**SEDGE CITY**

Consisting of residences, workshops, and a community gathering space, the proposed plan is an open-ended, **fractal pattern, utilizing three, self-similar sizes of spatial/thermal modules, that allows maximal flexibility, growth, and change.** [[1]](#footnote-1)

An “incubator” village, this multi-use shelter demonstrates a human settlement that achieves harmony with nature. The plan respects 10,000 years of stewardship. It considers the current context of the land—flora, fauna, geographic features, and climate—and the contemporary interests of the people—resident and visiting—in keeping with Fly Ranch values and Burning Man culture.

**EXEMPLAR PASSIVE DESIGN AND TECHNOLOGY** provides shelter, heating and cooling, lighting, water collection, and waste treatment in Fly Ranch’s challenging setting. Importantly, this design utilizes resources as close to the site as possible to operate:

* in the least number of thermodynamic steps
* at ambient temperatures
* with a minimum of moving parts

**A TRIPTYCH OF PROVEN PROTOTYPES** creates **architecture that acts more like plants in its structure, metabolism, and aesthetics**. This complex sequesters carbon by its very construction and existence.

**1. BALE CONSTRUCTION** In the 1890s, when baling machines had just been invented, homesteaders on the sandy prairies of the great plains, who had no access to standard building materials suited to their harsh climate, resourcefully used baled prairie grasses. Some of these buildings are still in use today.

This construction technique was revived in 1980 in response to America’s energy crisis because straw bales provided three times the insulation value of standard wood frame walls, and structures could be built easily by community effort. Agricultural waste, such as rice straw, provided good material and could help reduce air pollution from straw field-burning.

By 2015, details and code requirements were formalized and other materials and geometries tested, to explore the greater potential of bale construction such as use of other materials, load bearing walls, ease of achieving complex geometry, and broader carbon reduction methods involving local acquisition and construction.[[2]](#footnote-2)

**2. VERTICAL SHELLS** After World War II, creative buildings were built using Ferrocement shells. Spectacular structures were possible because double-curved complex geometries could overcome the problem of local buckling in thin shells.[[3]](#footnote-3) Later, recognition of problems like minimum insulation and expensive formwork could be overcome by combining this technique with bale construction to create triple-layer composites. Bale walls are easy to curve and provide excellent formwork and “tooth” for a cementitious skin on each side. The result is a composite, triple-layer wall of two thin shells held together on each surface of the highly compressive center that forms a stronger element than two individual shells.

**3. ROOF POND THERMAL OPTIMIZATION** Of all the thermal energy systems developed in the passive solar movement of the 1980s, the roof pond is the only one to:

* Provide 100% heating and cooling to buildings in climates like Fly Ranch
* Allow equal thermal comfort to all enclosed areas, not just to rooms that face south
* Provide the most consistent comfort because of its large surface area providing radiant transfer from thermal mass

The proven advantages of roof ponds were then restrained by patents held by the inventor. Patents now expired; this open source technology is available to enable climate optimizing shelter at Fly Ranch.[[4]](#footnote-4) Today’s roof ponds are improved by an intermittent insulation system developed for use in Northern New Mexico. Like a gentle snow fall, at a set daytime temperature, cloud-gel coated insulating beads move pneumatically from storage chambers into a segmented 7.6cm space. Even on the hottest summer days, this prevents overheating of the water pond and keeps rooms cool while allowing diffused light. On cold nights and in winter, the reverse happens. This allows heat from sunlight, absorbed by the roof pond’s thermal mass, to warm interior spaces.

Ancillary technologies for settlement sustainability and environmental sensitivity include rainwater collection, PV solar power generation, and composting lavatories for waste management and production of topsoil.

**RADICAL ON-SITE IMPLEMENTATION & USES**: Most exciting to imagine is the community engagement process of bale building. Mini demos during Burning Man, word-of-mouth, and social media draw interested volunteers including residents, Burners, and/or eco-tourists of all ages. No prerequisite skill is required. Volunteers gather for onsite sedge baling and bale “wall raising”. This guided, hands-on experience generates self-reliance, self-expression, and joy!

