ECOLOGICAL LAND PLAN

-----------

PASSIVE SOLAR ARCHITECTURE

FOR

GRIFFIN-WEST RESIDENTIAL COMMUNITY

THE CENTER FOR
MAXIMUM POTENTIAL
BUILDING SYSTEMS
AUSTIN, TEXAS
May 22, 1986

Mr. Pliny Fisk  
Center for Maximum Potential Building Systems  
8604 FM 969  
Austin, Texas 78724

Gentlemen:

Pursuant our discussion and as an extension of the work already preformed by your office on behalf of Griffin West Residential, we find it necessary to enter into a contractual relationship with you for future services.

We would like you to consider a 2% overall fee related to the construction of the project. This will encompass architectural design, site planning, including landscaping, site development as well as design and floor plans for the multi-family buildings. We estimate the construction cost to be approximately $8 million.

If the above items meet with your approval, we would like to enter into negotiations at this time.

Sincerely yours,

Gabriel Ponce  
Managing Partner
Princeton Parks Philosophy

Ike Griffin, Developer

There is a rapidly growing school of thought concerning the economics of communities and nations stemming from the frustrations of the last forty years' experience and based on self reliance. It is fast growing because it is so basically honest. The Gurus of this thought are Ian McHarg, Jane Jacobs, Paul Hawken, Hazel Henderson, and Wendell Berry. Between them, they have written a truckload of books on their individual subjects. The proof of their genius is that you know instinctively the truth of what they are telling you though you have long since put it aside for something more expedient.

These truly great thinkers certainly deserve more than one line synopsis of their thesis but for the sake of brevity, here is what they talk about:

McHarg: We are an extension of the flora and fauna of the land we live on. If we manage those things better, we enrich ourselves.

Jacobs: Import substitution is the key to guarding and increasing our wealth. This is true in Nations and Communities.

Hawken: The world is finally tired of and is rejecting the throw away economy.

Henderson: Even the poorest community has wealth which can be built upon through self reliance.

Berry: The Metropolis is too wasteful of resources and energy to justify its' own existence. The most obvious justification is ego gratification. Society cannot afford it.

Pliny Fisk is one of the few Architects in the field who puts all this thought into workable situations. His Center for Maximum Potential Building Systems is guiding our Princeton Parks Development. What does all this mean for Princeton Parks? (emphasis added)
1. We will build with as many local products as possible. We are looking for a building material that comes out of this area. We would like to have a brick or tile made from this clay fired locally. Failing that, it would be good to find our building form, (Thermal Wall) filled with local building materials. We would like to manufacture Thermal Wall here. Most of our lumber comes from far off places and we feel that is a shame.

2. We will favor local sub-contractors and suppliers. Princeton has a good supply of competent trades and we want to use them. We won't subsidize local trades but we will award contracts locally if everything else is about equal.

3. We will landscape with native plants indigenous to the area. These plants should survive in drought and winter freeze without any unusual care. Ground cover of wildflowers and prairie grasses do not require mowing or watering. That saves on tools, time, water and fuel. Of those, time is the only one we produce here in Princeton. Native plants that are started in California or Florida have no appeal for us. We would rather have plants started within a few miles of here.

4. Buildings will be so positioned to take advantage of passive solar heating and cooling summer breezes. Landscaping will be done with the same goals in mind. Early Texas style architecture lends itself well to this theme. Higher ceilings and porches add to the natural comfort of dwellings. This costs something in planning and landscaping but it saves 40% of the energy cost immediately and forever. Energy is an import, so by substituting design for import, we conserve wealth locally.

5. Many of our houses will have cisterns to catch rain water from the roof to use on landscaping during periods of heavy drought. We will favor low volume plumbing fixtures to further conserve water.

6. There will be areas set aside for personal gardens in both the single family and multi-family units. Princeton is already a heavy gardening community and we want to encourage that in the new areas.

7. Paving will be minimized and natural drainage maximized. We all recognize our dependency on the auto but we don’t want to be reminded of it too often. We want to hide all the cars possible.
8. Walking and bicycle trails will be connected to green belts and all parts of the development to encourage walking.

9. Usable porches on all the dwelling units will serve to encourage community and discourage crime.

10. Our homes will be over built by today’s standards. We want lending institutions to know that there will still be a structure there long after the mortgage is paid. They will be made affordable to our target market by downsizing the inside living area even though we are adding outside porch space.

11. Appliances like compactors, washers, dryers and refrigerators should be left off the mortgage. They usually wear out in about 10 years so they should not be paid for over 25 or 30 years. People should be free to use an appliance that Grandmother gave them if they care to. Even heating and air conditioning should be addressed as a variable option. A central system is not the only nor the most economical way to make your living space comfortable.

12. We would like to see the Princeton Planning and Zoning Board re-think some regulations to allow some home industries in residential areas. Home industry is the fastest growing segment of new business right now. Of course much of that is caused by the wide acceptance and use of the home computer, but there are other clean and residentially oriented businesses which add a lot of texture to a community. It also keeps a bedroom community from becoming a desert from 9 to 5 daily. There are hoards of social implications involved with this. Many sociologists now feel that the strict separation of business from residential by zoning which became popular in the 60's has been a disaster for society. It is hard to undo. Fortunately, it has not really affected Princeton yet.

We want to be a good and positive influence on an already good community. We want to be good neighbors. It is not always easy to see what is best and impossible to not step on some toes. Please know that our intentions are the best and actions will not be unstudied. I am not ashamed to ask that you pray for our proper guidance and for our community.
<table>
<thead>
<tr>
<th>INVENTORY</th>
<th>ANALYSIS</th>
<th>PRE-SYNTHESIS</th>
<th>ISSUES</th>
<th>TECHNICAL STUDIES</th>
<th>MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXISTING &amp; PROPOSED REGIONAL LAND USE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 2 SCALES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITE BOUNDARIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXISTING AND PROPOSED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- R.O.W.S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- SETBACKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- UTILITY EASE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYSIOGRAPHY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- SEASON SOLAR AZIMUTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- HILL (VIEWS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- VALLEY (PRIVATE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLIMATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- DEGREE DAYS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- COMFORT ZONE CHART</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- GROUND TEMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOILS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- EROSION POT.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- DEPTH OF CLAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYDROLOGY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- FLOOD PLAIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- DRAINAGE PAT.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIMNOLOGY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- SURFACE WATER QUALITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- SEASONAL/STANDING WAT.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEGETATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- WILDLIFE HABIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- VEG. PATTERN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- VEG. HEIGHT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- VEG. TYPE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME/DISTANCE STUDIES REGIONAL &amp; COUNTY PLANNING AGENCIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIGHWAY DEPT. UTILITY DIST. CITY PLAN COMPILED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTOUR ANALYSIS SITE INSPECT. PHOTOGRAPHIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. WEATHER BUREAU INTERP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMPBS LIBRARY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOIL CONSERV. SERVICE INTERPRETATION SLOPE ANALYSIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. CORP OF ENGINEERS TEXAS DEPT. WATER RESOUR.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WATER SAMPLING VIA HEALTH DEPT.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NICH OR POT. NICH IDENT. VIA HEARD NAT. SCIENCE MUSEUM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITE LAND USE COMPATIBILITY WITH REGION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL LAND PARCEL DEVELOPABLE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACCESS/COMMUNITY FOCAL POINTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROSION CONDITIONS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTENTIAL SOLAR INPUT USE OF GROUND AS HEAT SINK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTENTIAL GREEN BELT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEFUL PONDS AND WATER CONTACT RECREATION AREAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEGETATIVE PRIORITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRELIMINARY LAND USE PLAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITE IDENTIFICATION (EXAMPLES)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSSIBLE ZONING ADJUSTMENTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYSICALLY DEVELOPABLE LAND AND ITS RELATION TO FINANCIAL ANALYSIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMPACT OF PROPOSED GROWTH ON SITE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUPER-STRUCTURE/INFRA-STRUCTURE OPTIONS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST OF ENVIRONMENTAL IMPROVEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEGETATIVE SPECIES MISSING FOR COMPLETE WILDLIFE HABITAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEAST COST MANAGEMENT PLAN FOR OPEN SPACE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOLDING CAPACITY OF SITE AS DETERMINING FACTOR FOR GROWTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUN/SHADE/WATER USE OPTIMIZATION IN RELATION TO PHYSICAL LAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Collin County has experienced a remarkable growth over the past few years. In McKinney there has been a population growth of 19% between 1980 and 1985. Land values have soared while the number of residential and commercial projects being executed or on the drawing board continues to rise. This growth is beginning to spill over into adjacent population centers as employment opportunities become available by the relocation of several manufacturing facilities - E.D.S., Frito-Lay, Fisher Electronic, Texas Instrument, etc.

Housing development along the North Central Expressway between Plano and McKinney continues with housing costs already beyond the affordable range for the middle and low income population. This has created a market opportunity for the development of single and multi-family housing in Princeton, Texas. A population survey done for the city of Princeton (attached) indicates a 97% rate of occupancy which is very high. The following chart shows a similar rate of occupancy in surrounding communities (see page 2). It is interesting to note that Princeton had a negative rate of growth during 1980-1984, and a positive rate of growth of 19% in 1985. This would appear to reflect the increasing cost of land and housing cost which has pushed buyers and renters further out, but within reasonable commuting distance of the Dallas area.
-2-

<table>
<thead>
<tr>
<th>City</th>
<th>Distance from Princeton</th>
<th>Occupancy Rate</th>
<th>Household Size</th>
<th>1980-1984 Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>McKinney</td>
<td>8 miles</td>
<td>94%</td>
<td>2.7</td>
<td>3.5%</td>
</tr>
<tr>
<td>Farmersville</td>
<td>9 miles</td>
<td>95%</td>
<td>2.6</td>
<td>2.35%</td>
</tr>
<tr>
<td>Lucas</td>
<td>14 miles</td>
<td>95%</td>
<td>3.3</td>
<td>8.5%</td>
</tr>
<tr>
<td>Wiley</td>
<td>15 miles</td>
<td>96.7%</td>
<td>2.85</td>
<td>8.7%</td>
</tr>
<tr>
<td>Allen</td>
<td>16 miles</td>
<td>94.6%</td>
<td>3.05</td>
<td>7%</td>
</tr>
<tr>
<td>Princeton</td>
<td></td>
<td>97%</td>
<td>2.95</td>
<td>-4.5%*</td>
</tr>
</tbody>
</table>

* +19% in 1985 alone

Further growth is expected in the area. The student population for the Princeton school district is forecast to be 2,796 students for the school year 1990-91, an increase of 53% over 1984-85 enrollment. (See projection attached.) A new high school in Princeton will be completed by the fall of 1986, and a Bond issue already approved for 2 million dollars for a new elementary school to house 700 students within two years. All multi-family units in Princeton are 100% occupied, and 68 units in a trailer park opening in December of 1985 have been sold.

The Project: The development here proposed is based on the premise that the communities to be built in the 80s and 90s and beyond should not be designed with the social and environmental conditions of the 70s. Rather, they must be designed anticipating land use policies, water availability, energy resources, transportation modes, work patterns and life styles that may prevail in the years from now.

The scale and potential impact of the changes forecast indicate that alternative strategies and new ideas are required
for future human settlements. These would have to reflect the changing socio-economic, legal and financial aspects of community development, as well as significant technological response to the problems of resource scarcity and environmental concerns.

This community development project will strive to mitigate resource and environmental constraints by establishing stringent criteria and performance standards to provide the maximum possible levels of energy conservation, energy self-sufficiency and passive energy design. The urban development will be structured for medium density concentration to allow for surrounding open spaces and green belts for common use.

Social considerations such as rising divorce rates, dwindling birthrate, a growing tendency to postpone or omit marriage, the increasing number of women in the labor force must be taken into account as development factors. Thus, this project intends to provide housing for single occupancy, including ambulatory elderly, as well as extensive day care facilities for divorced parents and working couples. Thus the average unit size will be markedly reduced.

The use of "defensive space" will reduce the incidence of crime while encouraging social interaction and neighborliness. Community layouts and designs of individual units will reflect personalized living environments to economize the use of space, conserve energy, and provide employment.
Escalating land values, construction costs and the resultant shortage of affordable housing suggest the very real need to reduce the cost of housing. The use of technology utilizing prefabricated techniques and passive energy design will be introduced in this project. Buildings will be oriented to maximize energy savings and solar collectors will supplement on site power availability.

Considerable attention has been paid to the quality of the proposed urban development in terms of environmental land planning. The project has retained Mr. Pliny Fisk of the Center for Maximum Potential Building Systems in Austin, Texas. As an environmental architect and land planner (resume attached), Mr. Fisk will undertake the ecological urban plan and site development to take advantage of the vegetation and topography of the site. To assist in the process, we have retained the Heard Museum of Natural Science to provide the vegetation and habitat analysis.

The Development Concept: The total development acreage available to the project is 210 acres of which 18 acres will be used for multi-family residential units, 2 and 3 bedroom duplexes and quadruplexes. This 18 acre development will be of medium density with up to 9 units per acre for a total of 162 rental units.

Of the 210 acres, approximately 42 acres have been allocated as green belts along the flood plain of Tickey Creek
and on the south central portion of the development where there are natural grasses and substantial wildlife habitats. These acres will be converted into natural trails for hiking, park areas, and the general use of the community. The remaining 150 acres will be allocated for detached single family housing.

The project will be developed in phases. Phase I will supply the local market with much needed rental units. Building nodes of 4 units each will be erected along or connecting to green belt areas until a cluster of 12 has been achieved. As an amenity, an extensive day care center will be built that can function as a community building.

The architectural style will be Early Texan, properly oriented to utilize and harness solar heating in the winter and wind currents for ventilation in the summer. The extensive use of porches and exterior staircases will permit social intercourse, neighborliness and security.

It is hoped that this development of multi-family units will provide a stepping stone into the single family development and aid in the presale of the same. Tenants can watch as the development takes place with the expectation and confidence that the homes will be as good a quality as the rental units, thus bridging our marketing effort with the sales plan.
PRINCETON PARKS
MARKET ANALYSIS

Princeton Parks multi-family development is located in Princeton, Texas on the southwest corner of Highway US 380 and Farm to Market Road 982.

Princeton is approximately 30 miles from Dallas and eight miles east from McKinney in Collin County.

The population of Princeton did not grow as rapidly as did the rest of the county during 1980-1984. However, between 1984 and 1986, Princeton grew by 19%. It would be difficult to categorically state that a growth trend has been set based upon last year's dramatic growth, but one could deduce several possibilities.

One, the demographic expansion of the Dallas metroplex area has pushed housing prices up, thus forcing people further out to seek affordable housing. Secondly, the growth registered in Collin County of 7.45% per year from 1980 to 1985 has created a demographic immigration into the county following the rapid growth of Plano, McKinney, Wylie, Allen, Frisco and other communities as a consequence of business and industry relocations into the county. Some of these companies are: Texas instrument, Electronic Datas System, Firto-Lay, and Fisher Electronics.
The Texas Employment Commission reports that in 1985 the county registered only 3.9% unemployment. As of February 1986 Collin County has a 4.1% unemployment as compared with Dallas County which shows 5.8% unemployment and 8.8% for the state of Texas for the same period. The Employment Commission report shows that approximately 2,000 new jobs were created in Collin County during 1985.

The economic development has created a growing, strong economy independent of the energy situation prevailing throughout the state at this time.

Thirdly, the economic expansion of the county has accelerated the effective income per household. In Collin County the effective buying income registered a 12% rate of growth from 1975 to 1983. In absolute terms, the EBI for Collin County is $34.00 as compared $26.00 for Dallas and $23.40 for the state of Texas.

In Princeton it could be stated that there is almost full employment. The Census Bureau reports that the number of people over 16 years of age that file for unemployment is 1.6% of the labor force.

The income level of Princeton is substantially below that of the county at $21,000. This reflects the composition of the labor force, mostly blue collar workers who depend on employment in job markets outside Princeton e.g. McKinney, Plano, and North Dallas. It is this market segment Princeton

Parks plans to target in its residential development of rental units and single family homes of several price ranges to accommodate expected rise in income.
EXISTING RENTAL UNITS & COMPETITIVE ANALYSIS

There are 200 rental units in Princeton with an occupancy rate of 97%.

40 of these units are elderly housing and 60 are subsidized Farmers Home Administration rental units.

Of the units surveyed (see attached), the quality of construction was poor, and there are no 3 bedroom units available.

Occupancy rate in McKinney is running at 94% with 200 units already being built and more on the drawing board.

There are no rental units available in Farmersville, 9 miles away.

Rentals run between $380 to $330 for a single bedroom, 1 bath, to $320 to $375 for a 2 bedroom, 1 bath.
PRINCETON PARKS
SITE DESCRIPTION

Griffin-West residential properties is located within commuting distance to Dallas, Plano and McKinney on U.S. Highway 380 and off Central Freeway. It is also connected to Dallas/Fort Worth further north through Farm to Market Road 121 which is programmed to be a 4 lane freeway from Princeton to the Dallas/Fort Worth International Airport (see chart).

The project is located in rolling hills with large wooded areas and crossed by Tickey Creeks and other smaller creeks, thus providing the site with superior environmental attributes.

The City of Princeton's long range development plans all benefit the project. The city promises to finish a 12 inch water main to supply C Water District. The project has 900 foot frontage on this route. A 14 inch distribution line is planned to supplement the existing 12 inch line that is already there on Highway 380.

The drainage and sanitary sewers encircle the property insuring it long term development potential and the economical cost of its development.

There are several areas with large trees and virgin grass which we will enhance to create nature trails. We will transplant vegetation to landscape building sites with the use of wild flowers.
The natural setting together with the early Texas architecture will create a unique environment at affordable cost since the proposed amenities are economical to implement and will improve the quality of life of the development.
## PRINCETON POPULATION STRATIFICATION
### BY AGE - 1986: 1986-91 PROJECTION

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Actual</th>
<th>Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 4</td>
<td>131</td>
<td>293</td>
</tr>
<tr>
<td>5 - 9</td>
<td>327</td>
<td>843</td>
</tr>
<tr>
<td>10-14</td>
<td>337</td>
<td>326</td>
</tr>
<tr>
<td>15-19</td>
<td>98</td>
<td>228</td>
</tr>
<tr>
<td>20-24</td>
<td>213</td>
<td>264</td>
</tr>
<tr>
<td>25-29</td>
<td>261</td>
<td>325</td>
</tr>
<tr>
<td>30-34</td>
<td>360</td>
<td>446</td>
</tr>
<tr>
<td>34-44</td>
<td>533</td>
<td>660</td>
</tr>
<tr>
<td>45-54</td>
<td>268</td>
<td>332</td>
</tr>
<tr>
<td>55-59</td>
<td>95</td>
<td>118</td>
</tr>
<tr>
<td>60-64</td>
<td>78</td>
<td>97</td>
</tr>
<tr>
<td>65-74</td>
<td>450</td>
<td>558</td>
</tr>
</tbody>
</table>

---

1. U.S. Bureau of Census 1980 population, stratification by age groups.


3. Non student population projection based on 7% annual rate of growth for Collin County.
<table>
<thead>
<tr>
<th>% of Dwellings with</th>
<th>0 Bedrooms</th>
<th>1 Bedroom</th>
<th>2 Bedrooms</th>
<th>3 Bedrooms</th>
<th>4 Bedrooms</th>
<th>5 Bedrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>14%</td>
<td>43%</td>
<td>35%</td>
<td>5%</td>
<td>1%</td>
</tr>
</tbody>
</table>

1 U.S. Bureau of Census 1980 Census, Collin County Housing Classification
<table>
<thead>
<tr>
<th>Units</th>
<th>Bedrooms</th>
<th>Rent</th>
<th>% Occup.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colonial Apts</td>
<td>1</td>
<td>344-190</td>
<td>100%</td>
<td>Subsidized</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>360-216</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Hazelwood Apts.</td>
<td>1</td>
<td>330</td>
<td>100%</td>
<td>Medium to poor quality</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>375</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boi D'Arch Apts</td>
<td>1</td>
<td>300</td>
<td>98%</td>
<td>Average quality</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. Hwy 380 Apts</td>
<td>1</td>
<td>280</td>
<td>98%</td>
<td>Poor quality</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elderly Housing</td>
<td></td>
<td></td>
<td>100%</td>
<td>Subsidized</td>
</tr>
</tbody>
</table>

2 Griffin-West Survey, March 1986
COMMUNITY ACCEPTANCE

Griffin-West has returned to Princeton, the place where the Griffins and the Wests were born.

We have erected our first building, a commercial venture. It has passive solar characteristics and has the Early Texas architectural look with clay roof tile and floors. All opposition to our rezoning the first multi-family project vanished once the town saw the quality of construction and the care we have taken to minimize the ecological and urban impact this project will have in the community.

Further rezoning requests for the same purpose meet no opposition, but rather we have received favorable comments on our efforts in Princeton to develop an ecological, affordable housing project.

