

Biophilic Design, Regenerative Design, and Equity: An Intersection

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Abstract

This research studies how equity can exist at the intersection of regenerative and biophilic design strategies within an affordable housing model. Regenerative and biophilic design are both human and planet centered models of ethical architectural practice, promoting equity for both. In the three case studies presented, design strategies were examined through the context of Terrapin’s Fourteen Patterns of Biophilic Design as well as the Living Building Challenge design guide for regenerative design. The analysis revealed that equity can operate through place, a Living Building Challenge imperative, as well as through connection to natural systems, a Terrapin pattern. The case studies were selected from three contrasting climates: cold Minneapolis, MN; temperate Santa Monica, CA; and hot El Paso, TX, and each was analyzed in the context of the Living Building Challenge Imperatives ecology of the place, urban agriculture, and energy; as well as the Terrapin Patterns visual connection to nature, material connection to nature, and refuge. Each one proved intricately connected to place by its specific regenerative and biophilic design strategies, as well as honored its respective natural systems. Thus, place and connection to natural systems have the potential to act as conduits to human and planetary equity.

Introduction

As architectural design begins to take a critical look at its ecological impact, there has been a chronological pattern of first mitigating impact, then sustaining a state of zero net loss, and now to regenerating a mistreated ecology. As steps are taken towards regeneration, the Living Building Challenge and Terrapin’s 14 Patterns of Biophilic Design are design guides that have set forth a framework that reconciles design serving the human and the planet. This research will explore design strategies that support a healing ecology that encompasses the planet and all its inhabitants. In order to

delve into this opportunity for design, overlaps will be made to uncover how these design frameworks work concurrently with each other. Three case studies will reveal how biophilic and regenerative design achieve overlaps, through specific design strategies. The case studies were selected from three diverse climates: The Rose Apartments from the cold, harsh climate of Minneapolis, MN; 2602 Broadway Apartments from the temperate climate of Santa Monica, CA; Paisano Green Communities from the hot climate of El Paso, TX. The value of studying architecture’s role in ecological regeneration is that architecture is a cultural, social, and political

discipline – a robust opportunity to create an impact. Such a significant discipline owes itself to a mission so grave as promoting and protecting the planetary ecology.

Regenerative Design

Regenerative design is rooted in the concept of growth, and regrowth. The earth is equipped to regrow, and regenerative design allows such process to occur. Regenerative design aims to restore, renew, and revitalize the integrity of nature, the integrity of humans, and the integrity of humans in nature. It has the potential to achieve this end by acknowledging and responding to throughput flows, cyclical flows, consumption centers, and sinks (Lyle, 1996). Regenerative design is based on an understanding of the inner working of ecosystems that grants opportunity to regenerate rather than deplete underlying life support systems and resources within socio-

ecological wholes (Mang, Reed, 2012).

