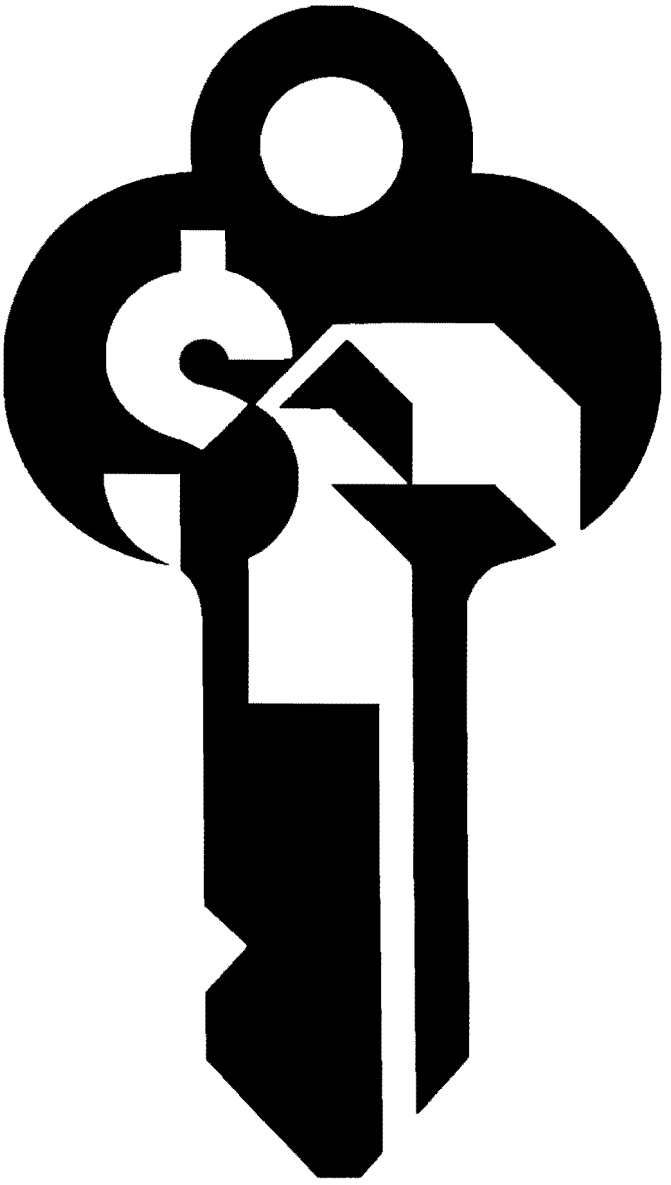
U.S. Department of Housing and Urban Development
Office of Policy Development and Research

National Association of Home Builders

An Approach for the 80's:

Affordable Housing Demonstration



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Acknowledgements

Many individuals contributed valuable time and expertise toward making Approach '80 successful. Although space does not allow a complete listing of all who contributed, some individuals were so important to the project's success that, without them, Approach '80 would not have been possible. These individuals include Las Vegas builder/developers Dudley Smith and Ernest Becker, Las Vegas Mayor William Briare, Las Vegas Deputy City Manager Donald Saylor, and Orville Lee of HUD's Office of Policy Development and Research. Also, NAHB's Approach '80 Task Force co-chairman Robert Gardner, Grand Junction, Colorado, and Larry Goldrich, Virginia Beach, Virginia, were important individuals to the project. James Cashman, Riverside, California, was extremely helpful in obtaining approvals from the City of Las Vegas. Milton Smithman, NAHB Staff Vice President of Special Projects, coordinated the efforts of all the participants. David Jensen, Denver, Colorado; Cy Paumier, Jr., Columbia, Maryland; and Stephen Mead, Des Moines, Iowa, provided land plans and architectural input.

In addition, several building product manufacturers and trade associations were extremely helpful in providing technical expertise. These included Champion International, Shell Chemical, Qest Plumbing Products, Hoover Universal, California Redwood Association, Zinc Institute, American Plywood Association, and American Wood Preservers Institute.

This report was prepared by the NAHB Research Foundation, Inc., for the U.S. Department of Housing and Urban Development. The statements and conclusions contained herein are those of the author, E. Lee Fisher, Director of Industrial Engineering, and do not necessarily reflect the views of the U.S. Government in general nor HUD in particular. Neither the U.S. Government nor HUD makes any warranty, expressed or implied, as to the accuracy or completeness of the information contained herein.

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Introduction

Although more residential construction has occurred in America during the last few decades than in any comparable period in history, the United States is facing a housing crisis of alarming proportions. Costs of developed land, building materials, and labor, plus extremely high interest rates have severely limited homeownership possibilities for all but the most affluent. In addition, each year brings new constraints to builders and developers in the form of governmental regulations, which invariably add to the total housing cost.

In addition to the added construction cost of each regulation, in many areas, a corresponding proliferation of governmental agencies and bureaucratic procedures have created a confusing network of approvals that are extremely time consuming and costly, ultimately to the home buyer. Outdated, conflicting, and complicated codes and standards, environmental issues and requirements, and energy conservation issues all add to the dilemma—and to the cost—of home ownership.

Originally, regulations and standards were promulgated to insure a safe and healthy environment for dwelling occupants. Today, many regulations have little, if any, relationship to health and safety. However good the intention, however small the cost of each regulation, the sum of the controls has created a substantial cost that is added to each new home built.

In addition to the additional cost of regulations, the average size of new homes has increased steadily each year since World War II. During this period home buyers were demanding and getting larger homes with more amenities on larger lots. The situation was not dissimilar to the automobile industry that was able to create mammoth luxury cars out of small economy cars in a few short years of "improvements." Like homebuilding, the auto industry has had to contend with increased governmental regulations, rapidly rising material and labor costs as well as the consumer's desire for a larger product with more gadgets.

Therefore, the excessive cost of producing a home has become a problem with multiple causes that will require multiple solutions to correct. Against this troubled backdrop, Approach '80 was conceived.

Background

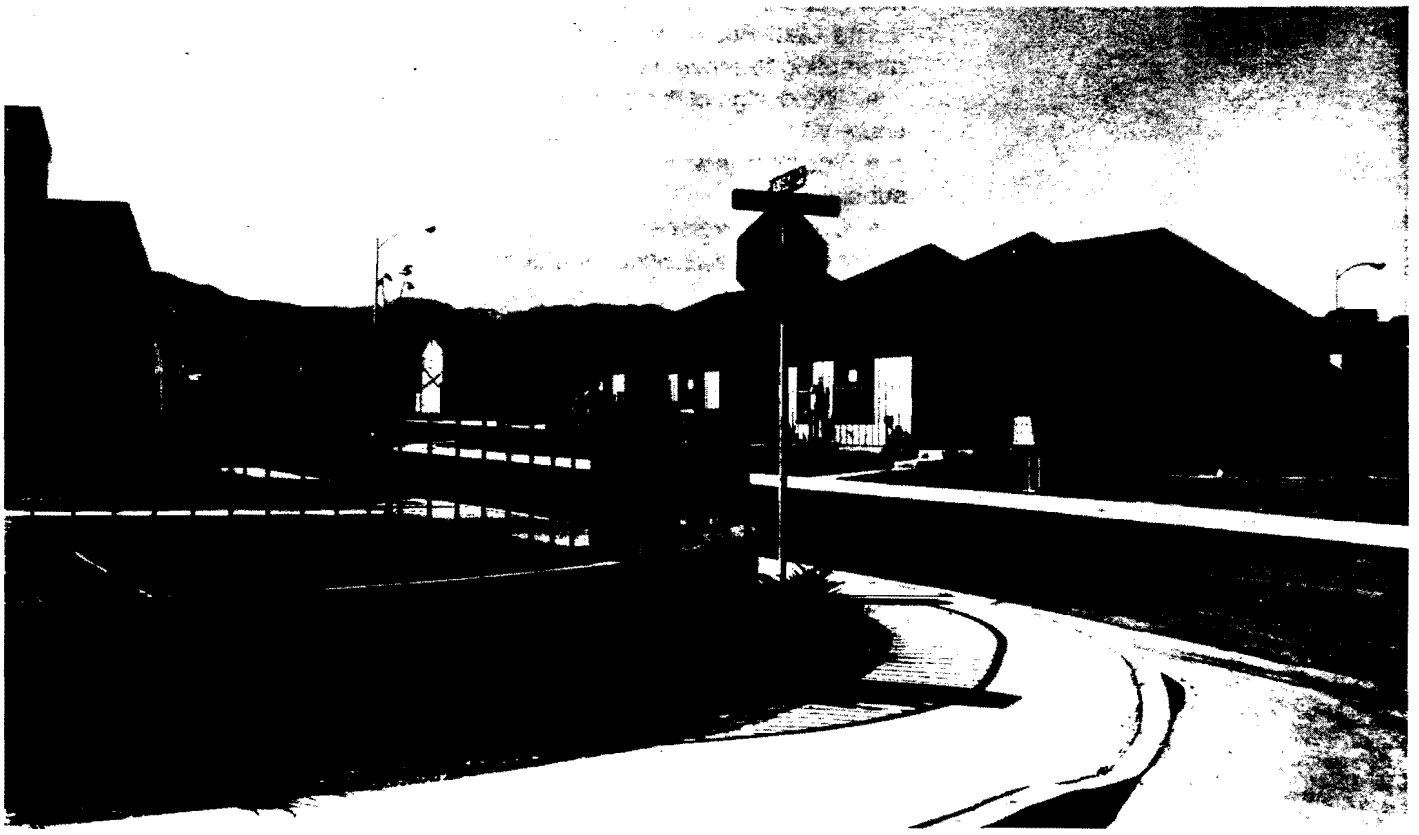
For years the National Association of Home Builders (NAHB) and the NAHB Research Foundation, Inc., have been searching for solutions to the rising cost of housing. NAHB has created special committees on affordable housing, the cost of governmental regulations, labor and material costs, and others. It has sponsored research on reasonable land development standards, cost-effective energy performance guidelines, construction cost control, productivity, and management techniques. Through the NAHB Research House Program, many innovative products and techniques have been demonstrated. Indeed, almost all of NAHB's standing and special committees have been charged with finding ways to produce safe and healthy homes and apartments at an affordable price.

The NAHB Research Foundation, a wholly owned subsidiary of NAHB, has also been involved with the problem of housing affordability. In addition to

conducting much of NAHB's research efforts over the years, the Research Foundation contracted with building product manufacturers, governmental agencies, and individual building firms in an attempt to find solutions to housing the greatest number of Americans at the least cost. Under contract to the U.S. Department of Housing and Urban Development (HUD) the Research Foundation has developed the Optimum Value Engineered (OVE)[1] construction system, two Energy Efficient Residences (EER) and several other cost effective housing systems, products, and techniques. Working with the building products industry, the Research Foundation has developed construction systems and products that improve housing value, such as the Engineered 24 inches-on-center building system.

HUD has worked to develop programs to make housing affordable. In addition to the OVE and EER systems, HUD created a National Conference on Housing Costs, which resulted in the Housing Cost Reduction Demonstration and the Building Value into Housing programs. HUD also has sponsored independent research on building codes, updating the Minimum Property Standards (MPS), minority housing, and housing for the physically handicapped, much of which was conducted by the NAHB Research Foundation. Throughout the years HUD has developed financing and subsidy programs aimed at making housing affordable to a greater number of Americans.

Therefore, a combination of HUD, NAHB, and the Research Foundation was uniquely equipped to develop a housing project that would demonstrate land development and construction methods to create lower cost homes.



Entrance to Approach '80

1. *Reducing Home Building Costs With OVE Design and Construction, Guideline 5*, Superintendent of Documents, Washington, D.C.: Government Printing Office.

Approach '80 Concept

In 1978 HUD's National Conference on Housing Costs called together a broad cross-section of National leaders, members of the private housing sector (including NAHB and the NAHB Research Foundation), consumer interests, academics, and state and local officials. This conference recognized the need of a multifaceted approach to reducing housing costs.

At the same time, Ernest Becker, then president of NAHB and a Las Vegas builder, became a leading industry proponent of affordable housing and asked the NAHB Standing Committee on Research to design and build two dwellings in Las Vegas in time for the 1979 NAHB Convention/Exposition that would demonstrate cost-saving construction techniques without compromising health and safety of the occupants.