In order to renew the ties with the community, a series of articles called "Griff-O-Crams" has been published in the local newspaper. These articles provide the common bond between the community and Griffin-West enterprise. A copy is attached to the report.
2.1 DESCRIPTION

Residential development programming is a very complex activity. The program must respond creatively to two major forces: the needs and desires of a multitude of participants who are either directly or indirectly involved and the influences of the site and project context. The program must also respond to issues that are much broader in scope, the most important being adaptability to population and physical change through time.

Five participant groups can be identified with unique, overlapping, and often conflicting sets of objectives.

1. USERS  The principal users of the programmed environment are the residents. Within many architectural programs, the principal users and the client may be the same, which eases the problem of clearly defining the needs of the user. But in most residential problems situations the specific character of the users will become known only upon project completion. User characteristics and needs, therefore, must be simulated (based upon observation of individual and group behavior and previous experience). User needs determined through simulation pose the potential danger of being overly simplistic and deterministic, but they can only be reasonably accommodated in this fashion.

2. PROJECT NEIGHBORS  Project neighbors form a group of secondary users who are directly affected by action occurring within their territory. Potential conflict of goals and objectives exists which, if not resolved, may form a formidable barrier to program implementation. The adjacent community is impacted either positively or negatively in physical, social, and economic ways. Often its goals and objectives are not well articulated until issues of conflict arise. However, through negotiation and trade-offs effective programming solutions can be attained which take the neighbor's concern into account.
3. MUNICIPALITY The municipal body usually does not operate as a client; nevertheless it is a strong ratification force. Most of the interests within a politically defined boundary are arbitrated at this level and are funnelled through municipal mechanisms. Ideally the municipal body expresses goals and objectives based on the values of the larger community. Ratification of any program is based upon a broad set of social goal satisfactions and municipal service impact criteria. A broad area of negotiation is centered upon the public cost/benefit balance.

4. DEVELOPER Ultimate implementation of a project depends upon the skills of the developer acting in his own interest or as an agent for another party. His participation brings project economics to bear upon implementation feasibility. Generally the developer is operating on a restricted budget which limits his objectives. Maximization of profit, financial leverage, and liquidity as well as the minimization of risk, operating expenses, construction time and costs place constraints upon the program. The developer's objectives cannot be met without the ability to market a package of physical, social and environmental products which are based on a set of predictions of uncertain market behavior; thus he must be an anxious advocate of the project and be willing to negotiate with all participants.

5. STATE/FEDERAL GOVERNMENT The fifth participant is the state and/or Federal government. Their participation can involve direct or indirect subsidies to the project in the form of various aid programs. The governmental role is usually that of a ratifier and is contingent upon the objectives, policies, and standards of the applicable programs.

The particular issues that must be responded to in residential programming affect the components of the program and the process of programming. The major influences include:

1. Ecological conditions of the land. The program must respond to ecological determinants for determining suitable uses and developing adaptive strategies.

2. Market determinants. The effective and non-effective demands of the housing market, capture rate, and absorption rates are major determinants of the program. But this data
must be weighed against the additional demand that the development itself may create and against the potential for altering the market forces.

3. Social objectives. Each project has either implicit or explicit social objectives in terms of what population or what part of the market is desired and how that population can be attracted and how their needs can be met.

4. On-site/off-site factors. The level of services in the surrounding area offers opportunities for attaching or detaching the project from its surroundings. An over-sufficient program in terms of services provided may be appropriate in order to meet unfulfilled demand or reduce the impact of the project in the surrounding area. An under-sufficient program may be appropriate where existing levels of service is high.

5. Type of developer. Public and private developers have very different objectives in providing housing and this will affect the content of the program and the method of programming.

6. Construction process. An industrialized or systems development may require a vastly different program than conventional construction and development processes.

7. Timing. The timing and pace of development determined by the market influences the program due to its effect on costs and the critical mass of housing required to support ancillary services.

2.2 IMPLICATIONS FOR PROGRAMMING METHODS

These influences suggest that programming is highly political in nature and that the issues involved are heavily value laden. This fact, coupled with the necessary interdisciplinary nature of residential problem solving, suggests that an appropriate method is not a decision-making model but a framework for organizing and displaying information that exposes the critical issues from which creative decisions can be made.

An examination of trade-offs is the major requirement for a method of programming. This is a device for carrying out actual or simulated negotiations between the participants and their needs and the influencing conditions of the specific problem at
hand. The dimensions of the possible trade-offs are difficult to determine but this is a necessary task for effective problem solving.

The method must also interface with the design process and allow opportunities for early design decisions such as responding to the condition of the land, circulation requirements, service networks, and critical edge conditions. A graphic component, therefore, seems to be necessary. But since rapid construction and evaluation of alternatives are required, a calculating component is also demanded which can keep an accurate account of program quantities and their costs.

These are the basic issues which have framed our approach in formulating a flexible modular programming process.
MODULE PROGRAMMING METHOD

3.1 CONCEPT

Module programming is an information packaging and display model rather than a decision model; it is essentially a method of establishing an environment for creative problem solving. It is a graphic tool that effectively interfaces programming and design activities, and it is a calculating tool that allows rapid aggregation and manipulation of program quantities. Module programming can be applied to a broad range of residential programming scales, it possesses sufficient flexibility to respond to most residential problem situations, and it can be used for general or very detailed examinations.

Manipulating units of pre-aggregated and pre-defined quantities and relationships is the major operational feature of the method. These units are of two basic types:

1. Density/Planning Modules: A density module is an information block relating a population group to a particular level of environment at a specific residential density. Applying area dimensions to the density module coefficients result in a Planning Module which can be physically applied to the site, and the demands for supporting functions can be quantified. Thus, the planning module allows manipulation of sets of dwelling units and relationships rather than individual units.

2. Thresholds: A threshold is a construct which describes the scale and nature of demand necessary to support a given type and environmental level of a service, amenity, infrastructure technology, construction process, etc.

Using these two concepts not only allows rapid and accurate development of a residential program but also provides opportunities for examining
alternative levels of environmental quality which are possible and trade-offs which determine how the particular level can be achieved. Being able to clearly conceptualize trade-offs allows more sophisticated decision-making and, therefore, provides opportunities for increasing the quality and variety of planned residential environments.

A third unit outside the spatial module defines area wide community amenities such as community park, daycare center, churches, community center, etc. These have been summarized with typical planning ratios. Some of these ratios are as follows:

<table>
<thead>
<tr>
<th>Facility</th>
<th>Acres/1,000 Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playground</td>
<td>1.5</td>
</tr>
<tr>
<td>Neighborhood Parks</td>
<td>2.0</td>
</tr>
<tr>
<td>Playfields</td>
<td>1.5</td>
</tr>
<tr>
<td>Community Parks</td>
<td>3.5</td>
</tr>
<tr>
<td>District Parks</td>
<td>2.0, 10.5</td>
</tr>
</tbody>
</table>

3.2 DENSITY/PLANNING MODULE

A density module is a non-area defined vector which relates a population group and a quality of environment to a specific residential density. The quality of environment and the characteristics of the population served are the most significant dimensions of the module; density is used only to relate these relationships to a possible range of dwelling unit types and to determine ranges of spatial quantities. For any given density many different modules can be developed. A change in population profile or a change in the level of environment will alter the spatial coefficients in the module and the demand or ability to supply threshold quantitites for support functions.
The module is essentially an information block with two major components: a population profile and its coefficients and spatial coefficients which are designed in response to population needs at particular densities.

The population profile is determined by making assumptions about the probable occupation of the units through time. The coefficients in the module should respond to the housing market conditions for the specific problem situation. The following information is required:

1. Household income range: This information is required for determining the spatial needs of the socio-economic classes involved. Provisions for private and public open space, recreation facilities, and other services vary significantly across income groups.

2. Household type/size distribution: This describes the character of the probable population in terms of household type: elderly, singles, married couples, small families and large families. From this information dwelling unit sizes can be broken down into age groups.

3. Age group distribution: This information provides a basis for determining the demand for certain services, such as recreation facilities, schools, and daycare centers.

4. Dwelling unit size distribution: This provides a bedroom count mix for the module which determines the floor area ratio, a key to determining spatial coefficients.

The information above is required for determining the spaces for each module and for quantifying demands or potentials for threshold testing.

The spatial coefficients included in the density module are those which are intimately related to the dwelling and do not vary significantly through different project scales. Parking, private open space, attached public open
space, and recreation space are included. Other needs which vary by project scale are carried as thresholds. The coefficients within the module should contain sufficient flexibility to allow for creative design freedom for determination of housing types and spatial arrangements. Open space in particular should be flexible because of the potential trade-offs between private and public open space, public space that is attached to the units, and space that is aggregated into larger units at some distance from the dwelling.

We have used FHA’s Land Use Intensity Standards for our initial module formulations. The relationships between densities/floor area ratios vary relatively consistently and they supposedly represent comparable environmental qualities, at least in simple spatial terms. Although we are not familiar with the biases which underlie their formulation and possible would disagree if we were, they do form a real administrative minimum on many projects.

The spatial coefficients that are included in the module are:

1. Floor Area Ratio (total residential floor area/land area). The F.A.R. is determined by the dwelling unit size distribution and forms the basis for the remainder of the coefficients.

2. Open Space Ratio (land area-building coverage/floor area). Maximum coverage is determined by the O.S.R. If less than the maximum allowable is used this space can be translated within the module to livability or recreation spaces.

3. Livability Space Ratio (open space-circulation and parking/floor area). The maximum amount of circulation can be determined by subtracting the total livability space from total open space. The livability space itself includes recreation space, private open space, and passive public open space contiguous to the unit or building. Excess livability space can be distributed into recreation space
or non-contiguous public open space.

4. Recreation Space Ratio. For our purposes this includes adjacent recreation space that is located close to the dwelling in relatively small quantities (2,000 sq. ft. to 7,000 sq. ft.) for tot lots and recreation areas for other age groups and local recreation space which is aggregated into one to two acre increments at a farther distance (generally 1/8 mile maximum) from the dwelling. Recreation space is included in livability space. Their quantitative relationships for various densities can be seen in Figure 3-1.

5. Parking Ratio. This includes both resident's and visitor's parking.

Density modules are multiplied by area factors to form program modules which can be applied to the site as spatial aggregates. The population characteristics are also transformed into aggregates for threshold testing. Program modules can vary in size according to the level of detail which is desired or the scale of the problem. A one acre module is sufficient for most work and provides an opportunity for finely detailed programming.

The format of the density module and illustrations of the program modules developed for Princeton, Texas are presented.

3.3 THRESHOLDS

Residential developments occur at many scales and often scale is a key determinant of what environmental support can be provided to the dwelling units themselves. Thresholds are the scalar quantities that must be achieved to provide various facilities, services, amenities, etc., which are the major determinants of environmental quality. The concept of thresholds is not new; it is the basis for most standards and rules of thumb
L.U.I. OUTDOOR SPACE/D.U.

Figure 3-1
in residential programming. An elementary school of 600 students typically requires 900 dwellings, etc. However, the threshold concept can be used in a much more sophisticated manner as a means for programming, defining levels of environmental quality, and providing a framework for examining trade-offs.

There are many components of residential development to which the threshold concept can be applied. Some of these are:

1. Residential support services such as recreation, schools, shopping facilities, etc.

2. Infrastructure technologies such as water supply, sewage, solid waste disposal, elevators, etc.

3. Transportation technologies.

4. Socio-economic mixes for scales of homogeneity and heterogeneity (i.e. minimum social groups that should be homogeneous, etc.).

5. Amenities such as lakes or ponds, protection of natural vegetation, etc.


We have chosen to deal only with service thresholds in demonstrating the programming method; however, the other types could be treated in the same manner with this model. The remainder of the discussion will deal primarily with services but the issues discussed are equally applicable to other threshold types.

Service thresholds relate to various types of demand. The typical basis of total population or total dwellings for determining services is not adequate.
Thresholds are functions of the following:

1. Total dwelling units or demand related to the number of households. This type is not sensitive to household size, density variations or particular sub-groups. The major examples are utility systems and some commercial facilities which depend upon disposable household income.

2. Total dwelling units of a particular housing type or density. Household types and, therefore, family sizes vary with residential density. Recreation space and transportation facilities are examples of dependent thresholds.

3. Total population or demand varying by household size. Many standards are expressed in these terms. Possible examples are certain recreation facilities and some infrastructure technologies.

4. Population by sub-group. This includes age groups and socio-economic class or ethnic groups. Examples include schools, daycare centers, special recreation facilities, etc.

5. Time. This type is related primarily to construction processes and the ability to spend more for site services with savings in construction costs.

6. Area size. This is also a construction process function where economies of scale might allow spending more for housing quality or services.

The nature of the service itself determines the threshold function. Various threshold functions include:
1. Linear or slope function. This relates to a service, such as public open space, that can continuously increase. A variation of this is a step-slope function which requires an initial critical mass for providing a service, but it can then expand linearly until another unit can be developed.

2. Step function. This indicates a facility which has a fixed size; a second facility cannot be supplied until a second level of demand is reached. Examples include swimming pools, corner stores, etc.
3. Curve function (such as a logarithmic curve) which indicates that a service can achieve economies of scale. Maintenance services and elevators are examples.

4. Curve function (such as an exponential curve) which indicates that as demand increases at a greater rate than provision of facilities. A regional shopping center is an example.

Many combinations of these are possible. For the purposes of illustrating the model, we have only dealt with two types: step-slope and step function.

The information required for threshold testing includes the following:

1. The size, space, equipment and personnel required for the service in terms of alternative environmental levels.

2. The nature of operation and maintenance.

3. Total development cost.
4. Annual operating cost.

5. Description of the threshold function.

6. Identification of the type of demand.

7. The amount of support required.

8. The minimum initial quantity that can be supported.

The services thresholds for Princeton, Texas are illustrated.

3.4 MODULE PROGRAMMING PROCESS

The overall programming process is diagrammed in Figure 3.2. Its major feature is the ease with which a designer can place the program modules and the related supporting services on a site plan, and make adjustments according to site specific design criteria and objectives for environmental quality. The technique of graphic display along with a computerized threshold calculator program make the adjustment of spatial quantities a relatively fast operation. Hence, the number of adjustment cycles is determined by the level of program detail desired.

The first step in the process is to assemble site and project context information including physical conditions of the site and surrounding area, existing services and housing quality, demographic and market data. This information must then be interpreted and formulated into working assumptions or objectives for programming. Alternative gross programs and mixes are put together by hand using density modules constructed or adjusted to the specific problem situation.

The modules are then graphically displayed and the first threshold tests
run for the program modules. The program mixes can then be adjusted to respond to the quantity and quality of service and their spatial distribution. For each program mix option, different levels of environmental quality can be constructed. The process of examining trade-offs can begin then by weighing the thresholds in combination, by examining the relationships between the modules and thresholds, and by examining partial aggregations of modules. The trade-offs can also be examined in terms of timing and phasing strategies. Total costs and costs per dwelling for various environmental levels can be examined in order to determine cost-quality trade-offs and threshold combination trade-offs.

Recycling the process in greater levels of detail can continue well into physical design activities. In fact design issues will be raised during the first graphic display and design decisions can be constantly built-in in successive levels of refinement.

In order to test and evaluate the module programming process as a conceptual technique the following Section describes our application of the method on a real site using current data.
MODULE PROGRAMMING PROCESS

DATA ANALYSIS

INTERPRETATION AND WORKING ASSUMPTIONS

ALTERNATIVE GROSS PROGRAMS

PROGRAM MIXES

interaction

figure 3-2

. site
. market
. existing services
. demography

basis for programming exercise
different total programs based on varying market conditions

THRESHOLD TESTING FOR SERVICES

adjustment between dwelling unit modules and services provided - alternative levels of environment
APPLICATION OF METHOD

4. PRINCETON, TEXAS DENSITY/PROGRAM MODULES

For demonstration of the method on the Princeton, Texas project, we developed two modules which relate to the apparent market demand:

1. 4 MODULE - 4 dwelling units/acre:
   single family detached

2. 11.5 MODULE - 11.5 dwelling units/acre:
   multi-family attached & detached

Each module was assigned a household and family size distribution, family sizes were estimated, and age group distributions generated. We had little local data on which to base our assumptions; the family size and age group estimates are derived from data for Princeton, Texas.

Each of the modules are presented below with their respective population profiles, spatial coefficients and minimum square footage standards for a two acre planning module. Each module is presented graphically in two variations to illustrate the range of design flexibilities. Generally one variation retains a maximum amount of private or attached open space and the minimum recreation space; the other variation reduces private and attached open space to a minimum and expands the recreation space portion. The second variation is the only one presented in this preliminary report because we are dealing with multi-family. Although not illustrated, many other flexibilities exist: savings in circulation space, building coverage or utilization of horizontal building surfaces can significantly increase the amount of attached open space or recreation space in each module. The first illustration for each variation presents spatial quantities first for a two acre module and secondly for a single dwelling unit or a vertical section of units. Following the spatial diagrams are: illustrative plans and isometrics for the two variations.
## POPULATION STRATIFICATION

<table>
<thead>
<tr>
<th>AGE</th>
<th>1985</th>
<th>1991</th>
<th>% CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>131</td>
<td>293</td>
<td>55.3%</td>
</tr>
<tr>
<td>5-9</td>
<td>327</td>
<td>843</td>
<td>61.2%</td>
</tr>
<tr>
<td>10-14</td>
<td>337</td>
<td>326</td>
<td>&lt;3.37%</td>
</tr>
<tr>
<td>15-17</td>
<td>98</td>
<td>228</td>
<td>57%</td>
</tr>
<tr>
<td>18-19</td>
<td>98</td>
<td>228</td>
<td>57%</td>
</tr>
<tr>
<td>20-24</td>
<td>213</td>
<td>264</td>
<td>19.3%</td>
</tr>
<tr>
<td>25-29</td>
<td>261</td>
<td>325</td>
<td>19.7%</td>
</tr>
<tr>
<td>30-34</td>
<td>360</td>
<td>446</td>
<td>19.3%</td>
</tr>
<tr>
<td>35-44</td>
<td>533</td>
<td>660</td>
<td>19.2%</td>
</tr>
<tr>
<td>45-54</td>
<td>268</td>
<td>332</td>
<td>19.3%</td>
</tr>
<tr>
<td>55-59</td>
<td>95</td>
<td>119</td>
<td>20.2%</td>
</tr>
<tr>
<td>60-64</td>
<td>78</td>
<td>97</td>
<td>19.6%</td>
</tr>
<tr>
<td>65-74+</td>
<td>450</td>
<td>558</td>
<td>19.4%</td>
</tr>
</tbody>
</table>
## PLAN TYPES

<table>
<thead>
<tr>
<th>SI</th>
<th>MI</th>
<th>LI</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 SQ. FT.</td>
<td>480 SQ. FT.</td>
<td>560 SQ. FT.</td>
</tr>
<tr>
<td>EFF.</td>
<td>1 BDRM.</td>
<td>1 BDRM.</td>
</tr>
<tr>
<td>1 PARK. SP.</td>
<td>1.5 PARK. SP.</td>
<td>1.5 PARK. SP.</td>
</tr>
<tr>
<td>S1.5</td>
<td>M1.5</td>
<td>L1.5</td>
</tr>
<tr>
<td>560 SQ. FT.</td>
<td>672 SQ. FT.</td>
<td>784 SQ. FT.</td>
</tr>
<tr>
<td>1 BDRM.</td>
<td>2 BDRM.</td>
<td>2 BDRM.</td>
</tr>
<tr>
<td>1.5 PARK SP.</td>
<td>2.0 PARK SP.</td>
<td>2.0 PARK SP.</td>
</tr>
<tr>
<td>S2</td>
<td>M2</td>
<td>L2</td>
</tr>
<tr>
<td>800 SQ. FT.</td>
<td>960 SQ. FT.</td>
<td>1120 SQ. FT.</td>
</tr>
<tr>
<td>2 BDRM.</td>
<td>2 BDRM.</td>
<td>3 BDRM.</td>
</tr>
<tr>
<td>2.0 PARK SP.</td>
<td>2.0 PARK SP.</td>
<td>2.5 PARK SP.</td>
</tr>
<tr>
<td>S2.5</td>
<td>M2.5</td>
<td>L2.5</td>
</tr>
<tr>
<td>960 SQ. FT.</td>
<td>1125 SQ. FT.</td>
<td>1344 SQ. FT.</td>
</tr>
<tr>
<td>3 BDRM.</td>
<td>3 BDRM.</td>
<td>4 BDRM.</td>
</tr>
<tr>
<td>2.5 PARK SP.</td>
<td>2.5 PARK SP.</td>
<td>3.0 PARK SP.</td>
</tr>
</tbody>
</table>
### Assumptions

- **Land Area**: 90,169 sq. ft
- **Land Use Intensity Factor** (Outdoorspace/Dwelling Unit): 4.01
- **Resident Household Income**