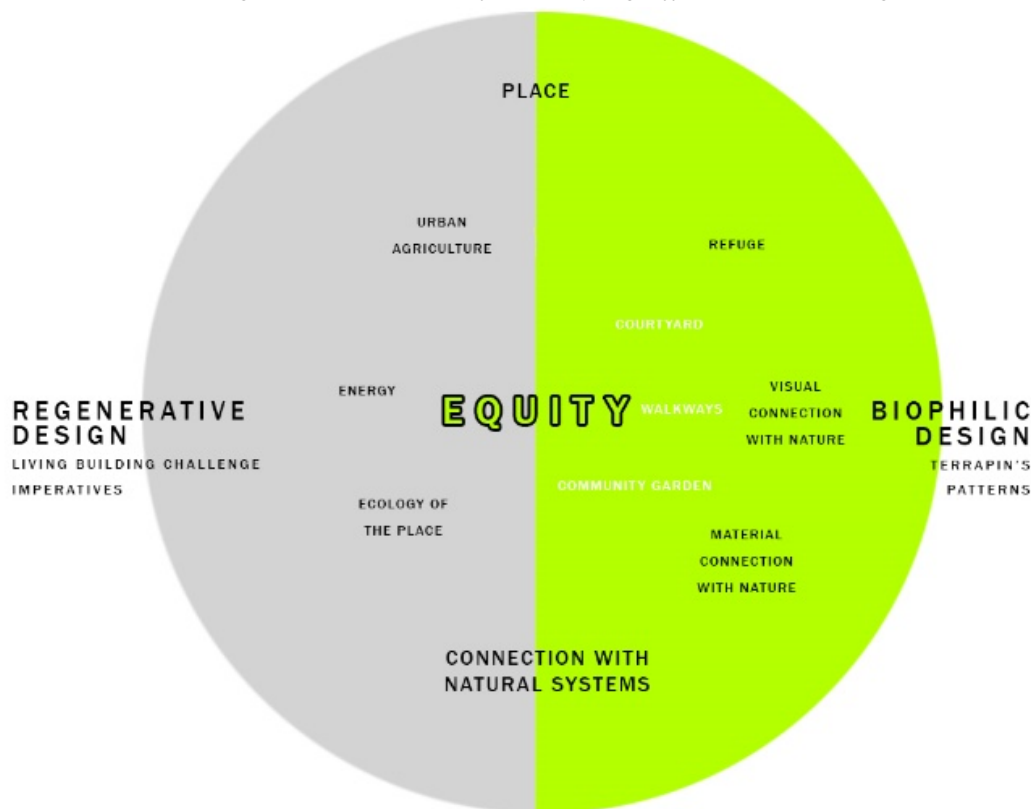
Biophilic Design

Biophilic design honors the hypothesis introduced by EO Wilson that our desire to connect to life and lifelike processes is beneficial to humans and is a part of our very biology. Such design embraces the human nature connection, bringing life in mutuality, respect, and enrichment to the sometimes ambiguous human and natural realms. Biophilic design blurs the line between natural and built. The concept of space becomes a concept of life, and such spaces are inspirational, restorative, and healthy. (Soderlund, 2019; Lewis, 2018; Browning, Ryan, Clancy, 2014).

Definitions

Place: A place is a designed space that exists within natural systems. Upon access, it has the potential to enliven and transform the space into

Figure 1. Framework for Studying Affordable Housing



an environment that supports and promotes the human sense of belonging (Jagannath, 2018). In the context of affordable housing, it is space across numerous scales where historically excluded individuals might feel inclusion and belonging.

Connection to natural systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystems that include humans. (Kellert, Judith, Martin, 2008).

Equity: For affordable housing to be equitable, individuals have access to all the elements of the ecosystem that the design engages in order to sustain themselves physically, mentally, and emotionally. Situated within a niche of the ecosystem that is the building and its context, the building is transformed from a space for residing into a place that rejuvenates.

Methodology

All three multi-family apartment buildings were studied through a regenerative

The Rose Apartments: Summary The Rose is mixed-income affordable housing in Minneapolis, MN with priority to create community through a community garden and courtyard as well as to strive towards net-zero energy use (mnshi, 2014).

Latitude & Longitude:

19.6° N, 99.0° W

Architect:

MSR

design lens and a biophilic design lens. As a metric for regenerative design, the Living Building Challenge was used, as it is the most comprehensive and widely used standard of goals. In particular, the regenerative design imperatives of ecology of the place, urban agriculture, and energy were studied as they apply to the apartments. To examine biophilic design strategies, Terrapin's 14 Patterns of Biophilic Design were used, as these patterns of design are also the most comprehensive and widely used. Specifically, the patterns of visual connection to nature, material connection to nature, and refuge were studied. These design strategies were mapped according to their relation to the regenerative design imperative of place and the biophilic pattern of connection to natural systems, as conduits towards equity. This framework and methodology are summarized in figure 1.

Ecology of the Place & Urban Agriculture

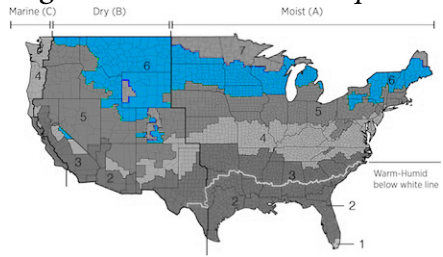
The Living Building Challenge

Figure 2. The Rose Affordable Housing



(Photo obtained from WWMO)

Figure 3. Climate Zone Map



Climate zone 6 (moist, cold)

Photo obtained and edited from the International Energy Conservation Code (IECC)

2602 Broadway Apartments: Summary

2602 Broadway is a six-building affordable housing complex in Santa Monica, CA for those making less than 20% of the area median income (AMI). The design prioritizes net-zero energy by using passive design strategies, utilizing solar shading and natural ventilation (SustainableSM, 2012).