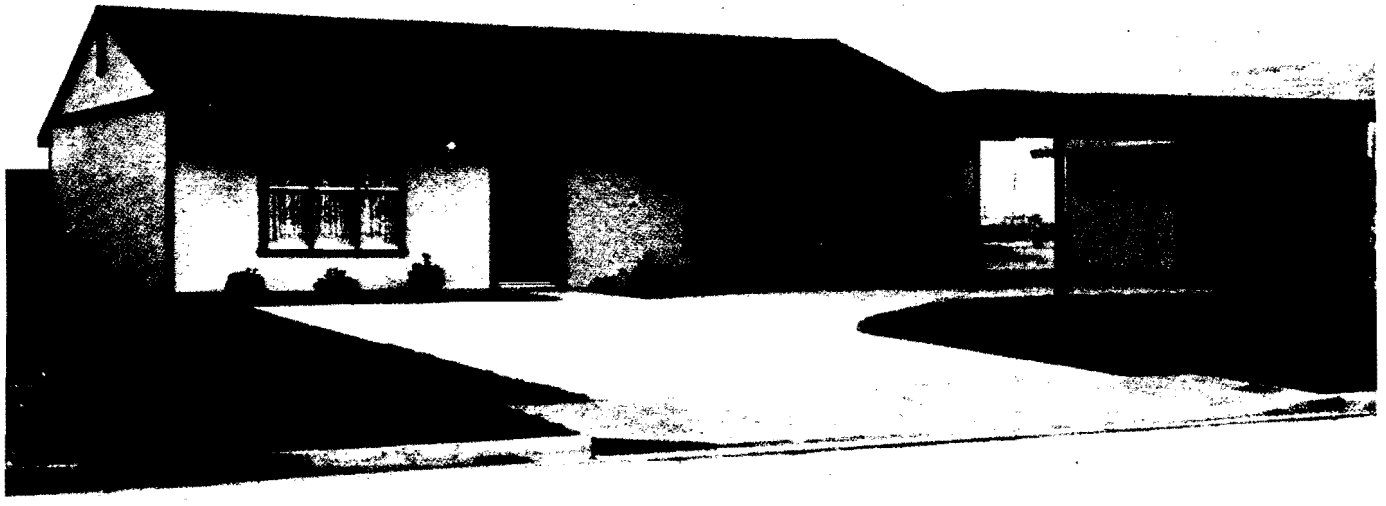
The City of Las Vegas made special exceptions to the building code to allow the homes to be built and occupied. Using conventional building materials and methods and a well-thought-out, well-engineered plan, builder Dudley A. Smith, then chairman of the Research Committee, built the two Cost Buster homes. The work drew heavily on past research done by the NAHB Research Foundation, especially the OVE house.

The Cost Buster project was conceived as a demonstration of modern, economical construction, free from unnecessary codes and regulations. The project did not attempt to prove marketability, customer acceptance, or adaptability to other locations. It did clearly illustrate that a safe, sturdy home can be built at reduced cost. Direct construction cost savings amounted to about 25 percent of the cost of a conventionally built Las Vegas home of similar size.

The Cost Buster homes made considerable impact on the residential building community. They were featured on a national television network newscast and articles were written about the homes in many of the nation's leading newspapers and housing periodicals.

The Cost Buster demonstration was extremely successful in what it was attempting to prove. However, valid criticisms of the project were offered:

- The design of the homes might prove unmarketable in many parts of the country.
- The homes were built on standard size lots in a conventionally developed subdivision.
- Cost of developed land in some parts of the country would be more of a factor in total sales price than direct construction cost.



Cost Buster House

Some builders had difficulty identifying with Cost Buster because of some construction techniques were not used in their areas. For example, the Cost Buster homes built on concrete slab foundations/floors. Some builders who built on basements or crawl space foundations dismissed the demonstration as being unusable back home. Since the foundation/floor was only a part of the demonstration, rejection of the total project on this basis seems to indicate that more builder education would be in order.

Because of the interest in Cost Buster and the unresolved questions raised by the project, a joint task force was formed from NAHB's Standing Committees on Research and Land Use.

Members of this Task Force, along with NAHB staff members and the Research Foundation went to HUD with the concept of an affordable house community—also to be built in Las Vegas—that would integrate efficient land planning, cost effective construction, and maketable design. HUD agreed to help sponsor such an undertaking and offered its support in obtaining approvals as well as financing assistance. The houses were to be built under the HUD Experimental Housing Program and to be insured under HUD Section 233 pursuant to Section 245 Graduated Mortgage Program. Under Section 233 if any defects develop in the experimental aspects of these houses HUD guarantees their restitution and repair.

Ernest Becker obtained a suitable site for the project and Dudley Smith developed the site and built the homes. Both were instrumental in getting Las Vegas city officials to support the project. Stephen Mead, AIA, of Des Moines, Iowa, was selected to design the housing units while the land plan work was assigned to the Land Use Committee. The Research Foundation was charged with providing construction system advice and with monitoring of construction.

The Approach '80 Task Force met several times and agreed on a land plan and the dwelling designs. The underlying theme of Approach '80 was to develop a relatively high-density subdivision containing single-family detached homes, duplexes, and townhouses arranged in such a way so as to provide privacy, along with a feeling of openness.

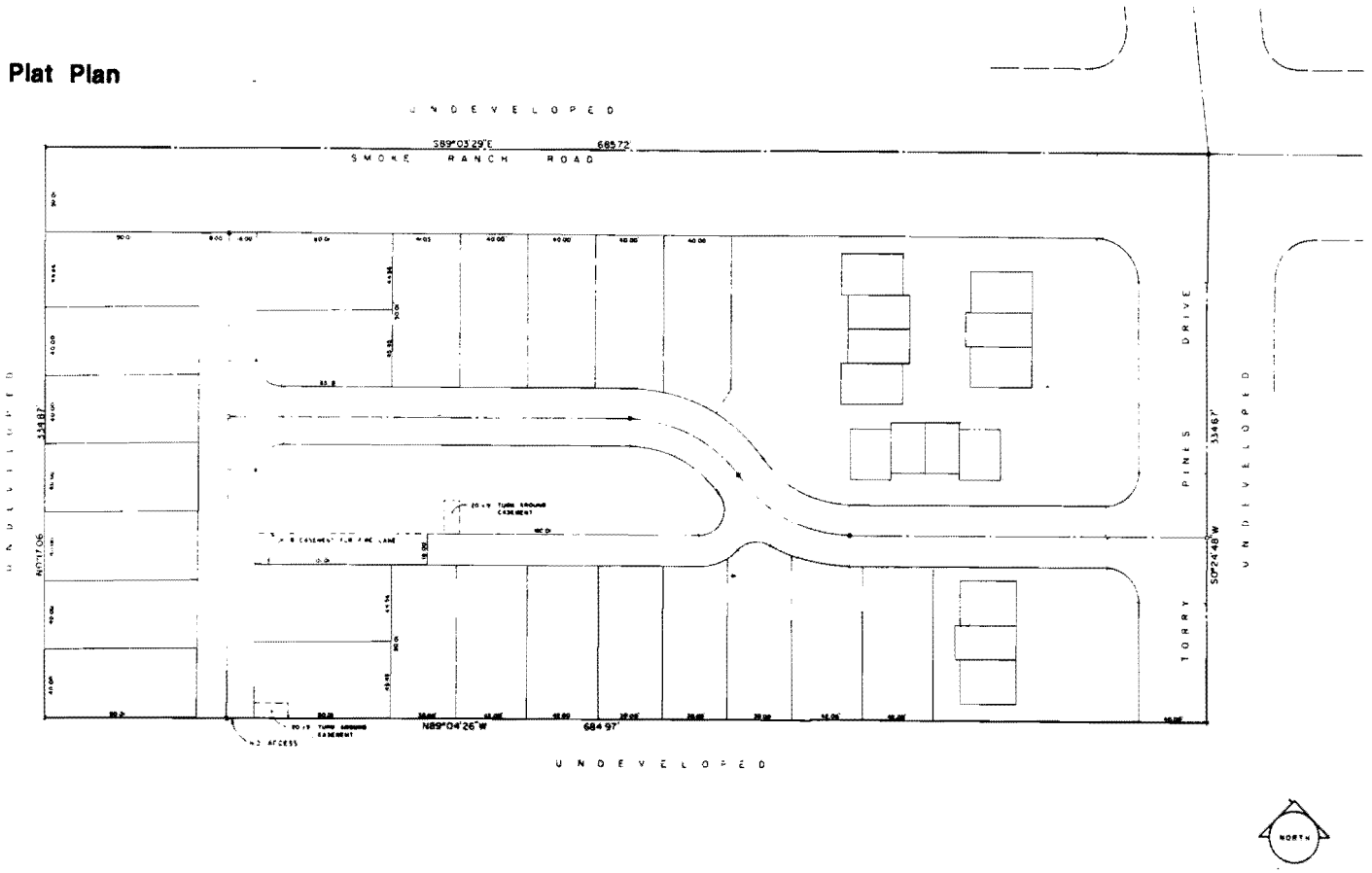
Land Development

The Approach '80 site is a 5-acre rectangular tract located at the northwestern fringe of the urbanized area of Las Vegas. The approximate dimensions of 335 feet by 685 feet include one-side of two major Las Vegas streets, Smoke Ranch Road and Torrey Pines Drive, which reduced the total area to be developed to about 4.2 acres. The site was originally zoned as a residential planned development allowing 8 dwelling units per acre (RPD-8). Under existing standards, the planned unit development (PUD) allows for maximum flexibility in residential design and land utilization. The PUD may consist of attached or detached single-family units, townhouses, cluster units, condominiums, garden apartments, or any combination thereof. All development in an RPD was to be in acordance with the design standards adopted by the City Commission. In the case of Approach '80, the design standards were amended to provide maximum density and liveability at minimum cost.

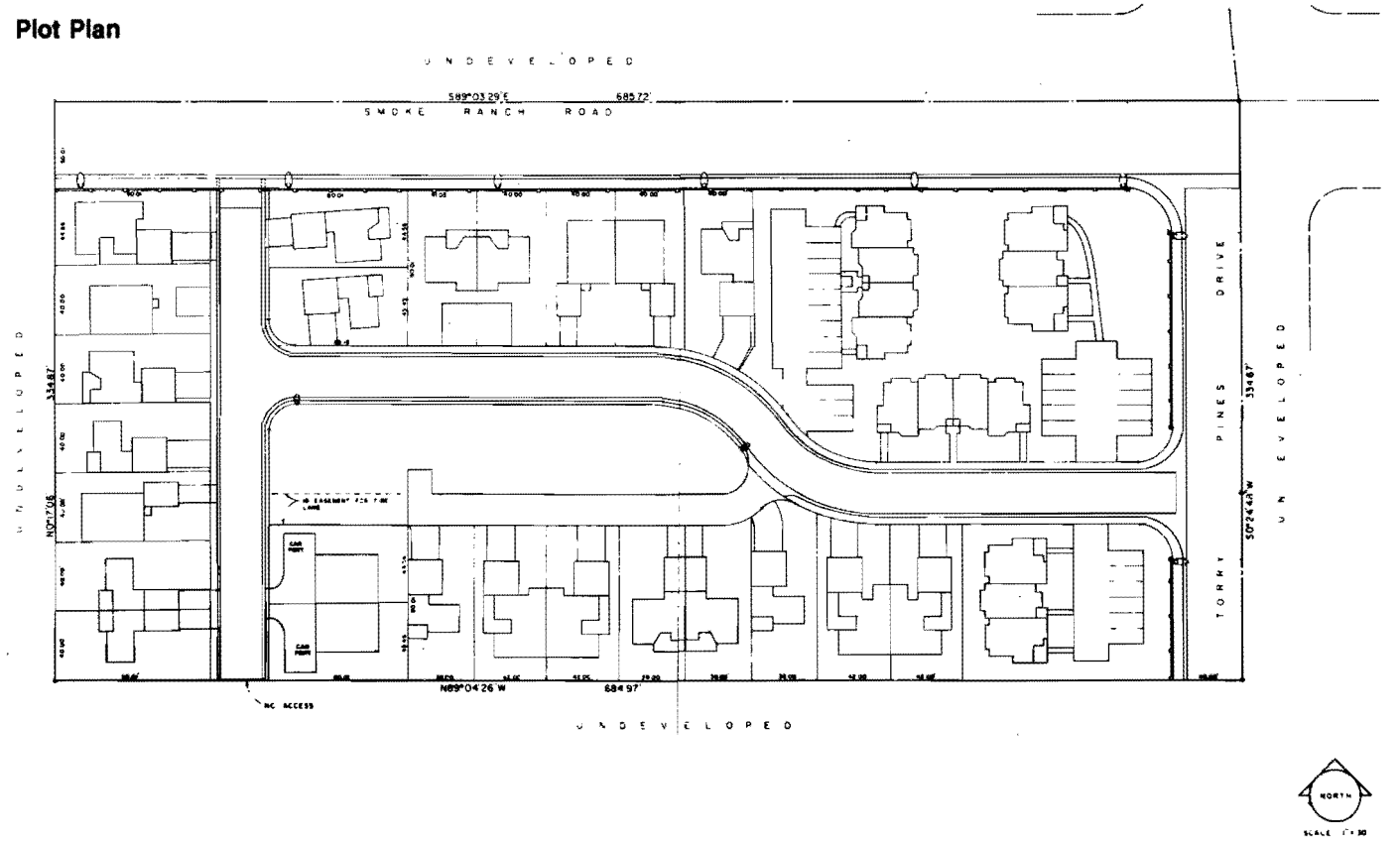
The RPD-8 zoning on the 5 acres allowed for a density of 8 dwelling units per gross acre or 40 dwelling units. The land plan adopted by the Approach '80 task force provided 38 units—10 single-family attached units, 14 duplex units, and 14 units in clusters of threeplexes and fourplexes—all in a zero-lot-line configuration. Prior to Approach '80, the city of Las Vegas had never allowed multifamily and single-family detached units in the same subdivision.