### Age Groups

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Pop/DU</th>
<th>Pop/Mod</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65-74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Total School Children

### Total Population

### Household Types

- **Elderly**
- **Single**
- **Couple**
- **Family (3-4)**
- **Family (5+)**

### D.U. Sizes

<table>
<thead>
<tr>
<th>No. BDRMS</th>
<th>FL. Area</th>
<th>% Dist.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2960</td>
<td>13.28</td>
</tr>
<tr>
<td>2</td>
<td>9136</td>
<td>40.68</td>
</tr>
<tr>
<td>3</td>
<td>5285</td>
<td>23.58</td>
</tr>
<tr>
<td>4+</td>
<td>8064</td>
<td>35.98</td>
</tr>
</tbody>
</table>

- **Average FL. Area/D.U.:** 977.6 sq. ft
- **Average FL. Area/Module:** 22,485 sq. ft
## Modular Spaces

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Spaces Sq. Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area Total</td>
<td>90,169</td>
</tr>
<tr>
<td>Floor Area Total</td>
<td>22,485</td>
</tr>
<tr>
<td>Open Space Total</td>
<td>67,684</td>
</tr>
<tr>
<td>Public</td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td></td>
</tr>
<tr>
<td>Recreation Space Playgrounds</td>
<td></td>
</tr>
</tbody>
</table>

## Modular Community Parts (Amenities)

<table>
<thead>
<tr>
<th>Parking Space</th>
<th>Shade Trees</th>
<th>(10x15)x(41)</th>
<th>6,150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Visitor</td>
<td>Low Heat Absorption Paving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sidewalks</td>
<td>Paths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fencing</td>
<td>Shrubbery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Modular Building Envelopes

<table>
<thead>
<tr>
<th>Single Story Cottage</th>
<th>Two Story Cottage</th>
<th>One Story Duplex</th>
<th>Two Story Duplex</th>
<th>One Story Triplex</th>
<th>Two Story Triplex</th>
<th>One Story Quadplex</th>
<th>Two Story Quadplex</th>
<th>One Story Apartment Bl</th>
<th>Two Story Apartment Bl</th>
<th>SM</th>
<th>MED</th>
<th>LRG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation Ditching</td>
<td>Heat Pump Ditching</td>
<td>Heat Pump Well</td>
<td>Cisterns</td>
<td>Water Lines</td>
<td>Electric Lines</td>
<td>Telephone</td>
<td>Sewage</td>
<td>Cable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Modular Utilities

<table>
<thead>
<tr>
<th>Utilities</th>
<th>Foundation Ditching</th>
<th>Heat Pump Ditching</th>
<th>Heat Pump Well</th>
<th>Cisterns</th>
<th>Water Lines</th>
<th>Electric Lines</th>
<th>Telephone</th>
<th>Sewage</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>750 ft²/ton</td>
<td>14,990</td>
<td>2,998 vert. ft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Modular Plans

<table>
<thead>
<tr>
<th>Plans</th>
<th>Spatial</th>
<th>Utilities</th>
<th>Modular Building Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>L-1</td>
<td>North Porches</td>
<td>Breezeway</td>
</tr>
<tr>
<td>S-1.5</td>
<td>L-1.5</td>
<td>Roof Vents</td>
<td>Trellises</td>
</tr>
<tr>
<td>S-2</td>
<td>L-2</td>
<td>E-W Porch</td>
<td>South Porch</td>
</tr>
<tr>
<td>S-2.5</td>
<td>L-2.5</td>
<td>Balconies</td>
<td>Overhang</td>
</tr>
<tr>
<td>M-1</td>
<td></td>
<td>Windows</td>
<td></td>
</tr>
<tr>
<td>M-1.5</td>
<td></td>
<td>Reflect. Curt.</td>
<td></td>
</tr>
<tr>
<td>M-2</td>
<td></td>
<td>Outside Stairs</td>
<td></td>
</tr>
<tr>
<td>M-2.5</td>
<td></td>
<td>Low Water Toilet</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage Shed</td>
<td>Energy Eff. LT. Blbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low FL. Shower</td>
<td>Found. Heat Island</td>
</tr>
</tbody>
</table>
MODULE

3) COMMUNITY AMENITIES EXTERNAL TO MODULAR PROGRAMING UNIT

ROADS
   MAJOR ARTERIAL
   MINOR ARTERIAL

PATHS
   HIKE AND BIKE TRAILS

RECREATION
   COMMUNITY PARKS
   REGIONAL PARKS

RELIGIOUS FACILITIES

GOVERNMENT BUILDING
   POST OFFICE

EDUCATIONAL FACILITIES
   DAYCARE
   ELEMENTARY
   HIGH SCHOOLS
MODULE

ASSUMPTIONS
LAND AREA - 90,169 SQ. FT
LAND USE INTENSITY FACTOR
(OUTDOOR SPACE / DWELLING UNIT)
RESIDENT HOUSEHOLD INCOME

AGE GROUPS
AGE GROUPS | POP/D.U. | POP/M.O.D
0-4        |          |
5-9        |          |
10-14      |          |
15-17      |          |
18-19      |          |
20-24      |          |
25-29      |          |
30-34      |          |
35-44      |          |
45-54      |          |
55-59      |          |
60-64      |          |
65-74      |          |

TOTAL SCHOOL CHILDREN
TOTAL POPULATION

HOUSEHOLD TYPES

<table>
<thead>
<tr>
<th>HOUSEHOLD TYPE</th>
<th>HOUSEHOLD SIZE</th>
<th>% DIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELDERLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SINGLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COUPLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAMILY (3-4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family (5+)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AVERAGE POP/D.U. -
AVERAGE POP/MODULE -

D.U. SIZES

<table>
<thead>
<tr>
<th>NO. BD RMS</th>
<th>FL. AREA</th>
<th>% DIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AVERAGE FL. AREA/D.U. -
AVERAGE FL. AREA/MODULE -
## MODULAR SPACES

<table>
<thead>
<tr>
<th>Land Area Total</th>
<th>Ratio</th>
<th>Space Sq. Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Area Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Space Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation Space</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## MODULAR COMMUNITY PARTS (AMENITIES)

<table>
<thead>
<tr>
<th>Parking Space</th>
<th>Shade Trees</th>
<th>Low Heat Absorption Paving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visitor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sidewalks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fencing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrubbery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## MODULAR BUILDING ENVELOPES

<table>
<thead>
<tr>
<th>Modular Building Envelopes</th>
<th>SM</th>
<th>MED</th>
<th>LRG</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Story Cottage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Story Cottage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Story Dog Run</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Story Dog Run</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Story Duplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Story Duplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Story Triplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Story Triplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Story Quadruplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Story Quadruplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Story Apartment BL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two Story Apartment BL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## MODULAR UTILITIES

<table>
<thead>
<tr>
<th>Modular Utilities</th>
<th>One Story Cottage</th>
<th>Two Story Cottage</th>
<th>One Story Dog Run</th>
<th>Two Story Dog Run</th>
<th>One Story Duplex</th>
<th>Two Story Duplex</th>
<th>One Story Triplex</th>
<th>Two Story Triplex</th>
<th>One Story Quadruplex</th>
<th>Two Story Quadruplex</th>
<th>One Story Apartment BL</th>
<th>Two Story Apartment BL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation Ditching</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pump Ditching</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pump Well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cisterns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## MODULAR PLANS

<table>
<thead>
<tr>
<th>Modular Plans</th>
<th>Spatial</th>
<th>Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>L-1</td>
<td>North Porches</td>
</tr>
<tr>
<td>S-1.5</td>
<td>L-1.5</td>
<td>E-W Porch</td>
</tr>
<tr>
<td>S-2</td>
<td>L-2</td>
<td>Balconies</td>
</tr>
<tr>
<td>S-2.5</td>
<td>L-2.5</td>
<td>Decks</td>
</tr>
<tr>
<td>M-1</td>
<td></td>
<td>Bay Windows</td>
</tr>
<tr>
<td>M-1.5</td>
<td></td>
<td>Outside Staircase</td>
</tr>
<tr>
<td>M-2</td>
<td></td>
<td>Storage Shed</td>
</tr>
<tr>
<td>M-2.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3) COMMUNITY AMENITIES EXTERNAL TO MODULAR PROGRAMMING UNIT

ROADS
  MAJOR ARTERIAL
  MINOR ARTERIAL

PATHS
HIKE AND BIKE TRAILS

RECREATION
  COMMUNITY PARKS
  REGIONAL PARKS

RELIGIOUS FACILITIES

GOVERNMENT BUILDING
  POST OFFICE

EDUCATIONAL FACILITIES
  DAYCARE
  ELEMENTARY
  HIGH SCHOOLS
PERSPECTIVE
2 AC MODULE
GRiffin-West Residential
Phase One

Population Total On-Site:

MULTI-FAMILY:

8 blocks x 75 persons/block 600 people (184 D.U.)
(with each block representing 23 D.U.)

SINGLE-FAMILY:

38 D.U. x 2.5 persons/D.U. 95 people (38 D.U.)

Total Population Served: 695 People (222 DU)

* * * * * * * * *

Multi-Family Bedroom Breakdown Per Block:

<table>
<thead>
<tr>
<th>Bedrooms/Unit</th>
<th>Units/Block</th>
<th>Persons/DU</th>
<th>Total Pop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bedroom</td>
<td>4 units</td>
<td>1.5 people</td>
<td>6 people</td>
</tr>
<tr>
<td>2 bedroom</td>
<td>8 units</td>
<td>2.5 people</td>
<td>20 people</td>
</tr>
<tr>
<td>3 bedroom</td>
<td>5 units</td>
<td>4 people</td>
<td>20 people</td>
</tr>
<tr>
<td>4 bedroom</td>
<td>6 units</td>
<td>5 people</td>
<td>30 people</td>
</tr>
</tbody>
</table>

Total Dwelling Units: 23

Total Population: 75
PARKING PROGRAM:

PARKING PLACES:

- Princeton Code for Apartments = 1.5 DU + 4/10 DU Loading

At 23 DU/2 Acre Block = 34.5 parking places

Plus loading factor (34.5 + 4) = 38.5 parking places 40 TOTAL

- Austin Code for Apartments

<table>
<thead>
<tr>
<th></th>
<th>Parking Pl/DU</th>
<th>Total Parking Pl</th>
</tr>
</thead>
<tbody>
<tr>
<td>S 1.5</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>S 2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>S 2.5</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>M 1.5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>M 2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>M 2.5</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>L 1.5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>L 2</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>L 2.5</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

TOTAL PARKING UNITS PER BLOCK: 52
PARKING BARN SPACE:

A. At 60° Angle Parking:

ONE WAY

GARAGE

PARKING

60-DEGREE ANGLE is most popular method. Parks a lot of cars with easy access. Cars per 100 lineal feet of double bay ... 20
Area required per car in double bay ... 330 sq. ft.

B. One Way Loop

Two Way Entrance

GARAGE

PARKING

AT 45° ANGLE


STREETS (HAMMOND 1977, p. 43)

<table>
<thead>
<tr>
<th>WIDTH</th>
<th>UNITS SERVED</th>
<th>ONE/TWO WAY PRKG.</th>
<th>STREET WALK.</th>
<th>SIDEWALK.</th>
<th>SEP. PATH</th>
<th>MAX. LGTH.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCESS C-1</td>
<td>24'</td>
<td>&gt;40</td>
<td>2</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>ACCESS C-1M</td>
<td>31'</td>
<td>&gt;40</td>
<td>2</td>
<td>NO*</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>COLLECTOR ST.</td>
<td>34'</td>
<td>1000/ HR CAP</td>
<td>2</td>
<td>1 SIDE</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

* = BIKE LANE

ACCESS C-1 - GARAGE CUL-DE-SAC, SINGLE FAMILY COLLECTOR
ACCESS C-1M - MODIFIED, EAST-WEST CUL-DE-SAC
COMMUNITY FACILITIES:

RECREATION:

<table>
<thead>
<tr>
<th>Facility</th>
<th>Required Area</th>
<th>Actual On-Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Playground Areas</td>
<td>.5 ac/1000 pop.</td>
<td>.5 acre</td>
</tr>
<tr>
<td>Field Play Area for Young Children</td>
<td>1.5 ac/1000 pop.</td>
<td>1.0 acre</td>
</tr>
<tr>
<td>Sports Field</td>
<td>1.5 ac/1000 pop.</td>
<td>1.0 acre</td>
</tr>
<tr>
<td>Tennis/Basketball</td>
<td>1 ac/5000 pop.</td>
<td>1.0 acre</td>
</tr>
<tr>
<td>Picnicking</td>
<td>4 ac/1000 pop.</td>
<td>3.0 acres</td>
</tr>
<tr>
<td>Passive Water Sports</td>
<td>1 ac/25,000 pop.</td>
<td>1 lake/develop.</td>
</tr>
<tr>
<td>(fishing/rowing/canoeing)</td>
<td></td>
<td>= 1,500 pop.</td>
</tr>
<tr>
<td>Parking @ Recreation Areas</td>
<td>1 ac/1000 pop.</td>
<td>.75 acre</td>
</tr>
</tbody>
</table>

TOTAL RECREATION AREA: 7.25 ACRES + 1 LAKE

LAUNDRY FACILITIES:

- 1 Washing Machine/5 DU = 15 washing machines/2 acre block
- 1 Dryer/7 DU = 10 dryers/2 acre block

SPACE REQUIREMENT: 450 SQ. FT./BLOCK

* * * * * * * *
**EDUCATION:**

<table>
<thead>
<tr>
<th>Nursery/Day Care</th>
<th>Distance</th>
<th>Assumed Site Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 60 children/1000 pop.</td>
<td>1/8 - 1/4 mile</td>
<td>4000 sq. ft./40 children</td>
</tr>
</tbody>
</table>

** * * * * * * * **
ENERGY USE SUMMARY
GRIFFIN-WEST RESIDENTIAL

In attempting to derive energy conservation strategies for development purposes, it is essential to understand basic energy use patterns and relationships for the proposed land uses. Residential and commercial land uses offer the greatest potential for passive energy conservation strategies since energy loads here are directly related to heating and cooling loads and lighting. Industrial and transportation energy uses are basically fixed quantities related to given production requirements and basic travel needs and therefore will not be addressed herein.

Residential and commercial energy use in Texas has been analysed by Reed. Reed’s findings illustrate the basic energy use pattern of both residential and commercial development.
Residential Natural Gas

<table>
<thead>
<tr>
<th>Primary Energy</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort Heating</td>
<td>55.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Water Heating</td>
<td>27.2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking</td>
<td>9.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort Cooling</td>
<td>2.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

100.0%

Commercial Natural Gas

<table>
<thead>
<tr>
<th>Primary Energy</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort Heating</td>
<td>28.6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Water Heating</td>
<td>33.2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking</td>
<td>16.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort Cooling</td>
<td>10.6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>10.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

100.0%

Residential Electric

<table>
<thead>
<tr>
<th>Primary Energy</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>20.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort Cooling</td>
<td>32.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort Heating</td>
<td>10.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking</td>
<td>5.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Heating</td>
<td>5.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>25.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

100.0%

Commercial Electric

<table>
<thead>
<tr>
<th>Primary Energy</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>45.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort Cooling</td>
<td>35.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort Heating</td>
<td>5.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking</td>
<td>2.9%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Heating</td>
<td>1.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

100.0%
The data clearly shows the bulk of residential energy usage, about two-thirds, is devoted to space heating and cooling and water heating. This finding is confirmed by a study by Texas Power and Light Company for all electric homes in North Central Texas.
AVERAGE ANNUAL KWH
BY APPLIANCE

Source: Texas Power and Light Co. Percentages are applicable to North Central Texas
These findings imply that significant residential energy savings can occur if solar water heating and low cost passive solar design strategies (both site planning and architectural) are utilized. By analyzing the bioclimatic attributes of the site and applying these to reduce the summer and winter energy consumption peaks, substantial energy cost savings can be provided for the residential consumer. The methodology for achieving these savings will be outlined below.

Read's data also imply a potential for energy use reduction in the commercial sector; however, this situation is more complicated than its residential counterpart. Commercial energy consumption is dominated by demands for lighting and cooling, a full two-thirds of the energy total. Hot water and space heating account for an additional twenty percent (20%) of energy usage. Solar water heating and passive solar space heating will provide viable benefits in the commercial sector, but it is obvious the real savings will result from reducing cooling and lighting loads.

The relatively low commercial heating load is a result of excess heat production by the concentration of people in this use and by lighting. The most efficient lamp converts only 25% of incoming energy into light; the remaining three-quarters is given off as excess heat. Thus, while heating loads are reduced, cooling loads increase. (This accounts for the less pronounced seasonal peaks in commercial energy use.) By emphasizing
daylighting (especially from April through September) and task oriented/low voltage lighting standards in commercial buildings, substantial energy savings can be achieved here as well. Thus, energy efficient commercial development mandates careful architectural planning.

BIOCLIMATIC SITE ANALYSIS

The climatic analysis performed by CMPBS for GRIFFIN-WEST is based on Olgay's bioclimatic chart and Sol-Air approach. Temperature and relative humidity data were averaged on a monthly basis (over a 16-year period) for five times a day: 6:00 AM, 9:00 AM, Noon, 3:00 PM, and 6:00 PM. These monthly averages were then plotted on the bioclimatic chart. (See Figure )
From this information, passive solar design strategies can be formulated for each condition indicated by the chart. Before continuing, a brief explanation of the chart should be given.

The bioclimatic chart is a graph which relates temperature (vertical axis) to relative humidity (horizontal axis). Within a given range of temperatures and relative humidities a person located in the shade will be comfortable; that is, not too hot or too cold. This range of temperature and humidity is the comfort zone (see chart above). You will notice below the comfort zone depicted as a series of parallel lines. These lines represent the amount of solar radiation required to push one back into the comfort zone if the temperature is below 70' F. Above the comfort zone you will notice two more sets of lines; one set dashed, the other set solid. It is the set of solid lines that concern us, as the dashed set refers to a need for humidification -- a need rarely encountered in Princeton. The solid lines above the comfort zone indicate levels of air movement required to drop one back into the comfort zone.

With this understanding of the bioclimatic chart, we can now begin to see the actions required to reduce winter heating and summer cooling loads. During the months of November, December, January, February, and March, full access to sunlight must be provided. In April and October, only the morning hours are below the comfort zone, thereby indicating a need
for morning sunlight and afternoon shading. The month of May appears to lie squarely in the comfort zone as long as shade is provided. During the months of June, July, August, and September, it is apparent that as long as a sufficient quantity of air movement is provided, one will remain in the comfort zone. It should be noted, however, that due to the nature of averaging, certain days in any given month will not correspond with these charts. Therefore, it is imperative that flexibility be incorporated into the passive solar design strategies to allow for use adjustment in response to anomalous conditions.

With the information gleaned from the bioclimatic chart, we now need to examine the actual building site to determine which areas offer the most and least potential for achieving the actions called for by the chart. Since solar radiation and air movement are the remedial actions dictated, sun angles and prevailing breezes were evaluated in relation to on-site features, notably vegetation.

Using a sun angle calculator with attached sun chart and the solar radiation data from the bioclimatic chart, a set of sun angles which refer to periods of full solar exposure to full shading were generated. (See Fig. )
The sun chart allows one to read off solar altitude and azimuth angles for any given time on any given day. Azimuth angles are read by extending a radius to the outer scale which intersects the desired time and day. Altitude angles are read off this same intersection point by the concentric arcs. The sun chart herein shows an area divided into five sub-areas. This area is bounded top and bottom by the summer and winter solstice lines and left and right by a 20° altitude angle. The five sub-areas represent five different solar conditions based on requirements from the bioclimatic chart.

Area 1 describes the period of full solar access (winter). Area 2 describes the period of spring solar access; Area 3, the period of both spring solar access and fall shading; Area 4, the period of fall shading. Area 5 describes the period of full shading (summer).
For our current purposes, that of locating prime climatic conditions on-site, only the lower corners of Area 1 are of concern. These corners give us the altitude and azimuth angles of sun at 9:00 AM and 3:00 PM on December 21. These angles, 20° and 43.3° respectively, allow the longest (thus most restrictive) shadows of the year to be mapped. This map combined with wind maps will define areas of prime climatic condition. It should be noted here that the other areas indicated on the sun chart should be used to determine building fenestration (window) strategies and vegetative types and locations for landscaping.

According to the requirements of the bioclimatic chart, summer breeze exposure should be maximized. Wind roses (graphic summaries of percentage wind direction and speed for a given season) were obtained for the Dallas area and analyzed to determine the predominate summer breeze direction of south by south-southeast (S-SSE). Using this prevailing wind direction and the knowledge of the effects of vegetation on wind speeds, a wind use map was generated. This map illustrates areas where substantial breeze reduction can occur.

