SECTION 2
Design Considerations

Garland Urban Agriculture Center
Rooftop Gardens
INTRODUCTION

Section 2 of this proposal for the Garland Urban Agricultural Center addresses design considerations for rooftop gardens as applicable to the proposed Center.

According to Wikipedia, a roof garden is any garden on the roof of a building. Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, and recreational opportunities. The practice of cultivating food on the rooftop of buildings is sometimes referred to as rooftop farming. Rooftop farming is usually done using green roof, hydroponics, aeroponics or air-dynaponics systems or container gardens. Besides using the already present space at the roof itself, additional platforms could possibly be created between high-rise buildings called "aero-bridges".

ENVIRONMENTAL IMPACT AND BENEFITS OF ROOFTOP GARDENS

Plants have the ability to reduce the overall heat absorption of the building, which then reduces energy consumption. "The primary cause of heat build-up in cities is insolation—the absorption of solar radiation by roads and buildings in the city and the storage of this heat in the building material and its subsequent re-radiation. Plant surfaces however, as a result of transpiration, do not rise more than 4–5 °C above the ambient and are sometimes cooler." This then translates into a cooling of the environment between 3.6 and 11.3 degrees Celsius (6.5 and 20.3 °F), depending on the area on earth (in hotter areas, the environmental temperature will cool more). The University of Cardiff performed the study. 

Plantings in containers are used extensively in roof top gardens. Planting in containers prevents added stress to the roof's waterproofing.

EXAMPLES OF ROOFTOP GARDENS

**CHICAGO CITY HALL**

One high-profile example of a building with a roof garden is Chicago City Hall. Chicago’s most famous rooftop garden sits atop City Hall, an 11-story office building in the Loop. City Hall and the adjacent Cook County building appear to most people as one building spanning a city block bounded by LaSalle, Randolph, Clark and
Washington streets. First planted in 2000, the City Hall rooftop garden was conceived as a demonstration project - part of the City's Urban Heat Island Initiative - to test the benefits of green roofs and how they affect temperature and air quality. The garden consists of 20,000 plants of more than 150 species, including shrubs, vines and two trees. The plants were selected for their ability to thrive in the conditions on the roof, which is exposed to the sun and can be windy and arid. Most are prairie plants native to the Chicago region.

Like all green roofs, the City Hall rooftop garden improves air quality, conserves energy, reduces stormwater runoff and helps lessen the urban heat island effect. The garden's plants reflect heat, provide shade and help cool the surrounding air through evapotranspiration, which occurs when plants secrete or "transpire" water through pores in their leaves. The water draws heat as it evaporates, cooling the air in the process. Plants also filter the air, which improves air quality by using excess carbon dioxide to produce oxygen.

The rooftop garden mitigates the urban heat island effect by replacing what was a ballasted, black tar roof with green plants. The garden absorbs less heat from the sun than the tar roof, keeping City Hall cooler in summer and requiring less energy for air conditioning. The garden also absorbs and uses rain water. It can retain 75% of a 1-inch rainfall before there is stormwater runoff into the sewers.

**Texas is No Stranger to Rooftop Gardens**

![Texas Baptist Memorial Sanitarium Rooftop Garden 1909](image)

Rooftop gardens are not a "new-fangled notion." They have been around for thousands of years. One of the early examples in Texas was the 1909 rooftop garden of the Texas Baptist Memorial Sanitarium (Baylor Medical). A rooftop garden was just one feature of the grand and ornate Texas Baptist Memorial Sanitarium, opened on October 14, 1909. It was one of the most modern medical facilities in the Southwest. Among the amenities in the building were push-button elevators just large enough for one person and one centrally located elevator that was seven feet square. The building also included a central vacuum system, 25 house telephones, a power plant, a temperature regulation system, an artesian well, and a roof garden for use by convalescents.
One of the buildings planned for roof replacement was the School of Public Health. The subject building is a 12-story structure composed of structural concrete framing. The existing roof consisted of a spray-applied polyurethane foam 2 to 4 inches thick applied over a gravel-surfaced built up roof membrane. The roof was comprised of a main level and two mechanical penthouses encompassing a plan area of approximately 21,000 square feet. To provide further exposure to rooftop technology, Price Consulting Inc. (PCI), organized the construction of test plots or mock-up samples of various extensive garden roof assemblies.

In August 2002, four different roofing/waterproofing assemblies were installed on another UTHSC building. The area selected for the test roofs was on top of a parking structure of another UTHSC building. The area had a concrete curb (retaining wall) around the perimeter where a cooling tower structure once stood. The subject area was divided into four quadrants (approximately 300 square feet each) to provide independent areas to receive the new materials.

