# PROTOTYPES

chapter 5

## applying the lessons of tradition

Traditional housing holds many lessons for today's designers and builders in the creation of humane and environmentally appropriate environments. Following are prototypical house designs and neighborhood arrangements based on traditional principles. The prototypes are compared to a typical "starter-home" as one might find in a Southwestern subdivision of mass-produced houses, representing today's conventional method of production.

The prototypes have compact plan forms with the goal of building affordably and efficiently. While a contemporary trend in new housing development is towards building larger houses more cheaply, an alternative thesis is to build smaller and more efficient houses from higher-quality materials with greater energy efficiency. To do so affordably will require an emphasis on efficient house design and neighborhood planning.

Each prototype is presented first as an individual floor plan, then in a typical cluster or block plan, and finally expanded to the scale of a neighborhood. The neighborhood plans are presented to illustrate the types of densities and arrangements that are possible with the house types considered. Thought is given to the creation of common public space for each neighborhood. This might be a park with a playground, a recreation center, or a school. In the planning of new neighborhoods with a large enough population to support commercial development, coordination among developers, builders and municipalities can create a plan that includes a market, café or business center in the form of a small town plaza. These common elements serve as both literal and symbolic centers to a neighborhood.

Design of these public elements, and related concerns, such as traffic planning, is beyond the scope of this study. The neighborhood plans are therefore diagrammatic, serving to illustrate the principles of density, courtyards, and the creation of private and public space. This preliminary exercise in town planning is not intended to be followed literally. In an actual development a variety of house types should be designed that work together to create block patterns with a built-in variety of floor plans and sizes. By working with common modules, a range of 2, 3 and 4 bedroom plans can be developed

The prototypical housing designs which follow include:

- Detached single-family house plan based on the Anglo ranch house and bungalow traditions.
- Attached L-shaped and U-shaped courtyard house plans based on the Hispanic tradition.
- Attached 2-story row-house with terraces based on the Native American pueblo tradition.

The prototypes were designed with 16 inch thick exterior walls to permit the use of any of the three alternative materials discussed here: adobe, rammed earth or straw bale. The interior spaces are based on the same program as the Base Case suburban house with regard to the functions accommodated and the sizes of rooms. In comparing the gross floor areas of the conventional Base Case with the prototypes, it must be remembered that the prototypes are based on thick-walled systems, while the Base Case has six inch thick wood frame exterior walls. Therefore, the gross floor area of the prototypes is greater than that of the conventional house.

Efficiency concerns not only the design of individual houses, but more significantly the urban form or land use pattern employed in developments. Compact house forms with a minimum of exterior walls are both less expensive to build and to operate. The free-standing rectangular box, typical of subdivisions, minimizes exterior wall area by its centralized shape, yet it is exposed on all sides because it doesn't share walls with its neighbors. If the detached housing model is followed, large land areas are necessary along with extensions of roads and utilities. Land and infrastructure costs must be factored in to the overall cost of the development.

Significantly higher densities can be achieved by joining dwelling units and sharing walls. This reduces both the initial construction cost and the land cost attributable to each unit, as well as the cost of supporting infrastructure. Savings can be dramatic for a medium to large-scale development.

In evaluating the prototypes, interior floor area is expressed as a ratio of exterior surface area of the walls and roof. A greater ratio result indicates a more efficient enclosure system. For example, the efficiency ratio of the detached single-family (Base Case) house equals .46, while the efficiency ratio of the two-story row house (Urban Prototype 3) is approximately *four times greater*, equalling 1.88.

Shared walls between attached units are not counted in the calculation, as they are not exposed to the elements and do not contribute to heat loss and gain.

The alternative prototypes proposed have two basic problems in regard to costs: (1) they are larger than the standard minimum tract house, and (2) they are designed of more expensive materials. To be feasible for affordable housing the prototypes must be more efficient in their overall design, construction and land use. With additional planning, costs can be reduced.

For traditional materials, such as adobe or rammed earth, to be economically feasible for use in affordable housing, walls must be shared. These high-thermal mass materials are twice the cost of conventional frame walls, and so must be "built once and used twice" that is, shared by two dwellings to be affordable. There are further climatic advantages to sharing walls, as this reduces the amount of exterior wall area subject to heat loss or gain.

As seen consistently in traditional housing, affordability favors simplicity. The floor plans resolve into rectangles and squares. Rooms are arranged in simple volumes and alignments, and often connect directly one to the other without hallways. This directness and simplicity may seem startling, but is the result of the designers and builders using the most direct and economical means.

Sure ways to reduce construction costs include reducing the size of houses, and sharing functions within a single space. A combined living/dining/kitchen area is a more efficient use of space than creating separate rooms. All of the prototypes may be further reduced in cost by reducing the size

or number of rooms. For example bedrooms may be reduced by up to 20 percent in area by reducing them from a standard 12 ft. by 11 ft. size to an 11 ft. by 10 ft. dimension. Houses can function adequately with one bathroom, rather than two as is now commonly expected. Dividing bathroom plumbing fixtures so that a toilet and sink are together in one space, and a tub/shower and a second sink are in an separate space, allows the family the effective use of two bathrooms, while not incurring the cost of two full bathrooms.

To reduce the life-cycle costs of maintenance, the use of durable materials, such as adobe or rammed earth, is encouraged. Using traditional passive heating, cooling and ventilation methods as explored in this report will reduce utility bills, as the house can stay comfortable for more of the year without needing to run the mechanical system. The initial cost of building a traditionally planned house using traditional southwestern materials is higher than using conventional planning and materials. Yet the home owner can learn the value of owning a more efficiently designed house, built of environmentally responsible materials, that costs less to own and operate over its lifespan.

In considering these alternatives, the concept of building smaller houses of higher quality design and materials is valid with regard to advancing the use of adobe or other alternative construction materials in the Southwest border region.

To maintain privacy for individual dwellings while achieving higher density development, use of the courtyard type of housing is very important. Courtyard and patio homes are also climatically and culturally appropriate for many low-moderate income families in the U.S. Southwest. Courtyards provide the oasis in the desert at the heart of each dwelling, as witnessed in the numerous traditional examples surveyed.

The greater efficiency of the high-density/ low-rise design approach can off-set the higher cost of building with adobe, rammed earth or straw bale. Although the construction cost of an adobe courtyard house is higher than that of a standard detached wood frame house, the overall project cost may be equalized once the costs of land and infrastructure are taken into account. Courtyard housing appears to be a feasible alternative for a number of reasons.

*Cultural and social factors:*

- Courtyard houses reflect a centuries-old Latin tradition.
- The courtyard at the heart of the house is essentially a large out-door room, a private place for outdoor living.
- Neighborhoods of courtyard houses are pedestrian-friendly, a positive social environment with greater . opportunities for social interaction.
- Greater population density creates defensible space, reducing crime.

*Environmental factors:*

- Courtyards have passive cooling and heating advantages, creating an oasis/micro climate for the summer and allowing sun in the winter.
- Shared walls reduce exterior surface and reduce heat loss & gain.
- Greater efficiency of land use reduces infrastructure costs, preserves wildlife.

*Economic factors:*

- Higher densities possible with courtyard planning reduce land and infrastructure costs.
- Shared walls between courtyard houses can make use of adobe or rammed earth possible.
- Compact houses with courtyards use less energy and cost less to own and operate than detached suburban houses.
- The courtyard provides the largest room in the house: views into the courtyard make the interior feel more spacious, allowing smaller-sized rooms to be used.

Following are prototypical house designs presented in order of increasing density. Preliminary cost estimates are based on regional per-square-foot costs for single-story houses with nine foot ceilings, wood or metal truss roofs, exposed concrete floors, and economy-standard, finishes, fixtures and hardware, as of summer 2004.

*"The stereotype of the conventional individual dwelling is that of a box sitting on a lot surrounded by space. The box has no privacy as the windows are outward looking, and the surrounding [yard] is [also] not private."*

Peter Land,
*Economic Housing: High Density, Low Rise, Expandable*

The comparative cost estimates which follow, for the Base Case and the four alternative prototypes, are based on approximate land and construction costs in southern Arizona, current as of the fall of 2004. Because costs vary with both market conditions and geographic areas, these estimates serve only to illustrate in relative terms the range of probable costs incurred by varying housing types and land uses.

Construction costs are estimated on a per-square-foot basis, which serves to set the cost within a range, plus or minus ten percent. For purposes of these estimates, construction is as illustrated in the prototypical wall sections presented in Ch.3. Many design decisions which affect building costs have to do with finishes (such as floors, walls, ceilings, roofing etc.). These estimates assume that floors are exposed colored concrete. Straw bale walls are plastered inside and out. Stabilized adobe walls are left exposed (i.e. unplastered) inside and out. Interior partitions and ceilings are finished with gypsum board and painted. Such elements as doors, windows, and cabinets are assumed to be of moderate production quality, meeting minimum property standards, of the sort used in production homes. Roofs are structured with prefabricated wood or metal trusses. Roofing is corrugated galvanized iron sheeting.

