

CHAPTER THREE

Characteristics of Housing Construction in Tecate colonias



The quality of housing construction in border *colonias* and the impact of this on the environment and on the health, safety, and quality of life of their inhabitants stems directly from the methods of construction of these dwellings, the materials used, and their design. These were investigated for two Tecate communities, El Rincon and El Descanso, which included *colonia* settlements. Conditions in these were compared to those in other *colonias* located in the border region and for the border region overall.

The characteristics of housing construction observed firsthand in El Rincon and El Descanso is similar to those of the general settlement and habitats in *colonias* of the U.S.-Mexico border. A relatively detailed review of selected *colonias* in and around Nogales, Sonora, based on surveys conducted in the selected *colonias*, provides a snapshot of construction and design practices in that region (Sadalla et al., 1998). Comparisons confirm that the findings in El Rincon and El Descanso are similar to observations further east in and around Nogales. Of the houses in the Nogales study area, 57% of the dwellings were composed primarily of wood, 32% of brick block or cement, and 3.3% of cartons/paper, while the rest were comprised of amalgamations of materials, including found materials.

Building on such findings the El Rincon and El Descanso *colonias* studies probed the means, methods and quality of housing construction especially regarding the range of materials and construction methods used; the sources of materials; the contractual methods and mode of construction and the capacity to create quality shelter; the diversity and capability of the contractor and subcontractor communities; and the prevalence of own-account or self-help housing. This information on the existing physical and social infrastructure, the economics of housing



Figure 13-19: Pictures of Housing in El Rincon

CAMERA 10	Place	Time	Comment
1		2:10 PM	Anabel Valdez. She does not like from her house that it does not have floor or light
2		2:10 PM	Anabel Valdez. She does not like from her house that water leaks through the roof and walls
3		2:15 PM	María Felicita Moreno. She does not like from her house that it leaks
4		2:18 PM	María Felicita Moreno. She does not like that water runs through her land when it rains



Figure 20: Pictures of Housing in El Descanso

Figure 21: Residents of El Rincon Photograph and Comment on their settlement

delivery, and the comfort levels and sustainability or lack of housing in the region provides a basis for assessing how a reconfiguration of the residential supply chain can more directly incorporate sustainable design and construction into colonia housing stock.

The presence of a large fraction of wood housing is surprising given the prevalence of concrete and masonry in formal housing in the region. The sources of these materials ranged from purchased to found materials, with a significant fraction of materials consisting of items found within a short distance of the colonia. The Nogales data indicated that approximately 60% of the floors in the study area were made of concrete (Sadalla et al., 1998).

Neighborhood infrastructure was quite variable. Very few of the residents sampled reported that they lived on paved streets. Only 7.9% of the areas self-reported the presence of pavement. The majority of the residents in this area arranged to have electricity in their homes. Overall, 80.8% of the sample reported some type of electrical connection, often informal or unregistered. The majority of dwellings in the surveyed *colonias* did not have a sewer connection. Thirty-one percent of the residents reported a sewer connection, while 69% reported no sewer connection. Residents who are not connected to a sewer system reported the use of latrines for the disposal of human waste. Based on observations of the area, latrines reportedly varied considerably in terms of quality of construction. However, a very large fraction were reportedly constructed in dense, rocky soil with poor drainage characteristics. Survey data indicated that houses with a sewer connection typically have piped in water; the fraction of houses reporting a water connection was identical to that reporting a sewer connection. Sadalla et al. (1998) point out that the conditions in the *colonias* they studied led to behaviors that were damaging to health and environment for the colonia residents and the surrounding communities. This concept was amplified by Davidhizar and Bechtel (1999).

Lumber is used elsewhere in the border region for the low income market. Lumber companies in Matamoros, Mexico had put into practice a

decent and affordable housing for low income market by selling simply-constructed houses (Transborder Shelter Network 1998a). Their typical product measures 12 ft by 20 ft and includes 4 to 5 windows, and two wooden doors. The structures are pre-fabricated at the lumber company, then are transported by truck to the purchaser's lot and placed on top of their foundation. By laying a concrete foundation, the owner improves the stability of the house. No climate control methods are provided. This housing is considered a low-income or "starter" product, but is installed in formal settings and as such, must meet minimum sanitary requirements within the city of Matamoros.