Widths of the 24 single-family lots varied from 38 to 42 feet and depths varied from 80 to 90 feet, which deviated from the 100-foot depth usually required. The zero-lot-line location of these units allowed more efficient use of the lots. Duplexes were attached at the lot line. Triplexes and quadruplexes were clustered at the eastern end of the project with common areas adjacent on all sides.

Plat Plan



Plot Plan

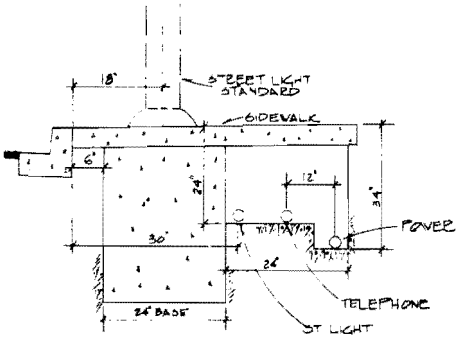


The road system within the 4.2 acres was designed to provide adequate movement for both vehicles and emergency equipment while minimizing high speed through traffic. The goal was to provide each lot and common area with satisfactory access while limiting excessive pavement and right-of-way to save land and development costs as well as reduce future maintenance costs. Dead end streets were utilized where cul-de-sacs would normally be required, saving land and paving costs. Turnaround easements were provided.

Jim Cashman, a Riverside, California builder and chairman of the NAHB Land Use Committee, assisted in negotiating approvals of the land plan. Many of the deviations from Las Vegas standards were approved by the city while compromises were made on other requests. Table 1 shows the usual Las Vegas land development requirements, the deviations requested, and the final approved designs.

In addition, longer than normal 4-inch house connection sewer service was allowed across public streets to main sewer lines, located in easements. The 20-inch minimum easement required for 4-inch water lines was reduced to 18 inches. More than one group of townhouses were served by a single 2-inch domestic water meter where an individual meter is normally required for each unit. Four-inch water mains were allowed in streets other than cul-de-sacs.

The major perimeter streets required street lights conforming to the Las Vegas standards. However, the street lights installed in the interior of the



Typical Trench Detail

Approach '80 Under Construction

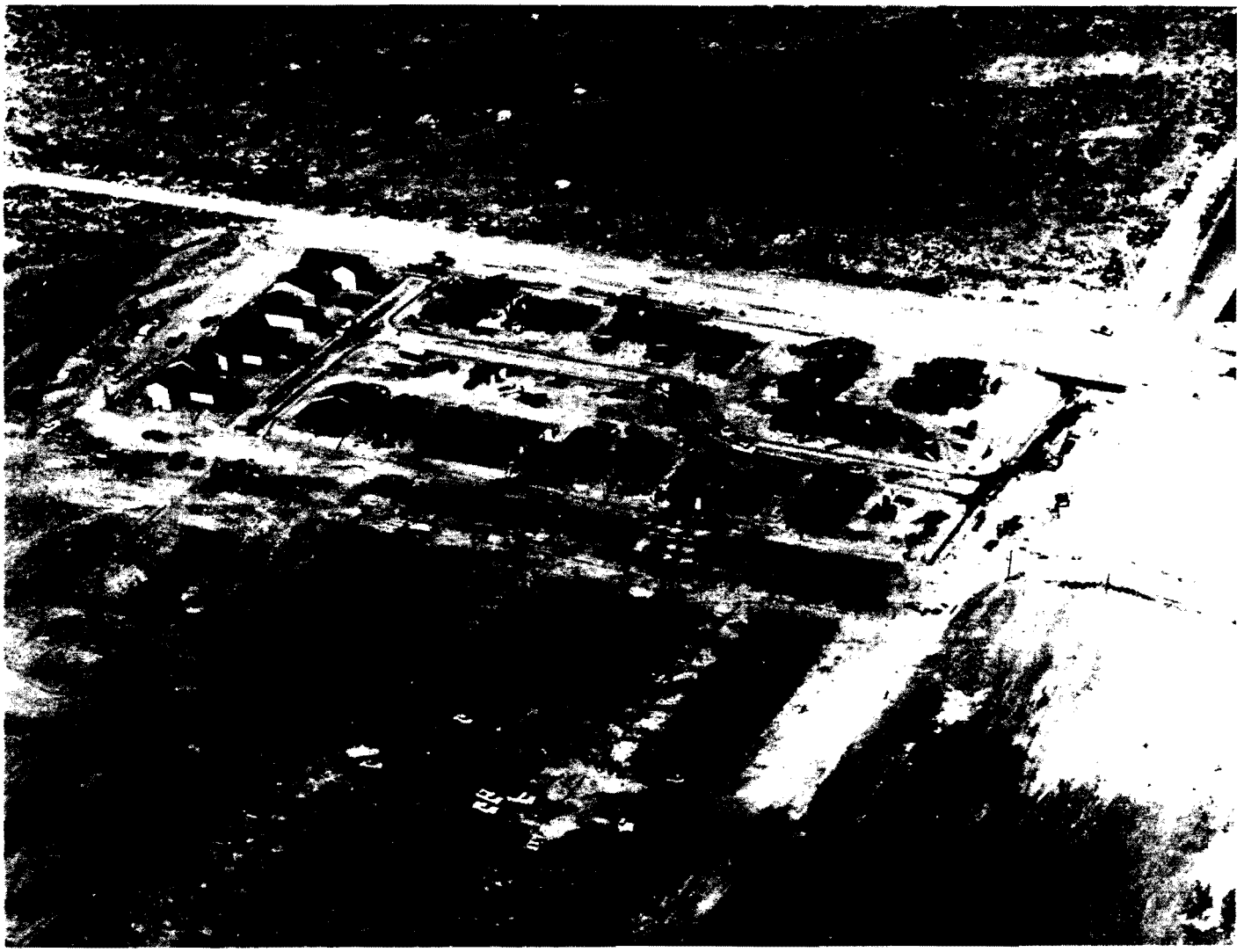
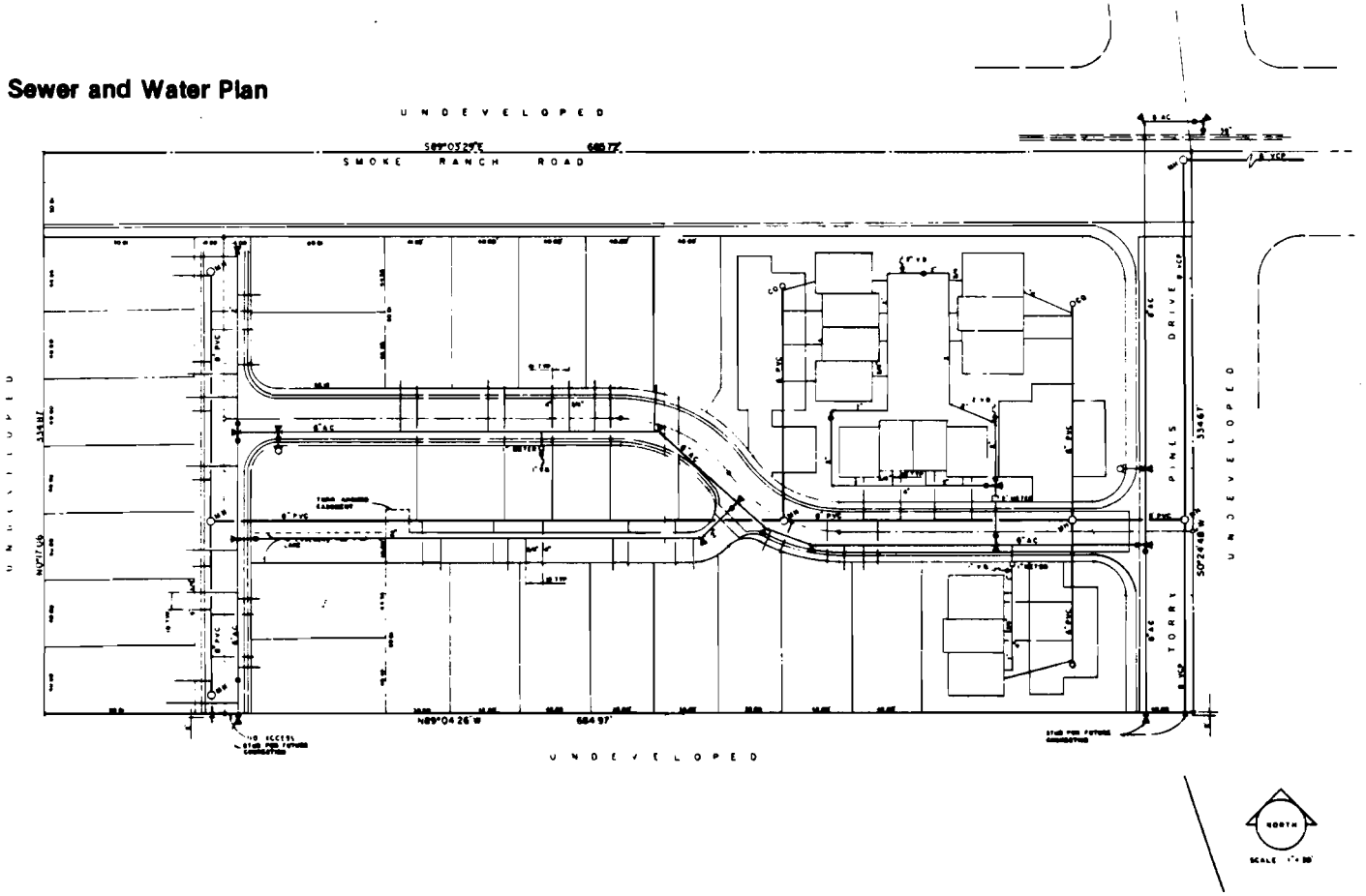


Table 1. Approach '80 Land Plan Negotiations with the City of Las Vegas

Item	Standard	Requested	Approved
R-1 lot size	60 × 120′	40 × 80′ 45 × 75′	40 × 90′ 45 × 80′
Front yard set back	25′	15′	15′
Side yard	0′ 10′	0′ 10′ 5′ garage	0′ 10′ 5′ garage
Street right-of-way	60′	20′ side 30′ interior 34′ entry	20′ 36′ 44′
Street paving	41′	16′ side 20′ interior 24′ entry	16′ 28′ 36′
Dead end streets	Cul-de-sac	Tee section	Break away barrier
Subdivision wall	Concrete block	Open sections and fencing	Open sections and fencing
Sidewalks	5′ each side	4′ one side	4′ one side
Sewer	8″ mainline	4″ & 6″ main	4″ & 6″ main

Sewer and Water Plan



subdivision were the down type lighting based on foot candle measure of lighting rather than maximum distance between lights.