The alternative designs with earthen walls are estimated with a per-square foot cost factor that is twelve percent higher than a conventional frame/stucco house. This reflects a rule of thumb that the exterior walls of a house account for roughly one-fifth of the total construction cost. Given that earthen walls cost twice as much to build as conventional frame/stucco walls, we have a 100 percent increase for 20 percent of the project, equaling a twenty percent greater cost for the alternative method of construction. Some of the additional cost can be recovered through sharing walls, but clearly not all walls can be shared. If approximately two fifths of the exterior walls can be shared through courtyard design and attached units, the twenty percent additional cost is reduced to around twelve percent greater overall. As an arithmetic equation, it looks like this:

Estimated cost for incorporating alternative wall systems in housing construction:

for freestanding house:
*100% cost increase of wall × 1/5 wall / house ratio = ( 1.0 × 0.2 ) = 20 % greater cost*

for attached house:
*20% greater cost × ( 100% - 40% shared walls ) = ( 0.2 × 0.6 ) = 12 % overall increase*

The approximate cost of land per acre is weighted to reflect urban versus rural locations. Urban land is estimated at $50,000. per acre, while rural land is estimated at $25,000. per acre. While land prices vary widely based on location, these amounts are averages of land prices found in the Multiple Listing Service for Southern Arizona counties.

These numbers are predicated on improved land, with roads and utilities existing to the lot lines. Rural sites may have wells for domestic water supply and septic systems for waste disposal, rather than connections to a municipal water and sewer systems. Additional costs for infrastructure including roads, water, sewer, natural gas, and electricity must be factored for remotely sited rural land or undeveloped urban lots.

The economic and environmental advantages of infill development on vacant urban land is underscored by the cost savings realized in using existing infrastructure.

| SUMMARY | | |
|---|---|---|
| Wall material: | 2 x 6 frame/stucco | |
| Gross Floor Area: | 1,224 sf | |
| Exterior Surface Area: | 2,657 sf | |
| Ratio of Floor Area to Surface Area: | .46 | |
| Estimated cost of construction: | @ $90/s.f. = | $ 110,160. |
| Density of land use: | 4.5 RAC | |
| Cost of land per unit @ ($50,000/Acre)/(4.5 RAC) | = | $ 11,111. |
| TOTAL ESTIMATED COST PER UNIT: | | $121,271. |

The housing needs and expectations of a family with from two to four children in the contemporary U.S. Southwest are reflected in the subdivisions found in sun belt cities such as El Paso, Las Cruces, Tucson and Yuma. The suburban model has been followed by both private non-profit and government sponsored housing programs, including Habitat for Humanity, USDA, HUD and FmHA rural housing programs, as well as on Native American reservations by the Bureau of Indian Affairs and local tribal governments. It is a widely accepted standard of what constitutes an affordable, adequate family home.

## PROGRAM

The Base Case home has a combined living/dining space adjoining a separate kitchen with a refrigerator, sink and stove. The dining area accommodates a table for six. There are three bedrooms, one slightly larger as a parents' bedroom, and two bathrooms, one of which is accessed from the parent's room. All bedrooms have closets. There is accommodation for a single car in a carport (shaded overhead, open on the sides). Space for clothes washing and drying machines is provided off the carport.

The typical house has a concrete slab-on-grade floor and wood stud walls finished with stucco at the exterior and gypsum board at the interior. The wall cavities and attic are insulated with fiberglass batting. The roof is pre-fab wood trusses with OSB sheathing and asphalt shingles. The house is mechanically heated and cooled by a heat-pump air conditioner, which must run much of the year as the house does not incorporate passive heating, cooling, or ventilating strategies.

The single-family detached house is placed in rows on blocks of subdivided land, each house in the middle of its lot with windows on all sides. There is a poor relationship of indoor to outdoor space. For example, if one wishes to dine outdoors in privacy one must bring food from the kitchen, across the carport, around the side yard, and finally to the backyard.

The Base Case represents a typical single-story southwestern neighborhood where emphasis is placed on accommodating the automobile. The resulting low-density development consumes a significant amount of land, and lacks a distinctive community form.

PLAN

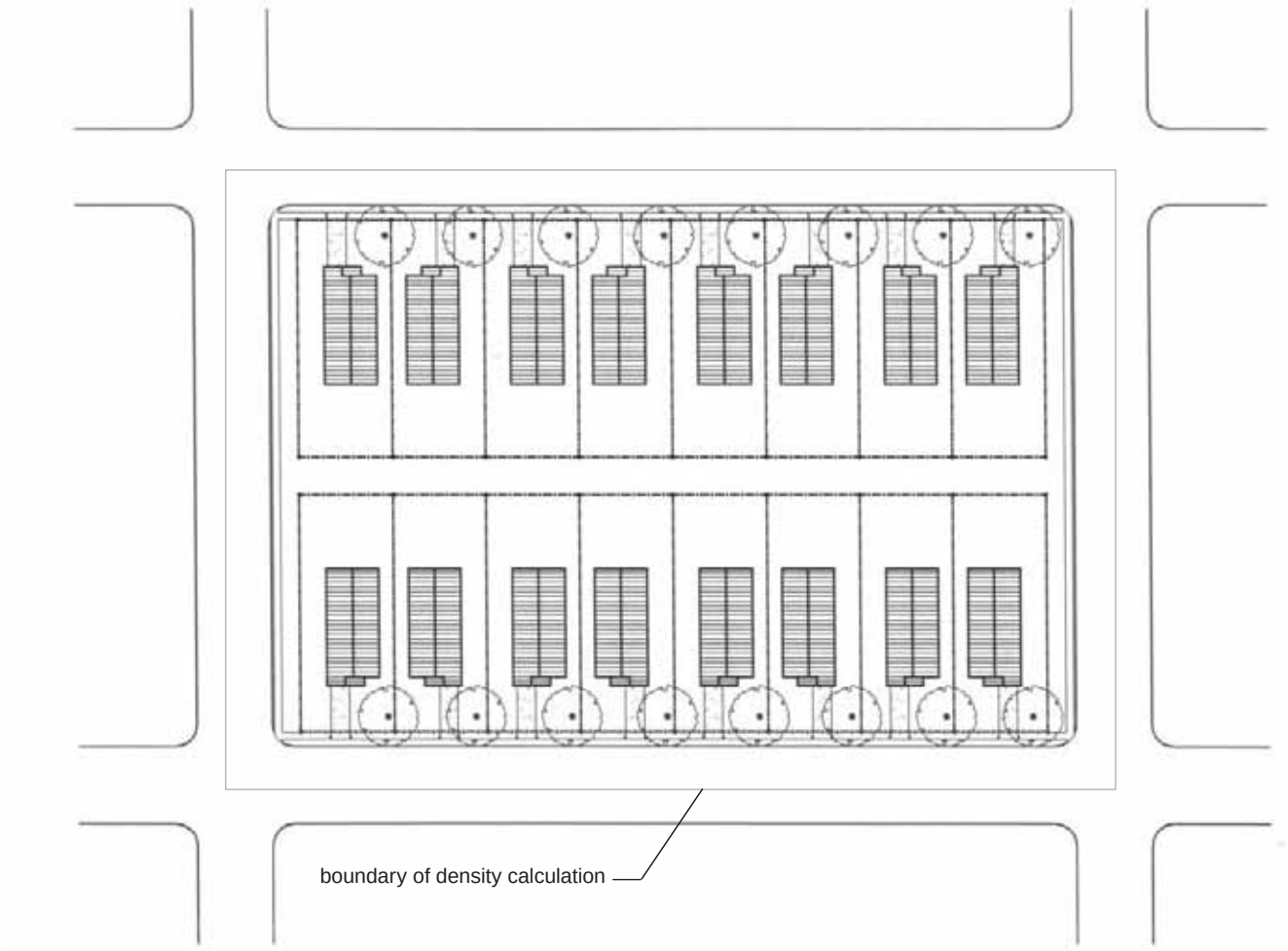
ELEVATION

N

0 16

scale in feet

BASE CASE CONVENTIONAL SUBURBAN HOUSE
EXTERIOR WALLS: 2x6 WOOD FRAME W/ STUCCO




0 100
scale in feet

NEIGHBORHOOD PLAN

N

"BASE CASE" CONVENTIONAL SUBURBAN HOUSE
16 RESIDENCES / 3.52 ACRES = DENSITY 4.5 RAC

*" Homes which keep or improve their quality will retain or multiply the original investment and support the tradition of keeping houses in families from generation to generation. Thus houses become genuine and stable assets for families, in contrast to rented apartments."*

---

Peter Land, *Economic Garden Houses*

SUMMARY

| | | |
|---|---|---|
| Wall material: straw bale exterior walls, rammed earth center wall | | |
| Gross Floor Area: | 1,320 sf | |
| Exterior Surface Area: | 2,532 sf | |
| Ratio of Floor Area to Surface Area: | .52 | |
| Estimated cost of construction: | @ $95/sf = | $125,400. |
| Density of land use: | 2.8 RAC | |
| Cost of land per unit @ ($25,000/Acre)/(2.8 RAC) = | | $ 7,100. |
| TOTAL ESTIMATED COST: | | $ 119,300. |

In rural areas with abundant inexpensive land, and where the detached single-family home is the preferred option, houses should be efficiently planned and responsive to the environment. Illustrated here is a modest interpretation of these goals based on the precedents of the traditional southwestern ranch house and bungalow. This prototype is recommended for small, isolated rural replacement housing, in clusters of from six to twelve houses.