The Fraccionamiento Voluntad provides a similar example located to the southwest of Mexicali (Transborder Shelter Network 1998b). At this location, new housing prototypes were constructed which were equipped with electrical and public lighting service. The housing units include 27 square meters, built with a multi-use room which can be divided with a wood or sheetrock wall. The typical lot covers an area of 160 square meters, which allows space for future expansion of the structure. A latrine is included in the housing to meet sanitary requirements. The structures were constructed with concrete block walls on a reinforced concrete foundation, and waterproof three-ply roof. Electrical service was provided in surface-mounted polyduct. The housing came without climate control equipment, but some ventilation was provided via anodized aluminum windows.

Some large tract developers have attempted to enter the low income market for *colonias* in the El Paso, Texas region (Transborder Shelter Network 1998c). These homes have been developed using prevalent U.S. technology of dimensional lumber combined with concrete masonry block, atop reinforced concrete floors and foundations. This market has been approached in some cases with specialized machinery and equipment to facilitate the efficient construction of homes and development of efficient supply chains. Some climate control methods have been implemented in the construction of houses, and housing is commonly

constructed with fiberglass roll insulation. The El Paso example included the development of a master-planned community, with additional neighborhood amenities such as a community center. This level of housing appears to be quite unusual for the market (Davidhizar and Bechtel, 1999; Koerner, 2002)

Outside of the formal tracts as described above, there are also informal settlements in Texas (Cisneros, 2001). Houses often begin as tents or makeshift structures of wood, cardboard or other material. The houses are primarily built by residents little by little using found materials. As their finances allow, the owners add improvements, and rarely use professional builders. Many of today's colonia residents use septic tanks and cesspools; which are often at odds with the building and environmental regulations common in the area.

HOUSING CHARACTERISTICS IN EL RINCON AND EL DESCANSO, TECATE

The Tecate region is primarily a hot arid climate. There are four microclimates in the region. The largest microclimate experiences average temperatures in the range of 12° C and 18° C. Owing to topographic features the temperature is somewhat variable, with some areas experiencing winter season temperatures averaging 4° C and some experiencing summer temperatures averaging up to 22° C. From a climate control perspective, cooling loads are dominant, although winter heating can be necessary for short periods, especially in the night-time hours. Average annual precipitation ranges from 150 to 300 millimeters. The winds are predominantly from the south and west.

The superficial soils in the region are mostly rocky. Fertility is quite variable, depending to a great extent on the availability of water. In the higher reaches of the landscape, litosols support pasturing and forest use. Land use is a mixture of industrial and hospitality, farming, and a mix of low-rise retail and residential sectors. The industrial use is concentrated predominantly in the urban zone of the city of Tecate. Brewing and viticulture are important industries. The region is an important tourist destination, with a

number of hotels and spas, and several areas for outdoor camping.

According to the General House and Population Census of 1980, the municipality had 30,540 inhabitants, who represented 2.6% of the state population 0.04% percent of the national population, and was (somewhat) disproportionately young. The density of population as of that census was 9.9 inhabitants per square kilometer. The city grew at an annual rate of 5.2 percents for the decade of 1970–1980. The urban population represents two thirds of the municipal population and it is concentrated, mainly, in the City of Tecate. By the time of the General House and Population Census of 2000, the municipality had grown to 77,795 inhabitants (mostly in the city), now representing 3.1% of the population of the state.

The increase in population has brought upward pressure to the housing stock. Housing is predominantly provided via the private sector. According to the General Census of Population and Housing of 2000, the municipality had 19,020 dwellings, 90.9% of these were private properties. Most of the houses surveyed had electrical service, but water and sewer service were provided at a lower rate than elsewhere in the State. While the housing materials included concrete, block, and brick, wood frame housing was most common. The city provides electrical power, public lighting, police, and fire in addition to a range of social services.