Homeowner's

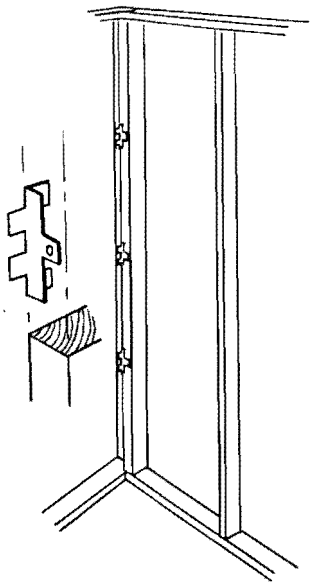
In order to provide on-going maintenance of Approach '80 common areas and to ensure easement rights, a homeowner's association was formed, complete with Articles of Incorporation and Declaration of Covenants, Conditions, and Restrictions.

The Houses

The 38 Approach '80 units included 10 detached homes, 7 duplexes, 2 threeplexes and 2 fourplexes. Units ranged in size from 704 square feet to 1,116 square feet. One unit, a detached split level, contained 1,008 square feet of finished living space and 392 square feet of expandable space in the lower level.

Although the objective of Approach '80 was to demonstrate low-cost, marketable land development and construction techniques, some of the demonstrated systems were not necessarily the least costly way to build in Las Vegas. For example, Las Vegas has been traditionally a slab-on-grade town with very few crawl space and basement homes built in recent years. The Approach '80 committee decided, however, to build basement and crawl space homes to show alternatives in foundation and floor construction. Construction techniques and systems demonstrated included the following:

Modular Design—Units were designed to a module of 2 feet, out-to-out, to reduce scrap, waste, and labor. They were also designed to minimize length of walls and partitions.



Two Stud Corner with Metal Drywall Backup Clips

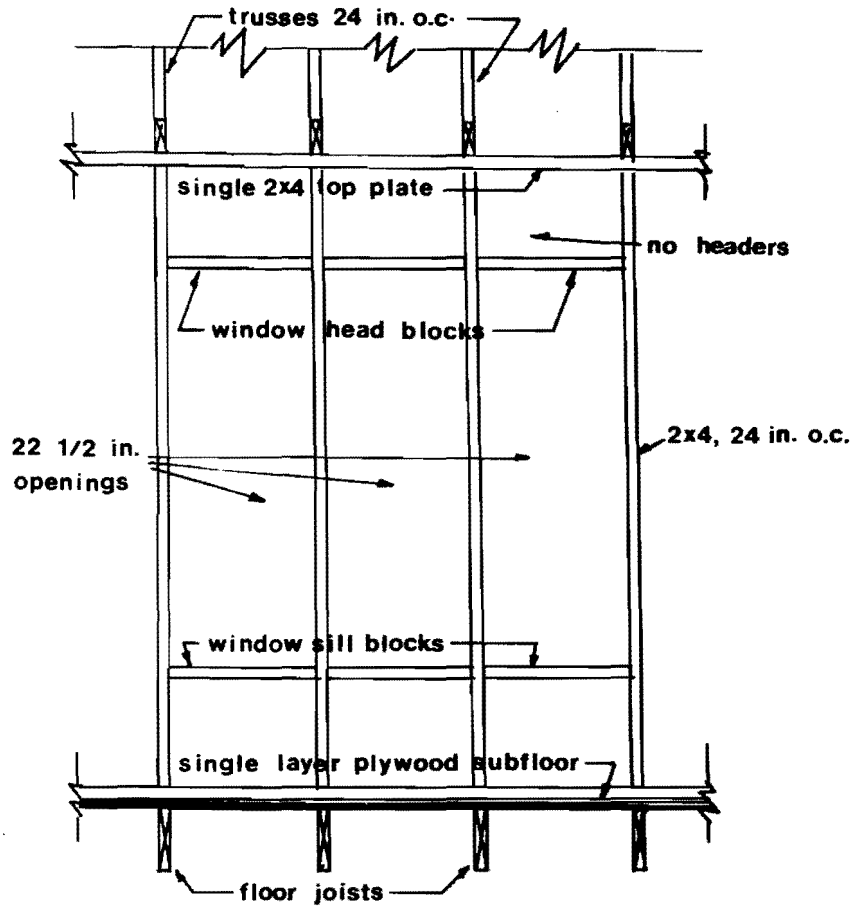
Value Engineering Techniques

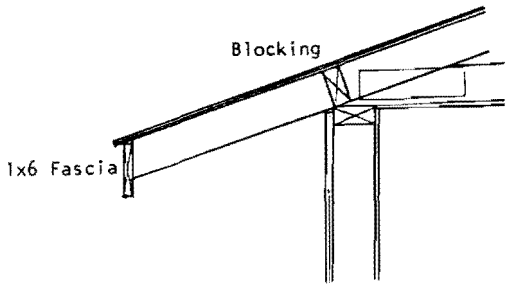
- Trusses, walls, and floor joists were framed 24 inches on-center, in line with each other.
- Two-stud corners were used with metal drywall backup clips.
- Plywood box beam headers were used instead of solid wood headers. These headers created a cavity for insulation.
- Windows 22½ inches wide were placed between studs 24 inches on center to eliminate window headers.
- In-line, off-center spliced joists were used on one home. This system allowed use of smaller floor joists and reduced labor costs.
- Single top plates were used on all walls.
- Metal drywall backup clips eliminated studs as drywall nailers.
- Single layer, glue-nailed T&G plywood (Sturdi-floor) systems reduced material and labor and contributed to a stiffer floor with fewer squeeks.
- Single layer plywood siding eliminated sheathing and corner bracing.
- Bulkheads (furred-down soffits) were eliminated over kitchen cabinets.
- Amount of blocking and bracing was reduced.
- Partition posts (channels) were eliminated.

Construction Systems

- Reduced thickness and width of footing based on soil bearing tests.
- A 2½ inch thick slab used in three slabs as demonstration.
- Pressure treated wood foundations used in one crawl space and one basement to demonstrate an alternative to cast-in-place concrete and concrete block foundations.
- Underfloor plenum heating/cooling system used in two homes. System uses underfloor area as supply plenum, eliminating ducts.
- Waterproof basement techniques demonstrated in basement homes.
- Prefabricated DWV plumbing trees
- Polybutylene hot and cold water supply plumbing was demonstrated in three homes.

Triple Window Opening in Bearing Wall

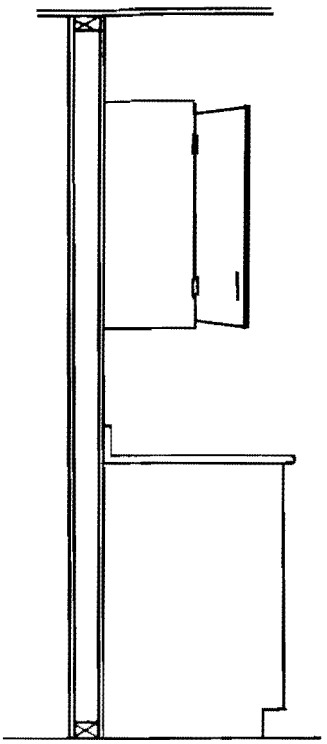




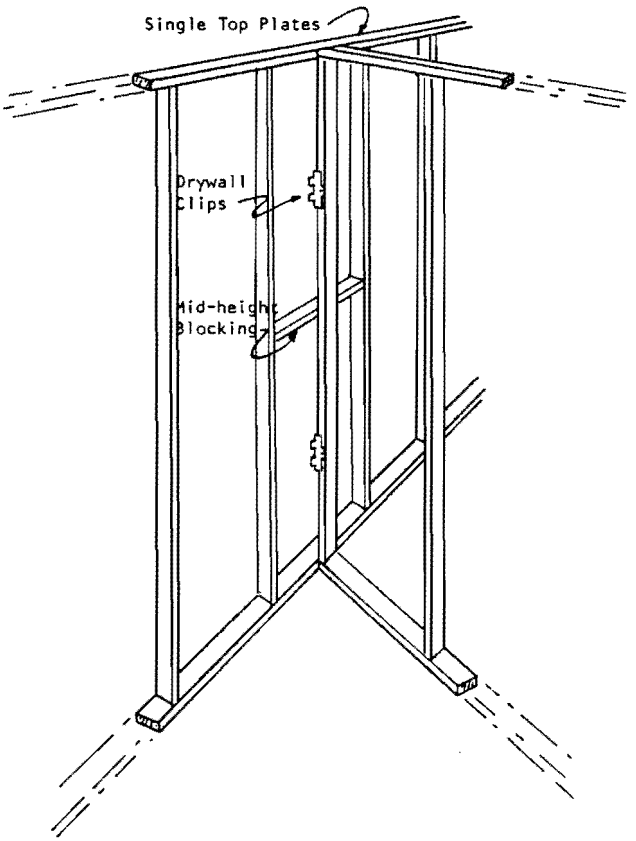
Open Soffit Overhang

22½-Inch Wide Windows Between 24-Inch On-Center Studs

Plywood Box Beam Headers



No Bulkhead Over Cabinets

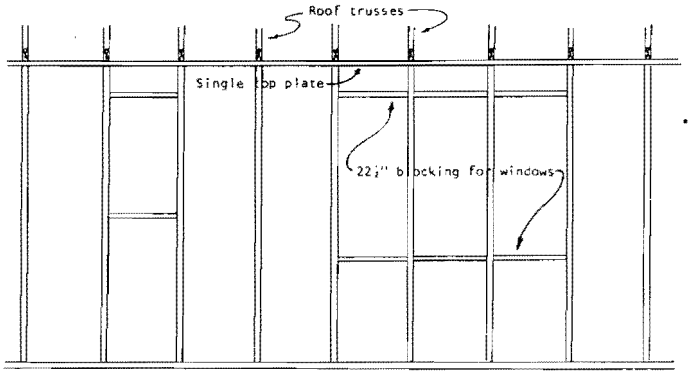


Interior Partition/Exterior Wall Connection

Single Layer Plywood Siding

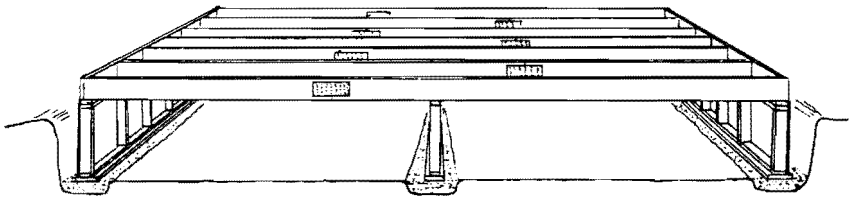
3/4-Inch Tongue and Groove, Single Layer APA Sturd-I-Floor