Although not indicated by the bioclimatic chart, it is common knowledge that it is best to be sheltered from cold winter winds. Indeed, it has been shown that 20 mile per hour winds can double the heating load of a building (LDZ pg. 127). For this reason wind rose data was also analyzed
to determine the prevailing winter wind direction of north by northwest (N-NW). Thus, a wind protection map was also generated showing areas of substantial wind protection.

The three climatic variables of solar access, wind protection, and breeze exposure, produce eight distinct climatic conditions depending on whether each variable is positive or negative. The eight climatic conditions can be arranged in a descending order of ideal to worst conditions (see Climatic Conditions).

**CLIMATIC CONDITIONS**

![Diagram of climatic conditions with priority numbers and descriptions]
By overlaying and combining the winter shadow, wind use, and wind protection maps, a composite climatic map was generated (see map). This map shows the existing pattern of climatic conditions and begins to indicate the spatial arrangements which will maximize the occurrence of the ideal climatic condition. It should be noted that for every area of ideal microclimate, there is generally a corresponding area of worst microclimate (i.e. shaded, no breeze, and winter winds). Areas of poor microclimate should be allocated to non-living space uses such as roadways, parking and setback areas, utility easements, and limited pathways and open spaces.

Every effort should be made to site residential uses in areas of prime microclimate. Detached single family units are in most need of ideal climatic conditions due to the high surface-to-volume ratio of such units. The table below indicates the energy intensity factors for various residential densities. (This data was interpolated from northeastern U.S. data and is only shown for illustrative purposes).
ENERGY INTENSITY FACTORS FOR DWELLING UNITS

(10 BTU/UNIT/YEAR)

<table>
<thead>
<tr>
<th>ENERGY FACTOR</th>
<th>SINGLE FAMILY</th>
<th>ATTACHED</th>
<th>LOWRISE</th>
<th>HIGHRISE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATING</td>
<td>49</td>
<td>35</td>
<td>30</td>
<td>21</td>
</tr>
<tr>
<td>COOKING, LIGHT,</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>REFRIGERATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIR CONDITIONING</td>
<td>25</td>
<td>17</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>92</td>
<td>69</td>
<td>61</td>
<td>49</td>
</tr>
</tbody>
</table>

Even though this data is roughly interpolated, it clearly shows the effect of massing on overall energy consumption. Given these reductions for heating and cooling loads in multi-family development, it would be possible to save ideal microclimates for single family development, while placing multi-family in areas of acceptable microclimate. Careful site design and landscaping to channel or restrict wind as needed could effectively upgrade the climatic condition of a given area.
NET EFFECTS OF PASSIVE CLIMATE STRATEGY

Having developed the basic framework and concepts for a passive climate development strategy, an effort was made to relate the energy saving effects of this strategy to the residential energy use patterns discussed at the beginning of this report. The pie chart of average annual energy consumption for North Central Texas was modified to include the contributions of the passive design strategies (as developed by Donald Watson in Clamatic Design). Certain base assumptions were made to facilitate the analysis, as follow:

1) Buildings are sited to maximize summer shading and ventilation, minimize winter wind exposure while allowing full winter solar access.

2) Building structures are properly insulated, maximize winter solar gain potential, and facilitate summer breeze usage.

3) Percentage of yearly heating and cooling hours can be directly related to percentage of Kilowatt hours (Kwh) of annual energy use for heating and cooling.
The results of the analysis show that passive cooling could account for 60% of annual cooling costs while passive heating could account for 70% of annual heating costs. According to the manufacturer’s information on the heat pump system under study, the remaining 40% of cooling and 30% of heating could easily be absorbed by that system. In addition, the heat pump could also reduce water heating requirements.
Figure 1. Building Bioclimatic Chart (after Givoni), showing psychrometric limits used for analysis reported in Tables 11-39.

| Table 1 Identification of climate control strategies on the Building Bioclimatic Chart (adapted after Givoni). |
|--------------------------------------------------|--------------------------------------------------|
| **BIOCLIMATIC NEEDS ANALYSIS**                  | **Control Strategies**                           |
| Total heating (< 68°F)                          | 1-5                                              |
| Total cooling (> 78ET*)                          | 9-17                                             |
| Total comfort (68°F - 78ET*, 5mm Hg - 80% RH)    | 7                                                |
| Dehumidification (> 17mm Hg or 80% RH)          | 8-9, 15-16                                       |
| Humidification (< 5mm Hg)                       | 6A, 6B (14)                                      |

<table>
<thead>
<tr>
<th><strong>STRATEGIES OF CLIMATE CONTROL</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrict conduction</td>
<td>1-5; 9-11, 15-17</td>
</tr>
<tr>
<td>Restrict infiltration</td>
<td>1-5; 16-17</td>
</tr>
<tr>
<td>Promote solar gain</td>
<td>1-5</td>
</tr>
<tr>
<td>Restrict solar gain</td>
<td>6-17</td>
</tr>
<tr>
<td>Promote ventilation</td>
<td>9-11</td>
</tr>
<tr>
<td>Promote Evaporative cooling</td>
<td>11, 13-14 (8B)</td>
</tr>
<tr>
<td>Promote radiant cooling</td>
<td>10-13</td>
</tr>
<tr>
<td>Mechanical cooling</td>
<td>17</td>
</tr>
<tr>
<td>Mechanical cooling &amp; dehumidification</td>
<td>15-16</td>
</tr>
</tbody>
</table>
### Dallas, TX

**Temperature (F) on 21st Day of:**

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Max DBT</td>
<td>53.3</td>
<td>55.9</td>
<td>67.1</td>
<td>77.1</td>
<td>86.4</td>
<td>93.4</td>
<td>95.7</td>
<td>92.7</td>
<td>88.4</td>
<td>77.1</td>
<td>62.3</td>
</tr>
<tr>
<td>Daily Ave DBT</td>
<td>42.8</td>
<td>47.1</td>
<td>55.5</td>
<td>68.0</td>
<td>76.9</td>
<td>83.5</td>
<td>86.5</td>
<td>82.5</td>
<td>78.1</td>
<td>66.8</td>
<td>52.5</td>
</tr>
<tr>
<td>Daily Min DBT</td>
<td>33.5</td>
<td>38.5</td>
<td>44.6</td>
<td>59.8</td>
<td>67.4</td>
<td>73.0</td>
<td>78.0</td>
<td>72.7</td>
<td>68.7</td>
<td>56.1</td>
<td>43.0</td>
</tr>
</tbody>
</table>

**Daily Max DPT**

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Max DPT</td>
<td>40.8</td>
<td>39.4</td>
<td>48.6</td>
<td>61.8</td>
<td>65.9</td>
<td>70.6</td>
<td>72.1</td>
<td>69.8</td>
<td>68.6</td>
<td>57.4</td>
<td>45.2</td>
</tr>
<tr>
<td>Daily Ave DPT</td>
<td>35.5</td>
<td>32.7</td>
<td>39.6</td>
<td>57.5</td>
<td>61.5</td>
<td>67.4</td>
<td>68.5</td>
<td>65.9</td>
<td>63.2</td>
<td>51.8</td>
<td>38.9</td>
</tr>
<tr>
<td>Daily Min DPT</td>
<td>27.2</td>
<td>26.4</td>
<td>32.1</td>
<td>52.2</td>
<td>57.3</td>
<td>63.4</td>
<td>64.4</td>
<td>61.4</td>
<td>57.8</td>
<td>45.2</td>
<td>31.6</td>
</tr>
</tbody>
</table>

**Daily Max WBT**

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Max WBT</td>
<td>46.6</td>
<td>46.9</td>
<td>55.1</td>
<td>66.2</td>
<td>70.5</td>
<td>75.1</td>
<td>76.6</td>
<td>74.4</td>
<td>73.3</td>
<td>63.7</td>
<td>52.2</td>
</tr>
<tr>
<td>Daily Ave WBT</td>
<td>39.1</td>
<td>41.0</td>
<td>47.8</td>
<td>61.7</td>
<td>67.1</td>
<td>72.6</td>
<td>74.0</td>
<td>71.3</td>
<td>68.5</td>
<td>58.4</td>
<td>46.3</td>
</tr>
<tr>
<td>Daily Min WBT</td>
<td>32.3</td>
<td>34.8</td>
<td>39.8</td>
<td>56.4</td>
<td>62.5</td>
<td>69.2</td>
<td>71.5</td>
<td>68.3</td>
<td>63.4</td>
<td>51.8</td>
<td>39.6</td>
</tr>
</tbody>
</table>

### Normal Daily Solar Radiation (Monthly Avg) BTU/SQ FT (Day)

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>821.1</td>
<td>1071.1</td>
<td>1422.1</td>
<td>1627.1</td>
<td>1888.1</td>
<td>2135.1</td>
<td>2122.1</td>
<td>1950.1</td>
<td>1587.1</td>
<td>1276.1</td>
<td>936.1</td>
</tr>
<tr>
<td>So Vertical</td>
<td>1164.1</td>
<td>1218.1</td>
<td>1195.1</td>
<td>942.1</td>
<td>843.1</td>
<td>870.1</td>
<td>893.1</td>
<td>992.1</td>
<td>1146.1</td>
<td>1308.1</td>
<td>1250.1</td>
</tr>
</tbody>
</table>

### Heating Degree Days Base 65F

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Degree Days Base 65F</td>
<td>2567.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating Degree Days Base 78F ET*</td>
<td>1051.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Winter Design DBT

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter Design DBT</td>
<td>99.0</td>
<td>18.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>97.5</td>
<td>22.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Summer Design DBT / Coincident WBT

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Design DBT / Coincident WBT</td>
<td>1%</td>
<td>102.0</td>
<td>75.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>100.0</td>
<td>75.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>97.0</td>
<td>75.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Summer Design WBT

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Design WBT</td>
<td>1%</td>
<td>78.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>78.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>77.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Total Heating Hours (Less Than 68F) I-V

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Total Heating Hours (Less Than 68F) I-V</td>
<td>48.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Humidification Hours VI.A + VI.B

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Humidification Hours VI.A + VI.B</td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Total Comfort Hours (Shading Required) VII

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Total Comfort Hours (Shading Required) VII</td>
<td>12.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Dehumidification Hours VIII

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Dehumidification Hours VIII</td>
<td>5.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Total Cooling Hours (Greater Than 78F ET*) IX - XVII

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Total Cooling Hours (Greater Than 78F ET*) IX - XVII</td>
<td>31.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Passive Cooling Hours IX - XIV

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Passive Cooling Hours IX - XIV</td>
<td>26.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Ventilation Effectiveness Hours IX + X + XI

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Ventilation Effectiveness Hours IX + X + XI</td>
<td>21.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Mass Effectiveness Hours X + XI + XII + XIII

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Mass Effectiveness Hours X + XI + XII + XIII</td>
<td>15.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Evaporative Cooling Effectiveness Hours XI + XIII + XIV + VI.B

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Evaporative Cooling Effectiveness Hours XI + XIII + XIV + VI.B</td>
<td>9.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### % Hours Beyond Passive Effectiveness VIII + XV + XVI + XVII

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Hours Beyond Passive Effectiveness VIII + XV + XVI + XVII</td>
<td>11.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>H</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehumidification VIII</td>
<td>5.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dehumidification and Cooling XV</td>
<td>2.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dehumidification and Cooling XVI</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling XVII</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Yearly Hours

<table>
<thead>
<tr>
<th>Month</th>
<th>Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>48.8</td>
</tr>
<tr>
<td>Feb</td>
<td>48.8</td>
</tr>
<tr>
<td>Mar</td>
<td>48.8</td>
</tr>
<tr>
<td>Apr</td>
<td>48.8</td>
</tr>
<tr>
<td>May</td>
<td>48.8</td>
</tr>
<tr>
<td>Jun</td>
<td>48.8</td>
</tr>
<tr>
<td>Jul</td>
<td>48.8</td>
</tr>
<tr>
<td>Aug</td>
<td>48.8</td>
</tr>
<tr>
<td>Sep</td>
<td>48.8</td>
</tr>
<tr>
<td>Oct</td>
<td>48.8</td>
</tr>
<tr>
<td>Nov</td>
<td>48.8</td>
</tr>
<tr>
<td>Dec</td>
<td>48.8</td>
</tr>
</tbody>
</table>
AVERAGE ANNUAL KWH
BY APPLIANCE

Source: Texas Power and Light Co. Percentages are applicable to North Central Texas
EXISTING AVERAGE ANNUAL
HOUSEHOLD ENERGY DISTRIBUTION

COOLING 22%
HEATING 28%
WATER HEATING 16%
LIGHTING 12%
APPLIANCES 22%

PROPOSED AVERAGE ANNUAL
HOUSEHOLD ENERGY DISTRIBUTION
RESIDENT COMMONS

COOLING 27%
HEATING 44%
WATER HEATING 70%
LIGHTING 12%
APPLIANCES 22%

RESIDENT COMMONS
This section combines most of the information available on air flow and buildings. The sections are divided up into there generic characteristics. A refers to a basic height unit and all distances and heights are measured in terms of A.

CHARACTERISTICS

1. Length
2. Height
3. Plan
4. Roof shape
5. Plan
6. Ventilation
IDEAL
SOLAR ACCESS, SUMMER BREEZE EXPOSURE, WINTER WIND PROTECTION

ACCEPTABLE
1) SOLAR ACCESS, SUMMER BREEZE EXPOSURE, WINTER W. PROT.
2) SOLAR ACCESS, SUMMER BREEZE REDUCTION, WINTER W. PROT.
3) NO SOL ACCESS, SUMMER BREEZE EXPOSURE, WINTER WIND PRO.

MARGINAL
1) SOLAR ACCESS, SUMMER BREEZE REDUCTION, WINTER WIND EXP.
2) NO SOLAR ACCESS, SUMMER BREEZE, WINTER WIND EXPOSURE
3) NO SOLAR ACCESS, SUMMER BREEZE RED., WINTER WIND PROT.

POOR
SHADED DURING WINTER, POOR BREEZE IN SUMMER, WIND EXPOSURE IN WINTER
GRiffin-West

Vegetation Management Plan

Prepared by:
Center for Maximum Potential Building Systems, Inc.
Austin, Texas
TABLE OF CONTENTS

I. INTRODUCTION ............................................. Page 1

II. GOAL DEFINITION ....................................... Page 2

III. THEME DEVELOPMENT .................................. Page 4

   A. Single Family Theme .................................. Page 5
   B. Multi-Family Theme .................................. Page 7
   C. Commercial Theme ................................... Page 9
   D. Industrial Theme ..................................... Page 11
   E. Recreation Area Theme ............................... Page 13
   F. Park/Plaza Theme ..................................... Page 15
   G. Natural Area Theme ................................... Page 17

IV. A Note on Natural Area Management .................. Page 18
GRiffin-West
Vegetation Management Plan

The purpose of this document is to establish landscaping strategies and development policies which will achieve long term goals of climatic design, water conservation, enhancement of natural ecology, provision of visual interest and diversity, and minimalization of management and maintenance costs for the Princeton Parks development project.

Contained herein are: (1) a description of plan goals; (2) delineation of landscaping themes; and (3) detailed data on available native plant material.

This document should set the stage for detailed design by the landscape architect.
Goal Definition

The five vegetation management goals discussed herein are derived from the concept of developing Princeton Parks in an ecologically sound manner which stresses resource economy and quality of the built environment. These goals are the foundation of the vegetation management plan and are used with various vegetative, physical, and management tools to develop the theme structures associated with different land uses. The main objectives of each goal are outlined as follows:

**Climatic Goals** aim to maximize the occurrence of ideal microclimatic conditions (winter solar access and wind protection with summer shading and breeze exposure)

**Water Use Goals** aim to maximize available water for landscape purposes as well as user needs inside dwelling units. This can be achieved by use of native vegetation, drip and soaker irrigation, effluent recycling, rainwater catchment systems, and runoff retention and absorption strategies.

**Ecological Goals** aim to enhance and respect the natural ecosystem inherent to the development site. Wildlife values (i.e. forage and cover) will be upgraded, and existing natural areas will be carefully protected. In addition, vegetation which can provide food for humans will be encouraged.

**Sensory Goals** aim to develop a landscape which is diverse and sensuous, providing visual focal points to aid in orientation and identification within the built environment. Careful selection and placement of colorful, fragrant and/or visually dynamic vegetation will facilitate this goal.

**Maintenance Goals** aim to ensure the long term economy of the landscape plan. Here, guidelines are established to prevent the wrong plant from being placed in the wrong location. (A situation which would create long term maintenance problems due to invasive roots, size problems, messy trees, etc.) Recommendations for efficient landscape management strategies will also be made herein.
These goals are inherently interrelated providing mutual conditioning to some degree. Climatic goals will aid in providing visual interest and identification as certain planting schemes will manifest a spatial coherence to the development (i.e. east/west trellage, solar setbacks, etc.). Thus, climatic and sensory goals overlap to a certain degree.

Water use and ecological goals exhibit a similar overlap. Low water use plants naturally exist in the given environment; thus, use of native vegetation in landscaping satisfies goals not only of water conservation but also of habitat renewal. Water use and ecological goals have contrasting effects on management strategies and sensory goals.

By stressing ecological and hydrological concepts in the design phase, certain management issues are addressed and resolved early in the development process. For example, management of urban runoff is greatly simplified by the extensive use of rainwater cisterns which will reduce the total volume of stormwaters, and by the use of specialized native plants with high absorption and evapo-transpiration rates in stormwater detention areas.

While ecological and water use goals tend to accent management goals, they tend to limit sensory goals. Use of high water demand, non-native decorative plant material could provide an extremely dynamic visual environment; however, such plants would defeat water use and ecological goals in most cases.

In a similar manner, the importance of realizing climatic goals, especially in the housing sector, far outweighs and therefore limits the scope of ecological goals. (Full restoration of native habitat is not suited to the intended housing densities; thus, "natural areas" must be segregated from areas of climatically designed buildings.) An emphasis on maximizing ideal microclimate and providing a visually dynamic landscape will also cause an inherent increase in maintenance. Such maintenance intensity (i.e. occasional pruning, raking, sweeping, etc.) is an acceptable cost given the long term benefits of reduced energy usage and an articulated, focus-oriented landscape scheme.
Theme Development

The relationships between the objectives stated in each goal are also effected by land use. The varying intensity and purposes of different land uses cause the relative importance of each goal to shift. Single family detached housing entails a different set of conditions than higher density apartments, which both differ from industrial or commercial activities. Land use therefore conditions the priority of landscape objectives, thereby altering the framework under which each goal must operate. By varying the utilization of specialized vegetation, physical improvements, and management strategies in order to accommodate the needs of and conditions set by each land use, landscaping themes were developed for each land use type.