Latitude & Longitude:

34.03° N, -118.47° W

Architect:

Kevin Daly Architects

Figure 4. 2602 Broadway Apartments



(Photo obtained from ArchDaily, 2014)

Figure 5. Climate Zone Map



(Photo obtained and edited from Pacific Gas and Electric Company (PGE) of California)

imperatives *ecology of the place* and *urban agriculture* are intricately connected, as ecology is promoted by urban agriculture, and urban agriculture protects the ecology. Both are connected in promoting a sense of place that enriches the connection between residents and the earth. This sense of place

promotes equity for the residents through a wholesome connection to natural systems as well for a resilient planet.

A large community garden is central to the programming at The Rose Apartments (figure 8). The presence of the garden creates a sense of place in the greater neighborhood, as it is open

Paisano Green Community: Summary

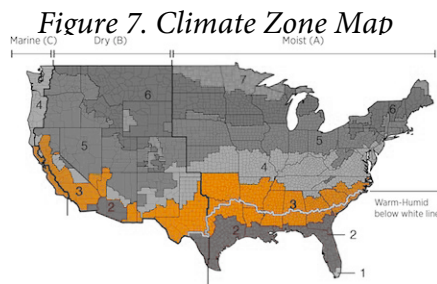
Paisano Green Community is an affordable housing complex in El Paso, TX for the elderly and disabled. The design priorities are based primarily on massing and addressing an extremely toxic local environment (Workshop8).

Latitude & Longitude:

31.77° N, 106.46° W

Architect:

Workshop8



Climate zone 3 (hot, dry)

Photo obtained and edited from the International Energy Conservation Code (IECC)

Figure 6. Paisano Green Communities



(Photo obtained from ArchDaily, 2014)

for use by those neighbors (AEON, 2019). By incorporating native plants, the apartment establishes itself in its geological place with design that honors the earth.

2602 Broadway has a small community garden as a part of its design that offers personal refuge for individuals to reconnect to the earth, as only a few individuals can occupy the garden space. It connects the individual to the natural systems, earth, place on a more intimate level than at The Rose (figure 9). 2602 Broadway utilizes native plants, with special attention paid to preserving pre-existing foliage (SustainableSM, 2012).

Paisano re-envisioned urban agriculture as honoring the dry ecology, offering a tapestry garden of drought tolerant plants for community gathering, and responds to the

native ecology. Like The Rose, the apartments are designed around this defining garden, shown in figure 10. Traditional urban agriculture promotes equity by providing fresh produce to those who are historically excluded from this right (Algert, Agrawal, Lewis, 2006). In the case of Paisano Green Communities, this design achieves equity by providing a mentally and emotionally rejuvenating garden. Urban agriculture connects people to the earth and to their community, creating a stronger and more global ecology.

Water preservation is a common strategy for all three apartments:

The Rose utilizes active design strategies to preserve water and protect the waterways—the ecology of the place—through artificial, water storing cisterns (AEON, 2019). Cisterns in the