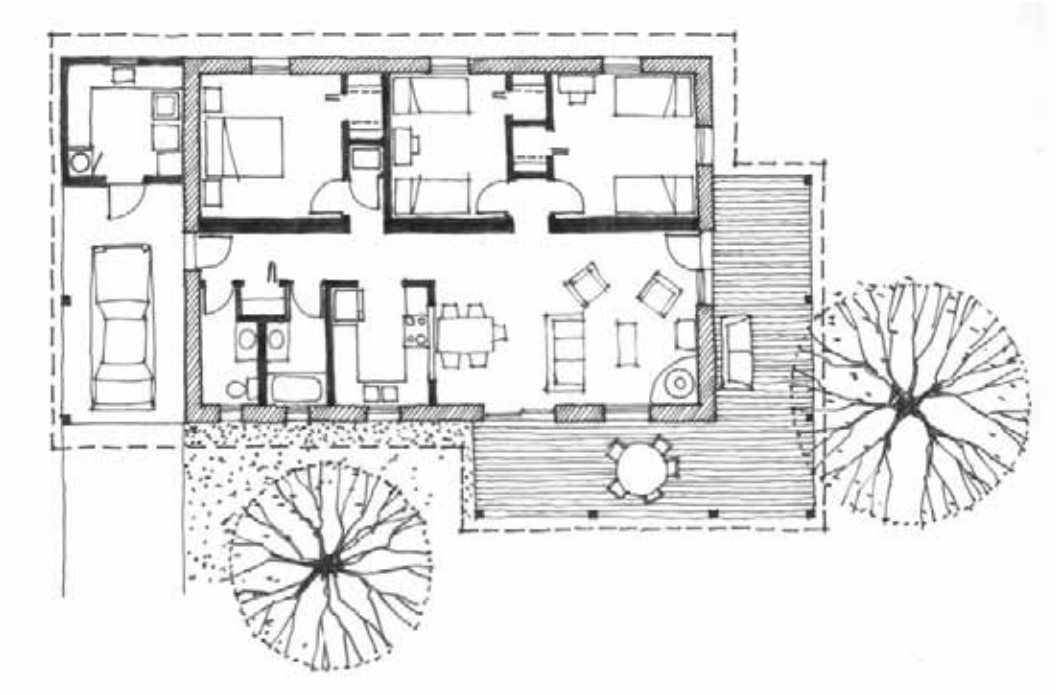
## FLOOR PLAN

The plan is a simple rectangle based on a 4-foot module to make the most of 4' straw bales, 24"on-center roof truss spacing and 4' x 8' roof sheathing. The plan measures 32' x 44' outside-to-outside. The exterior walls are proposed of 16" thick straw bale with lime/sand plaster. The window and door jambs carry the load of the roof, allowing the straw to serve as enclosure and insulation. A central wall running the length of the house is proposed of 16" thick rammed earth. This provides a central thermal mass to stabilize interior air temperatures. *The exterior straw bale walls provide high insulation value, while the central earth wall provides high thermal mass.* Roof framing is prefab wood or metal trusses with recycled cellulose insulation, OSB sheathing and corrugated metal roofing. Interior partitions are wood or metal studs with 5/8" gypsum board. Deep roof overhangs shelter the straw bale walls, and a porch wraps the corner of the living room to provide shaded outdoor living space.

Public and private spaces are separated by the central earth wall, with bedrooms along one side and the living/dining/kitchen on the other. Closets are placed between bedrooms to increase acoustic privacy. The children's rooms are grouped together, with the parent accessed by a private alcove. The bathroom design achieves the equivalent of two separate bathrooms with the plumbing of one bathroom. A tub/shower and sink together in one space, while a toilet and sink are in a separate space. This allows one family member to shower while another uses the toilet, effectively doubling the use of the bathroom at a reduced cost.

## SITE PLAN

The hypothetical site is flat irrigated cropland as found in many areas of California, Arizona, New Mexico, and Texas along the U.S./Mexico border. The houses are grouped informally around a central loop road that gives access off a primary county road, of the type that runs along section lines between agricultural fields in the rural southwest. This removes the houses from the higher-traffic area, and creates a common area for kids to play and neighbors to barbecue. The open space improves privacy between houses, which are oriented primarily east-to-west for favorable solar exposure.



material legend

straw bale

rammed earth

N

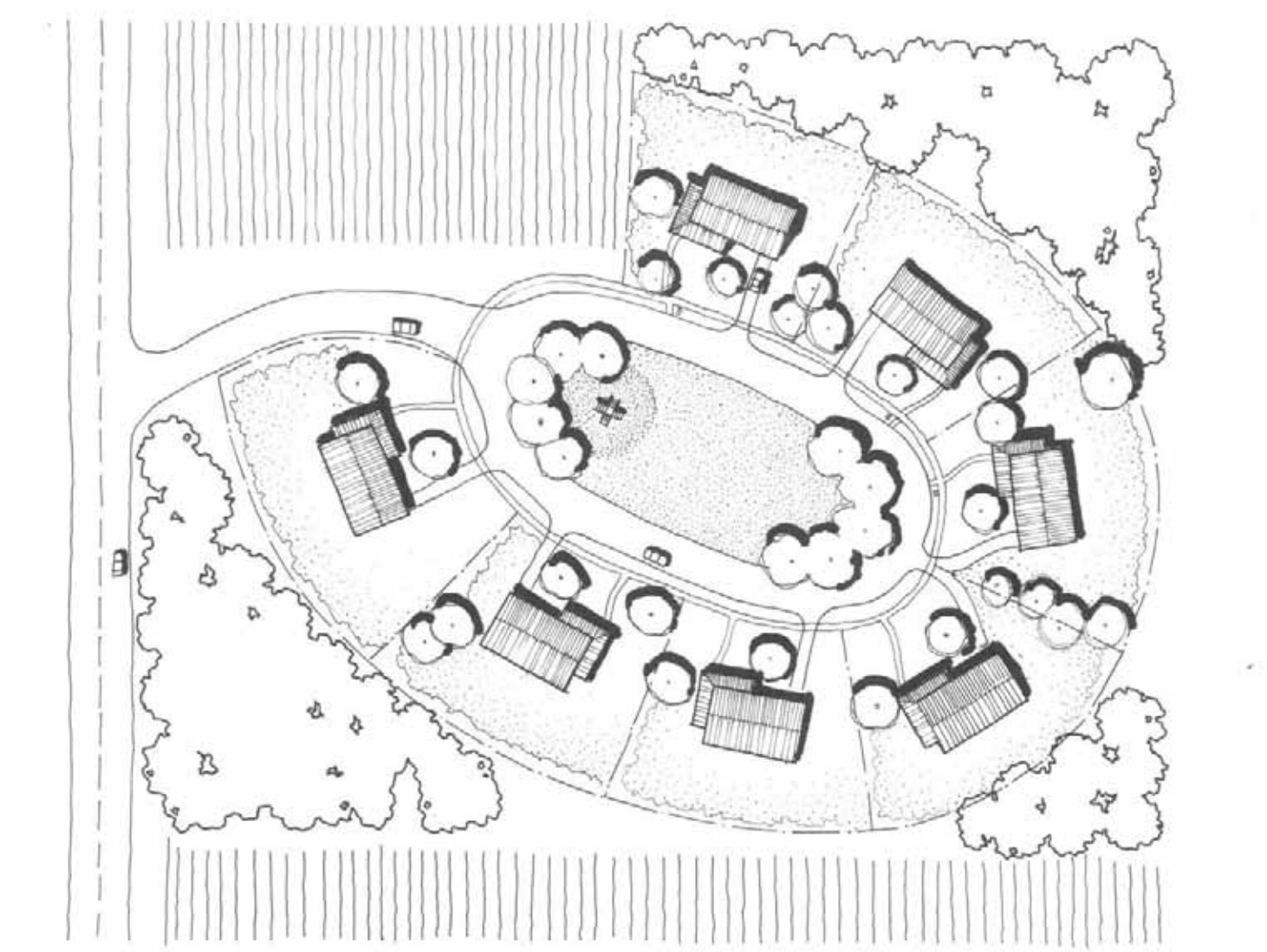
PLAN

0 16

scale in feet

ELEVATION

RURAL DETACHED PROTOTYPE



NEIGHBORHOOD PLAN

N

0 100

scale in feet

*"The patio or court-yard house is well suited to contemporary needs... Its history in vernacular and architectural forms goes back well over 2,000 years... It permits light and ventilation from the inside patio, thus eliminating the need for space or openings around the perimeter of the dwelling and thereby permitting houses to be nested contiguously at high densities on relatively] small lots with considerable economies in infrastructure."*

Peter Land, *Economic Housing: High Density, Low Rise, Expandable*

SUMMARY

| | | |
|---|---|---|
| Wall material: adobe, rammed earth or straw bale. | | |
| Gross Floor Area: | 1,600 sf | |
| Exterior Surface Area: | 1,987 sf | |
| Ratio of Floor Area to Surface Area: | .67 | |
| Estimated cost of construction: | @ $100/sf = | $ 160,000. |
| Density of land use: | 7.1 RAC | |
| Cost of land per unit @ ($50,000/Acre)/(7.1 RAC) = | | $ 7,000. |
| TOTAL ESTIMATED COST: | | $ 167,000. |

Where a closely-knit community form is desired for cultural, climatic or economic reasons, the "U" type courtyard house provides a good model. This example is drawn from the zaguán and courtyard tradition of the Southwestern U.S. and Northern Mexico. It can be built efficiently in groups of four, eight, or multiples of eight. Where multiple blocks are developed, the placement of housing blocks creates a central common park or plaza.