The Theme Development Matrix shows the basic structure of each theme (land use) related to climatic, water use, ecological, sensory, and maintenance issues. The following section details the specific methods utilized to satisfy goals for each land use category.
# Vegetative Plan

## Areas

<table>
<thead>
<tr>
<th>1, 2, 3, 4, 5</th>
<th>2</th>
<th>2, 3, 4</th>
<th>3, 4, 5</th>
<th>1, 2, 3, 4, 5, 6, 7, 10</th>
<th>1, 2, 3, 4, 5, 6, 7</th>
<th>1, 2, 3, 4, 5, 6, 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 3, 4, 5, 9, 10</td>
<td>6, 8</td>
<td>1, 2, 7</td>
<td></td>
<td>1, 2, 3, 4, 5, 6, 7, 10</td>
<td>1, 2, 3, 4, 5, 6, 7</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
<tr>
<td>1, 2</td>
<td>1, 2, 3, 4</td>
<td>1, 2, 3, 4</td>
<td>2</td>
<td>1, 2, 3, 4, 5, 6, 7, 10</td>
<td>1, 2, 3, 4, 5, 6, 7</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
<tr>
<td>2, 3, 4, 5</td>
<td>_________</td>
<td>1, 2, 3, 4, 5, 6</td>
<td>1, 2, 3, 4, 5</td>
<td>1, 2, 3, 4, 5, 6, 7, 10</td>
<td>1, 2, 3, 4, 5, 6, 7</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>_________</td>
<td>_________</td>
<td>1, 2, 3, 4</td>
<td>1, 2, 3, 4, 5, 6, 7, 10</td>
<td>1, 2, 3, 4, 5, 6, 7</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
</tbody>
</table>

## Sections

- F. Residential
- 3. Natural Areas
- 4. Recreation
- 5. M.F. Residential
- 6. Park
- 7. Commercial
<table>
<thead>
<tr>
<th>THEME DEVELOPMENT MATRIX</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDUSTRIAL</td>
</tr>
<tr>
<td>SINGLE FAMILY RES.</td>
</tr>
<tr>
<td>NATURAL AREAS</td>
</tr>
<tr>
<td>RECREATION</td>
</tr>
<tr>
<td>MULTI-FAMILY RES.</td>
</tr>
<tr>
<td>PARK / PLAZA</td>
</tr>
<tr>
<td>COMMERCIAL</td>
</tr>
<tr>
<td>#1 SOLAR ACCESS</td>
</tr>
<tr>
<td>#2 WIND PROTECTION</td>
</tr>
<tr>
<td>#3 BREEZE EXPOSURE</td>
</tr>
<tr>
<td>#4 SHADE TREES</td>
</tr>
<tr>
<td>#5 EAST WEST TRELIXES</td>
</tr>
<tr>
<td>#1 DROUGHTY PLANTS</td>
</tr>
<tr>
<td>#2 WET SOIL PLANTS</td>
</tr>
<tr>
<td>#3 SOIL MODIFICATION</td>
</tr>
<tr>
<td>#4 CISTERNS</td>
</tr>
<tr>
<td>#5 DRIPIRIGATION</td>
</tr>
<tr>
<td>#7 STORM WATER ABSORPTION</td>
</tr>
<tr>
<td>#7 EFFLUENT IRIGATION</td>
</tr>
<tr>
<td>#8 RAINFALL ONLY</td>
</tr>
<tr>
<td>#8 CUL-DE-SAC DISTRIBUTOR</td>
</tr>
<tr>
<td>#10 FOOD GARDEN</td>
</tr>
<tr>
<td>#1 WILD LIFE VALUE</td>
</tr>
<tr>
<td>#2 EDIBLE WILD PLANTS</td>
</tr>
<tr>
<td>#3 FULL RANGE HABITAT</td>
</tr>
<tr>
<td>#4 AQUATIC HABITAT</td>
</tr>
<tr>
<td>#1 STRIKING FORM</td>
</tr>
<tr>
<td>#2 LEAF COLOR</td>
</tr>
<tr>
<td>#3 FLOWER COLOR</td>
</tr>
<tr>
<td>#4 FRUIT COLOR</td>
</tr>
<tr>
<td>#5 FRAGRANTIC</td>
</tr>
<tr>
<td>#8 SOUND ABSORPTION</td>
</tr>
<tr>
<td>#1 WEAK BRANCHES</td>
</tr>
<tr>
<td>#2 INVASIVE ROOTS</td>
</tr>
<tr>
<td>#3 LARGE CANOPY</td>
</tr>
<tr>
<td>#4 MESSY</td>
</tr>
<tr>
<td>#5 DISEASE PRONE</td>
</tr>
</tbody>
</table>

- **CLIMATE**
- **WATER USE**
- **ECOLOGY**
- **SENSORY**
- **MAINTENANCE**

- • MAJOR STRATEGY
- • MINOR STRATEGY
- X MAJOR CONSTRAINT
- X MINOR CONSTRAINT
- • DAYLIGHTING
Single Family Theme

Climatics:
The following criteria must apply not only within each lot but also for all single family lots in toto (i.e. adjacent lots must not compromise each other). It may be necessary to include deed restrictions to ensure long term compliance especially with regard to solar access.

**Solar Access** - south lot unobstructed by buildings or vegetation

**Wind Protection** - windbreaks (hedges) to north-northeast

**Breeze Exposure** - clear breeze channels to south

**Shading (summer)** - shade trees for yard & street in combination with trellis espalier on east & west walls

**Water Use:**
- native ornamentals (not to exceed 50’ in height) for landscaping
- buffalo grass lawn areas
- soil modification to increase absorption (compost)
- garden areas to act as major absorption areas
- rainwater catchment from roofs (cistern) to provide drip/soaker irrigation source for gardens and ornamentals
- pathway stormwater collection
- cul-de-sac stormwater distribution to absorber areas

**Ecology:**
- selective use of edible (human) plant materials (i.e. nuts, fruits)
- food producing gardens
- selective use of bird attracting plant materials
- native ornamentals

**Sensory:**
- limited use of colorful, fragrant vegetation (owner discretion)
  (trellis areas ideal for this purpose)
- heavier use of accent vegetation at entries to greenbelt system, community center, neighborhood parks, tot lots, etc.
Maintenance:
- avoid plant material with weak limbs, disease susceptibility
- keep trees with invasive roots clear of utility gangways
- avoid rapidly spreading plant material
- street trees should be maintained by homeowners
Multi-Family Theme

Climatics:
Solar Access - keep areas south of buildings unobstructed by either structures or significant vegetation where possible
Wind Protection - large windbreaks on north & northeast edge of multi-family site
Breeze Exposure - maintain open breezeways to south-southeast
Shading - use compact, low maintenance trees for shading paved areas, streets, lawn areas in combination with vines, trellis and espalier on east and west facing walls

Water Use:
- specify droughty native ornamentals
- buffalo grass turf areas (walk-on)
- soil modification to increase absorption/retention
- rainwater catchment from roofs (dwelling unit cisterns to irrigate private areas, car barn cisterns to irrigate common areas)
- community garden areas to facilitate water absorption
- drip irrigation/soaker hose systems
- cul-de-sac stormwater distributors
- minor wetland absorber areas with associated wet soil plant material
- absorber beds at juncture of paths and parking, also between streets and parking

Ecology:
- limited use of edible ornamentals (nuts, fruits)
- specify native plants
- food producing gardens

Sensory:
- ornamentals selected should offer a variety of color displays (leaf, flower, fruit) over the year
- selective use of fragrant plant materials
- "pocket prairie" areas for groundcover accents
- use of small hedges and vegetative barriers for space delineation
- trellis area should exploit colorful vines

**Maintenance:**

Maintenance of multi-family landscaping will undoubtedly be handled through the project manager with costs being subsidized by rent payments. In the interest of minimizing those costs, maintenance-intensive plant materials should not be used here. Thus, **avoid plants** which:

- have weak branches
- have vigorously invasive roots
- tend to spread rapidly (space constraints)
- drop messy fruits and/or large quantities of leaves
- are highly susceptible to disease or insect damage
Commercial Theme

Climatic:
- **Solar Access** - emphasis here should focus on daylighting rather than space heating; however, access for solar water heating should be protected
- **Wind Protection** - north-northeast windbreaks should be provided where possible - not an absolute necessity
- **Breeze Exposure** - maintain breeze channels to the south if possible (again, not a necessity)
- **Shading** - shade trees for parking areas and streets - trellis and vines for east and west walls

Water Use:
- native ornamentals
- soil modification to create deep absorber beds
- direct absorption of rainwater from roofs into high absorption beds
- stormwater detention and absorption system to drain parking area and filter runoff prior to discharge into creek or impoundment (wetland absorber)
- absorber beds at juncture of paths and parking, also between streets & parking

Ecology:
- native plant material
- wetland absorbers associated with permanent impoundment

Sensory:
Commercial properties as public use areas and entry points for the entire development should display a combination of plant materials which provide year-round color. Use of color and dynamic plant forms should be used to create focal points and draw one both physically and visually into the development. Use of fragrant and sound generating (due to slight breeze) plants will reinforce the attraction and quality of these properties as well.
- stress showy displays of color (leaf, flower, fruit)
- provide focal points with plant massing
- use "pocket prairie" and wildflowers as groundcover scheme
- "hide" parking areas with berming and/or low hedges

**Maintenance:**
The commercial project manager will be responsible for landscape maintenance which is again paid for via lease payments. Higher levels of maintenance will be required due to the emphasis on colorful landscaping (leaf and flower drops, etc.); however, this will more than pay for itself in terms of the quality of the commercial property being offered. However, plants with inherent maintenance problems should be avoided. These are plants with weak limits or aggressive roots which spread rapidly, have messy fruits, or are abnormally susceptible to disease, insects, or pollution.
Industrial Theme

Climatics:
Generally, climatic design does not yield great savings in the industrial sector; however, this is largely dependent on the nature of the industrial activity. Solar water heating can be provided from rooftop collectors so solar access conditions can be relaxed to provide rooftop protection only. Otherwise,
- protect from winter winds if possible
- allow free passage of southerly breezes
- provide shade trees for parking and paved areas as well as east and west facing walls

Water Use:
- emphasize droughty native plants
- modify soil as needed to increase absorption
- cisterns and drip/soaker irrigation as needed
- stormwater detention and absorption system to drain parking areas and catch runoff from saturated soil and/or cisternless structures
- include wetland plant materials to increase absorption of stormwater

Ecology:
- utilize a good range and mix native materials to provide a "garden-industrial" type setting (link to greenbelt)
- wetland absorbers associated with permanent impoundments (aquatic habitat) to enhance wildlife value
- utilize native perennials (wildflowers) and prairie grasses for groundcovers

Ecology of interior environments should also be addressed for industrial properties. Poor air quality inside an industrial building can be upgraded with the use of odor-giving/odor-eating plants as well as by plants which actually purify air by removing air-borne contaminants and producing large quantities of oxygen (i.e. spider plants). The creation of interior greenbelts or courtyards for industrial buildings by using rainwater catchment strategies, water features (noise generating) and walls of air modifying plant materials to separate large industrial interiors should be explored in greater detail.
Sensory:
- provide interesting plant massing with some color displays to
  reinforce garden industrial concept
- "pocket prairie" and wildflowers for accent and visual quality
- utilize highly fragrant indoor plants

Maintenance:
Again, maintenance will be the responsibility of the lessor; thus, every
effort should be made to design a low-maintenance, naturalist setting. (As
an aside, many maintenance/management issues could be resolved by the
presence of a commercial composting operation. The composter could have
an exclusive contract for maintaining Griffin-West properties
(commercial, multi-family, recreation areas, etc.) and "recycle" tree and
grass trimmings through the compost operation). In general, industrial
landscaping should avoid the previously described maintenance intensive
plants whenever possible. (However, spreading plants could be acceptable
under the proper conditions.)
Recreation Area Theme

Climatics:
Solar Access - no special provisions
Wind Protection - windbreaks of various sizes (based on needs) to reduce northerly winds
Breeze Exposure - maximize free movement of south-southeasterly breezes
Shading - provide ample park-scale (height >50') trees with wide canopies

Water Use:
- emphasize drought tolerant vegetation
- provide flood tolerant vegetation in low-lying areas
- buffalo grass for playing fields
- utilize treated effluent for irrigation of playing fields and specimen areas

Ecology:
- provide ample wildlife forage and cover
- provide some edible vegetation types
- use the fullest range and mix of native vegetation as feasible
- include aquatic habitat with associated wetlands (stormwater feed)

Sensory:
- use hedge forms and plant massing to delineate spaces, separate areas, and provide privacy
- make optimum use of colorful and interesting vegetation to indicate pathways, activity centers, and focal points
- surround picnic areas with fragrant plants (beware of drawing excessive bees and ants)
- utilize cottonwoods (P. deltoides) for their sound and shade value (also good for wildlife cover)
- utilize large trees with dynamic forms as specimens (i.e. bur oak, pecan, sycamore, juniper)
**Maintenance:**

Other than picnic areas and playing fields, maintenance of recreation areas will be very low. However, these two exclusions can account for large maintenance costs. This situation lends itself well to a commercial/composter contracting for trimmings, etc. as previously mentioned. Several options are available for transfer of management responsibilities from the developer to some other authority:

(1) homeowners association;
(2) dedication of area to city or county; or
(3) transfer to a private operator.

These options need to be explored by the developer to determine the best long term alternative-based economics and assets to the development.
Park/Plaza Theme

The combination park and plaza area will be a major focal point and entry feature for Princeton Parks. This area will be the first element visitors and buyers will notice upon coming to Princeton Parks. The design of this area therefore should employ most if not all of the landscaping concepts applied throughout the development in order to serve as demonstrative example and to set the tone for the entire project. The plaza area must be designed to allow people to gather and relax within its confines. It should enjoy areas of ideal microclimatic conditions to ensure year-round usage and comfort.

The major component of the adjoining park area (lower section park, upper section plaza) will revolve around runoff control strategies. Wetland absorber areas alongside a permanent water impoundment will establish the aquatic habitat necessary to support waterfowl, crayfish, and aquatic vegetation. Overall, the park/plaza area will utilize native specimens for an interplay of color, form, and texture, and will be kept lush and vigorous using a combination of composting techniques, drip or soaker irrigation, and treated effluent recycling.

Climatics:
Solar Access - provide areas of unobstructed access to winter sunlight
Wind Protection - tall hedges on north-northeast edges of plaza area
Breeze Exposure - provide clear breeze channel(s) to the south
Shading - utilize decorative shade trees with taller, denser varieties to western edge to reduce afternoon insolation

Water Use:
- emphasize droughty, showy native plants
- modify soil to optimum condition with compost
- irrigation with combination of drip/soaker system, treated effluent and absorber beds
- utilize "pocket prairie" and wildflower groundcover scheme
- water feature supplied by rainwater and/or recycled water
**Ecology:**
- emphasize true native plant species
- selective use of bird attracting plant material (i.e. *Ilex s.*, hawthorns, sugarberry)
- introduce aquatic vegetation type to encourage aquatic habitat

**Note:** It will be critical from an ecological viewpoint to develop and perfect the wetland absorber/water impoundment techniques in the park/plaza area during this first phase of the development. The success of these techniques in terms of sizing, layout, and reaction to drought will make or break the efforts to provide diverse and viable wildlife habitat in the natural areas. Careful analysis and modification of techniques developed in the first phase (which will have limited wildlife value due to its proximity to high intensity use areas) will ensure the effectiveness of wetlands/watering areas in subsequent phases of the project.

**Sensory:**
- provide year-round color display
- introduce fragrant plant material
- optimize interplay of shape, form, color, and texture
- provide small, semi-private areas

**Maintenance:**
Responsibility for the park/plaza would best be handled by the manager of the commercial properties as this area will be integral to commercial activities. In general, high maintenance plants (i.e. weak limbs, invasive roots, unusually messy, rapid spreading and/or disease or insect prone) should be avoided, especially in the upper section of the area (plaza). It is important to demonstrate here that a lush natural environment can occur with little associated maintenance.
Natural Area Theme

Climatics:
No special considerations here, other than pathways and nodes should be laid out to capitalize on existing microclimatic opportunities.

Water Use:
Area should be able to rely on rainfall alone with existing soil conditions. Soil modification should only occur as needed to establish wetland absorbers receiving runoff from other areas of the development (i.e. housing and streets).

Ecology:
- introduce species which are currently absent from the native plant regime
- emphasize enhancement of wildlife values of forage, cover, and drought-resistant watering areas
- establish wetland and aquatic habitat areas supplied by urban runoff strategies (rainfall based)

Sensory:
- utilize specimen material for focal points at entryways and nodes on a limited basis

Maintenance:
- occasional clearing of pathways (best performed by interested individuals)
- generally a "hands-off" policy should exist
A Note on Natural Area Management

Conversations with the Texas Parks and Wildlife Department regarding the establishment of natural areas which will support a diverse wildlife population have brought to light some very important management issues. In order for such an area to become a viable habitat, two needs must be satisfied.

First, year-round watering areas must exist. The urban runoff strategies currently being proposed should be able to meet this requirement if properly implemented. Water impoundments should have littoral edges (i.e. gently sloping areas subject to flooding by stormwater and exposure during drought periods). The impoundment should also have a rather deep portion (greater than 4') to ensure drought resistance and to maintain the needed dissolved oxygen content.

The second requirement presents a more difficult problem. If wildlife habitat is to be seriously promoted, natural areas must in reality be one continuous area and, obviously, the larger, the better. Economic constraints will of course dictate a compromise as our primary purpose is not to establish a wildlife preserve. Nonetheless, every effort should be made to provide the largest, most cohesive natural area possible.

According to state officials, the minimum width a natural area can reach and still remain as "connected" habitat is 20'-30' of cover (i.e. exclusive of undeveloped open space). Looking at the existing vegetation condition on-site (see map below; disregard shadow patterns), we can see that Griffin-West property currently does not meet this requirement. However, if the area of vegetation indicated by the dashed rectangle is included as a portion of the natural area, the requirement is almost satisfied. Full satisfaction would occur if the area circled were planted to widen this juncture point.
Unfortunately, the property indicated by the rectangle is not in the hands of Griffin-West; thus, the long term status of this property is uncertain. An effort must be made to ensure this property remains as it is if Princeton Parks is to have realistically viable wildlife habitat. If this land were cleared or stripped for any purpose, the natural areas of Princeton Parks would be severely compromised.

Several options exist to achieve the preservation of the area in question. Outright purchase of the property from Ammon Smith would give the most control. However, since the area would be preserved in its natural state, paired with the fact that it lies almost totally within the floodplain, there would be no way for the property to generate the level of income required to cover the purchase cost. Other options of protecting the area would be to establish a conservation easement.
A conservation easement would preserve the area in its natural state while retaining current ownership and would not have to include public access. The easement could be granted to (read as purchased by) Griffin-West, or the owner could dedicate the area to the Texas Nature Conservancy Board. Dedication to the Conservancy Board is the most cost-effective option available. In fact, the State Legislature is currently considering the approval of major tax incentives for landowners who so dedicate their properties. In light of this information, perhaps the best option for the establishment of a native habitat area would be a joint dedication of property by Ammon Smith and Griffin-West to the Nature Conservancy Board. Not only would both parties benefit from tax advantages, but they also would reap the benefits of a mutually-shared and state-managed amenity to their own properties.
RECOMMENDED VEGETATION USES

CLIMATIC

**Solar Control:** Trees that provide summer shade and allow acceptable levels of winter solar access with *proper pruning*. Both trees listed are somewhat messy.

- Pecan
- Honey Locust

**Shading:**
**Shade Trees:**

- Black Walnut (park scale)
- Black Willow (natural areas)
- Bur Oak (park scale)
- Cedar Elm
- Cottonwood (park scale)
- Eve's Necklace (small, open shade)
- Green Ash (natural areas)
- Gum Bumelia (dense shade)
- Hackberry
- Honey Locust (light shade)
- Juniper (dense shade)
- Pecan (open shade)
- Redbud (small)
- Shumard Oak
- Soapberry
- Sycamore (park scale)
- Slippery Elm (natural areas)
- White Ash (natural areas)

**Espaliers/Trellis: shade for east and west walls**

- Rusty Blackhaw
- 'Possum Haw
- Mexican Plum
- Deciduous Holly
- Virginia Creeper
- Prairie Rose (trellis)
- McCartney Rose (trellis)
- Carolina Jessamine (trellis/evergreen)
- Crossvine (trellis/evergreen)
- Trumpet Vine (trellis)
Wind Breaks: see also Hedges

Bur Oak
Bois d'arc
Juniper

Soapberry
Hackberry
Gum Bumelia

Droughty Plants: significantly drought-tolerant plants

Juniper
Cottonwood
Hackberry
Bois d'arc
Hawthorns
River Plum

Redbud
Honey Locust
Eve's Necklace
Soapberry
Gum Bumelia
Rusty Blackhaw

Wildlife Value (Ecology)

Native plants with high forage and/or cover value:
* - indicates edible (human) plant

Hackberry
Mexican Plum*
River Plum*
Deciduous Holly
Rusty Blackhaw
Ashes
Prairie Rose

Pecan*
Cottonwood (cover)
Black Walnut*
Elderberry*
Coral berry
Oaks
Hawthorns
### SENSORY

**Specimen/Focus Plants: (showy form or color)**

<table>
<thead>
<tr>
<th>Eve's Necklace</th>
<th>Elderberry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous Holly</td>
<td>Dogwood (fragrant)</td>
</tr>
<tr>
<td>Gum Bumelia (fragrant)</td>
<td>Hog Plum</td>
</tr>
<tr>
<td>Hawthorn (fragrant)</td>
<td>River Plum (fragrant)</td>
</tr>
<tr>
<td>Rusty Blackhaw</td>
<td>Coral berry</td>
</tr>
<tr>
<td>Redbud (fragrant)</td>
<td>Prairie Rose</td>
</tr>
<tr>
<td>Shumard Oak</td>
<td>McCartney Rose</td>
</tr>
<tr>
<td>Texas Red Oak</td>
<td>Smooth Sumac</td>
</tr>
<tr>
<td>Juniper</td>
<td>Spring Herald</td>
</tr>
<tr>
<td>Carolina Jessamine</td>
<td>Trumpet Vine</td>
</tr>
</tbody>
</table>

**Hedges/Barriers:**

<table>
<thead>
<tr>
<th>Bois d'arc (large)</th>
<th>Dogwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawthorn</td>
<td>McCartney Rose</td>
</tr>
<tr>
<td>Elderberry (large)</td>
<td>Hercules-Club</td>
</tr>
<tr>
<td>Possum'haw</td>
<td>Texas Red Oak</td>
</tr>
<tr>
<td>Rusty Blackhaw</td>
<td>Coral Berry (low)</td>
</tr>
<tr>
<td>Smooth Sumac</td>
<td>Juniper (large)</td>
</tr>
<tr>
<td>Hog Plum</td>
<td></td>
</tr>
</tbody>
</table>

CLASSIFICATION KEY.