Although all *colonias* were originally located outside the city, many are relatively close to the city and some have been annexed by it. This pattern of annexing relatively poor, substandard residential pockets of poverty on the periphery of cities has produced an urbanization pattern in which these pockets of settlements provide inadequate tax resources and relatively large population density, making the increase in services required extremely difficult to satisfy. For example, the 1990 census reveals that water service was inconsistently provided in *colonias* within the city, with 23% of owner-occupied units reporting no treated water in the house. The use of untreated water for drinking, washing,

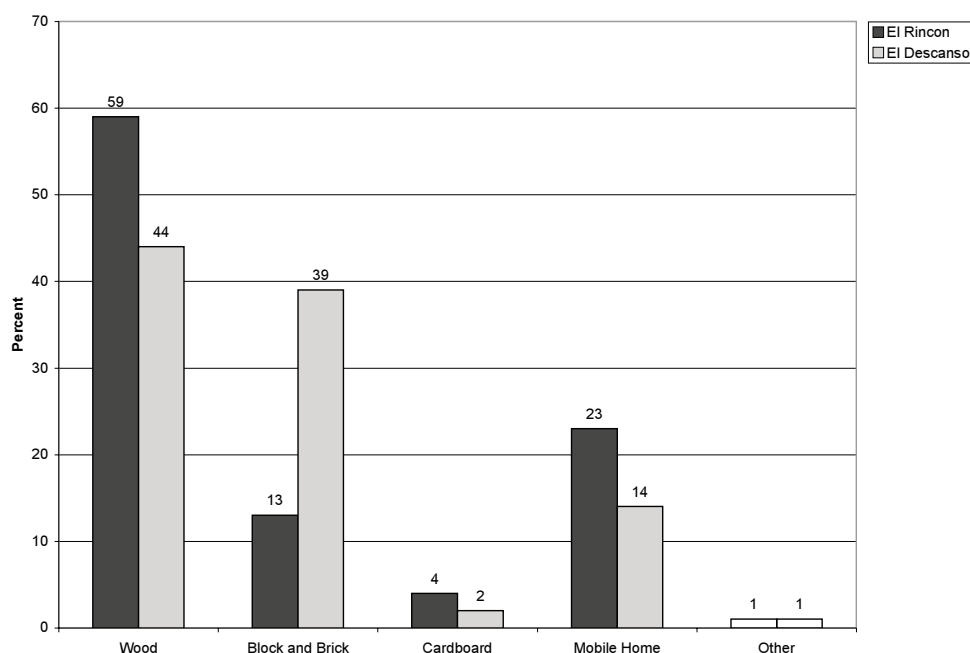


Figure 22: Primary Materials Used in House Construction in El Rincon and El Descanso

bathing and cooking ranged from 4% to 13% of households. The 1990 Census further indicates that approximately 50% and 20% of houses in rural and urban *colonias*, respectively, had incomplete plumbing facilities while 40% and 15% lacked complete kitchen facilities.

Site observations taken in 2004 in two Tecate *colonias*, El Rincon and El Descanso, revealed the methods and materials of construction of dwellings; the availability of services to the dwellings; the climate control methods employed; the regulatory policies that applied to construction standards; the capabilities of the local construction workforce; and, the general function of the construction services sector, as well as the construction materials supply chain. This provides insights into the production system currently in place in Tecate and the resulting housing and settlement products.

EL RINCON COMMUNITY

This residential area was characterized by substandard living conditions based on a sample of 175 houses. Of the houses in the El Rincon area, 59% were composed primarily of wood, 13% of brick or concrete block, 4% of paper carton, and 23% were pre-manufactured (mobile

homes or recreational vehicles), with the small remaining fraction consisting of amalgamations of found materials (Figure 22). Most dwellings seemed to have been built with local materials. There were some hardware outlets located close to this area and some, smaller scale ones were attached to dwellings within El Rincon.

The quality of the wood varied considerably in the majority of the houses which were built with wood products. A significant number incorporated a used garage door into the building envelope, and could only be described as informal constructions. Other wooden houses in the area had a more formal appearance, but were old and deteriorated. Houses ranged from about 25 to 100 square meters. Some homes had portable air conditioners installed in a window or through the wall.

A few houses were in the process of construction. These did not have a visible (required) construction permit issued by the authorities. Residents of this area said that the local authorities do not inspect construction within El Rincon. Houses constructed with wood were often stuccoed, with a layer of paper and a layer of metal lath used for backing. Insulation and

climate control equipment were not observed on these homes. Construction seemed to be conducted by the residents, sometimes with the assistance of family or friends.