Figure 8. *The Rose: Ecology of the Place & Urban Agriculture*

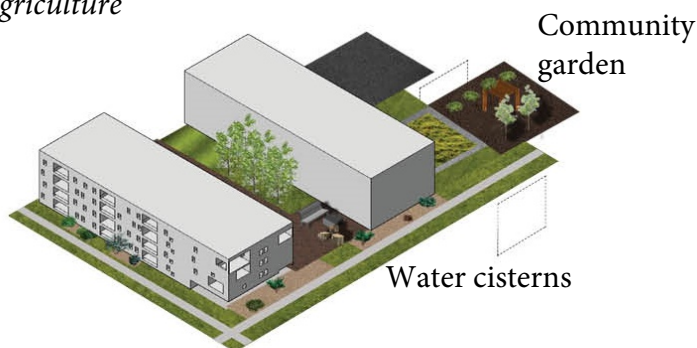


Figure 10. *Paisano Green Communities Ecology of the Place & Urban Agriculture*

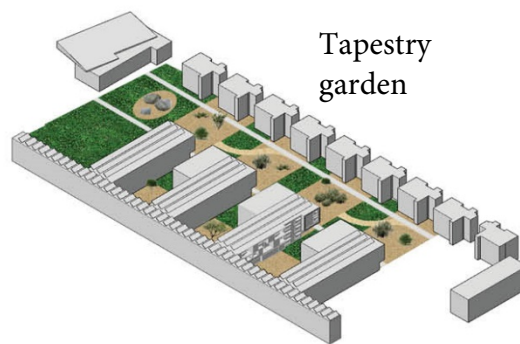
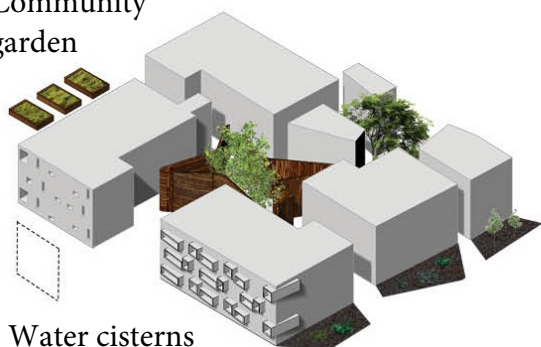


Figure 9. *2602 Broadway: Ecology of the Place & Urban Agriculture*
Community garden



parking lot and the garden collect a cumulative 83,600 gallons of stormwater for landscape irrigation each year. Such water preservation protects unfiltered water from eventually flowing into the Mississippi river (MWMO). Figure 8 demonstrates the strategic locations of the water cisterns.

2602 Broadway also utilizes active strategies to preserve water in its drought-plagued region of California. A 15,000 gallon man-made water reservoir as well as a highly efficient drip irrigation system working together towards water preservation. The design makes an enriching connection to nature possible for the residents without compromising the wellness of the ecosystem.

Paisano Green Communities honors the water scarcity by using a drought-tolerant

tapestry garden. The complex does not have a water cistern, and the implementation of a cistern might provide what little water is necessary for these plants.

Energy

The intent of the Energy Petal is to plan for a resilient future by reducing wasteful energy expenditures, resources, and capital, which in turn contributes to more resilient ecosystems and communities. As the cost of living rises and income disparity grows, access to electricity has become an issue of inequality. Low-income households spend a higher proportion of their income on energy bills than any other income group. This disparity exists despite their consuming less energy per capita and spending less on energy per square foot of living space than

Figure 11. The Rose: Site plan

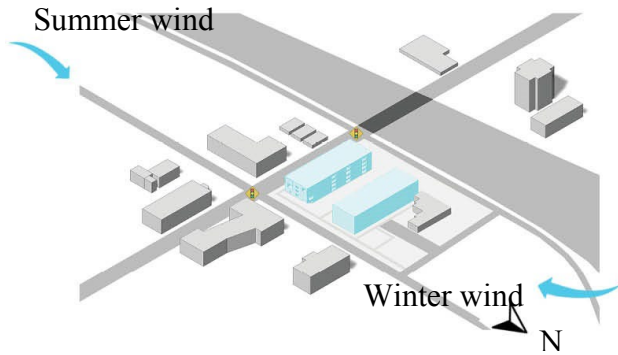
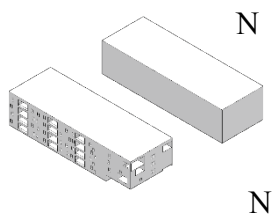


Figure 12. The Rose south broad facing wall absorbing the sun's heat (white), passively heating the building which is critical in the cold Minnesota climate. (June 21 - 12pm top, December 21 - 12pm bottom)



other income groups. A 2015 survey indicated that in apartment buildings with 2-4 units, 46% were experiencing some form of energy insecurity, sometimes being forced to forego food and medicine to instead pay for energy bills. 40% of households with income below \$50,000 found it difficult to pay their energy bills at least 'once in a while.' Clearly, energy is an issue of equity (Brown, Marilyn et. al.) To compound all this, as fossil fuel resources are depleted, energy prices will continue to rise. In contrast, as renewable energy becomes more popular, especially solar photovoltaic (PV) panels and energy storage systems, their prices will decline (Puri, Smith, 2018). Passive energy strategies are opportunities for regenerative design in affordable housing, as energy use tends to be higher in these high occupant density units (Oriya). Passive energy design takes advantage of a building's site, climate, and materials to minimize energy use. Well executed, it reduces