The following sheets categorize the characteristics of a given plant. Pages are headed by scientific name and common name(s). General propagation information follows, along with notes on plant vulnerability. **SIGNIFICANT ATTRIBUTES** lists positive characteristics of the plant. **RECOMMENDED USES** indicates the uses most suited to a particular plant and general notes as to optimum placement (i.e. in Parks, Natural Areas, Residential Areas, etc.). **AVOID** indicates specific situations to be avoided in utilizing the plant. These situations are based both on plant vulnerability and adverse effects of the plant itself. NOTE: A few pages (8) have NFOS in the upper right corner; this indicates a Plant Not Found On-Site (NFOS), but indigenous to Collin County according to the Collin County-Open Landscape Plan. These plants were analyzed in addition to those identified by the Heard study to determine their merit in upgrading the Property's natural habitat.

The lower section of each sheet provides the actual categorization of the plant. A darkened rectangle marks the appropriate category. Lack of a rectangle indicates an inappropriate category or absence of data. Groundcovers are analyzed according to height and ability to bear foot traffic. Shrubs are analyzed by relative size. (Note: large shrubs are often indicated as small trees as well.) Trees are broken into categories of similar height and spread ranges at maturity. Neither on-site nor indigenous vines have been identified, thus information here is limited. Vines are categorized by ability to climb and appropriate support (fence or trellis). The espallier category indicates the relative wall area a single
plant could cover by being tied back.

The remaining categories are applicable to all plants, although branch texture relates more to trees. Leaf texture indicates the relative size of individual leaves. Branch texture indicates the relative size and spacing of branches. Plant armament indicates whether or not thorns are present. Root structure is noted where possible and tagged if type is invasive. (Note: Tap root trees are generally difficult to move.) Leaf color is categorized according to fall color. The phase chart indicates general periods of foliation, blossom, and fruit bearing (by month). The eleven characteristics listed in the lower left portion of the page are categorized on a scale of high (filled circle), medium (half-filled) and low (empty circle). Further explanation of each category as follows:

- **WILDLIFE VALUE** relates to the number of users (foragers)

- **POLLUTION EFFECT** indicates tolerance to pollutants (notably ozone)

- **FLOOD TOLERANCE** indicates tolerance to flooding

- **WATER USE** relates to average water requirements

- **HARDINESS** indicates ability to withstand low temperatures

- **DISEASE PRONE** relates to disease susceptibility

- **MAINTENANCE** refers to levels of cleaning, pruning, spraying required

- **GROWTH RATE** is self-explanatory

- **LONGEVITY** indicates life span of plant: low is less than 100 yrs.; medium is 100-200 years; high is greater than 200 years
- DENSITY indicates the relative openness of the crown. High indicates a closed crown; low indicates an open crown.

**NOTE:** Lack of a circle, filled or unfilled, indicates an absence of data.

---

**PRELIMINARY VEGETATION MANAGEMENT STUDY**

Preliminary investigation of vegetation characteristics indicates the following recommended use groupings:

**Good Solar Trees:** period of foliation and branching pattern appear to provide required access to solar radiation.

- Pecan
- Honey locust

**Good Shade Trees:**

- Honey locust (light shade)
- Soapberry
- Pecan
- Shumard Oak
- Cedar Elm
- Cottonwood
- Hackberry
- Eve's Necklace (small)
- (Slippery Elm)
- Juniper (dense shade)
- Gum Bumelia (dense shade)
- White Ash
- Bur Oak
- Black Walnut
- Black Willow
- Redbud (small)
- Sycamore
- (Green Ash)
Windbreaks:

Juniper*  
Hackberry  
Bois d'arc  

Soapberry  
Gum Bumelia  
Bur Oak

Park Scale Trees:

Black Willow  
Cottonwood  
Pecan  
(Hackberry)  
Cedar Elm  

Honey locust  
Soapberry  
Bur Oak  
Shumard Oak  
Black Walnut

Hedge/Barrier Plants:

Bois d'arc  
Hawthorn*  
Elderberry  
Possum Haw  
Texas Red Oak  
Coral Berry (?)  
Spring Herald (?)  

MacCartney rose  
Hercules Club  
Smooth Sumac  
Hog Plum  
Juniper (large)  
Rusty Black Haw

Possible Espallier:

Rusty Black Haw  
Possum Haw  
Mexican Plum  

Prairie Rose (trellis)  
MacCartney Rose (trellis)
**Good Specimen/Accent Plants:** (showy form or color)

- Juniper*
- Shumard Oak
- Hawthorn*
- Redbud
- Deciduous holly
- MacCartney rose
- Gum bumelia
- Rusty Black haw
- Hog Plum
- Mexican Plum
- Rough-leafed Dogwood
- Elderberry
- Coralberry
- Pink prairie rose
- Eve's necklace
- Smooth sumac
- Spring Herald
- Texas Red Oak

**Edible Plants:** edible fruits or berries

- Pecan
- Elderberry
- Black Walnut
- Chinkapin Oak
- River plum
- Coral berry(?)
- Mexican plum (?)

**Street Trees:** for lining streets

- Juniper*
- Cedar Elm (large)
- Shumard Oak (large)
- Hackberry
- Bois d'arc
- Hawthorn
- MacCartney rose (roadside)
- Bumelia (?)
- Soapberry (large)
- Honey locust (messy)
- Smooth sumac
- Texas Red Oak (small)

**Plants not highly recommended:**

- Slippery elm
- B. Willow
- Green ash

* Junipers and hawthorns subject to cedar/apple rust.
Cedar-apple rust could cause a real problem in the vegetation management scheme. Currently there are few junipers on-site and an abundance of healthy hawthorns. This fact could be related as junipers are host to cedar-apple rust which attacks hawthorns (apple family) as well. Junipers have been considered for large-scale plantings as windbreaks. Such an action could inadvertently trigger a decline in the hawthorn population. If hawthorns are to be exploited for a landscaping and marketing theme, this would be a critical error. A plant pathologist (Texas A&M?) should be consulted to address this management issue with regard to potential impact of juniper introduction and possible cedar-apple rust management strategies.

Also, we should be considering general landscaping themes which can further "tie-together" the entire development. Such themes revolve around choosing a limited pallet of plant material which is heavily used throughout the development. There could be separate residential and commercial themes with a unifying overlap of certain materials, or a simple unifying pallet for the entire project. However, since plant moving and propagation may begin soon, it would be wise to firm up the plant material list so the most suitable species may be propagated in sufficient quantities.

**Residential Scale**

- Multi-trunk Shumard Oak (Bumelia)
- (Honey Locust)
- Hawthorn
- Texas Red Oak
- Smooth Sumac
- Rosa S.
- Mexican Plum
- Rough Leafed Dogwood
- Redbud (Pecan)
- Rusty Black haw
- Eve's Necklace
- Rosa B.
- Spring Herald
- Possum Haw
- (Soapberry)
**Juniperus virginiana**

**Eastern Red Cedar**

**Propagation by seed and grafting**
**Transplanting somewhat difficult.**

**Cedar-apple Rust, Spider Mites**
**Significant Attributes**
**Dense Evergreen, Droughty**
**Wildlife Value**

**Recommended Uses**
**Windbreak, Avenues (Enfranment)**
**Specimen, Large Hedge/Screen**
**Park, Natural Areas**
**Avoid**

**Groundcovers**
- Walk-on
- Non-walk-on
  - Under 12"
  - 12"-18"
  - Over 18"
**Vines**
- Self-climbing
- Fence
- Trellis

**Shrubs**
- Small
- Medium
- Large
**Trees**
- Height:
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 100'-125'
- Spread:
  - 35'-50'
  - 50'-75'
  - 75'-125'
**Leaf Texture**
- Fine
- Medium
- Coarse
**Branch Texture**
- Fine
- Medium
- Coarse

**Armament**

**Root Structure**

**Tap**

**Color**
- Leaf: D. Green
- Flower: Red Purple
- Fruit: Pale Blue
**Salix nigra**  
**Black Willow**

**Easily Propagated by Seed and Cuttings**

**Subject to Wind/Ice Damage**

**Significant Attributes**
- Wildlife Value
- Fast Growth

**Recommended Uses**
- Floodplain, Low Areas

**Avoid**
- Water Lines, Septic Field

### Groundcovers
- Walk-on
- Non-walk-on
  - Under 12”
  - 12”-18”
  - Over 18”

### Vines
- Self-climbing
- Fence
- Trellis

### Shrubs
- Small
  - Medium
  - Large
  - Foundation
  - Hedge

### Espalier
- Small
- Large

### Trees
- Height
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 100'-125'

### Leaf Texture
- Fine
- Medium
- Coarse

### Branch Texture
- Fine
- Medium
- Coarse

### Armament
- Root Structure
  - Invasive
  - Shallow Lateral

### Color
- Leaf: Green-Yellow Green
- Flower: Yellow Green
- Fruit: Green-Yellow

**Phases**

- **Maintenance & Hardiness**
  - **Shallow Lateral**
  - **Leaf**
  - **Root**
  - **Structure**
  - **Invasive**
  - **Leaf**
  - **Flower**
  - **Fruit**

**Exposure**

- **Water Use**
- **Hardiness**
- **Disease Prone**
- **Maintenance**
- **Growth Rate**
- **Longevity**
- **Density**

**Pollution Tolerance**
- **High**
- **Medium**
- **Low**
**Populus deltoides**

**Cottonwood, Alamo**

**Propagated by Seed and Suckers**
**Transplants well**

**Drops branches**
**Significant Attributes**
**Fluttering Sound, Drought, Wildlife Value**

**Recommended Uses**

**Shade**

**Park Scale**
**Avoid Waterlines, Septic Fields Parking**

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-On</th>
<th>Non-Walk-On</th>
<th>Under 12&quot;</th>
<th>12&quot;-18&quot;</th>
<th>Over 18&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vines</td>
<td>Self-Climbing</td>
<td>Fence</td>
<td>Trellis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrubs Small</th>
<th>Medium</th>
<th>Large</th>
<th>Trees 20'-35'</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Height 35'-50'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50'-75'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75'-100'</td>
</tr>
</tbody>
</table>

| Espallier Small | Large | Spread 20'-35' |
|                |       | 35'-50'       |
|                |       | 50'-75'       |
|                |       | 75'-100'      |

<table>
<thead>
<tr>
<th>Leaf Texture</th>
<th>Fine</th>
<th>Branch Texture</th>
<th>Medium</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Wildlife Value</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution Effect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood Tolerance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardiness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease Prone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longevity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Armament**

- Root Structure: Shallow Fibrous
- Invasive Leaf: Flower

**Color**
- Leaf: Yellow
- Flower: Red
- Fruit: Yellow/Cotton

**Phases**

- Drop Maple from Around
Carya illinoensis
Pecan

Propagation by seed, graft, cuttings
Somewhat difficult to transplant
Many varieties available
Subject to wind/ice damage
Subject to bark beetle attacks

Significant Attributes
Edible nut

Recommended Uses
Solar (pruned), shade, food

Residential, natural areas
Avoid parking areas, high use areas

Groundcovers
Walk-on
Non walk-on
Under 12"
12"-18"
Over 18"

Vines
Self-climbing
trellis

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20-35'
35'-50'
50'-75'
85'-100'
20'-35'
35'-50'
50'-75'
75'

Height
Can reach
150'

Spread

Leaf
Fine
Medium
Coarse

Branch
Fine
Medium
Coarse

Armament

Root
Structure

Leaf

Flower

Fruit

Color
Leaf
Yellow-Brown
Flower
Yellow-Green
Fruit
Green-Black

Pollution Effort
High
Medium
Low

Wildlife Value

Flood Tolerance

Exposure

Water Use

Hardiness

Disease Prone

Maintenance

Growth Rate

Longevity

Density

Phases

If maintained
Gond
**Quercus Shumardii**
*Shumard Oak*

**Propagate by Seed (must be fresh)**
Easily Moved

**Significant Attributes**
Fall Color, Likes Clay Soils
Tolerates Restricted Areas
Can be Multi-Stemmed

**Recommended Uses**
Excellent Shade Tree
Specimen
Avoid Water Lines

**Groundcovers**
Walk-on
Non Walk-on
Under 12"  12"-18"
Over 18"

**Vines**
Self-Climbing
Fence
Trellis

**Shrubs**
Small
Medium
Large
Foundation
Hedge

**Trees**
Height
20'-35'
35'-50'
50'-75'

Can Reach
120'
75'-100'
20'-35'
35'-50'
60'-75'
75'

Spread
Leaf Texture
Fine
Medium
Coarse

**Armament**
Root Structure
Deep Lateral?
Invasive
Leaf Flower Fruit

**Color**
Leaf Red-Orange
Flower Yellow-Brown
Fruit Brown

**Phases**

---

**High**  **Medium**  **Low**
Wildlife Value
Pollution Effect
Floor Tolerance
Exposure
Water Use
Hardiness
Disease Prone
Maintenance
Growth Rate
Longevity
Density
Celtis laevigata
Hackberry, Sugar Berry

Propagate by Seed
Easily Moved

Corky Growing on Bark (Trunk)

Significant Attributes
Wildlife Value, Droughty
Favored by Birds

Recommended Uses
Windbreak, Street Tree

Natural Areas
Avoid High Water Table

Groundcovers
Walk-on
Non Walk-on
Under 12"
12"-18"
Over 18"

Vines
Self-Climbing
Fence
Trellis

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20'-35'
35'-50'
50'-75'
75'-100'
20'-35'
35'-50'
50'-75'
75'

Height

Spread

Branch

Texture

Fine
Medium
Coarse

Leaf Texture

Armament

Root

Fibrous

Structure

Color

Leaf

Yellow

Flower

Fruit Dark Purple

Maintenance

Exposure

Pollution Effect

Floor Tolerance

Hardiness

Disease Prone

Growth Rate

Longevity

Density

PHASES

Leaf

Flower

Fruit
Ulmus Crassifolia
Cedar Elm

Propagation by Seed

Vigorous Trees Somewhat Resistant to Dutch Elm Disease

Significant Attributes
Good Tree in Heavy Clays
Dominant on Site Species
Irregular Shape (individualistic)
Takes Reflected Heat

Recommended Uses
Shade Tree, Street Tree

Avoid Potentially Invasive

Groundcovers
Walk-On
Non Walk-On
Under 12"
12"-18"
Over 18"

Vines
Self-Climbing
Fence
Trellis

High Medium Low

Wildlife Value
Pollution Effect
Flood Tolerance
Exposure
Water Use
Hardiness
Disease Prone
Maintenance
Growth Rate
Longevity
Density

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20-35'
35'-50'
50'-75'
75'-100'
100'-125'
125'+

Height

Spread

Leaf Texture
Fine
Medium
Coarse

Branch Texture
Medium
Coarse

Armament

Root Structure
Invasive
Flower
Fruit

Color
Leaf Yellow to Gold
Flower
Fruit Tan

Phases

Front to Back

Shallow to Deep Lateral Leaf
**Ulmus Rubra**  
Slippery Elm, Red Elm

**Significant Attributes**

- Short-lived, subject to insect damage

**Recommended Uses**

- Not highly recommended

**Groundcovers**
- Walk-on
  - Non-walk-on
  - Under 12"
  - 12"-18"
  - Over 18"

**Vines**
- Self-climbing
- Fence
- Trellis

**Shrubs**
- Small
  - Medium
  - Large
- Foundation
- Hedge

**Espalier**
- Small
- Large

**Trees**
- Height
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - Over 75'

**Leaf Texture**
- Fine
- Medium
- Coarse

**Branch Texture**
- Fine
- Medium
- Coarse

**Armament**
- Root Structure
- Color
  - Leaf
  - Flower
  - Fruit
  - Tan

**Pollution Tolerance**
- 1

**Wildlife Value**
- Low

**Flooding Tolerance**
- High

**Exposure**
- 1

**Water Use**
- 1

**Hardiness**
- 1

**Disease Prone**
- 1

**Maintenance**
- 1

**Growth Rate**
- 1

**Longevity**
- 1

**Density**
- 1

**Phases**

- Leaf
- Flower
- Fruit

---

---
Maclura Pomifera
Bois d'Arc, Osage Orange

Propagate by seeds, wood and root cuttings.
Easily moved.

Significant Attributes
Droughty, True Texas Native
Dominant on-site species
Males do not fruit

Recommended Uses
Windbreak, Roadside, Barrier

Avoid planting in high maintenance situations

Ground Covers
Walk-on
Non walk-on
Under 12"
12" - 18"
Over 18"

Vines
Self-climbing
Fence
Trellis

High Medium Low

Wildlife Value
Pollution Effect
Floor Tolerance
Exposure
Water Use
Hardiness
Disease Prone
Maintenance
Growth Rate
Longevity
Density

Shrubs
Small
Medium
Large
Foundation
Hedge

Espallier
Small
Large

Leaf Texture
Fine
Medium
Coarse

Trees
20 - 35'

Height
35' - 50'
50' - 75'
75' - 100'
20' - 35'
35' - 50'
50' - 75'
75'

Spread

Branch Texture
Fine
Medium
Coarse

Armament
Yes

Root Structure
Competitive
Flower
Fruit

Color
Leaf Yellow
Flower Yellow-Green
Fruit Green-Yellow + Orange

Phases

[Diagram of life cycle phases]
Crataegus mollis?  
Downy Hawthorn, Red Haw

Easily Mowed?

Cedar/Apple Rust

Significant Attributes
Showy Blossoms, Droughty

Recommended Uses
Accent, Potential Theme
Solid Barrier with close spacing
Natural Argas
Avoid Junipers

Groundcovers
Walk-on
Non Walk-on
Under 12"
12"-18"
Over 18"

Vines
Self-Climbing
Fence
Trellis

High  Medium  Low
Wildlife Value
Pollution Effect
Floor Tolerance
Exposure
Water Use
Hardiness
Disease Prone
Maintenance
Growth Rate
Longevity
Density

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20-35'
35'-50'
50'-75'
75'-100'
20'-35'
35'-50'
50'-75'
75'

Leaf
Fine
Medium
Coarse

Armament
Yes

Root Structure
Tap

Leaf Color
Yellow-Brown

Flower Color
White

Fruit Color
Red

Phases

Maintenance
Leaf
Flower
Fruit
**Rosa Bracteata**  
**Macartney Rose**

**Easily Transplanted, Propagated By**  
Cuttings

**Significant Attributes**  
Wildlife Value, Evergreen, Snowy Flowers, Spreads Readily

**Clump Forming Shrub**

**Recommended Uses**  
Barrier, Roadside, Erosion Control (Banks), Screen

**Natural Areas**

**Avoid Tight Areas**

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-on</th>
<th>Non Walk-on</th>
<th>Under 12&quot;</th>
<th>12&quot;-18&quot;</th>
<th>Over 18&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vines</th>
<th>Self-Climbing</th>
<th>Fence</th>
<th>Trellis</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrubs</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>May Reach 20&quot;</td>
<td>Foundation Hedge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trees</th>
<th>20-35'</th>
<th>35'-50'</th>
<th>50'-75'</th>
<th>75'-100'</th>
<th>20'-35'</th>
<th>35'-50'</th>
<th>60'-75'</th>
<th>95'</th>
</tr>
</thead>
</table>

| Height | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) |

<table>
<thead>
<tr>
<th>Spread</th>
<th>20-35'</th>
<th>35'-50'</th>
<th>50'-75'</th>
<th>75'-100'</th>
</tr>
</thead>
</table>

| \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) | \( \bigcirc \) |

<table>
<thead>
<tr>
<th>Leaf Texture</th>
<th>Fine</th>
<th>Medium</th>
<th>Coarse</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Branch Texture</th>
<th>Fine</th>
<th>Medium</th>
<th>Coarse</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Armament</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Root Structure</th>
<th>Spreading</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Leaf</th>
<th>Flower</th>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phases</th>
<th>Leaf</th>
<th>Flower</th>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Water Use</th>
<th>Hardiness</th>
<th>Disease Prone</th>
<th>Maintenance</th>
<th>Growth Rate</th>
<th>Longevity</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
<td>( \bigcirc )</td>
</tr>
</tbody>
</table>
Rosa setigera
Pink Prairie Rose

Propagated by cuttings
Easily moved

Suckers

Significant Attributes
Wildlife value, showy flowers
Disease free, climbs vigorously

Once established, difficult to remove

Recommended Uses
Trellis, fences, accent

Residential, natural areas
Avoid tight areas, seek permanency

Location

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-on</th>
<th>Non Walk-on</th>
<th>Under 12&quot;</th>
<th>12&quot;-18&quot;</th>
<th>Over 18&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vines</td>
<td>Self-climbing</td>
<td>Fence</td>
<td>Trellis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrubs</td>
<td>Small</td>
<td>Medium</td>
<td>Large</td>
<td>Foundation</td>
<td>Hedge</td>
</tr>
<tr>
<td>Trees</td>
<td>20-35&quot;</td>
<td>35'-50'</td>
<td>50'-75'</td>
<td>75'-100'</td>
<td>20'-35'</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td>Spread</td>
<td>Branch</td>
<td>Texture</td>
<td></td>
</tr>
<tr>
<td>Leaf Texture</td>
<td>Fine</td>
<td>Medium</td>
<td>Coarse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Armament</td>
<td>Yes</td>
<td>Root Structure</td>
<td>Color</td>
<td>Leaf</td>
<td>Redish</td>
</tr>
</tbody>
</table>