The majority of dwellings in the colonia did not have a sewer connection although residents reported that a main sewage system was installed to serve the area two years ago. Reportedly only a few dwellings actually completed a sewer connection as they lacked the financial means. Residents who were not connected to a sewer system used latrines for the disposal of human waste. Latrines varied considerably in terms of quality of construction. Virtually all were situated in dense, rocky soil a few feet from the dwelling, although only a few houses seemed to have their latrines incorporated into the dwelling. Houses with a sewer connection typically had piped water, while houses without a sewer connection relied on buckets and water tanks. The majority of the residents in this area had arranged to have some type of electrical connection, although many of these were informally obtained from nearby overhead wires.

A pilot study to capture the sensibilities of El Rincon residents was made by distributing disposable cameras to ten residents and asking them to take pictures of the home and surroundings to document what they liked, were concerned about, and would like to change, in their immediate neighborhoods (Figure 21). This study indicated that 68% of residents placed a high priority on improving their dwellings, while 20% expressed a high priority for improved services. Other wishes were more parks and playgrounds (5%), more schools or churches (3%), and cleaning up the Tecate River (3%).

EL DESCANSO

The El Descanso area exhibited better planning and housing conditions. Some of the streets were paved, and had curbs and gutters to control storm water. A sample of 175 houses was observed in order to obtain a breakdown of the construction materials used in existing housing units in the area (Figure 22).

Approximately half of the houses made out of brick, block, or concrete were two stories. In some of these houses, the second floor was made out of wood. Houses made using brick, block, or concrete were supported on stone foundations. This material is abundant in Tecate. Roof construction and maintenance was clearly a significant problem in the region. Significant numbers of residents and/or contractors were observed performing roof repairs during the visit.

In contrast to El Rincon, in El Descanso the dwellings observed under construction were being built by contractors. In most cases these were informal arrangements with individual tradesmen, and it appeared that typically two to three construction tradesmen were hired to perform the construction. Based on interviews and observations, it appeared that the work was performed without plans or any formal building inspection process. Workers reported that they built the houses according to owners' specifications, usually communicated verbally on a frequent basis. Several homes were observed being enlarged; construction of a small starter structure by a contract labor force, with later expansion, appeared to be a common technique.

El Descanso has electricity, storm drainage and piped fresh water. The majority of the houses in the area had a sewer connection. Residents who were not connected to a sewer system used latrines for the disposal of human waste, although latrines were rarely seen in this zone.

MATERIALS USED IN HOUSING CONSTRUCTION AND SUSTAINABILITY

The lines of small San Diego bungalows waiting to cross into Tijuana by truck (Cruz, 2006) are emblematic of a flow of used and reused materials, appliances, equipment, manufactured homes and recycled houses and house parts which filter across the border and serve to provide shelter and homes to residents south of the border. An examination of the characteristics of the residential housing production system currently in place in Tecate reveals similar flows of materials and structures.

The 2000 Mexican census (INEGI, Instituto Nacional de Estadística, Geografía e Infor-

mática), estimated that there were more than 3.9 million homes in the six states of northern Mexico. Many of these houses were located in irregular, or non authorized settlements lacking services and offering extremely poor living conditions. The statistical information compiled by INEGI on housing construction materials used in homes in the six Mexican states bordering the U.S. includes the category “other materials”, meaning many irregular, recycled, reused materials ranging from cardboard, resold older mobile-homes, old resold campers, scrap wood and other salvaged materials. 20% of roofs and 14% of walls of homes in these states are made of such “other materials”.

INEGI data for the state of Baja California reveals that 25% of homes use wood in the walls and 61% use it in roofs. This lumber consists mostly of salvaged materials and the walls and roofs lack insulation, creating severe thermal discomfort in the homes. The problem of using wood in the U.S.-Mexico border region is the extreme climate where temperatures commonly reach highs of 40° C or more in the summer, and lows below freezing in the winter. This climate makes small houses very warm most of the year and quite cold in the winter. In addition over 70% of low-income colonia houses along the Mexican border built with blocks and bricks use ones that are only 14 cm wide. Although concrete blocks have good thermal and mass properties they are still not sufficiently thick to moderate indoor temperatures. Most irregular settlements like El Rincon do not conform to any construction codes. Most of the housing is of poor quality and provides very poor thermal protection which is even worse than un-insulated brick homes. The typically low (2.1 meter) average ceiling height compounds heat problems in the summer by greatly concentrating and trapping heat. Not only are residents' comfort levels low but there are resulting health problems.