## FLOOR PLAN

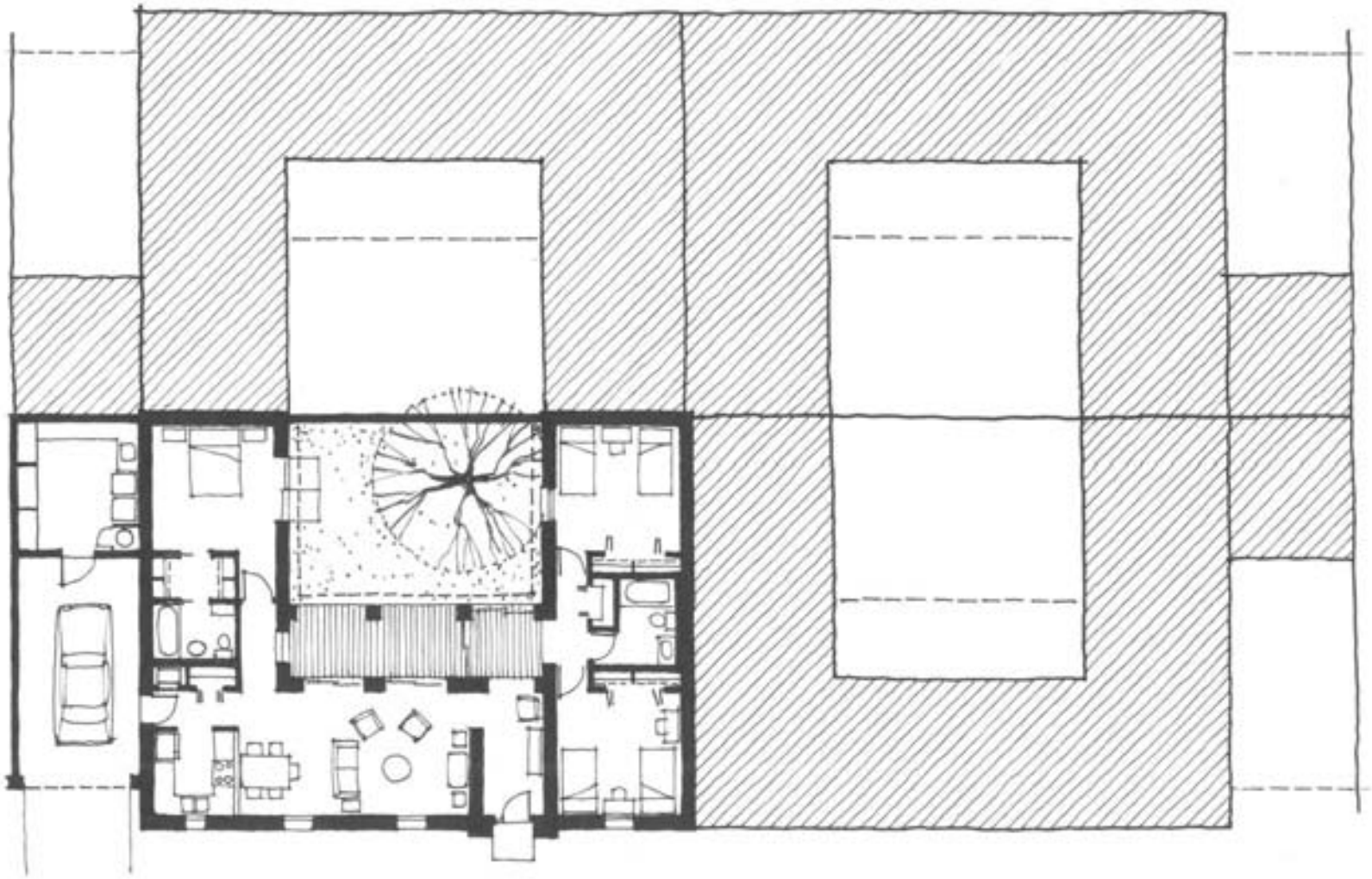
The "U" plan wraps a central courtyard on three sides, with public spaces fronting the street and bedrooms on the courtyard. Pedestrian entry is via a zaguán, that connects to the courtyard. A continuous porch connects the opposite sides of the courtyard. A parent's bedroom suite is across the courtyard from the children's wing for privacy. The bedrooms are large enough for two siblings each. Two full bathrooms are provided, as well as a utility room/laundry off the single carport. The house shares walls with its neighbors on two sides, while the carports also share a common partition.

Exterior walls are proposed of 16" thick stabilized adobe, left unplastered or (budget permitting) stuccoed with lime/sand plaster of varying integral colors. The wall thickness would allow either rammed earth or straw bale to be used as well. The roof structure is prefab wood or metal trusses with recycled cotton fiber insulation, OSB sheathing and corrugated metal roofing. Interior partitions are wood or metal studs with 5/8" gypsum board.

This prototype is superior in terms of functional arrangement and privacy. Due to the thick walls, the additional space of the zaguán entry, and the generous utility space provided, this 3 bedroom 2 bath prototype is larger than other options. At 1,600 s.f. it is 30 percent larger than the base case suburban model. To be competitive this prototype must achieve 30 percent savings in reduced land and infrastructure costs. A compact version of this house without the zaguán and with smaller rooms could be developed if necessary to make the approach feasible.

## SITE PLAN

The assumed site is a gently sloping plain near a small agricultural town in the southwest. Changes in grade can be accommodated by stepping the floor elevations along the shared walls, as illustrated by the Street Elevation. Changes in plaster color of the walls or wainscoting can be used to distinguish the joined houses from one another. This type of housing creates pedestrian scaled urban architecture along the model of the Rio Sonora valley towns.