Exterior Wall, 24 Inches On Center, Single Top Plate

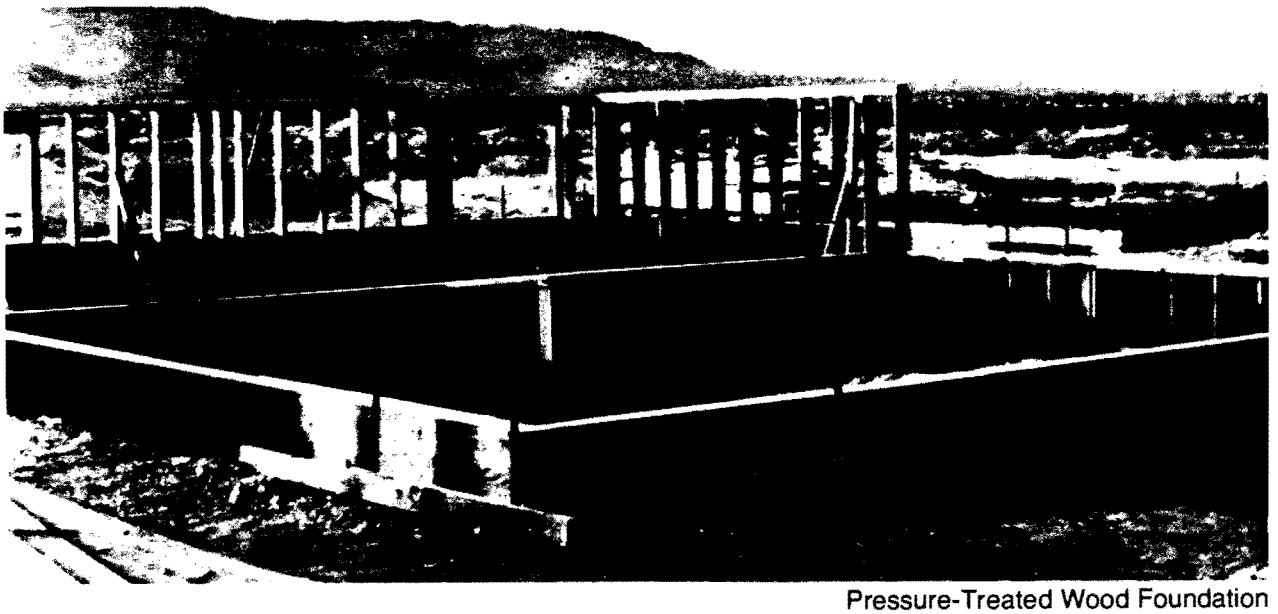


24-Inch, On-Center, In-Line Framing

In-Line, Off-Center Spliced Floor Joists



In-Line, Off-Center Spliced Floor Joists



Pressure-Treated Wood Foundation

Light Gauge Steel Studs

- Light gauge steel studs were installed in one demonstration unit to show an alternative to wood interior partition framing.

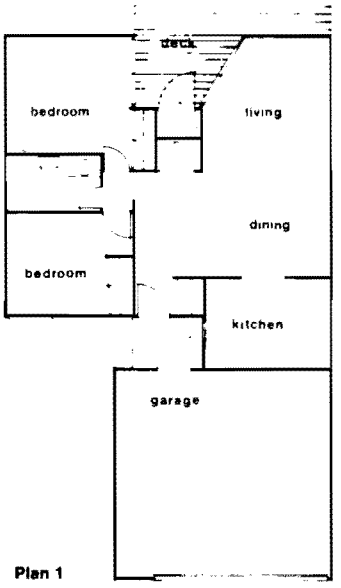
In most cases, the systems demonstrated proved to be less costly than conventional techniques and systems. In some cases, the demonstrated system may or may not be cost effective in some locales depending on local variations in material and labor costs.

A house-by-house description of the demonstration units follows. Seven of the units contained many of the systems that were being shown as techniques that might be usable in areas other than Las Vegas, such as basements, crawl spaces, wood floor framing methods. All 38 units contained value engineered framing, sheathing, siding, and other cost-reduction systems.

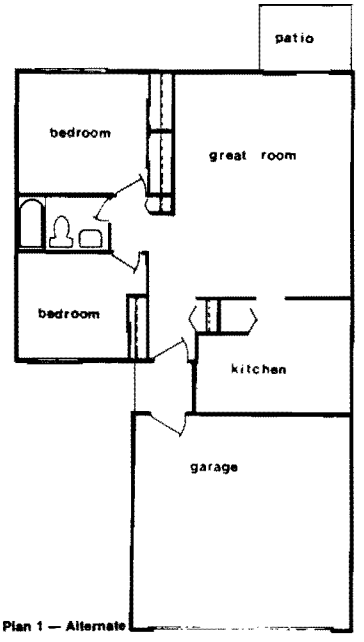
Prefabricated Plastic DWV Plumbing Tree

Polybutylene Water Supply Plumbing

Plan 1—A one-story, 782-square-foot, two-bedroom, one-bath home, featuring engineered framing, underfloor plenum heating/cooling, pressure treated wood foundation, steel interior partitions, and polybutylene supply plumbing.

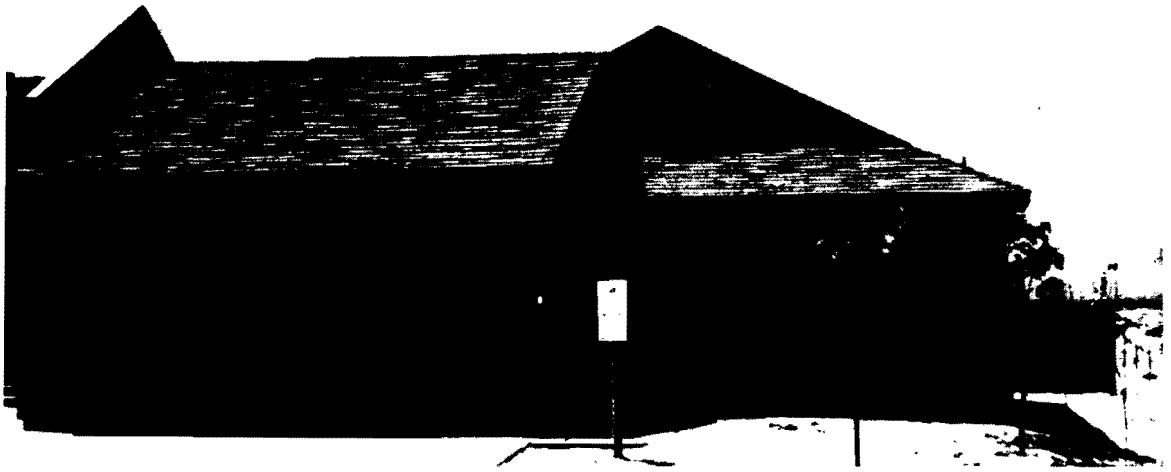


Plan 1

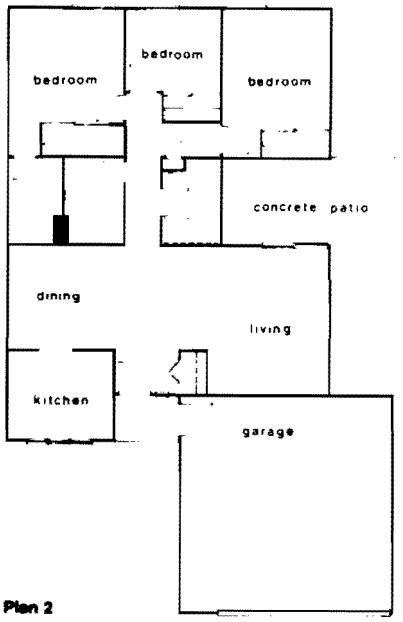


Plan 1 — Alternate

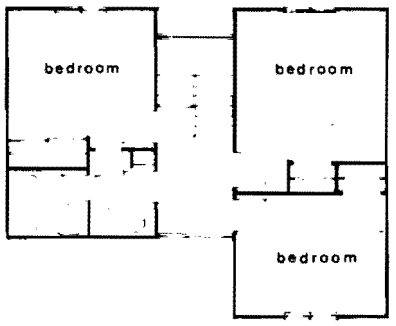
An alternate version of Plan 1 was built to evaluate the value of certain architectural features in a small home. Plan 1 contained an inset deck which provided a somewhat private outdoor space within the floor plan of the home. The alternate version was designed without the inset and with the kitchen made 2 feet wider, which added about 62 square feet of living area. These changes will be evaluated as to marketability of the two units.

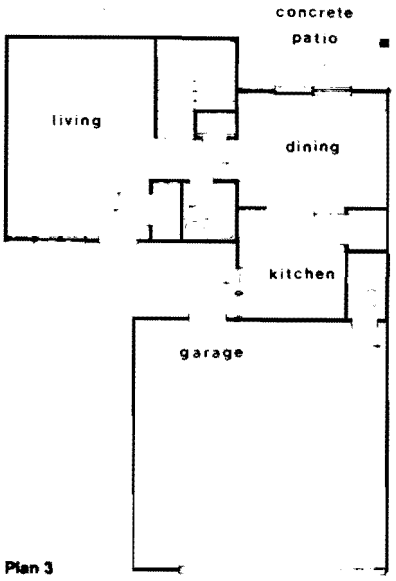


Plan 2—A one-story, 1,040-square-foot, three-bedroom, two-bath home with value engineered framing and an underfloor plenum heating/cooling system.



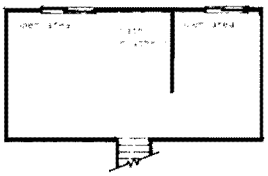
Plan 2



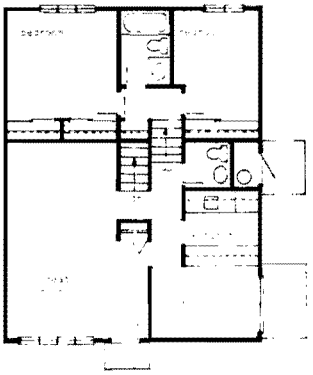


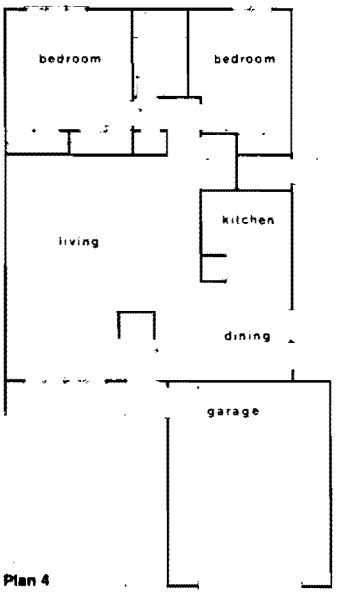
Plan 3

Plan 3—A two-story, 1,104-square-foot, three-bedroom, 1½ bath home, featuring waterproof basement construction and a lower-priced redwood lap siding.



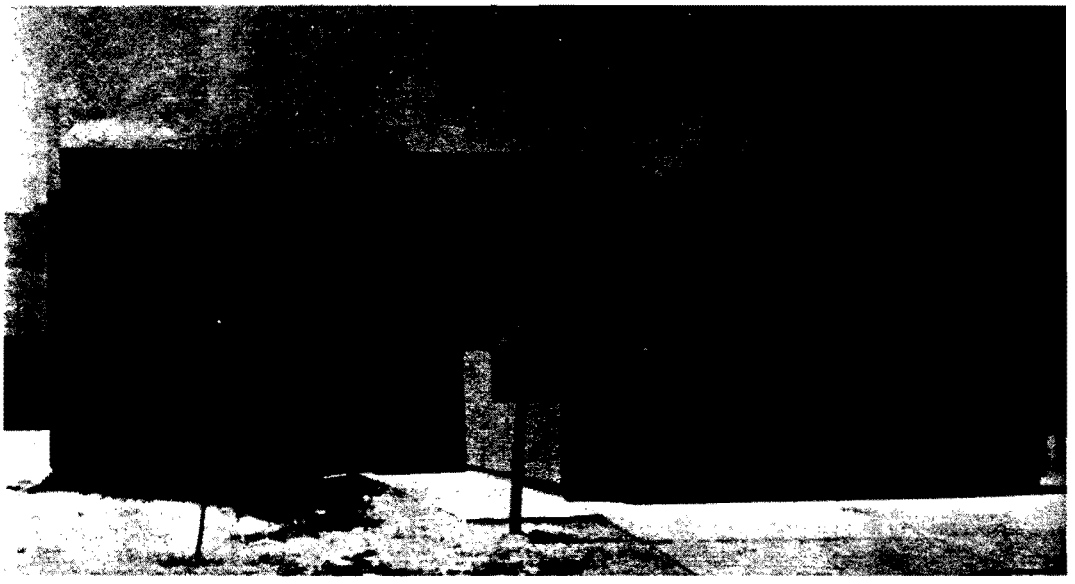
Plan 4—This plan was built as a split level and also as a slab-on-grade home. The split level version featured engineered framing, in-line, off center spliced floor joists, pressure treated wood foundation, and polybutylene supply plumbing. It contained 1,008 square feet of finished floor area with 392 square feet of expandable area in the lower level. Rough-in for a second full bath was provided in the lower level.



