	Adobe Pueblo of the ancient Pueblo people	Photo documentation and research	
36	Tierra Sangre Oro at Marfa Ballroom	Marfa, Texas	Exhibition on Adobe by Rafa Esparza including Sandro Canovas	Photo documentation and discussion	

37	Adobe Alliance	Marfa, Texas	Workshop space of foundation for equitable housing using earth with Sandro Canovas	Photo documentation and discussion	
38	Marfa Townscape	Marfa, Texas	Adobe townscape	Photo documentation	
39	El Cosmico	Marfa, Texas	Outdoor bathrooms by Design Build Adventure	Photo documentation	

40	Chinati Foundation Donald Judd Artwork	Marfa, Texas	Concrete sculpture by Donald Judd	Photo documentation	
41	Simone Swan House	Presidio, Texas	Adobe Vault House	Photo documentation and research	



**ISS Institute**  
Level 1, 189 Faraday Street  
Carlton VIC 3053

**T** 03 9347 4583  
**E** [info@issinstitute.org.au](mailto:info@issinstitute.org.au)  
**W** [www.issinstitute.org.au](http://www.issinstitute.org.au)

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