FLOOR PLAN

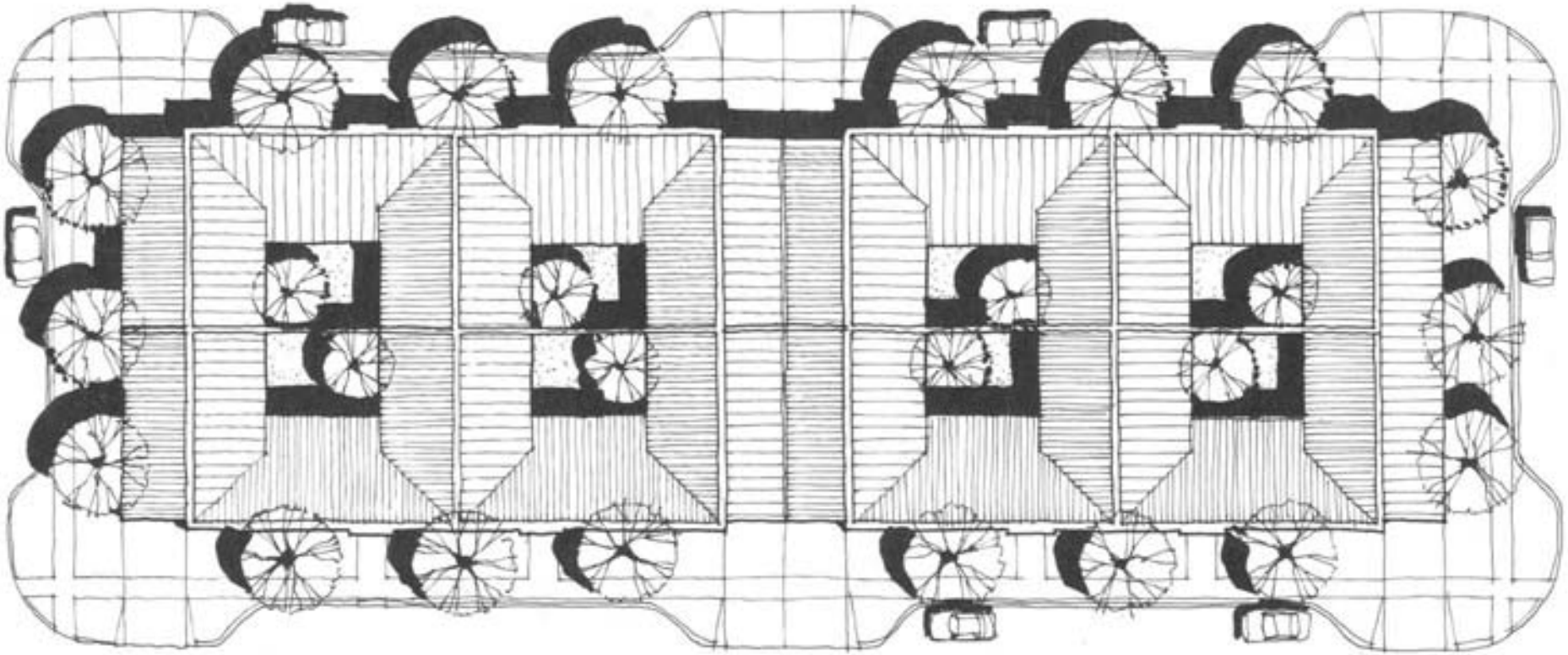
N

0 16

scale in feet

"U" TYPE COURTYARD HOUSE

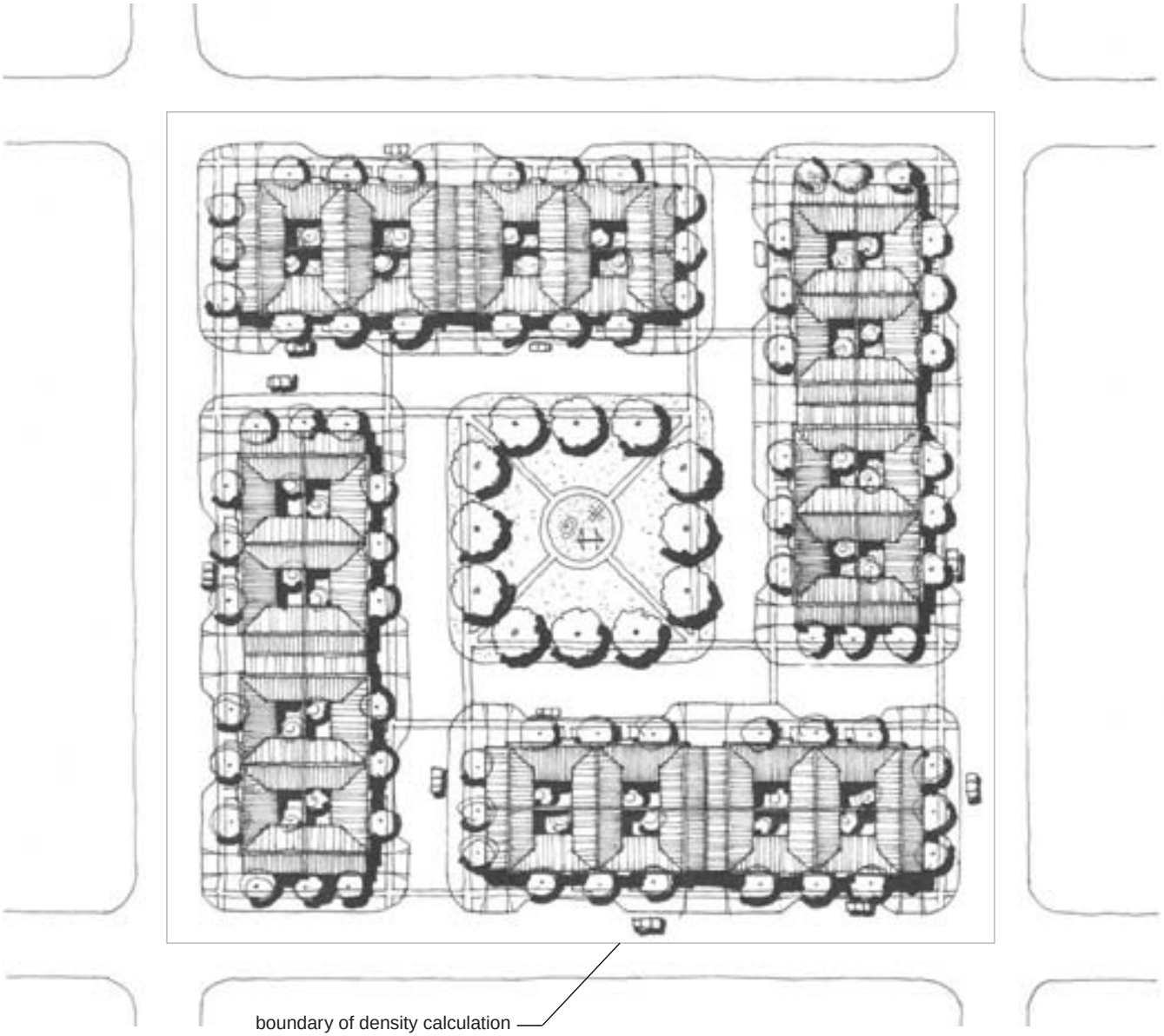
EXTERIOR WALLS: 16" THICK ADOBE, RAMMED EARTH, OR STRAW BALE




BLOCK PLAN

STREET ELEVATION

"U" TYPE COURTYARD HOUSE: 8 RESIDENCES / 1.13 ACRES = DENSITY 7.1 RAC




NEIGHBORHOOD PLAN

"U" TYPE COURTYARD HOUSE: 32 RESIDENCES / 5.68 ACRES = DENSITY 5.6 RAC

SUMMARY

| | | |
|---|---|---|
| Wall material: adobe, rammed earth or straw bale. | | |
| Gross Floor Area: | 1,311 sf | |
| Exterior Surface Area: | 1,937 sf | |
| Ratio of Floor Area to Surface Area: | .63 | |
| Estimated cost of construction: | @ $100/sf = | $ 131,000. |
| Density of land use: | 6.9 RAC | |
| Cost of land per unit @ ($50,000/Acre)/(6.9 RAC) = | | $ 7,000. |
| TOTAL ESTIMATED COST: | | $ 138,000 |

Based on Mexican examples in northern Sonora and southern Arizona, the "L" plan leaves a generous private patio or courtyard on one corner, and shares walls with adjacent dwellings on two sides. The house is brought forward to strengthen the pedestrian presence at the street, in stark contrast with the conventional subdivision's garage-dominated street facade. As with the "U" plan, the "L" plan locates its outdoor space within the house in the form of a courtyard.

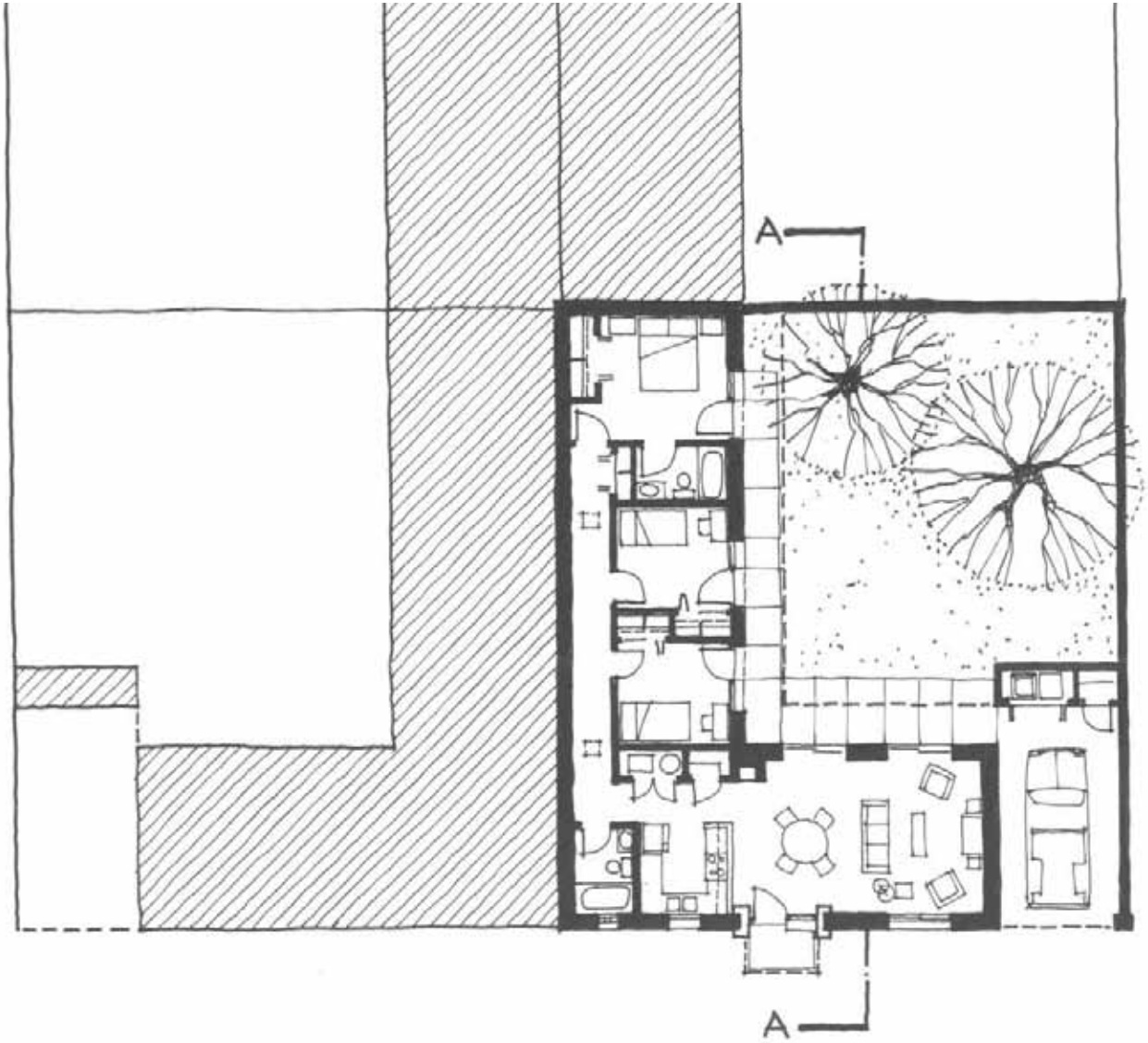
## FLOOR PLAN

The public spaces, living, dining and kitchen, are located on the short leg of the "L" at the street front. The bedrooms are placed on the long leg of the "L", each with direct access to the courtyard. A larger parent's room is located at the farthest end of the patio, with its own bath and closet. Two children's rooms connect to both the patio and an internal hall, which is necessary only at higher elevations in cooler zones. *At or below an elevation of 2,500 feet above sea level, the hallway may be omitted.* Deleting the hall would allow for larger bedrooms, accommodating a second child in each. As in Mexican examples, access to the bedrooms can be across the patio. A deep roof overhang protects the outdoor access, and shades windows and doors.