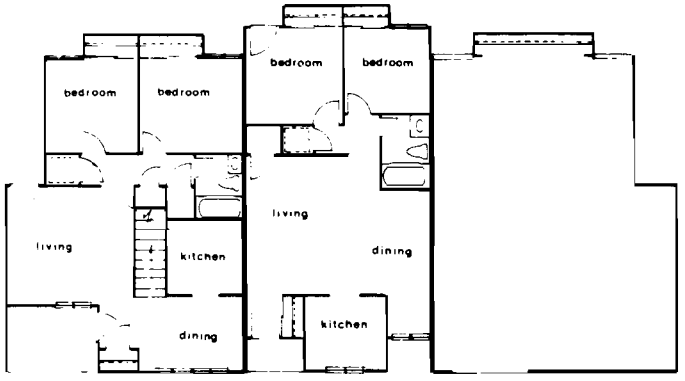


Plan 4

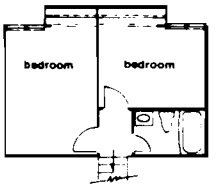
The slab version of plan 4 contained 1,008 square feet of living area, two bedrooms, and one bath. It featured value engineered framing and polybutylene supply plumbing.



Duplex—Each of the four floor plans was repeated in a duplex version at least once within the subdivision. The duplexes were basically the same with the obvious exception of firewalls included between units.



Triplex



Upper Level

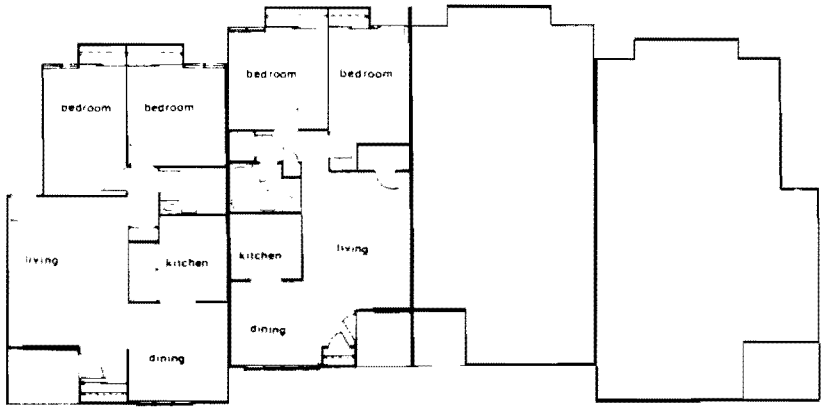
Threeplex

Threeplex Under Construction—The threeplex buildings contained two two-story units and one one-story unit.

Fourplex—The fourplexes contained four one-story units. Value engineered framing techniques were used throughout.

Fourplex

Quadruplex



In-Place Cost Analysis

NAHB Research Foundation industrial engineers monitored all Approach '80 costs and compared them with conventional Las Vegas subdivision costs, using local codes, standards, and building practices. Building to existing Las Vegas land development standards would have made the project impossible to build as conceived inasmuch as the requirements for street widths, sidewalks, and minimum lot sizes (see table 1) would have reduced total yield from 38 units to 33 units. This fact was considered when developing comparative in-place costs.

Land Development

Approach '80 land development costs consisted of both onsite and offsite costs. That is, the City of Las Vegas required that the subdivision pay for development of two major thoroughfares that abut the site. Costs of off-site utilities, sidewalks, curbs and gutters, and street lighting were absorbed by Approach '80. Table 2 shows land development costs for the entire project and the amounts that were inside and outside of the subdivision. Although some of the City standards were waived inside the project, none were waived for offsite work.

Table 2 shows that a large percentage (45.6%) of all land development costs were expended offsite. Because the offsite work was associated with public rights-of-way, the city was unwilling to waive standards in most cases. The one exception was a reduction in perimeter fence requirements. Las Vegas standards require a concrete block wall along major streets. For Approach '80, a revised design that contained open sections and fencing rather than solid concrete block was allowed. Total fencing costs were increased after the project began when the Approach '80 site was declared to be in a flood plain. Therefore, a 335-foot-long concrete block diverter fence was required along the western edge of the property.

Table 2. Approach '80 Land Development Costs—Onsite v. Offsite Cost Comparisons

Cost Item	On-Site	Off-Site	Total
Underground trench	$14,329.80	$13,016.52	$27,346.32
Water system	12,891.88	3,236.08	16,127.96
Sewer system	21,504.20	5,819.70	27,323.90
House water and sewer	18,230.50	0	18,230.50
Exterior street paving	0	64,132.98	64,132.98
Interior street paving	15,344.40	0	15,344.40
Exterior sidewalk	0	12,302.88	12,302.88
Interior sidewalk	5,489.86	0	5,489.86
Exterior curb and gutter	0	9,748.90	9,748.90
Interior curb and gutter	6,864.32	0	6,864.32
Interior cross gutter	185.82	0	185.82
Interior concrete drainage	373.92	0	373.92
Interior 2 × 4 headers	4,076.64	0	4,076.64
Regrade interior streets	4,675.14	0	4,675.14
Regrade exterior streets	0	2,835.94	2,835.94
Fence	0	17,977.42	17,977.42
Street lighting	2,600.00	9,100.00	11,700.00
Barricades	1,200.00	0	1,200.00
Landscaping, sprinklers	42,100.00	0	42,100.00
Civil engineering	21,848.48	5,461.74	27,310.22
Totals	$171,714.96	$143,632.16	$315,347.12
Average per unit	$4,518.81	$3,779.79	$8,298.60
Percent of total	54.4	45.6	100.0

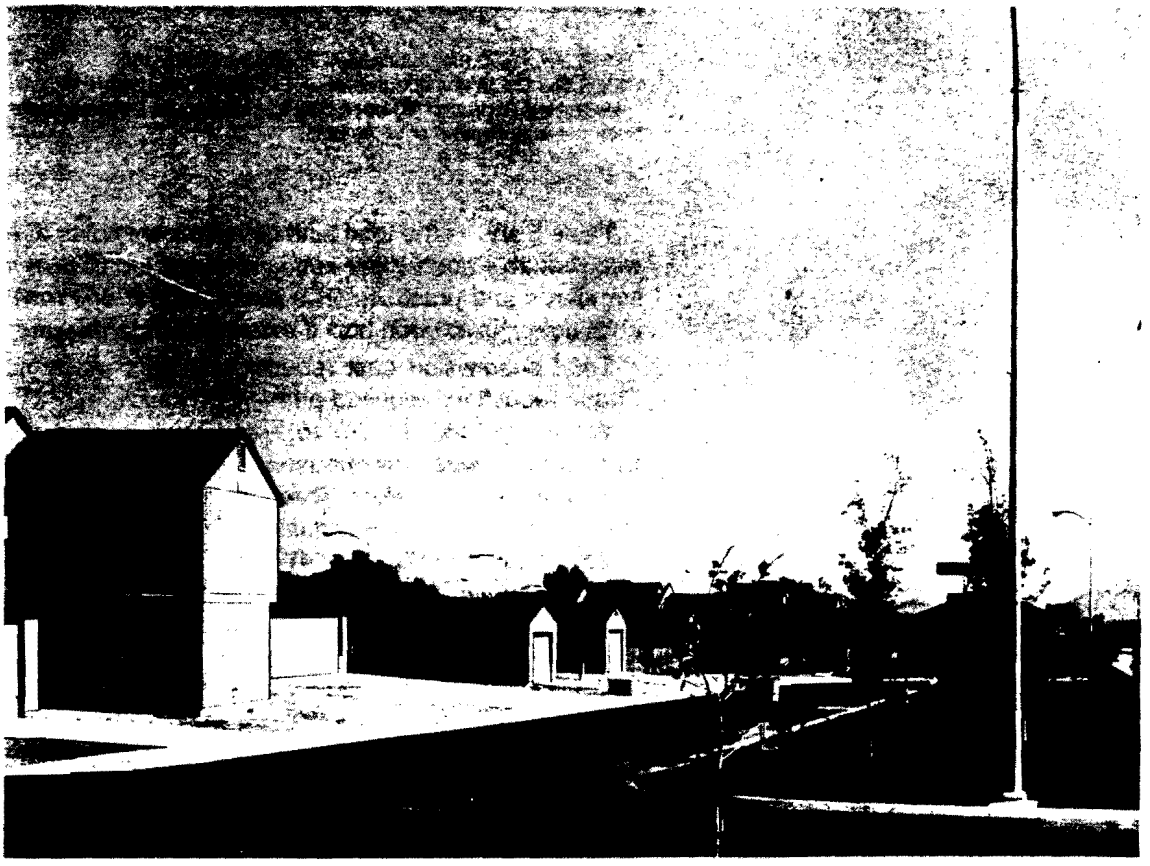


Table 3. Approach '80 Land Development Cost Comparisons, As-Built v. Conventional Las Vegas Practice

Cost Item	As-Built	Conventional	Savings
Underground trench	$27,346.32	$27,346.32	0
Water system	16,127.96	20,377.12	4,249.16
Sewer system	27,323.90	30,992.04	3,668.14
House water and sewer	18,230.50	18,230.50	0
Exterior street paving	64,132.98	64,132.98	0
Interior street paving	15,344.40	36,725.14	21,380.74
Exterior sidewalk	12,302.88	12,302.88	0
Interior sidewalk	5,489.86	13,604.00	8,114.14
Exterior curb and gutter	9,748.90	9,748.90	0
Interior curb and gutter	6,864.32	12,641.46	5,777.14
Interior cross gutter	185.82	185.82	0
Interior concrete drainage	373.92	373.92	0
Interior 2×4 headers	4,076.64	4,076.64	0
Regrade interior streets	4,675.14	4,675.14	0
Regrade exterior streets	2,835.94	2,835.94	0
Fence	17,977.42	23,909.98	5,932.56
Street lighting	11,700.00	16,900.00	5,200.00
Barricades	1,200.00	1,200.00	0
Landscaping, sprinklers	42,100.00	42,100.00	0
Civil engineering	27,310.22	27,310.22	0
Totals	$315,347.12	$369,669.00	$54,321.88
Average/unit	$8,298.61*	$11,202.09**	$2,903.48
Percent savings			25.9

*$315,347.12/38 unit subdivision = $8,298.61 per unit
**$369,669.00/33 unit subdivision = $11,202.09 per unit
Note: Had Approach '80 been built to existing Las Vegas standards, only 33 units would have been possible instead of 38 as built.

Table 3 shows the total land development costs of Approach '80 compared with probable costs if the subdivision were built conventionally to Las Vegas standards and practices. The averages per unit reflect the fact that only 33 units could have been built if existing standards were used.

Total subdivision cost reduction for land development was $54,321.88. These reductions resulted primarily from the following:

Water system ($4,249.16)—A 2-inch reduction in water main diameter throughout. Eleven townhouses were serviced by a single 2-inch meter rather than by individual meters. Three townhouses were serviced by a single 1-inch meter rather than by individual meters.

Sewer system ($3,668.14)—The standard 8-inch diameter main line was reduced to 4 and 6-inch mains throughout. Four-inch house connections were allowed to cross under public streets to the main lines, located in easements.

Interior streets ($21,380.74)—Standard rights-of-way were reduced from 60 feet for all streets to 20 feet for a side street, 36 feet for interior streets, and 44 feet for the entry street. Paving width was reduced from 41 feet to 16, 28, and 38 feet. Pavement thickness was reduced from 3¾-inch to 2-inch asphalt concrete.

Interior Sidewalks ($8,114.14)—Sidewalks were reduced from 5 feet wide on both sides to 4 feet wide on one side.

Interior curbs and gutters ($5,777.14)—Roll-type gutters were used instead of standard L type. No curb and gutter on the narrow side street.

Fence ($5,932.56)—Solid masonry block wall replaced by partial block, partial open space with fencing along major streets.

Street lighting ($5,200.00)—Seven standard Las Vegas street lights were replaced by three down-type lights within the interior of the subdivision.