**Initial construction includes a set of photovoltaic (PV) panels, one workshop, one residence, public restrooms (WC), and a charging station (EVC).** This provides sustainable power, permanent shelter, waste processing, and water collection sufficient to support bale-raising teams and prospective donors who “grow the village” as capital and volunteer resources are developed. Adding the community hall, more workshops and residences provides mid- and long-term possibilities for tribal ceremony, civic events, artists-in-residence, healing arts, research, education, tool shops, conservatory, Burning Man storage, a med clinic, Wi-Fi / AV broadcast hub, co-housing, and demonstration labs.

Fly Ranch is a place of surprising contracts on which Sedge City plays. Big dome skies cover flat dusty earth, desert lands meet sedge-covered marsh, hot days oppose cold nights, and minimalist flora host well-adapted fauna; all are celebrated by the design aesthetic.

**ENERGY • WATER • SHELTER • REGENERATION** **•** The whole of this climate resilient, sustainable settlement is greater than the sum of its parts and provides wonder, inspiration, and replicability.

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| **INPUTS + *Maintenance*** | **OUTPUTS** | **MATERIALS** & **DIMENSIONS** | **COSTS ESTIMATE** |
| **1.** BALE CONSTRUCTION | | | |
| Bales harvested from regenerated growth of nearby sedges  ***Local sedge, like rice straw, is resistant to decay.*** | Minimized labor and transportation costs, and community building opportunity | Local sedge bales from restored adjacent land:  W 50cm x H 50cm x L 150cm  Community Hall  W 30cm x H 50cm x L 150cm  Workshop/studios & residences  baling machine | Raw sedge bales in place:  12500 @ $3avg. =  $37.5K |
| **2.**  VERTICAL SHELLS | | | |
| Magnesium Oxychloride (MgO…) cement on exterior surface of stacked bales create vertical shelled walls. MgO…) can be sourced from local saline waters  ***Protected by cementitious skin & roof overhang, bale walls last hundreds of years.*** | strong spatial definition  superior insulation, minimum labor  relatively fast construction  √D2 seismic/exposure | MgO… cement | MgO… stucco skins:  $120 per sq. m. |
| **3.** ROOF POND | | | |
| Roof pond passive conditioning requires zero input except as provided by daytime solar radiation and night sky radiation.  H2O collected from roof in cisterns.  ***Semi-annual check on pond system*** | Superior heating & cooling comfort via radiant thermal transfer eliminates need for HVAC system.  Excellent wind flow moderation  √wind speed/snow load  Roof H2O collection, even in dry areas like Fly Ranch can be appreciable. The limiting condition is storage capacity. Using local rainfall figures, the community hall roof plan includes three cisterns sized to hold 126K liters each. A yield of 38K liters per year. | 14 steel tension rings:  15m. community hall  8m. workshops  6m. residences & WC  14 fiberglass shells and protective glass domes  66.5cu m. collected H2O to fill roof ponds (once only):    3060cu. m. opaque insulating beads  cisterns | Roof pond structure.  $ 6K x 1  $ 3K x 5  $ 2K x 7  $75K  $1.5K each |

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| **INPUTS + *Maintenance*** | **OUTPUTS** | **MATERIALS & DIMENSION** | **COSTS ESTIMATE** |
| **ANCILLARY SUSTAINABLE TECH** | | | |
| Solar power via Photo Voltaic panels  Electricity storage by Tesla Powerwalls  ***Minimal maintenance, wipe bird droppings periodically.*** | Power produced at build-out:  30 panels x 2 high = 24,000 watts  =144 kw per day  Powerwalls store the above. | 95m.  3 Tesla Powerwalls | Whole village:  PV installed  $415K  Powerwall installed  $35K |
| **Clivus Multrum compost toilets** tanks system provide public WC facilities, processing human waste.  ***Extraction of topsoil annually as needed for use in gardens.*** | Clivus system reduces volume by 90%. Over a year’s time in tank storage the waste is converted usable topsoil. | Watertight shallow cellar below the public WC & toilets  (Compost toilet options for residences don not require tank) | $3000  $ 300-600 each |
| **VENTING** (Small openings) high and low refresh interior air as needed  ***Vent openings require regular cleaning and maintenance.*** | Enables one air change per hour for big events: ½ change per hour other uses. | Fenestration sized for per module | TBD |
| **FINISHED SURFACES** integral to vertical bale walls. Any color may be used in the skin color coat.  Stabilized earthen flooring uses local earth and is a design opportunity.    ***Little maintenance is required for bale walls. Periodic dusting. Earthen floors need regular attention.*** | Structural integrity.  Most natural, local, no environmental impact if stabilized correctly. | Desired natural pigments  Local drain rock, pumas, road base, sand, clay, chopped straw  Linseed oil compacting/leveling tools | Cost included in vertical wall shell  TBD |