Phases

Leaf
Flower
Fruit
**PRUNUS MEXICANANA**
**MEXICAN PLUM**

**Propagate by Seed, Cuttings**
Easily moved

**Significant Attributes**
Showy, fragrant flowers, droughty
Does not sucker, good contrast
to red bud (spring color)
Wildlife value

**Recommended Uses**
Accent, small areas
May espalier
Residential, edges of natural area
Avoid

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-on</th>
<th>Non walk-on</th>
<th>Under 12&quot;</th>
<th>12&quot;-18&quot;</th>
<th>Over 18&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vines</td>
<td>Self-climbing</td>
<td>Fence</td>
<td>Trellis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrubs</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>Foundation</th>
<th>Hedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Espallier</td>
<td>Small</td>
<td>Large</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trees</th>
<th>Height</th>
<th>Spread</th>
<th>Branch Texture</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20'-35'</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Armament</th>
<th>Root Structure</th>
<th>Color</th>
<th>Leaf</th>
<th>Yellow</th>
<th>Flower</th>
<th>White</th>
<th>Fruit</th>
<th>Purplish-red</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**PRUNUS RIVULARIS**  
**RIVER PLUM, HOG PLUM**

**Self Propagating**
**Easily Moved**

**Thicket Forming**

**Significant Attributes**
**Edible Fruit, Showy Flowers**
**Wildlife Value**

**White Thickets in Spring**

**Recommended Uses**

**Accent**

**Natural Areas**

**Avoid Tight Areas**

---

**Groundcovers**
- Walk-on
  - Non Walk-on
    - Under 12"
    - 12"-18"
    - Over 18"

**Vines**
- Self-Climbing
- Fence
- Trellis

**High**
**Medium**
**Low**

**Wildlife Value**
**Pollution Effect**
**Flood Tolerance**

**Exposure**

**Water Use**
**Hardiness**
**Disease Prone**
**Maintenance**
**Growth Rate**
**Longevity**
**Density**

**Shrubs**
- Small
  - Medium
  - Large

**Trees**
- 20-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 20'-35'
  - 35'-50'
  - 75'

**Height**
**Spread**
**Branch Texture**

**Leaf Texture**
- Fine
- Medium
- Coarse

**Armament**

**Root Structure**

**Color**

**Leaf**
**Flower**
**Fruit**

**White**
**Bright Red**

**PHASES**

**Leaf**
**Flower**
**Fruit**

---
Cercis Canadensis
Redbud

**Propagate by seed, grafting**
Easily moved

Subject to wind/ee damage
Leaf spot can defoliate

**Significant Attributes**
Showy flowers, droughty

Tend towards early leaf drop

**Recommended Uses**
Excellent specimen/focus
Small open shade tree

**Residential Scale**
Avoid

**Groundcovers**
Walk-on
Non walk-on
Under 12"
12"-18"
Over 18"

**Vines**
Self-climbing
Fence
Trellis

**Shrubs**
Small
Medium
Large
Foundation
Hedge

**Espallier**
Small
Large

**Trees**
20-35'
35'-50'
50'-75'
75'-100'
20'-35'
35'-50'
50'-75'
95'

**Leaf Texture**
Fine
Medium
Coarse

**Branch Texture**
Medium
Coarse

**Armament**
Root structure
Shallow fibrous

**Root System**
Leaf
Flower
Fruit

**Color**
Leaf
Golden-yellow

**Flower**
Pink/lavender

**Fruit**
Purple Brown

**PHASES**

[Diagram of plant growth phases]
Gleditsia Triacanthos
Honey Locust

Propagate by seed, grafting
Easily moved

Significant Attributes
Open crown, droughty, quick growth

Recommended Uses
Solar (pruned), street tree
Good light shade

Avoid

Groundcovers
Walk-on
Non walk-on
Under 12"
12"-18"
Over 18"

Vines
Self-climbing
Fence
Trellis

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20'-35'
35'-50'
50'-75'
75'-100'
20'-35'
35'-50'
50'-75'
75'

Height

Spread
Fine

Leaf

Texture
Medium
Coarse

Armament
Yes

Root
Variable

Structure

Leaf

Color
L. green to yellow

Flower
Yellow-green

Fruit
Purple-brown

Phases

Maintenance

Longevity

Density
**Sophora Affinis**

**Eve's Necklace, Shoestring Tree, Texas Sophora**

**Propagation by Seed**
- Easily moved

**Significant Attributes**
- Young plant may freeze to ground, then sucker
- Nice flowers, very droughty
- Fragrant

**Recommended Uses**
- Good accent plant
- Light shade
- Park, residential
- Avoid

<table>
<thead>
<tr>
<th>Ground Covers</th>
<th>Walk-on</th>
<th>Non-Walk-on</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Under 12”</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>12’-18”</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Over 18”</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vines</th>
<th>Self-climbing</th>
<th>Fence</th>
<th>Trellis</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Shrubs</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Up to 25’</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Foundation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hedge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Espalier</th>
<th>Small</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fine</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trees</th>
<th>20-35’</th>
<th>35'-50’</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td></td>
<td>50'-75’</td>
</tr>
<tr>
<td><strong>Spread</strong></td>
<td></td>
<td>75'-100’</td>
</tr>
<tr>
<td><strong>Branch</strong></td>
<td></td>
<td>20'-35’</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td></td>
<td>35'-50’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wildlife Value</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pollution Effect</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Flood Tolerance</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Water Use</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Hardiness</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Disease Prone</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Growth Rate</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Longevity</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Density</th>
<th>Yes</th>
</tr>
</thead>
</table>

**Armament**

<table>
<thead>
<tr>
<th>Root Structure</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Leaf</th>
<th>Flower</th>
<th>Pale Pink</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leaf</strong></td>
<td>Fine</td>
<td>Medium</td>
<td>Coarse</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td>Fine</td>
<td>Medium</td>
<td>Coarse</td>
</tr>
</tbody>
</table>

**Phases**

- Leaf
- Flower
- Fruit

- Young plant may freeze to ground, then sucker
- Nice flowers, very droughty
- Fragrant

**Recommended Uses**
- Good accent plant
- Light shade
- Park, residential
- Avoid
**Zanthoxylum clava-herculis**  
Hercule's Club, Prickly Ash

**Propagated by Seed, Root Cuttings**  
**Easily Moved**

**Defoliated by Summer Insects**

**Significant Attributes**

**Recommended Uses**

**Barrier**

**Natural Areas**

**Avoid**

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-on</th>
<th>Non Walk-on</th>
<th>Under 12&quot;</th>
<th>12&quot;-18&quot;</th>
<th>Over 18&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vines</td>
<td>Self-climbing</td>
<td>Fence</td>
<td>Trellis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrubs</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Hedge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trees</th>
<th>20-35'</th>
<th>35'-50'</th>
<th>50'-75'</th>
<th>75'-100'</th>
<th>20'-50'</th>
<th>50'-75'</th>
<th>75'</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Height</th>
<th>Spread</th>
<th>Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>Fine</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leaf Texture</th>
<th>Medium</th>
<th>Coarse</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Armament</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Root Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Leaf</th>
<th>Flower</th>
<th>Yellow Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Rhus Glabra**
**Smooth Sumac**

**Propagate by seed, cutting, division**

**Easily mowed**

**Entire plant may be blown down, suckers**

**Significant Attributes**

**Droughty, great fall color**

**Wildlife value**

**Recommended Uses**

**Erosion control, specimen**

**Roadside, screening**

**Natural areas**

**Avoid tight areas**

**Groundcovers**
- Walk-on
- Non walk-on
- Under 12"
- 12"-18"
- Over 18"

**Vines**
- Self-climbing
- Fence
- Trellis

** Shrubs**
- Small
- Medium
- Large

**Hedge**

**Trees**
- 20'-35' <
- 35'-50'
- 50'-75'
- 75'-100'
- 20'-35'
- 35'-50'
- 50'-75'
- 75'

**Height**

**Spread**

**Leaf Texture**
- Fine
- Medium
- Coarse

**Branch Texture**
- Fine
- Medium
- Coarse

**Armament**

**Root Structure**
- Shallow spreading

**Leaf**
- Flower
- Fruit

**Color**
- Leaf: Scarlet red
- Flower: Yellow green
- Fruit: Red

**Phases**

**Exposure**

**Flood Tolerance**

**Pollution Effect**

**Water Use**

**Hardiness**

**Disease Prone**

**Maintenance**

**Growth Rate**

**Longevity**

**Density**
ILEX DECIDUA
DECIDUOUS HOLLY, POSSUM HAW

PROPAGATE BY SEED; CUTTINGS RECOMMENDED
EASILY MOVED

SIGNIFICANT ATTRIBUTES
HIGH WILDLIFE VALUE, RED FRUIT IN WINTER, SOMEWHAT DROUGHTY
ONLY FEMALES BEAR FRUIT

RECOMMENDED USES
GOOD ACCENT AGAINST DARK BACKGROUND

NATURAL AREAS
AVOID

GROUNDCOVERS
WALK-ON
NON WALK-ON
UNDER 12"
12"-18"
OVER 18"

VINES
SELF-CLIMBING
FENCE
TRELLIS

SHRUBS SMALL MEDIUM LARGE
TREES 20-35' 35'-50' 50'-75'

ESPALIER SMALL LARGE

LEAF FINE MEDIUM COARSE

TEXTURE

HIGH MEDIUM LOW

WILDLIFE VALUE

POLLUTION EFFECT

FLOOD TOLERANCE

EXPOSURE

WATER USE

HARDINESS

DISEASE PRONE

MAINTENANCE

GROWTH RATE

LONGEVITY

DENSITY

PHASES

LEAF
FLOWER
FRUIT

COLOR

LEAF

FLOWER BRONZE WHITE
FRUIT RED OR ORANGE

ARMAMENT

ROOT

STRUCTURE

HEIGHT 20'-35' 35'-50' 50'-75'

SPREAD 20'-35' 35'-50' 50'-75'

BRANCH FINE MEDIUM COARSE

TEXTURE
**Sapindus Drummondii**

**Soapberry**

**Propagates easily by seed, cuttings**

**Fairly easily moved**

**Significant Attributes**

**Droughty, fall color, somewhat showy, winter berries**

**Recommended Uses**

**Windbreak, shade, erosion control**

**Avoid**

**Groundcovers**

Walk-on

Non walk-on

Under 12"

12”-18”

Over 18”

**Vines**

Self-climbing

Fence

Trellis

**Shrubs**

Small

Medium

Large

Foundation

Hedge

**Espallier**

Small

Large

**Trees**

20-35’

35’-50’

50’-75’

75’-100’

20’-35’

35’-50’

50’-75’

95’

**Leaf Texture**

Fine

Medium

Coarse

**Armament**

Root structure

Spreading

Leaf

**Color**

Leaf

Yellow-Gold

**Flower**

White

**Fruit**

Gold

**Phases**

If maintained
**Cornus Drummondii**

**Rough-Leaf Dogwood**

**Propagate by Seed, Cutting, Division**

**Easily Moved**

**Significant Attributes**
- Fragrant
- Wildlife Value
- Fall Color
- Tolerates Wet Soils/Shade

**Recommended Uses**
- Accent Plant for Shady Areas
- Screen, Barrier
- Good for Natural Areas, Residential

**Avoid**

**Groundcovers**
- Walk-on
- Non walk-on
- Under 12"
- 12"-18"
- Over 18"

**Vines**
- Self-climbing
- Fence
- Trellis

**Shrubs**
- Small
- Medium
to 15'
- Large
- Foundation
- Hedge

**Espalier**
- Small
- Large

**Trees**
- 20'-35' <
- 35'-50'
- 50'-75'
- 75'-100'
- 20'-35' <
- 35'-50'
- 50'-75'
- 75'

**Leaf Texture**
- Fine
- Medium
- Coarse

**Branch Texture**
- Fine
- Medium
- Coarse

**Armament**

**Root Structure**
- Shallow

**Color**
- Leaf: Orange-Red
- Flower: White
- Fruit: White

**Phases**

<table>
<thead>
<tr>
<th>PHASES</th>
<th>FROM MATURE TO ABOND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Bumelia Lanuginosa**

**Chittamwood, Gum Bumelia, WoolyBucket**

**Propagated by Seed, Cuttings**

**Difficult to Move Established Plants**

Existing plants should be undisturbed

**Leaves favored by insects**

**Significant Attributes**

Drought, fragrant, wind resistance

Potentially evergreen, deep shade

Bird forage

---

**Recommended Uses**

Potential windbreak, specimen

Good for narrow/tight areas

Avoid turf area (deep shade)

---

**Groundcovers**

Walk-on

Non-walk-on

Under 12"

12"-18"

Over 18"

Vines

Self-climbing

Fence

Trellis

---

**Shrubs**

Small

Medium

Large

Foundation

Hedge

---

**Trees**

20-35'

35'-50'

50'-75'

75'-100'

20'-35'

35'-50'

50'-75'

75'

---

**Leaf Texture**

Fine

Medium

Coarse

---

**Branch Texture**

Medium

Coarse

---

**Armament**

Yes

---

**Root Structure**

Tap

---

**Color**

Leaf

Flower

Fruit

---

**Phases**

Leaf

Flower

Fruit

Whitish-Yellow

Blue-Black
Fraxinus Americana
White Ash

Propagated by Seed
Transplanting somewhat difficult

Subject to wind/ice damage
Significant Attributes
Fall color

Recommended Uses
Shade

Park, Natural Areas
Avoid

Groundcovers
Walk-on
Non walk-on
Under 12"
12"-18"
Over 18"

Vines
Self-climbing
Fence
Trellis

High Medium Low

Wildlife Value
Pollution Effect
Flood Tolerance
Exposure
Water Use
Hardiness
Disease Prone
Maintenance
Growth Rate
Longevity
Density

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20'-35'
35'-50'
50'-75'
75'-100'

Height

20'-35'
35'-50'
75'

Spread

Leaf Texture
Fine
Medium
Coarse

Branch Texture

Medium
Coarse

Armament

Root Structure

Shallow Fibrous

Leaf

Fruit

Color
Leaf
Yellow w/ purple

Flower
Purple

Fruit
Tan

Phases

Definite Drought

Definite Frost

Definite Freeze

Definite Winter

Definite Summer

Definite Spring

Definite Autumn

Definite Fall
**Sambucus canadensis**  
**Elderberry**

**Propagate by seed/cuttings best**  
**Easily Moved**

**Thicket forming in wet areas**  
**Subject to wind/ice damage, suckers,**  
**Significant Attributes**  
**Wildlife value, showy flowers, edible**  
**Likes wet soils**

**Recommended Uses**  
**Erosion control, Accent**  
**Barrier**  
**Natural Area (cap by stream or pond)**  
**Avoid**

<table>
<thead>
<tr>
<th>Ground Covers</th>
<th>Shrubs</th>
<th>Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk-on</td>
<td>Small</td>
<td>2.0-35'</td>
</tr>
<tr>
<td>Non-walk-on</td>
<td>Medium</td>
<td>Height</td>
</tr>
<tr>
<td>Under 12”</td>
<td>Large</td>
<td>35'-50'</td>
</tr>
<tr>
<td>12”-18”</td>
<td>Foundation</td>
<td>50'-75'</td>
</tr>
<tr>
<td>Over 18”</td>
<td>Hedge</td>
<td>75'-100'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vines</th>
<th>Espallier</th>
<th>Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-climbing</td>
<td>Small</td>
<td>20'-35'</td>
</tr>
<tr>
<td>Fence</td>
<td>Large</td>
<td>35'-50'</td>
</tr>
<tr>
<td>Trellis</td>
<td></td>
<td>50'-75'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High</th>
<th>Low</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood Tolerance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disease Prone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longevity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Armament**  
**Root Structure**  
**Aggressive Competitor**

**Leaf**  
**Color**  
**Flower**  
**Fruit**

**PHASES**

<table>
<thead>
<tr>
<th>IF</th>
<th>MANY</th>
<th>AGGRESSIVE</th>
<th>Leaf</th>
<th>Flower</th>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATURE</td>
<td>ON</td>
<td>COMPETITOR</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Symphoricarpos orbiculatus
Coral Berry, Turkey Berry, Indian Currant

Propagation by seed difficult; cuttings recommended.
Easily moved, divided.

Should be cut back each winter to promote more berries, bushier look.

Significant attributes:
Wildlife value, droughty.

Recommended uses:
Erosion control, border areas.
Attractive accent.
Natural areas.
Avoid.

Groundcovers:
Walk-on
Non walk-on
Under 12"
12"-18"
Over 18"

Vines:
Self-climbing
Fence
Trellis

Shrubs:
Small
Medium
Large
Foundation
Hedge

Espallier:
Small
Large

Leaf:
Fine

Texture:
Medium
Coarse

Trees:
20'-35'
35'-50'
50'-75'
75'-100'
20'-35'
35'-50'
50'-75'
75'

Height:

Spread:

Branch:

Texture:

Medium
Coarse

Armament:

Root:

Structure:

Color:

Leaf:

Crimson accent

Flower:

White-pink

Fruit:

Red to pink

Maintenance:

Hardiness:

Disease prone

Exposure:

Pollution effect:

Flood tolerance:

Water use:

Exposure:

Longevity:

Growth rate:

Density:

Phases:

Leaf

Flower

Fruit

Drought resistance:

Medium
Coarse
**Quercus Muhlenbergii**  
**Chinkapin Oak**

**Recommended Uses**

**Natural Areas**

**Avoid**

---

**Propagate by Seed (Must be Fresh)**

**Difficult to Transplant**

**Prefers Well Drained, Dry Soils**

**Significant Attributes**

**Very High Wildlife Value, Droughty**

**Edible Nut, Handsome Tree**

**Groundcovers**
- Walk-on
  - Non walk-on
  - Under 12”
  - 12”-18”
  - Over 18”

**Vines**
- Self-Climbing
- Fence
- Trellis

**High**
- Wildlife Value
- Pollution Effect
- Flood Tolerance
- Exposure
- Water Use
- Hardiness
- Disease Prone
- Maintenance
- Growth Rate
- Longevity
- Density

**Medium**
- Leaf Texture

**Low**
- Shrubs Small
- Medium
- Large
- Foundation
- Hedge

**Shrubs Small**
- Medium

**Trees**
- Height 20'-35'
- 35'-50'
- 50'-75'
- 75'-100'
- 20'-35'
- 35'-50'
- 50'-75'
- 75'

**Spread**
- Fine

**Branch Texture**
- Medium

**Armament**
- Deep Lateral Inviguer?

**Root Structure**
- Leaf Flower Fruit

**Color**
- Leaf Yellow-Brown
- Flower Yellow-Green
- Fruit Tan Brown

**Phases**

---
QUERCUS TEXANA
TEXAS RED OAK

Propagated by seed

Recommended uses

Significant attributes
Fall color, often multi-trunk
Wildlife value, small oak

Avoid

Natural areas, residential

Groundcovers
Walk-on
Non walk-on
Under 12”
12”-18”
Over 18”

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20-35’
35’-50’
50’-75’
75’-100’
20’-35’
35’-50’
50’-75’
75’+

Vines
Self-climbing
Fence
Trellis

Espallier
Small
Medium

Leaf
Fine
Medium
Coarse

Branch
Fine
Medium
Coarse

High
Medium
Low

Wildlife value

Pollution effect

Flood tolerance

Exposure

Water use

Hardiness

Disease prone

Maintenance

Growth rate

Longevity

Density

Armament

Root

Structure

Color
Leaf
Scarlet

Flower

Fruit

Phases

Leaf
Flower
Fruit
Quercus macrocarpa
Burr Oak

Propagate by seed
Difficult to transplant

Significant Attributes
Very high wildlife value, droughty
Will grow anywhere

Recommended Uses
Very large shade tree
Natural areas, park scale
Avoid small spaces/scale

Groundcovers
Walk-on
Non walk-on
Under 12"
12"-18"
Over 18"

Vines
Self-climbing
Fence
Trellis

High Medium Low

Wildlife Value
Pollution Effect
Flood Tolerance
Exposure
Water Use
Hardiness
Disease Prone
Maintenance
Growth Rate
Longevity
Density

Shrubs
Small
Medium
Large
Foundation
Hedge

Trees
20'-35'
35'-50'
50'-75'
75'-100'