Direct Construction Costs

Actual direct construction costs were developed for each of the 38 units and then estimates were made to determine how much each unit would have cost if it had been built under Las Vegas codes and normal Las Vegas practices. Cost savings were determined only on those items that were considered unique to Las Vegas construction methods. In other words, although a particular Approach '80 system consisted of very efficient use of materials and labor, it did not necessarily qualify as unique. For example, the electrical contractor was asked to design the most efficient code-complying wiring system possible, but, since no innovative materials or techniques were used, no cost reduction credit was taken for electrical wiring.

Where deviations from normal practice or local codes were made, material and labor take-offs resulted in cost-reduction estimates. Table 4 shows actual direct construction costs versus the estimated costs that would have occurred had the same units been built conventionally.

Total direct construction cost savings for Approach '80 amounted to $46,961.89. A discussion of the areas where costs were reduced follows:

Rough Framing, Sheathing, Siding, Carpentry Labor ($36,657.84)—OVE framing techniques were used throughout the subdivision. In 37 of the 38

Table 4. Approach '80 Direct Construction Cost Comparison, As-Built Versus Conventional Las Vegas Codes and Practices by Plan Number

Plan Number	Number Built	Average Cost Per Unit		
		As-Built	Conventional	Savings
1, detached, slab	1	$22,522.51	$24,017.07	$1,494.56
1, detached, crawl space	1	24,659.69	26,806.16	2,146.47
1, alternate detached, slab	1	23,523.75	24,883.10	1,359.35
1, duplex, slab, garage	2	21,860.07	23,136.19	1,276.12
1, duplex, slab, no garage	2	18,575.08	19,649.46	1,074.38
2, detached, crawl space	1	30,060.45	32,394.82	2,334.37
2, duplex, slab	4	28,290.29	29,845.75	1,555.46
3, detached, slab	3	30,629.06	32,090.23	1,461.17
3, detached, basement	1	36,364,30	37,347.65	983.35
3, duplex, slab	2	27,747.93	28,960.99	1,213.06
4,detached slab	1	23,013.69	24,552.48	1,538.79
4, detached, split level	1	30,581.14	32,101.21	1,520.07
4, duplex, slab, garage	2	23,234.25	24,586.10	1,351.85
4, duplex, slab, carport	2	22,673.13	23,690.89	1,287.76
Threeplex, end unit	4	20,255.03	21,479.33	1,224.30
Threeplex, middle unit	2	16,022.69	16,817.05	794.36
Fourplex, end unit	4	17,136.83	17,897.89	761.06
Fourplex, interior unit	4	16,203.27	16,964.04	760.77
Totals	38	$870,380.69	$917,342.58	$46,961.89
Average/unit		$22,904.76	$24,140.60	$1,235.84
Percent savings				5.1

homes interior partitions were framed with 2×4s spaced 24 inches on center. The other unit contained light gage steel studs, which are sometimes competitive with wood framing members. Exterior walls were also framed 24 inches on center with the exception of the first story of the two-story units and the entire wall of the one two-story home with horizontal lap siding. These exceptions were framed with 2×4s spaced 16 inches on center.

No solid wood headers were used over openings. Most were not needed inasmuch as windows were 22½ inches wide and fit between 24 inches-on-center studs. Plywood box-beam headers were used over doors and sliding glass doors in load-bearing walls.

Two stud corners were used throughout with metal drywall backup clips. Partition posts or "channels" were not used. Instead, wherever a partition intersected with an exterior wall, a midheight block was used to secure the partition and the metal drywall clips provided backing for gypsum wallboard. Single top plates were used on exterior and interior walls.

In homes with wood floors single-layer plywood sheathing (¾" APA Sturd-I-Floor plywood) was used without separate underlayment and glued with BFG PL-400 structural adhesive. In addition, single-layer plywood siding without sheathing or building paper was used on 37 of the 38 units. The exception was a two-story home with horizontal lapped redwood siding. Building paper was installed before the siding was put on. Average cost savings per unit was $964.68.

Foundations and Slabs ($5,177.12)—No welded wire mesh was used in any of the Approach '80 slabs. In addition, footing widths and depths were reduced based upon soil-bearing tests. In three of the units slab thickness was reduced from 3½ inches to 2½ inches to test the structural adequacy of a thinner residential slab. Four-sack mix, 2,000-pound concrete was used throughout with the exception of the 2½-inch slabs where more conventional five-sack mix was used. Average cost savings amounted to $136.24 per unit.

Rough Plumbing ($482.92)—Conventional copper supply pipe and plastic drain, waste, and vent pipe was used in all but three units. In those three, polybutylene pipe was used for all hot and cold supply piping. Average savings for the three PB homes was about $161. Had PB pipe been used in all 38 units, total Approach '80 savings would have amounted to $6,117.

Heating/Air Conditioning ($529.34)—Ductless underfloor heating/cooling systems were installed in two units. This "Plenwood" system, reduced total HVAC costs by an average of $264.67 because of the elimination of most supply ductwork.

Roofing ($1,277.94)—Roofing felt was eliminated under asphalt shingles for an average cost reduction of $33.63 per house. Although required by Las Vegas code and recommended by roofing manufacturers, roofing felt has been eliminated in many previously built experimental homes without noticeable effects. In addition, many production homes throughout the nation have been built without building paper under the singles.

Drywall ($2,836.67)—An average cost savings of almost $75 per unit was realized in gypsum wall board hanging and finishing, primarily because of the reduction in nails over conventional practice. The OVE framing techniques reduced the number of nails by about 30 percent.

Total Approach '80 Costs

Table 5 shows average costs of Approach '80 homes by major cost categories compared to conventionally built Las Vegas homes.

The total cost savings of Approach '80 over conventional construction techniques amounted to $5,491.86 per unit. Following is an item-by-item analysis of the cost savings by major cost category per unit.

Fees and Engineering—Fees and engineering on a per unit basis were not reduced. A total of $42,702.12 was paid in this category, $34,502.10 of which was for building permits and sewer, power, and water fees.

Table 5. Approach '80 Total Costs by Major Cost Category, As-Built v. Conventional Las Vegas Codes and Standard Practices

Cost Category	Average Cost Per Unit		
	As Built	Conventional	Savings
Fees and engineering	$1,123.74	$1,123.74	0
Raw land	4,089.82	4,709.49	$619.67
Land development	8,298.61	11,202.09	2,903.48
Direct construction	22,904.76	24,140.60	1,235.84
Indirect construction	1,943.77	2,093.83	150.06
Overhead and financing	3,289.91	3,545.22	255.31
Sales, marketing	4,486.53	4,814.03	327.50
Totals	$46,137.14*	$51,629.00**	$5,491.86
Percent savings			10.6

*Average cost for 38 units was $46,137.14.
**Average cost for 33 units was $51,629.00.
Note: Had Approach '80 been built to existing Las Vegas standards, only 33 units would have been possible instead of 38 as built.

Raw Land ($619.67)—Total cost of the Approach '80 site was $155,413.16 or slightly over $31,000 per acre. Sixteen percent of the total area was not within the subdivision but was required for two major Las Vegas streets. Of the remaining 4.2 acres 26 percent was required for interior streets, sidewalks, and common areas. Therefore, of the original 5 acres, only about 60 percent was available for dwelling units. Furthermore, had existing Las Vegas land development standards been followed, only about 50 percent of the land would have been available for housing, thereby reducing total yield from 38 units to 33 units. This change would have increased total cost of raw land by $619.67 per dwelling.

Land Development ($2,903.48)—Since only 33 units were possible, average land development cost reduction was 2,903.48 or 25.9 percent.

Direct Construction ($1,235.84)—Total direct construction costs would vary with the number of units built, but average direct costs would remain the same assuming the housing mix was constant. Therefore, direct construction cost savings, per unit, remains the same regardless of the number of houses built.

Indirect Construction ($150.06)—Some elements of indirect construction cost do not vary on a per unit basis while others vary according to total costs and others vary according to the number of units built. For example, the Approach '80 builder budgeted $500 per unit for supervision which would remain the same whether 33 or 38 units were built. General labor, security, vandalism, and contingencies, however, are budgeted as a percentage of direct costs and therefore will increase as direct construction costs increase.

Overhead, financing ($255.31)—As with indirect construction, some items of general overhead are fixed while others are variable according to the number of units. Financing is, of course, variable according to total cost of the project and the amount of time the project takes to complete and sell.

Sales and Marketing ($327.50)—Marketing costs such as signs and advertising increase on a unit basis if fewer units are built while sales commissions increase as the total sales price increases.

Table 6 shows an item-by-item breakdown of all average Approach '80 costs, by major cost category and by cost item within each category. Each cost item represented is also presented as a percentage of total cost. For example, land development accounted for 18 percent of total cost. When combined with the cost of raw land, each lot represents 26.9 percent of the total house cost.

Table 7 shows the category-by-category and item-by-item estimated average costs of the conventionally built Las Vegas comparison home. Percentages for each cost item are presented. The average cost of developed lots would have been 30.8 percent of the total.

Deviations Requested But Not Approved

The City of Las Vegas approved many deviations from existing codes and standards. Others, however were not approved. Still others were upgraded from the original request but were below existing requirements.

As shown in table 1, lot sizes, street rights-of-way, street paving widths and dead-end-street requirements were not approved as requested but were approved at less than typical Las Vegas standards. Waiver requests on fire-wall construction and concrete slab-on-grade thicknesses were denied.

If all requested deviations had been approved, substantial additional cost savings would have occurred. In addition, other potential deviations were not requested because of the certainty of denial. For example, reduction in electrical code requirements was considered, but since extreme problems with waiver approvals were anticipated, waivers were not requested. Also,

Table 6. Approach '80 Total Cost Breakdown for Average Unit by Cost Category and by Cost Item Within Each Category

Cost Category/Item	Average Cost Per Unit	Percent of Total
Fees and Engineering		
Architectural plans	$170.07	0.4
Building permits	138.08	0.3
Temporary water/power	45.72	0.1
Sewer fees/power and water	769.87	1.7
Subtotal	$1,123.74	2.4
Raw Land	$4,089.82	8.9
Land Development		
Trenching	719.64	1.6
Utilities	1,623.22	3.5
Street paving	2,091.51	4.5
Sidewalks	575.52	1.2
Curbs and gutters	451.92	1.0
Regrading	197.66	0.4
Fencing	473.09	1.1
Street lighting	307.89	0.7
Barricades	31.58	0.1
Landscaping, sprinklers	1,107.89	2.4
Civil engineering	718.69	1.5
Subtotal	$8,298.61	18.0

Direct Construction		
Foundations, slabs	2,323.88	5.0
Rough framing, materials and labor, incl. plywood and siding	5,888.14	12.7
Rough plumbing	1,241.27	2.7
Finish plumbing	2,500.47	5.4
Heating/air conditioning	1,742.65	3.9
Sheet metal	118.03	0.2
Rough electrical	1,219.27	2.6
Electrical fixtures	72.78	0.1
Roofing	642.23	1.4
Insulation	472.02	1.0
Drywall	1,551.56	3.4
Windows and doors	968.19	2.1
Finish lumber	75.00	0.2
Finish carpentry	239.12	0.5
Cabinets and countertops	657.13	1.4
Range/oven/hood	234.00	0.5
Finish hardware	130.61	0.3
Glazing, mirrors	24.05	0.1
Garage doors	106.45	0.2
Painting	895.50	2.0
Finish flooring	731.10	1.6
Driveways, patios, walks	888.31	1.9
Clean-up	183.00	0.4
Subtotal	$22,904.76	49.6
Indirect		
General labor	336.56	0.7
Supervision	500.00	1.1
Security and vandalism	66.88	0.1
Contingency	1,040.44	2.3
Subtotal	$1,943.77	4.2
Overhead, financing		
General overhead	592.10	1.3
Construction interest	2,697.81	5.8
Subtotal	$3,289.91	7.1
Sales, marketing	$4,486.53	9.7
Total	$46,137.14	100.0

reduced-size plumbing vents have proven effective in many studies but waivers were not requested because of a negative response from code officials.

The following item-by-item analysis shows the estimated cost savings that would have occurred if all waiver requests had been approved by the City of Las Vegas.