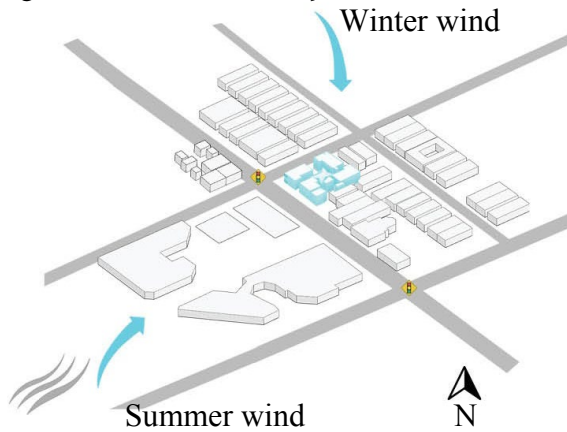
heating and cooling through energy-efficient strategies and design (U.S. Department of Energy).

Energy is connected to place by providing an environment and means to work, play, and live in a way that celebrates life. These energy strategies contribute to creating a place in which human beings might thrive. In a space in which the residents are confident that there are passive energy strategies reducing energy bills, stress might reduce. Energy is also connected to biophilic design, as residents are exposed to the means of saving energy—particularly, the sun and wind.

Energy strategies create a sense of place using connection to natural systems. All three apartment buildings obtain a sense of place within the context of an urban environment that often discriminates against enlivening space. The site plans reveal the discriminating factors towards equity for each of the complexes, exhibited in figures 11, 12, and 13. The Rose neighbors one of the busiest highways in the state (I-35W), with car exhaust wafting towards the building (Google Earth), see figure 11. 2602 Broadway is bordered by two intersections (Google Earth), see figure 12. Paisano Green Community is surrounded by a border checkpoint with trucks idling all the time, a zoo with unpleasant odors, and a wastewater treatment plant (Workshop8) shown in figure 13. In light of these site-specific challenges, energy strategies are climate specific while promoting an equitable sense of place. With place established, equity flows naturally.

At The Rose, the natural systems of the sun and wind are harnessed as passive energy saving strategies – by solar heat gain and passive ventilation, respectively. Passive energy strategies

Figure 13. 2602 Broadway: Site Plan



are those which utilize the building’s site, climate, and materials to minimize energy use. (U.S. Department of Energy). These strategies, in turn, connect the residents to the natural systems by the large windows on a broad south-facing wall, with warm wind approaching during the summer (mnshi, 2014). This strategic massing is revealed in figure 11, and the connection to the natural system of the sun is conveyed by a sunlight analysis in figure 12. Furthermore, the HVAC system might not be a direct connection to natural systems, but it honors the place in the cold Minnesota climate in order to promote equity for the residents.

Besides exposing the courtyard to air gusting through, the design fails to provide what would be an equitable HVAC system (SustainableSM, 2012). There is prudent use of solar shading to protect certain facades of the complex from heat, a measure more reliable than passive ventilation across a six-building complex. This strategy is shown in figure 14. This solar shading to provide selective relief, but as is evident in figure 14, the relief is only affective at certain times of the day. The white portion indicates the sun hitting the window boxes and the dark portion the shadow. This analysis reveals that during the summer, there is effective

shading as the window itself is in shadow, while ineffective during the winter months. Thus, the energy saving strategies fail to establish 2602 Broadway in its ecological place or to connect them to the benefits of its natural systems, failing to provide full equity—as fair access to reliable energy. 2602 Broadway (figure 13) relies heavily upon connection to natural systems, to the extent that it arguably creates a chaotic sense of place. Passive ventilation by the cool ocean winds is contradicted by arranging six building units in a block, creating an arrangement in which buildings have differential access to the cooling summer winds. Since some units do not have direct access to ventilation (SE and SW facades), cooling of those units depends on the northern-facing units having their doors and windows open throughout the day to allow a flow through those buildings, across the courtyard, and into southerly units. Access to ventilation for these opposite units depends on their doors and windows also being open to allow air flow (SustainableSM, 2012).