Spread
20'-35'
35'-50'
50'-75'
75'+

Leaf Texture
Fine
Medium
Coarse

Armament

Root Structure

Color
Leaf
Yellow-Brown
Flower
Yellowish Green
Fruit
Tan-Brown

Phases
**Virburnum rufidulum**

**Black Haw (Rusty)**

*Propogation by cuttings, seeds*

*Transplants easily*

**Significant Attributes**

*Showy, droughty, slightly fragrant*

*New leaves, bronzy red, wildlife value*

---

**Recommended Uses**

*Specimen, Screen*

*Residential, Natural Areas*

*Avoid flood plain*

---

**Groundcovers**

*Walk-on, non walk-on, under 12", 12"-18", over 18"*

**Vines**

*Self-climbing, fence, trellis*

---

**Shrubs**

*Small, medium, large, foundation, hedge*

**Trees**

*20'-35', 35'-50', 50'-75', 75'-100', 20'-35', 35'-50', 50'-75', 75'*

**Height**

*May reach 40'*

**Spread**

*50'-75', 75'*

**Leaf Texture**

*Fine, medium, coarse*

**Branch Texture**

*Fine, medium, coarse*

---

**Armament**

*Root Structure*

*Shallow, widespread, leaf, flower, fruit*

**Color**

*Leaf gold and orange*

**Flower**

*White*

**Fruit**

*Blue to black*

---

**Phases**

*DFMNTSAGOND*
**Forestiera pubescens**

**Spring Herald, Downy Forestiera**

- Elbow bush
- Propagated easily by seed, cuttings
- Easily transplanted if severely cutback

**Thicket Forming**

**Significant Attributes**

- High wildlife value, droughty
- Good for areas of dense shade to full sun

**Recommended Uses**

- Good background, erosion control
- Natural areas
- Avoid

**Groundcovers**

- Walk-on
- Non-walk-on
- Under 12" (High)
- 12"-18" (Medium)
- Over 18" (Low)

**Vines**

- Self-climbing
- Fence
- Trellis

**Shrubs**

- Small
- Medium
- Large

**Trees**

- Height: 20'-35'
- 35'-50'
- 50'-75'
- 75'-100'
- 20'-35'
- 35'-50'
- 50'-75'
- 75'

**Leaf Texture**

- Fine
- Medium
- Coarse

**Branch Texture**

- Fine
- Medium
- Coarse

**Armament**

- Root Structure
- Color Leaf

**Phases**

- Leaf
- Flower
- Fruit

- Flower: Greenish
- Fruit: Purple-Black
**JUGLANS NIGRA**
BLACK WALNUT

**Propagated by Seed, Grafting**
**Difficult to transplant**

**Secrets a Plant Toxin (Protective)**

**Significant Attributes**
**Edible Nut, Droughty**

---

**Recommended Uses**
**Large Shade Tree**

**Parks, Natural Areas**
**Avoid Proximity to Gardens**

---

**Groundcovers**
- Walk-on
  - Non Walk-on
  - Under 12”
  - 12”-18”
  - Over 18”

**Vines**
- Self-Climbing
- Fence
- Trellis

**Shrubs**
- Small
- Medium
- Large
- Foundation
- Hedge

**Trees**
- Height
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'

**Spread**
- 20'-35'
- 35'-50'
- 50'-75'
- 75'

**Leaf Texture**
- Fine
- Medium
- Coarse

**Branch Texture**
- Fine
- Medium
- Coarse

**Armament**

**Root Structure**

**Tap**

**Leaf Color**
- Golden-Yellow

**Flower Color**
- Yellow-Green

**Fruit Color**
- Y-G to Black

---

**Wildlife Value**
- Low
- Medium
- High

**Exposure**
- Low
- Medium
- High

**Water Use**
- High
- Medium
- Low

**Hardiness**
- Low
- Medium
- High

**Disease Prone**
- Low
- Medium
- High

**Maintenance**
- Low
- Medium
- High

**Growth Rate**
- Low
- Medium
- High

**Longevity**
- Low
- Medium
- High

**Density**
- Low
- Medium
- High
FRAXINUS PENNSYLVANICA
GREEN ASH

PROPAGATION BY SEED
EASILY MOVED

SUBJECT TO WIND/ICE DAMAGE

SIGNIFICANT ATTRIBUTES
DROUGHTY

RECOMMENDED USES
NOT RECOMMENDED

AVOID HEAVY CLAYS

GROUNDCOVERS WALK-ON
NON WALK-ON
UNDER 12"
12"-18"
OVER 18"

SHRUBS SMALL MEDIUM LARGE

TREES 20-35'
HEIGHT 35'-50'
50'-75'
75'-100'
20'-35'
35'-50'
50'-75'
75'

ESPALLIER SMALL MEDIUM

SPREAD 50'-75'
75'

LEAF TEXTURE FINE MEDIUM COARSE

BRANCH TEXTURE MEDIUM COARSE

WILDLIFE VALUE
POLLUTION EFFECT
FLOOD TOLERANCE
EXPOSURE
WATER USE
HARDINESS
DISEASE PRONE
MAINTENANCE
GROWTH RATE
LONGEVITY
DENSITY

ARMAMENT

ROOT STRUCTURE SHALLOW FIBROUS

COLOR LEAF YELLOW/ORANGE
FLOWER PURPLE
FRUIT TAN/BROWN

PHASES
**Platanus occidentalis**
Sycamore, American Planetree

**Propagate by seed, cutting**
**Easily transplanted**

**Subject to wind/ice damage**

**Significant Attributes**

---

**Recommended Uses**

---

**Park Scale**
**Avoid Windbreaks, Parking Areas**

---

**Groundcovers, Walk-on**
- Non Walk-on
  - Under 12"
  - 12"-18"
  - Over 18"

**Vines**
- Self-climbing
- Fence
- Trellis

---

** SHRUBS**
- SMALL
- MEDIUM
- LARGE
- FOUNDATION
- HEDGE

** ESPALLIER**
- SMALL
- MEDIUM

**Trees**
- HEIGHT
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 100'+

- SPREAD
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'+

**Leaf Texture**
- FINE
- MEDIUM
- COARSE

**Branch Texture**
- MEDIUM
- COARSE

---

**Armament**

- Root Structure
  - Shallow Fibrous
  - Leaf
  - Flower
  - Fruit

**Color**
- Leaf
  - Tan-Brown

- Flower
  - Yellow-Green

- Fruit
  - Tan-Brown

---

**Phases**

- [Diagram of Phases]
  - [Diagram of Phases]
**Juniperus Ashei**

**Ashe Juniper**

- **Propagated by Seed**

---

**Recommended Uses**

- Small Shade Tree, Windbreaks
- Specimen
- Avoid South Lot Areas

---

**Significant Attributes**

- Apparently does not carry the Cedar-Apple Rust

---

### Groundcovers

- Walk-on
- Non Walk-on
- Under 12"
- 12"-18"
- Over 18"

### Vines

- Self-climbing
- Fence
- Trellis

### Shrubs

- Small
- Medium
- Large
- Foundation
- Hedge

### Espallier

- Small
- Medium

### Trees

- Height
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
  - 100'-150'
- Spread
  - 20'-35'
  - 35'-50'
  - 50'-75'
  - 75'-100'
- Branch
  - Fine
  - Medium
  - Coarse
- Leaf
  - Fine
  - Medium
  - Coarse
- Texture
  - Medium
  - Coarse

### ARMAMENT

### Root Structure

### Color

- Leaf
- Flower
- Evergreen
- Flower
- Fruit
- Blue

### PHASES

- Leaf
- Flower
- Fruit
**Buchloe dactyloides**
**Buffalo Grass**

**Limited Availability**

**Not Shade Tolerant**

**Significant Attributes**

**Low Maintenance, Water Use**

**Recommended Uses**

**Residential, Recreation Area**

**Groundcover**

**Avoid Shade**

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-on</th>
<th>Non Walk-on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 12&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12&quot;-18&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 18&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vines</th>
<th>Self-climbing</th>
<th>Fence</th>
<th>Trellis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrubs</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Espallier</td>
<td>Small</td>
<td>Medium</td>
<td>Fine</td>
</tr>
<tr>
<td>Leaf</td>
<td></td>
<td>Medium</td>
<td>Coarse</td>
</tr>
<tr>
<td>Texture</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trees</th>
<th>20'-35'</th>
<th>35'-50'</th>
<th>50'-75'</th>
<th>75'-100'</th>
<th>20'-35'</th>
<th>35'-50'</th>
<th>50'-75'</th>
<th>75'+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spread</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coarse</td>
</tr>
</tbody>
</table>

**Wildlife Value**

**Pollution Effect**

**Flood Tolerance**

**Exposure**

**Water Use**

**Hardiness**

**Disease Prone**

**Maintenance**

**Growth Rate**

**Longevity**

**Density**

**Armament**

**Root Structure**

**Color Leaf**

**Flower**

**Fruit**

**Phases**

<table>
<thead>
<tr>
<th>Leaf</th>
<th>Flower</th>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Bouteloua hirsuta**  
SIDE OATS GRAMMA

**Recommended Uses**

- **Good Accent and Border**  
- **Groundcover – All Areas**

**Significant Attributes**  
LOW MAINTENANCE, WATER USE

<table>
<thead>
<tr>
<th>Groundcovers</th>
<th>Walk-On</th>
<th>Non Walk-On</th>
<th>Small Shrubs</th>
<th>Medium Shrubs</th>
<th>Large Shrubs</th>
<th>Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Under 12''</td>
<td>12''-18''</td>
<td>Medium</td>
<td>Large</td>
<td>Foundation</td>
<td>Height</td>
</tr>
<tr>
<td></td>
<td>OVER 18''</td>
<td></td>
<td>Hedge</td>
<td></td>
<td></td>
<td>20'-35'</td>
</tr>
<tr>
<td>Vines</td>
<td>Self-Climbing</td>
<td>Fence</td>
<td>Espallier</td>
<td>Small</td>
<td>Fine</td>
<td>20-35'</td>
</tr>
<tr>
<td></td>
<td>FENCE</td>
<td>TRELLIS</td>
<td></td>
<td>MEDIUM</td>
<td>TEXTURE</td>
<td>35'-50'</td>
</tr>
<tr>
<td>High</td>
<td>![HIGH]</td>
<td>![LOW]</td>
<td>![MEDIUM]</td>
<td>![COARSE]</td>
<td>![FINE]</td>
<td>50'-75'</td>
</tr>
<tr>
<td>Medium</td>
<td>![MEDIUM]</td>
<td>![LOW]</td>
<td>![MEDIUM]</td>
<td>![COARSE]</td>
<td>![FINE]</td>
<td>75'-100'</td>
</tr>
<tr>
<td>Low</td>
<td>![LOW]</td>
<td>![LOW]</td>
<td>![MEDIUM]</td>
<td>![COARSE]</td>
<td>![FINE]</td>
<td>100'-150'</td>
</tr>
</tbody>
</table>

**Wildlife Value**

- ![HIGH]
- ![LOW]

**Pollution Effect**

- ![HIGH]
- ![LOW]

**Flood Tolerance**

- ![HIGH]
- ![LOW]

**Exposure**

- ![HIGH]
- ![LOW]

**Water Use**

- ![HIGH]
- ![LOW]

**Hardiness**

- ![HIGH]
- ![LOW]

**Disease Prone**

- ![HIGH]
- ![LOW]

**Maintenance**

- ![HIGH]
- ![LOW]

**Growth Rate**

- ![HIGH]
- ![LOW]

**Longevity**

- ![HIGH]
- ![LOW]

**Density**

- ![HIGH]
- ![LOW]

**Armament**

- ![HIGH]
- ![LOW]

**Root Structure**

- ![HIGH]
- ![LOW]

**Color**

- ![HIGH]
- ![LOW]

**Leaf**

- ![HIGH]
- ![LOW]

**Flower**

- ![HIGH]
- ![LOW]

**Fruit**

- ![HIGH]
- ![LOW]

**Phases**

- Leaf
- Flower
- Fruit
LIGHT/ GAS/ ELECTRICITY

SUMMER SUNLIGHT DIFFUSED THRU REFLECTIVE MEANS

WINTER SUNLIGHT USED DIRECTLY BUT CAN BE DIFFUSED BY SHADES IF DESIRED

LOW VOLTAGE ENERGY EFFICIENT LIGHTS

LIGHT DIFFUSING SHADES

WHITE HIGH GRIP DECK SAND TO DISTRIBUTE LIGHT

GAS ENTRY AND STREET LIGHTS USING METHANE FROM SEWAGE TREATMENT

WHITE CALICHÉ BLOCK FOR LIGHT DIFFUSION

COMMON TRENCH TYPE NO. 1
- METHANE GAS
- WATER
- WASTE WATER

COMMON TRENCH TYPE NO. 2
- COMMUNICATION
- ELECTRICITY
- HEAT PUMP HEAT HEAT EXCHANGER

INSULATED MEMBRANE FOR HOLDING MOISTURE & TEMPERATURE CONSTANT IN HIGHLY EXPANSIVE SOILS BENEATH FLOATING SLAB FOUNDATION
WATER / HOT WATER / WASTE WATER

PASSIVE LOWCOST
BATCH WATER HEATER
BACKUP FOR HEAT
PUMP HEATED
DOMESTIC
WATER

EAST / WEST SHADE
TRELLIS ON MULTI-
FAMILY AND ALL
YARD PLANTS ARE
WATERED BY CISTERN
ROOF WATER

COMMODES ARE
OFF THE SHELF
& DO NOT NEED
SPECIAL WATER
CONSERVATION
FIXTURES - ALL
WATER IS
RECYCLED

A DOWNSIZED
WATER TO AIR
HEAT PUMP HEATS
& COOLS BLDS & HEATS HOT WATER

ALL WATER FOR TOILETS IS RECYCLED FROM
TREATED WATER AT HYACINTH WASTE
TREATMENT PLANT

ALL WATER FOR GARDENING COMES FROM
ROOF CISTERNs
HIGH CLAY SOIL URBAN RUNOFF PLAN

COMMERCIAL

WINDMILL WITH PHOTO VOLTAICS IN TOWER FOR PUMPING WATER FROM TREATMENT PLANT TO ENTRY POND

PARKING LOT

DEEP ROOT DECORATIVE PLANT ROOF WATER ABSORPTION

E-W SHADE PROTECTION USING VINES WATERED FROM ROOF

MULTI & SINGLE

FAMILY RESIDENTIAL

CREEK TANK CATCHMENT FOR CLEAN URBAN WATER RUNOFF

WETLAND ABSORBER

EVAPORATIVE BED SAND FILTER USING OIL TOLERANT PLANT SPECIES

METHANE GAS OPERATED STREET LIGHTS

SINGLE FAMILY WITH CISTERNS AND GARDEN

MULTI-FAMILY WITH CISTERNS AND GARDENS

CAR BARN WITH CISTERNS-LOWERS CISTERNS AND GARDENS RUNOFF & HEAT GAIN IN PARKING AREAS

MULTI-FAMILY WITH CULTIVATION

PATHS AND PARKING

PARKING ENTRANCE PLANTING IN DEEP COMPOSTED ABSORBERS TO CONTROL RUNOFF INTO STREET USING OIL TOLERANT PLANTS AT EDGES

PARKING LOT

CAR BARN COLLECTS WATER IN CISTERNS THUS REDUCING RUNOFF & SAVES WATER FOR DRY PERIODS

DEEP COMPOST PLANTER ABSORBER AT JUNCTURE BETW PATH & PARKING

PASSING AT CURVES WITH SWALE ABSORBER

PATH & BIKE LANE AS DRAINAGE TRIBUTARY

STREET & CUL-DE-SAC

CREEK WITH GABIONS USED AS WETLAND BANK AND FLOOD CONTROL

LOWER TIER WETLAND PLANT SPECIES

MIDDLE LEVEL FLOOD PRONE PLANT SPECIES

UPPER TIER GRASSES AND DRY LAND PLANT SPECIES AT CUL-DE-SAC DISTRIBUTOR

COMPOSTED ABSORBER WELL FOR FLOOD TOLERANT TREE SPECIES TOWARDS END OF CUL-DE-SAC
MULTI-FAMILY PLAN DESCRIPTION

- Plans may be flipped on east/west axis but not on north/south axis—plans allow for better solar access but also entry on any side for design flexibility.
- All plans oriented around single planning wall (see kitchens & bathrooms).
- Small, medium, and large plans range from single story to 2 1/2 story (140 sq. ft. efficiency-114 sq. ft. 4 bedroom).
- East/west walls never more than 24', never longer than 25'- nothing bigger than 3 stories. Largest possible unit is 2 1/2 story 2 1/2 story building. Smallest possible unit is 1 story 2 1/2 story building.
- Poonches are added depending on orientation; small sheds for storage and laundry are added as well, but not so as to interfere with basic orientations. These lend character and diversity of designs.
- Some units stackable with each other, others can share common walls.

SHEDS:
- Shed at unit two.
- Shed at unit three: Similarly to the above.

UNITS:
- Units with stair access.
- Units with unit access.
STRUCTURAL AND FABRICATION SYSTEM

LIGHT WEIGHT R- 3.9/IN FLYASH CONCRETE FORMED WITHIN WOOD JOIST CAVITY

REINFORCING BAR PLACED AND TIED ONTO SPREADERS OF PERMANENT FORM

WINDOW AND DOOR OPENINGS CAN BE CUT AND TRIMMED AFTER POURING THUS REDUCING FORMWORK TIME & COST

100% 40LB/FT³ FLYASH CEMENT, CURED INSIDE THERMALLY INSULATED FORM (INSIDE FORM REMOVED AFTER CURE FOR PROPER THERMAL PERFORMANCE)

2500 PSI FLYASH CEMENT (NON-PRESTRESSED) FLOATING SLAB

MAIN JOIST ATTACHMENT CAN BE DRILLED AND BOLTED THROUGH LIGHTWEIGHT FLYASH BEARING WALL

HIGH SHRINK SWELL SOILS PRE-WETTED AND CONFINED INSIDE MEMBRANE TO CONTROL POTENTIAL FOUNDATION PROBLEM
CONTINUOUS WELL SIZED RIDGE VENT TO ENSURE ADEQUATE ROOF AND ATTIC VENTILATION

LARGE CHANNEL SIMULATED TILE ROOF WITH RADIANT BARRIER BENEATH FOR LOW HEAT GAIN IN ROOF

LOWERED SOUTH PORCH ROOF TO PREVENT HEAT GAIN UNDER EAVES AND TO CORESPOND TO GEOMETRY OF THE SUN FOR PROPER WINTER SOLAR ACCESS

SOUTH PORCH AS SOLAR OVER HANG TO PREVENT SUMMER HEAT GAIN THROUGH WINDOW AREAS

CALICHE BLOCK PORCH FLOOR AND PATHWAYS

CLOSED CELL INSULATION PLACED 4-5 FEET INTO SOIL TO PRODUCE CONSTANT TEMPERATURE ISLAND FOR ENERGY CONSERVATION AND TO PRODUCE CONSTANT MOISTURE FOR LIMITED SHRINK/SWELL

USE OF BOTTOM OF MOISTURE/HEAT BARRIER TRENCH AS DITCH FOR LIQUID TO AIR HEAT PUMP THUS TRIPPLING THE USE OF THIS DITHING EFFORT AND REDUCING COSTS
GRiffin-West Residential

PREPARED BY:
THE CENTER FOR MAXIMUM
POTENTIAL BUILDING SYSTEMS
8604 F.M. 969,
AUSTIN, TEXAS

LAND USE

SCALE
1" = 200'

A, B
A, B, C, D, P
A, B, C, D, F, P
A, B, H
A, B, Q, W, Y
A, B, Y
A, B, W, Y
A, Q
A, Q, X
A, Q, W, Y

A, X
A, X, E
A, Y
B, X
C, D, H
E
E, W
G,
G, R
Z

P
Q
Q, S
Q, W, Y
R
R, Y
S, W
T
U
U, R
U, S
U, T
W, Y
<table>
<thead>
<tr>
<th>Riparian Conservation Areas Inside Floodplain (with selective thinning)</th>
<th>Pond Rehabilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenbelt Development or Land Reclamation Inside Floodplain</td>
<td>Waste Treatment Lagoon Converted to Scenic Lake Area</td>
</tr>
<tr>
<td>Greenbelt Improvement Inside Floodplain</td>
<td></td>
</tr>
<tr>
<td>Greenbelt Development Outside Floodplain</td>
<td></td>
</tr>
<tr>
<td>Greenbelt Improvement Outside Floodplain</td>
<td></td>
</tr>
<tr>
<td>Plant Thinning Areas</td>
<td></td>
</tr>
<tr>
<td>Areas of Scattered Individual Tree Species Useful for Shade and Landscaping</td>
<td></td>
</tr>
<tr>
<td>Nursery Area to Propagate Vegetation Removed from Construction Areas</td>
<td></td>
</tr>
<tr>
<td>Major Road Right of Way to Be Handled According to Specification</td>
<td></td>
</tr>
<tr>
<td>Fence Row Rehabilitation as Part of Greenbelt or for Climatic Purposes</td>
<td></td>
</tr>
<tr>
<td>Fence Row Removal of All Except Larger Tree Species - Others Transplanted When Possible</td>
<td></td>
</tr>
</tbody>
</table>

**Habitat Synthesis**

SCALE 1" = 200'
WATER / HOT WATER / WASTE DISPOSAL
CONSTRUCTION SEQUENCE