Lot Size—Existing standards call for minimum single family lots of 60 × 120 feet. Reduction to 40 × 80 feet and 45 × 75 feet was requested with 40 × 90 feet and 45 × 80 feet approved. Had the requested lot sizes been approved, between 225 and 400 square feet per lot would have been available for either building more units or providing more common open area. Almost 12,000 square feet would have been available. Inasmuch as each lot would contain between 3,200 and 3,375 square feet, three more building lots might have been available had the requested sizes been approved. Therefore, 41 units

Table 7. Conventional Total Cost Breakdown for Average Unit by Cost Category and By Cost Item Within Each Category

Cost Category/Item	Average Cost Per Unit	Percent of Total
Fees and Engineering		
Architectural plans	$170.07	0.3
Building permits	138.08	0.3
Temporary water/power	45.72	0.1
Sewer fees/power and water	769.87	1.5
Subtotal	$1,123.74	2.2
Raw Land	$4,709.49	9.1
Land Development		
Trenching	828.68	1.6
Utilities	2,109.08	4.1
Street paving	3,056.32	5.9
Sidewalks	908.59	1.8
Curbs and gutters	695.46	1.3
Regrading	227.60	0.4
Fencing	724.54	1.4
Street lighting	512.12	1.0
Barricades	36.36	0.1
Landscaping, sprinklers	1,275.76	2.5
Civil engineering	827.58	1.6
Subtotal	$11,202.09	21.7
Direct Construction		
Foundations, slabs	2,460.12	4.8
Rough framing, materials and labor, incl. plywood and siding	6,852.85	13.3
Rough plumbing	1,253.98	2.4
Finish plumbing	2,500.47	4.8
Heating/air conditioning	1,756.58	3.4
Sheet metal	118.03	0.2
Rough electrical	1,219.27	2.4
Electrical fixtures	72.78	0.1
Roofing	675.86	1.3
Insulation	472.02	0.9
Drywall	1,626.18	3.2
Windows and doors	968.19	1.9
Finish lumber	75.00	0.1
Finish carpentry	239.12	0.5
Cabinets and countertops	657.13	1.3
Range/oven/hood	234.00	0.5
Finish hardware	130.61	0.3
Glazing, mirrors	24.05	-
Garage doors	106.45	0.2
Painting	895.50	1.7
Finish flooring	731.10	1.4
Driveways, patios, walks	888.31	1.7
Clean-up	183.00	0.4
Subtotal	$22,140.60	46.8

Indirect		
General labor	371.50	0.7
Supervision	500.00	1.0
Security and vandalism	73.79	0.1
Contingency	1,148.54	2.2
Subtotal	$2,093.95	4.0
Overhead, financing		
General overhead	638.05	1.2
Construction interest	2,907.17	5.7
Subtotal	$3,545.22	6.9
Sales, marketing	$4,814.03	9.3
Total	$51,629.00	100.0

could have been built instead of 38, and this change would have reduced land development costs from $8,298.61 per unit to $7,691.39 per unit and raw land costs from $4,089.82 per unit to $3,790.56 per unit. Total additional cost reduction would have been $906.48 per unit.

Right-of-Way and Street Paving—Standard Las Vegas residential street right-of-way is 60 feet and street paving width is 41 feet. Deviations requested included street widths of 16 feet for a side street, 20 feet for interior streets, and a 24 feet wide entry street. The approved compromise deviation included a 16-foot side street, 28-foot interior street, and 36-foot entry street. Had the requested widths been approved, an additional 6,856 square feet of paving would have been saved. The 6,856 square feet would have created enough land for two more units, which could have reduced total land development and raw land costs another $534.03 per unit. At $5.40 per square yard for paving costs, total paving savings would have been $95.67 per unit.

Dead End Streets—Las Vegas standards require a cul-de-sac at the end of dead end streets. Simple street width dead ends with tee-section turn-around easements were requested. This was basically approved except for a break away barrier at the end of one of the dead end streets for emergency vehicle access. The required barricade cost $1,200 or $31.58 per unit.

Off-Site Requirements—Approach '80 was required to pay $143,632.16 in off-site improvements. This amounted to almost 46 percent of all land development costs (see table 2). Since no deviations from Las Vegas standards were allowed, no cost reduction was experienced.

Off-site costs included paving one-half of two Las Vegas streets. Pavement widths of the two streets were 88 and 68 feet. One street, Smoke Ranch Road, was originally designed as an arterial street that would eventually connect with a freeway about 2 miles west of Approach '80. However, this intersection supposedly had been changed and Smoke Ranch Road was no longer to be a major arterial street.

If Smoke Ranch Road and the other street, Torrey Pines Drive were designated as collector and subcollector streets respectively, 36-feet-wide pavement would have been adequate according to NAHB's Residential Street Development Standards. If so, paving cost reduction would have been $36,450, or $959 per unit.

The concrete block wall around Approach '80 cost $17,977.42. The practice of enclosing a subdivision behind a high wall is debatable and many communities, especially in the West, have such requirements. If it had not been required, a $473.09 per unit could have been saved.

Street lighting along Smoke Ranch Road appeared to be excessive. Five 250 watt HPS Luminaire street lights were installed at a cost of $1,300 each. If

Smoke Ranch Road were downgraded to a collector street, three street lights would have been sufficient, a savings of $2,600 or $68.42 per unit. Street lights, by the way, were installed directly in the middle of the 6-feet-wide sidewalk.

Off-site sewer, water, and utility costs amounted to $22,072.30 including trenching. These costs included about 1,300 feet of off-site sewer line to connect to the nearest available existing line. Approximately $7,800 would have been saved had the sewer line been located as near Approach '80 as the water line. This amounts to about $205 per unit.

Fire Wall Construction—Early meetings with building code officials indicated that the requirements for a 30-inch high 2-hour fire rated parapet wall atop roofs located on property lines would be waived. However, once construction was underway, city officials decided the parapet walls were required.

Besides being quite unsightly, the add-on parapet walls were expensive. Average cost was $652.00 per unit. Two units were exempt from this requirement because these units could each be 3 feet away from property lines. (The units were still 10 feet apart). The split level home and fourplex units were also exempt because they did not contain 1,000 square feet on any one level and had no attached garages. Therefore, average per unit cost of the parapet wall for all 38 units was $377.63.

Reduced Slab Thickness—A request to reduce slab-on-grade thickness from 3½ inches to 2½ inches was denied although the city did allow 2½-inch slabs in three "experimental" units with the condition that the builder sign a letter of responsibility for the performance of the slabs. The request was based on the condition of the subdivision soil and load-bearing tests, which indicated that a 2½-inch-thick slab would be adequate for normal residential loading conditions. Had the 2½-inch slab been allowed in all 34 slab-on-grade homes, savings would have amounted to $175.00 per unit.

Table 8 shows the potential additional cost savings that might have been realized had all items requested for Approach '80 been approved and had off-site requirements been relaxed.

Table 8 shows that an additional $3,826.44 per unit could have been saved if all requested waivers had been approved and if off-site requirements had been relaxed. This change would have raised total cost savings from $5,419.86 per unit to $9,318.30 or a total savings of 18 percent.

Table 8. Approach '80 Estimated Potential Cost Reduction of Items Not Approved by the City of Las Vegas

Item	Cost Per Unit
Lot size larger than requested	$ 906.48
Interior streets wider than requested	629.70
Dead end street barricade required	31.58
Off-site requirements	
Street paving widths too great	959.00
Fencing not necessary	473.09
Street lighting too intensive	68.42
Sewer connection too remote	205.00
Parapet fire walls atop roofs	377.63
3½'' thick slabs required vs. 2½'' requested	175.00
Total	$3,826.44

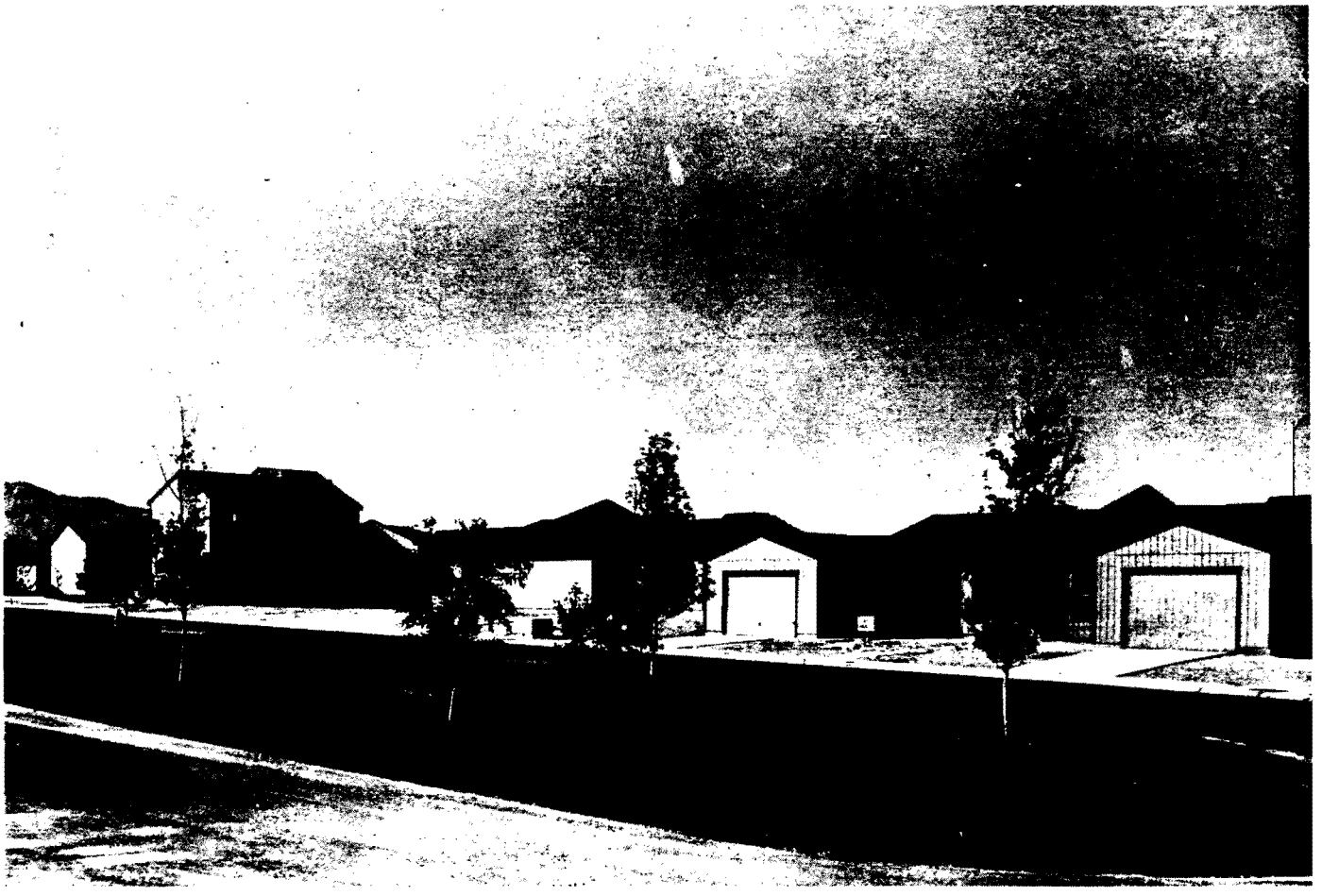
Conclusion

The Approach '80 project was an unqualified success in what it was attempting to accomplish. It proved that comfortable, safe, and attractive homes can be built at substantially less cost if government officials, land planners, and builders come together with a common goal.

Approach '80 was not, however, a cure-all for affordable housing. Indeed, the average sales price of about $51,000 was about $10,000 lower than comparable homes in Las Vegas, but the price and high interest rates still make owning a new home impossible for too many Americans.

The homebuilding industry must continue to search for solutions to the massive problem of building affordable dwellings. These solutions may be found by continually looking at new products, materials, and methods that will lower costs and increase value. But, more importantly, builders and land developers must work closely with those governmental agencies that are involved in regulating the housing industry to eliminate excessive regulatory costs and to streamline the process of providing shelter for the majority of Americans.

The Common Area



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