The Paisano Green Community maintains tight sealing whilst also connecting the residents to natural daylight and wind by the sight of towering turbines (Workshop8). The massing strategy with the deep shelves promoting natural daylighting without solar heat gain is revealed in

Figure 14. 2602 Broadway south window awnings only partially effectively reflecting bright light (white) away from windows (dark grey) as a passive cooling strategy. (June 21 - 12pm top, December 21 - 12pm bottom). The strategy is effective on the summer solstice, but the winter solstice light is evidently hitting the window directly, heating the building (bottom left image)

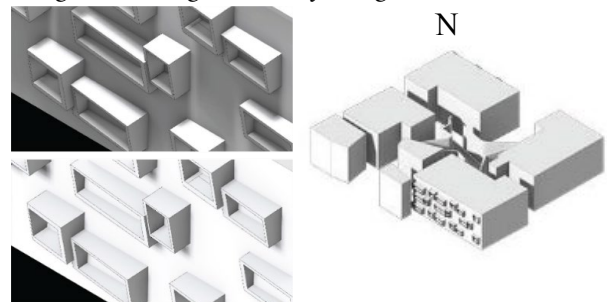


Figure 15. Paisano Green Communities:

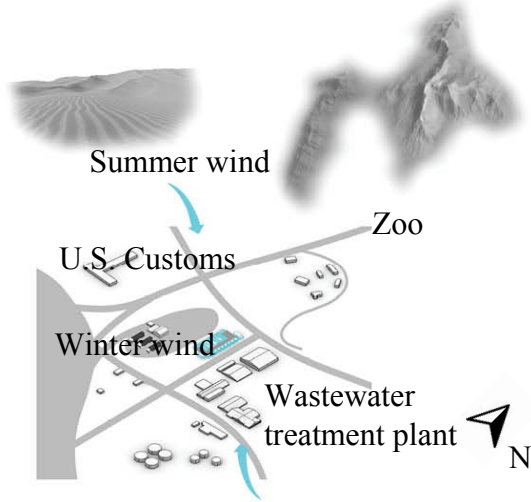


figure 16. In this case, the HVAC system might not be a direct connection to natural systems, but it honors the place to promote equity for the residents. Finally, Paisano Green Communities utilizes massing strategies as well as onsite renewable energy regeneration that capitalize on the intense sun and the winds from the neighboring desert (Workshop8). Paisano’s renewable energy strategies are specific to a large site, but The Rose has demonstrated a similar commitment on its smaller scale, as it is “PV-ready.” “PV-ready” indicates that it has the infrastructure to install PV panels, but has not yet moved forward due to financial and logistical concerns. Nonetheless, there is a clear commitment to saving energy. In addition to these energy-saving measures promoting equity for the residents, they promote equity for the earth, as these exacting measures reduce the building’s ecological footprint.

Biophilia

Definitions:

Visual Connection to Nature: A view to elements of nature, living systems, & natural processes. The experience is to feel whole, grab attention, stimulate and calm, and to convey a sense of living things (Interface, 2016).

Material Connection to Nature: Material and elements from nature that involve minimal processing, reflect the local ecology or geology, and create a distinct sense of place. The experience of them is to feel rich, warm, and authentic; sometimes stimulating to the touch (Interface, 2016).

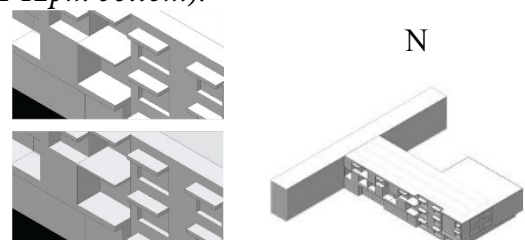
Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected. The experience of it is to feel safe, retreat, and withdraw from work—for protection, rest, or healing; to feel separate or unique from surroundings. Spatial characteristics can be thoughtful, embracing, and protective, but not necessarily disconnected (Interface, 2016).