SOURCE OF CONSTRUCTION MATERIALS IN TECATE

Few construction materials are produced locally in Tecate. Materials are largely brought in from Mexicali and, more significantly from

Tijuana. Much of Tecate's commercial activity is clustered in and around the city of Tecate, the rest of the municipality having virtually no commercial activity apart from small tienditas (small local grocery stores). Most of the businesses in Tecate limit themselves to the basic goods of daily consumption and a very small fraction of the business community is involved in selling construction goods. There are approximately five hardware stores, only one of which specializes in the sale of wood and lumber.

The formal construction industry still uses mostly traditional materials for housing. Managers of construction materials stores and local developers who were interviewed reported that brick and concrete are the material of choice. They noted that the reason most low-income families use wood on roofs is because it is cheaper and requires less time to construct than is required for pouring concrete roofs. Over 90% of families temporarily build their homes, completely or in part, using wood, with the objective of rebuilding, as soon as they can afford to, with construction materials, such as brick and concrete. INEGI reports nearly 61% of wood roofs statewide. In the community of El Rincon the research team found almost 59% of homes utilized wood as the primary material of construction. Homeowners in the community reported that as soon as their land occupancy was regularized and legalized they would start to rebuild with concrete and block or brick.

Information obtained from the five major hardware and construction material stores in Tecate (Ferretodo [2 stores], Materiales Jimenez, Materiales Gomez and Tarimas del Toro) indicated that over 80% percent of the wood used for low-income housing is salvaged from construction sites in the United States. Some businesses buy truck loads of old disposed wood and sell it in Mexico for multiple uses such as the construction of housing, for forms needed for concrete construction and even furniture. This trade in recycled wood from the United States does not benefit local businesses that sell traditional materials nor those that sell wood and similar kinds of materials locally.

EL RINCON

The El Rincon community consists of approximately 1000 inhabitants, about 300 low-income families. Housing and settlement conditions are irregular and out of code. During the time of the field survey local and federal governments were in the process of deliberating whether to grant the irregular component of the community full legal land tenure. The residents cooperated with and were eager to participate in the survey as they hoped to be able to implement some of the design parameters that would be suggested in improving their housing if tenancy rights were obtained. The housing conditions of El Rincon needed attention at every level from urban planning, house design to material selection. The sample of 175 houses surveyed to determine the types of materials used in construction (Figure 22) reveal that the majority of the materials used for housing construction on the unregulated settlement of El Rincon were salvaged materials that do not offer any substantial thermal mass and/or good thermal properties. Many of these houses were built with single layers of plywood, old doors, second-hand lumber boards and cardboard. None of the materials used met construction codes and/or city regulations. The main conditions for thermal comfort are air temperature, radiant temperature, air speed and humidity. To achieve healthy indoor comfort, a combination of good thermal mass and insulation is needed. None of the needed thermal conditions were met in any of the surveyed homes. Single layer material for walls and roofs that allow air infiltration are a basic problem in these improvised houses. Examples of the types of materials that are being used in home construction in El Rincon are illustrated in Figures 23–26.

CLIMATE AND WEATHER

The municipality of Tecate can reach extreme temperatures over the summer and winter seasons. In September 1972 it registered a record of 34.9° C and then in August 1985 another record of 35.6° C. In February 1972 the Comision Estatal de Aguas (CEA State Water Commission) registered a low of -1.2° C. In winter these low temperatures can be exacerbated by rain. From November to March the region can get up to

337.8 mm of rainfall, which makes for very uncomfortable living conditions for people living in homes which lack proper insulation and sealed, non-leaking roofs. Weather conditions must be factored in order to make appropriate selection of construction materials. Average temperature readings over the year for the City of Tecate are shown in Figure 27.