The exterior walls are proposed of adobe or rammed earth, exposed or plastered (budget permitting). As with all proposed prototypes, roof framing is prefab metal or wood trusses with corrugated metal roofing. Interior partitions, finishes and cabinets are economy standard. The special qualities of the house would come from the earthen walls, stained concrete floors and the courtyard space. This option has a large courtyard measuring 33' x 38', as compared with a 24' x 24' square courtyard including an 8' wide porch at the "U" plan. This leaves open the possibility of adding a future room along the side of the courtyard behind the carport/laundry area. This might be a studio, a workshop or an additional bedroom/bathroom. This built-in flexibility is a distinct advantage of this plan type.

## SITE PLAN

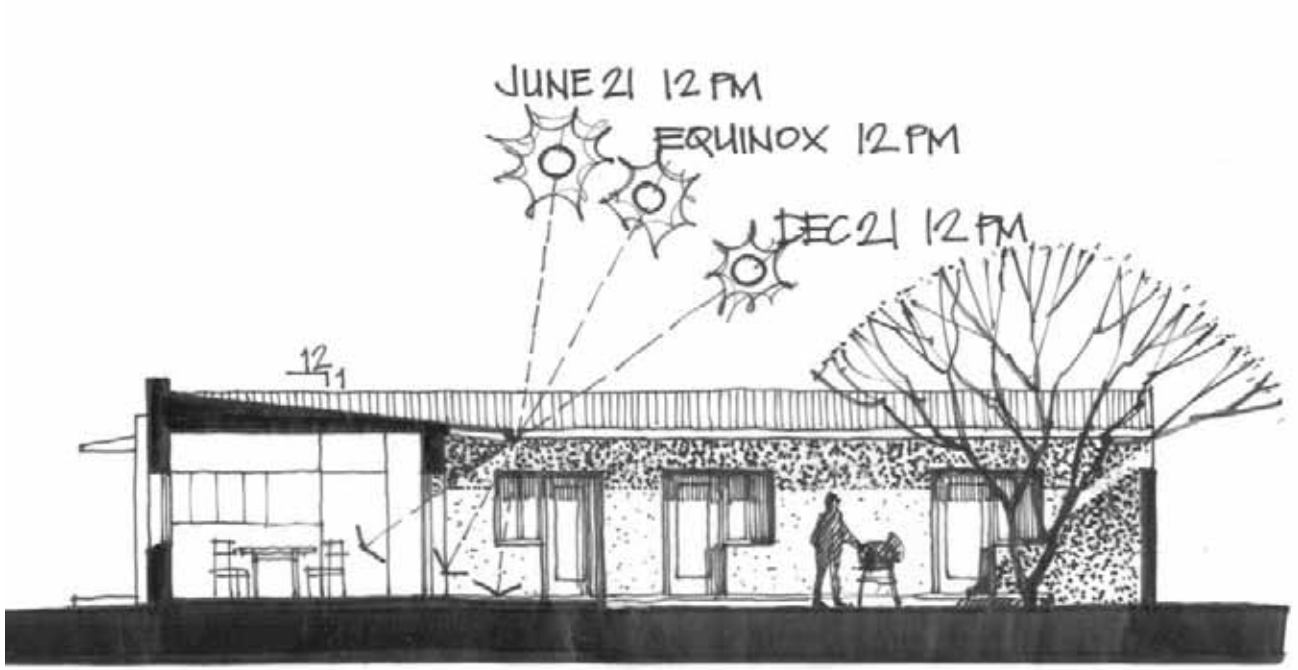
Following the principles of courtyard housing, the "L" plan permits high-density/low-rise development. The Block Plan and Neighborhood Plan illustrate the degree of density that may be achieved while yet maintaining privacy by virtue of the courtyard. The modularity of the block plan allows for subtle changes in grade between the groupings of houses. The overall neighborhood is focused on a central plaza with open space for recreation.