Each of the three buildings incorporate biophilia as a part of their experience - an expression of equity on the part of the design. Biophilic design is critical in transforming a space into a home, a place that sustains and rejuvenates those who live there, against whose health there are often many discriminating factors (such as poor access to healthcare or high external stress factors).

Refuge

In The Rose, there is safety and protection in the

Figure 16. Paisano Green Communities deep window ledges protecting the windows from sun (white) as a passive cooling strategy. This is achieved while still reflecting light up toward the window for natural daylighting (6.21 12pm top, 12.21 12pm bottom).



community spaces of the courtyard and the community garden. These are both community-oriented spaces, and the courtyard with the buildings framing the site and the garden nestled amongst plants and trees, offers a space of safety and protection within the larger community.

In 2602 Broadway, refuge is more individual, personal. One might feel the protection and safety out of the wind looking into the shadowed courtyard garden oasis, void of people rushing around. There is also a sense of refuge in the small community garden situated on the periphery, away from traffic, where, on account of its size and location, just a few individuals might be found in the intimate refuge of a small cove of nature (SustainableSM, 2012).

Paisano Green Community is a hybrid of both community and personal refuge experiences. Within the tapestry garden surrounded by the buildings, with people milling about to get the mail, there might be a sense of refuge in the community--safety and protection in and amongst people. There is also refuge in the Jewel Box, a space with the calm of prospect out to the mountains as well as the protection and closeness of the small space where just a few individuals might fit.

Visual Connection to Nature

The Rose demonstrates a commitment to visual connection to nature, especially in its large community garden and courtyard space. Stumps used as stools are scattered across the courtyard, trees line the courtyard's perimeter, and a wood pavilion occupies the center of the community garden.

2602 Broadway exhibits a biomorphic visual connection to nature, as it relies on non-orthogonal forms such as in diagonal supporting

beams or curved sidewalks to create connection.

Paisano Green Communities exhibits a visual connection to nature across numerous scales, with a small garden outside each unit, a larger tapestry garden, and views to the mountains from the jewel box. This scale jumping establishes a very united sense of place within the greater ecology.

Material Connection to Nature

In The Rose, there is an especially distinct connection to nature's material, in the garden and community spaces. The garden is filled with organic plants, soil, and a wood pavilion at its heart. Furthermore, the community space has a strong connection to wood forms, in the seating and courtyard pavilion structure, among others.

In 2602 Broadway, the material connection is limited, and might benefit from bolstering. There are wood balustrades, which connect the residents to nature. This design element is overshadowed by a strong reliance on concrete and metal poles circling the internal courtyard. In a climate with little rain and low risk for mold, there is ample opportunity to utilize natural materials throughout the site.

Within the Paisano Green Community, there is limited exposure to material connection to nature. This deficiency is less critical because the residents do not engage as much with the space due to limited mobility and disability. Perhaps some creativity on the part of the design should incorporate more connection to natural materials.

Conclusion

Regenerative design and biophilic design work synergistically to engender what is at the heart of affordable housing: equity and fairness. Energy reduction, a regenerative design

imperative, re-invigorates both the individual and the planet. It connects marginalized populations to a global context – an expression of equity. Each building reveals a strong connection to the local climate, harnessing that climate for energy reduction and connecting the residents to those natural systems. Responding to the character of the climate was revealed as an effective measure to make energy both affordable and equitable. Ecology of the place and urban agriculture, regenerative design imperatives, create a sense of place by promoting a stable, resilient earth and local ecology. They root the residents in an equitable place within the ecological and social ecology. Lastly, a visual connection to nature, a refuge from frequent chaos, and a material connection to nature, transform the purpose of the apartments from merely housing to spaces that are rejuvenating. As communities and individuals are immersed in nature, biophilia has the potential to create a sense of equity for the individual and the community. Biophilia establishes them in a sense of place, as the residents develop a longing for these amenities that draw them to the space. By the natural systems and materials that enrich an experience of biophilia, individuals connect to a rightful place in the ecology of life. Equity extends to the planet as well, as regenerative design promotes regrowth, and biophilic design clothes it in dignity. The sites have taken advantage of the climate of their site as agents for change, giving historically excluded communities access to the gifts of nature.

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