**SEDGE CITY: Environmental Impact Summary**

Environmental impacts of the proposed Sedge City are couched in the environmental opportunities provided by a sustainable approach. Overarching tactics to optimize available resources and mitigate negative impacts include generating renewable energy; sourcing materials as close to the site as possible; and choosing to use magnesium oxychloride cement rather than the standard Portland cement (a major CO2  contributor).

Negative impacts during bale construction—noise, transportation, dust—is far less than conventional construction.

**Historic & Cultural Sites**: Recognizing the First People relationship to the site, ongoing inclusion, and consultation of Northern Paiute tribal representatives is essential to ensure a respectful project which honors the ancestors and mitigates any negative impacts to places of significant importance.

**Biological**: A minimal negative impact to the building site is expected as some natural scrub is cleared, and footings are placed. Restoration of adjacent agricultural grazing land, enhanced to grow native perennial sedge, provides more habitat for marshland dwellers and material for local baling. Perennializing agriculture is an impactful gateway for climate change mitigation. Native sedge is effective in sequestering carbon into soil which has a positive effect on the planned construction effort.

There are no known negative impacts to threatened or endangered species.

**Air & Water**: Use of magnesium oxychloride cement is less carbon intensive and can be made from saline water such as occurs on Fly Ranch.

Rainwater catchment off roofs into storage tanks filtered for human use slightly reduces the volume of water moving into the ground, a negative impact.

Clivus Multrum systems contain human waste, protect the watershed, and yield quality topsoil.

PV-generated energy powers all modules and charging stations. Sedge City’s self-reliant philosophy emphasizes the pedestrian, bicycles, and shared electric vehicles.

**Aesthetic, Social & Economic:** Sedge City’s design calls for compatible, low rise structures with natural, fractal patterns, and use of local materials and colors of the natural surrounds.

The roof pond domes are clear, with intermittent insulation of opaque beads. When lit from the interior, they are visible at night in the summer. The light is diffused, creating a soft glow and a minimal negative impact to the view of the desert sky. In winter, when the insulation is closed, no light is emitted at night.

The environmental controls system is quiet. In each module, only one small, intermittent fan runs five minutes twice daily. In addition to helping keep interiors temperate, and in conjunction with the convex ceiling, bale walls provide for good interior acoustics and exterior sound attenuation within the affected area.

In 2020, the *Reno Gazette-Journal* reported that Washoe County’s housing market is one of the least affordable in the U.S. Thus, Sedge City would provide on-site housing options for researches, artists, and/or Fly Ranch managers in long- or short-term residence. This would reduce commuter transportation pollution and local wildlife disturbance while enabling onsite stewardship. Sedge City could one day be a year-round eco-tourism destination and regional economic generator where guests are sustainably accommodated while volunteering.

1. “…networks that sustain life are self-similar fractals.” From *Scale: Universal Laws of Life, Growth and Death in Organisms, Cities, and Companies* by Geoffrey West. [↑](#footnote-ref-1)
2. California Straw Building Association (CASBA), strawbuilding.org/recommended-reading [↑](#footnote-ref-2)
3. “…incredible lightness and strength….to make still further design and structural innovations possible.” From *Pier Luigi Nervi* by Ada Louise Huxtable [↑](#footnote-ref-3)
4. “A full-scale evaluation of a residence using such a system has shown that a high level of space comfort can be obtained without the use of auxiliary energy…”from *Nocturnal Cooling & Solar Heating with Water Ponds and Movable* *Insulation* by American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) *Transactions* Vol 83 1976 [↑](#footnote-ref-4)