ENVIRONMENTAL COMFORT

Indoor temperatures in the types of structures observed in El Rincon are not ideal for achieving an acceptable and healthful environment. It is important to understand thermal comfort so that recommendations on construction materials can be developed. Figure 28 delineates the periods during the year when temperatures in Tecate fall above 81° F (dark yellow) or below 68°F (blue) which is the comfort range defined by ASHRAE. The diagram illustrates that both heat and cold must be contended with in Tecate and shows the time of the year when heat or cold is a problem.

The thermal environment can be evaluated with simple calculations or by using computer simulation models. Full-scale laboratory testing could be developed to evaluate real operational temperatures for the existing houses in the El Rincon community. However information gathered from a sample of 30 heads of family revealed the thermal comfort levels that were experienced by the residents. The survey corroborated what the comfort zone chart (Figure 28) indicates. Most of the families surveyed stated that both low and high temperatures were a major problem in their community. The PPD indicator, or percentage of people dissatisfied, recorded rates of over 90%, especially among the elderly and minors. Cold temperatures were reported as the main discomfort factor. Residents reported that warmer temperatures could be reduced by using electric fans, and manipulating fenestration (opening and shutting doors and windows at appropriate times).

Figure 29 illustrates the different environmental factors within a house that affect El Rincon families the most. Most of the thirty



Figure 23: House Constructed of Second-Hand Salvaged Doors
 Figure 24: Interior Side of Exterior Wall Constructed of a Single Layer of Plywood Board
 Figure 25: House Constructed of Used Plywood Sheets and Wood Boards
 Figure 26: Outhouse Constructed of Single Layer of Recycled Wood Boards

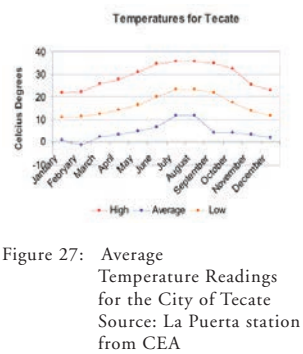


Figure 27: Average Temperature Readings for the City of Tecate
 Source: La Puerta station from CEA

Figure 28: Tecate Comfort Zones
 Source: Ernesto Fonseca

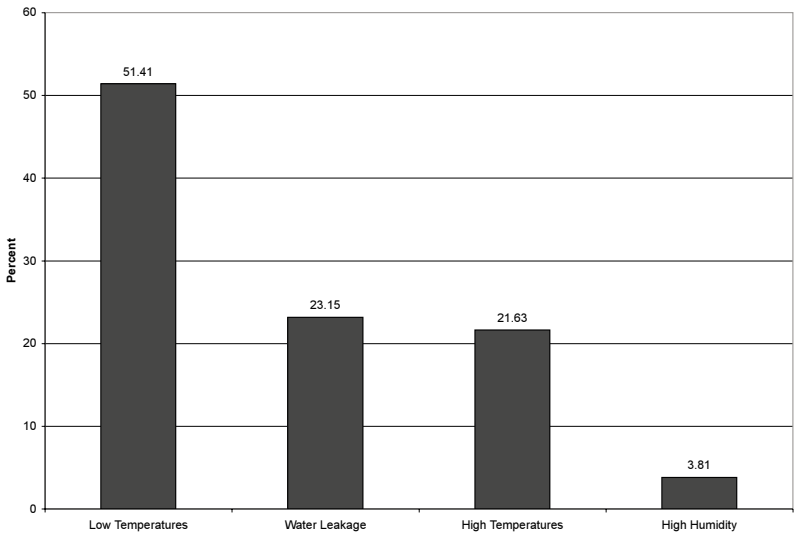


Figure 29: Factors Causing Environmental Discomfort in Homes

households interviewed reported that it was much easier to adapt and/or to tolerate warm and high temperatures, but that it was not possible to tolerate or protect against extreme low temperatures. Humidity was not reported as an important issue, but some people reported that even though it was not a major problem, it would be useful to design housing taking into consideration humidity rates during the summer.

It is clear that inhabitants of the two communities studied would benefit from housing designed to maximize comfort under the climatic conditions that exist in Tecate. Sustainable design for these dwellings would minimize the use of energy and use appropriate materials. Concepts and applications for such design and material use are provided in the next two chapters.