FLOOR PLAN

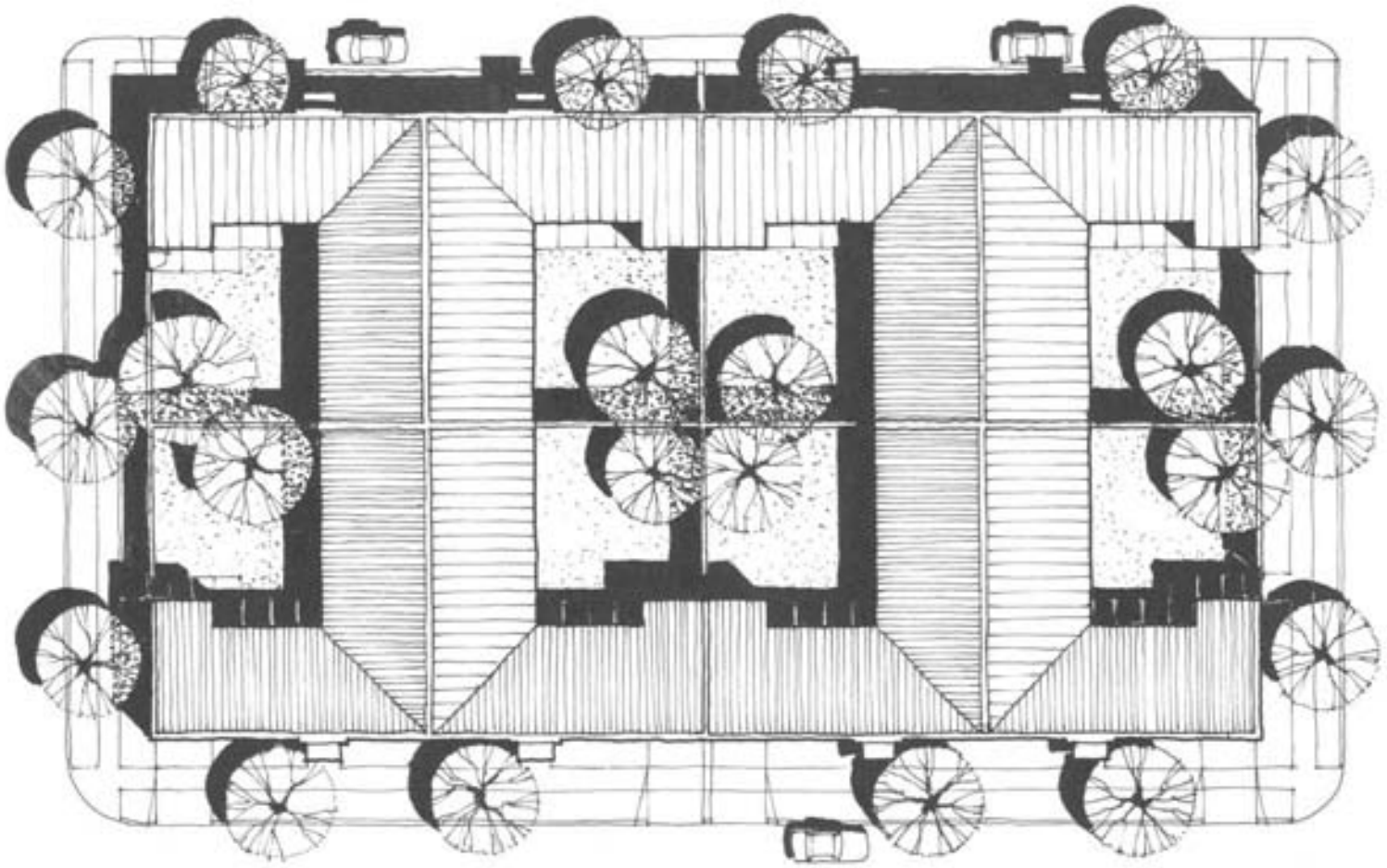
"L" TYPE COURTYARD HOUSE

EXTERIOR WALLS: 16" THICK ADOBE, RAMMED EARTH, OR STRAW BALE




SECTION A-A

0 8
scale in feet



BLOCK PLAN

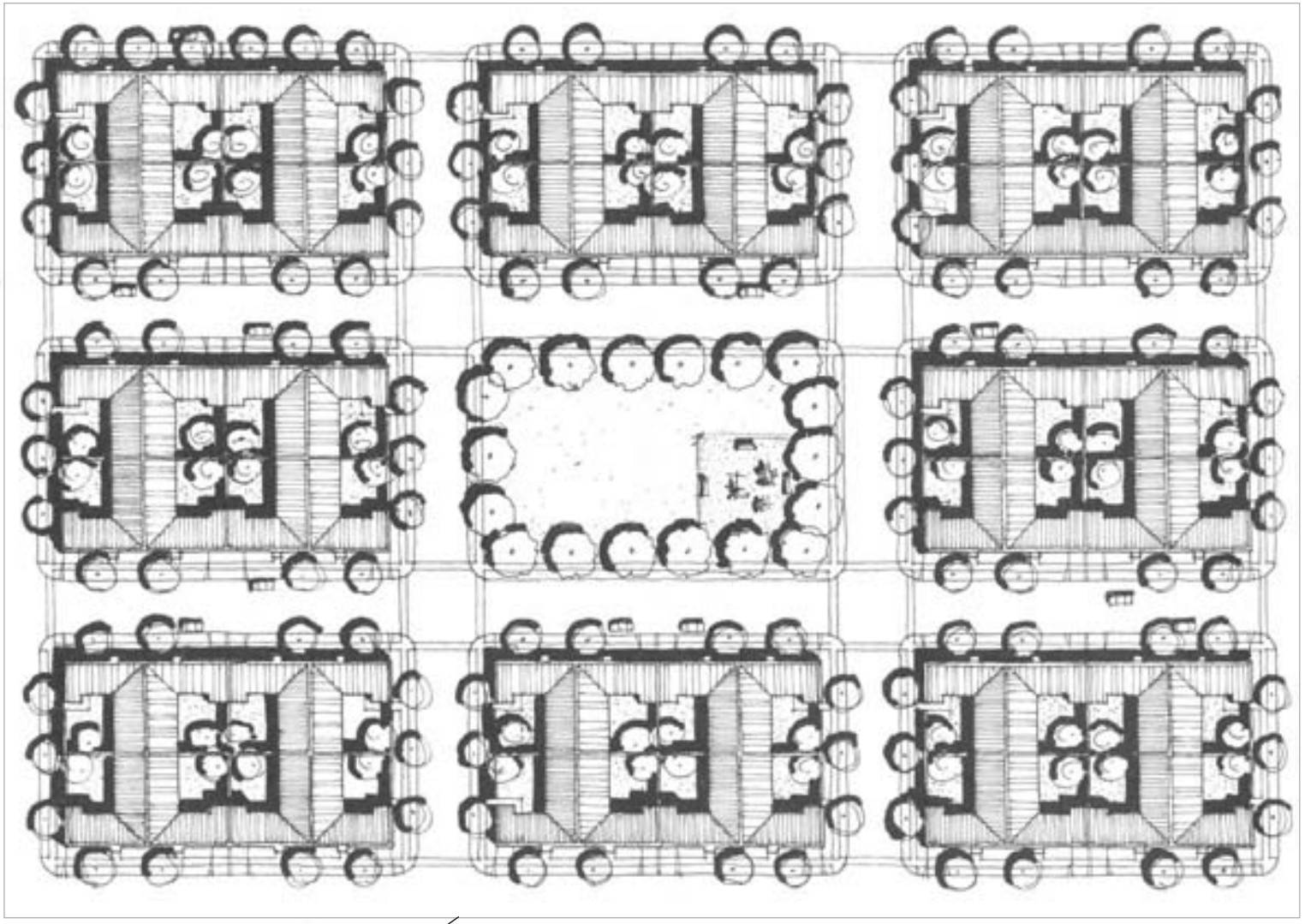
N

0 32

scale in feet

STREET ELEVATION

"L" TYPE COURTYARD HOUSE: 8 RESIDENCES / 1.16 ACRES = DENSITY 6.9 RAC



boundary of density calculation

NEIGHBORHOOD PLAN

N

0 100

scale in feet

"L" TYPE COURTYARD HOUSE: 64 RESIDENCES / 9.7 ACRES = 6.6 DENSITY RAC

*"Characteristics of houses and neighborhood:*

*a) Individual houses to create an optimum habitat for contemporary living needs in compact groupings which maintain independence and allow [human interpersonal] contact.*

*b) Houses oriented to interior patio gardens for family privacy, outside extension of living [space] and full use of all lot area.*

*c) Expandable houses which can increase in size from minimal units to ones of optimum area with internal flexibility to accommodate changing family space needs.*

*d) Low unit costs achieved through simplified unit design, maximum use of minimum space, improved building methods and dimensional standardization.*

*e) High density and compact development to (a) minimize distances and introduce walking as the main form of movement and communication; (b) reduce the extension of infrastructure and (c) use land efficiently.*

*f) Pedestrian streets as the main spatial focus in the neighborhood onto which face clusters of community facilities, such as shops, schools, kindergartens, etc., within walking distance from all houses.*

*g) Carefully relating vehicles and pedestrians for safety, secure family life, and tranquil movement for walkers.*

*h) Landscaped overall environment of small community gardens, patios, lanes with trees and planting."*

---

Peter Land, *Economic Housing: High Density, Low Rise, Expandable*

SUMMARY

| | | |
|---|---|---|
| Wall material: straw bale infill walls w/ CMU piers & glue-lam beams | | |
| Gross Floor Area: | 1,408 sf | |
| Exterior Surface Area: | 748 sf | |
| Ratio of Floor Area to Surface Area: | 1.88 | |
| Estimated cost of construction: | @ $95/sf = | $ 133,760. |
| Density of land use: | 11.1 RAC | |
| Cost of land per unit @ ($50,000/Acre)/(11.1 RAC) = | | $ 4,500. |
| TOTAL ESTIMATED COST: | | $ 138,260. |

Where the greatest efficiencies of land use and environmental performance are sought, the two-story prototype is most relevant. This approach is derived directly from Acoma Pueblo of New Mexico. Parallel rows of multi-story joined dwellings are oriented towards the south. Each dwelling has terraces providing private outdoor space for each family. Privacy between adjacent terraces is achieved by means of a stair-stepping wall, which lends visual screening while yet allowing sunshine to reach the terrace and house interior.

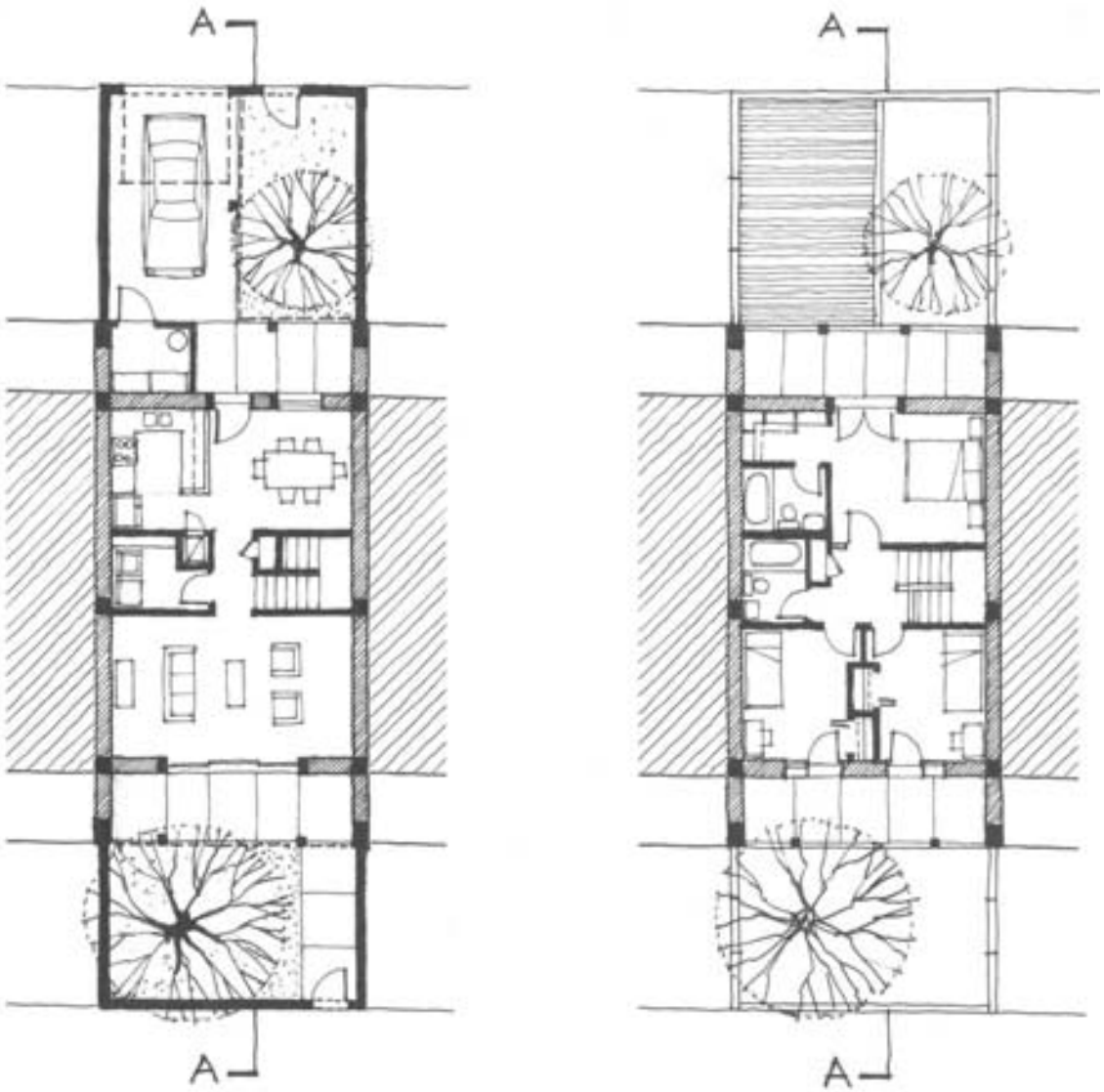
## FLOOR PLAN

Each house is accessed through small private courtyards, one each at ground level on the south and north sides. The east and west sides of each unit are common walls shared with adjoining houses, achieving a high level of economic and environmental efficiency. The ground floor includes the public spaces, while the private spaces are on the second floor accessed by a centrally located stair and utility core. As illustrated in both plan and cross section, second floor terraces/balconies at the north and south are accessible from each of the three bedrooms. The parent's suite is located across the central core from the children's rooms for privacy's sake. The terraces provide a covered porch below at the ground floor. Each dwelling has a single carport and exterior utility/mechanical room.

Walls are proposed of straw bale infill with reinforced concrete masonry (CMU) piers providing vertical and lateral support. Straw bale when finished with lime/sand plaster on both sides is an effective acoustic as well as thermal insulator, isolating the units one from the other. Roof and second floor construction is composite wood framing. Glued-laminated beams are used where spans require. This is a spacious house within a compact form.

## SITE PLAN

Drawing from the urban form of Acoma, rows of houses are aligned facing south along the east-west axis. A common space is located between the two rows of housing. This area might include a play ground, a meeting and recreation room, or (community budget permitting) a swimming pool. Trees are located to shade the exposed end walls of the east and west units. This example represents an efficient use of both land and building technology.




1ST FLOOR

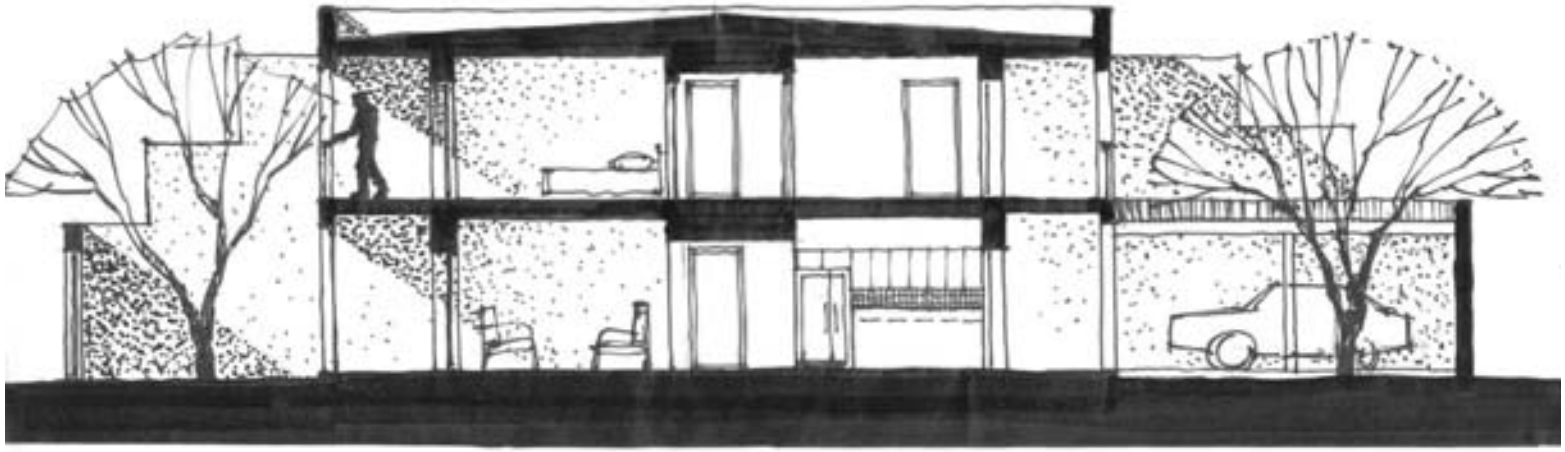
2ND FLOOR

N

0 16

scale in feet

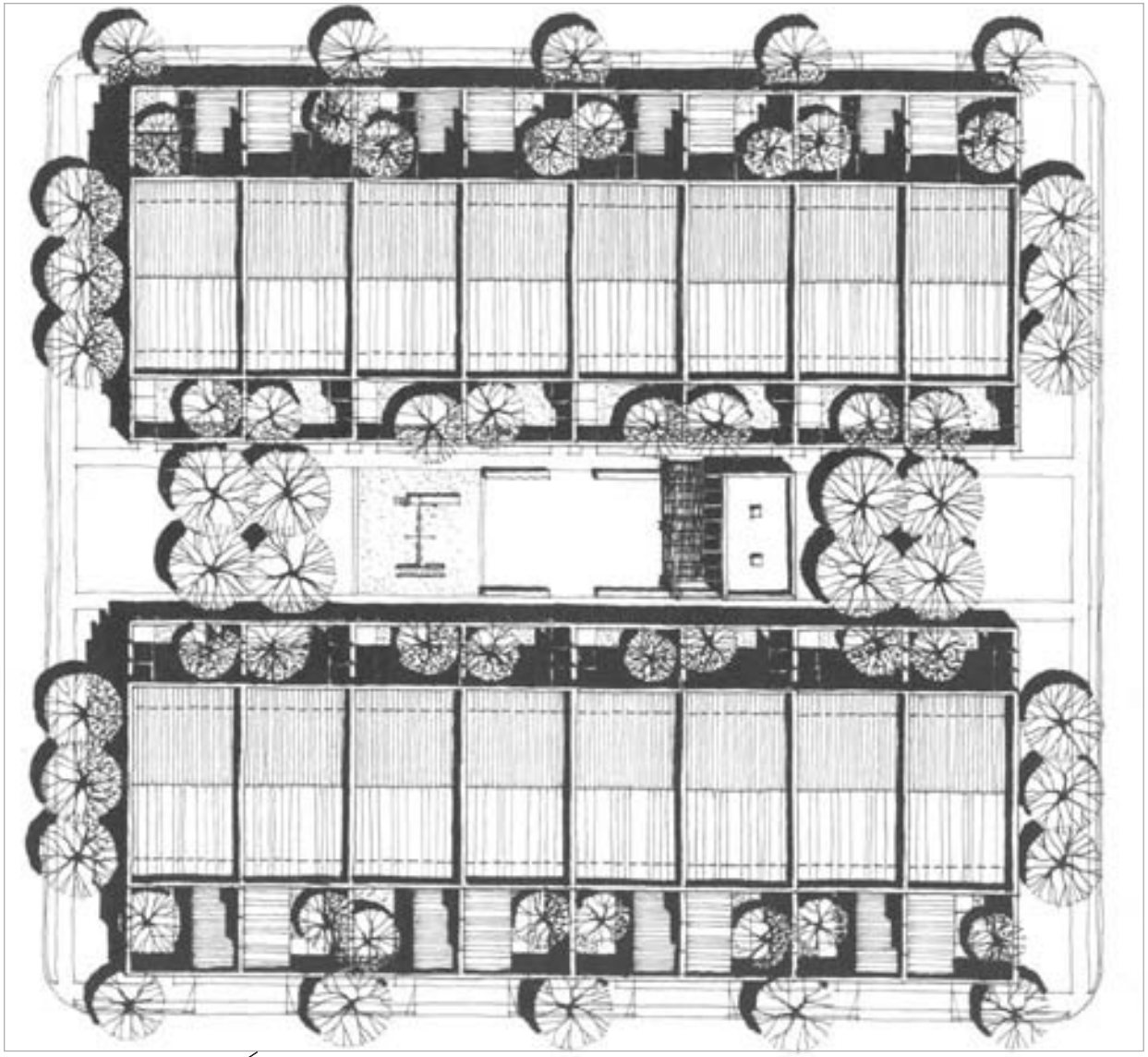
2-STORY ROW HOUSE (POST AND BEAM STRAW BALE INFILL)



SECTION A-A

0 10

scale in feet



boundary of density calculation

N

0 20

scale in feet

## NEIGHBORHOOD PLAN

2- STORY HOUSE: 16 RESIDENCES / 1.44 ACRES = DENSITY 11.1 RAC

# FINAL REMARKS

We hope this study of regional building traditions will support alternative design and construction methods in the production of affordable housing in the U.S. Southwest. Nonprofit developers, builders, planners and architects are invited to build upon the work begun here. Using traditional materials and design concepts in new housing can both reduce energy use within the home and result in healthier communities. Nonprofit developers are encouraged to look beyond the first cost of building houses to consider life-cycle costs, while creating more humane and culturally sensitive environments for southwestern families.

Traditional housing and community planning ideas can still be relevant to new developments, even where the higher cost of materials, such as adobe or rammed earth, prohibit their use. For example, our study suggests that rammed earth is feasible for affordable housing only if it is largely subsidized by volunteer labor. Where this is not possible, and where conventional materials must be used, the ranch house, the bungalow, the courtyard and the zaguán still have much to tell us regarding the design of individual houses and neighborhoods.

Thus, even if traditional materials cannot be used for financial or practical reasons, the affordable housing community is encouraged to apply the valid ideas embodied in traditional housing models.