After placement of the growing medium, UTHSC personnel planted a variety of vegetation species and seeds in the quadrants. After the planting, UTHSC personnel performed random watering to help establish the various plants and monitored the progress.

Upon completion of this process, PCI was directed to develop specifications and drawings for roof replacement of the School of Public Health. The construction process was started in the latter part of April 2003.

The scope of work included removal of the existing roof materials (including the thermosetting fill) down to the structural concrete deck. The replacement systems included a traditional low-sloped roof assembly on the western portion and the mechanical penthouses and a garden roof on the eastern portion of the roof.

The installation of the drainage panel, insulation, filter fabric, and pavers was completed in mid to late August 2003.
Siplast, the roof membrane system manufacturer based on its past experiences in garden roof technology, provided the guidelines for the specifications of the growing medium or “engineered soil”. The proportions of the constituents consisted of the following: lightweight “engineered soil” containing 55% expanded slate, 30% coarse sand, 5% pine bark humus, and 10% compost. The roofing contractor found and used a local resource for the engineered soil.

The “engineered” growing medium (soil) was pre-mixed and bagged by the LETCO Group L.P. of Houston, Texas. The soil was packaged in 4,000 40-pound bags delivered on 68 pallets to the site and raised to the roof via a hoist by the contractor.

A soil scientist was consulted in regard to the plant types proposed and the desired results for this project. John Ferguson, with Nature’s Way Resources in Conroe, Texas, recommended mixing a bacterial root stimulator into the soil. Four 40-pound bags of “Microlife Ultimate 8-4-6” organic fertilizer supplied by San Jacinto Environmental Supplies of Houston, Texas, were blended with the engineered soil.

Several resources participated in the plant selection. METANOVAstudios, Inc. in conjunction with Siplast and provided a “Plant Selection Recommendation” for the project team during the design process. UTHSC staff botanists selected and planted a variety of species in the test green roofs and monitored the growth and survival results of these plants from 2002 to 2003. During the project-planning phase, Competition Roofing was referred to Heidi Sheesley at Treesearch Farms, Inc. in Houston, Texas. Using the expertise of each of these resources, a finalized list of plants was developed by Sheesley for the project.

Plants would have to survive common weather characteristics of the Houston area, including high humidity, high heat, pollution, potential drought, and torrential downpours. In addition, no supplemental rooftop irrigation was planned for the project and minimal, if any, maintenance.

A total of 1,492 plants from 23 species were planted in the four quadrants (see Table 1). The plants were placed in rows and oriented in groupings to provide ease of identifying and monitoring of the vegetation in the future and not positioned for purposes of achieving a “sculptured landscaped design.”

The plants were delivered to the site, transported to the roof via hoist, and roofing contractor personnel planted them from September 18 - 20, 2003.

Since the subject roof was symmetrical, a direct comparison of the costs of the garden roof system and the traditional modified bitumen roof system could be achieved. Reportedly, industry professionals estimate that extensive green roofs could cost on the order of $7 to $12 more per square foot than traditional systems.
Although the anticipated roof maintenance work and related costs for garden roofs remain unknown, it is believed that on this specific roof, they should be minimal, as the roof membrane and flashings are concealed and not exposed to weathering elements. Anticipated maintenance would be related to the monitoring of the vegetation (i.e., weed control, plant replenishment, and watering, if necessary).

The next step is prepping the roof for proper drainage and waterproofing. First put
down a tapered layer of insulation to channel excess water into storage tanks on the
ground. Over that goes a layer of deck paneling secured to the roof with foam adhesive.
These panels provide a hard surface for the garden and keep wayward roots from
reaching the roof. The final layer is a special weatherproofing rubber.

Here are the specs for one home that was fitted with a rooftop garden:
The Specs
House: 3,500-square-foot, four-bedroom contemporary
Location: Greenwich, N.Y.
Project: Building a green roof
Cost of materials: $15.50 per square foot for entire project
Time to install: Six days
Eco-advantage: Creates wildlife habitats, absorbs CO2, insulates roof

[Source; http://www.popsci.com/environment/article/2009-12/green-dream-
installing-rooftop-garden Accessed Jan. 31, 2013]

DESIGN ISSUES

1. **Structural Integrity**: Make sure the roof can hold the load. Get a licensed pro to
do this. Soil and pots are heavy to begin with and will get heavier as the plants
grow. If you've ever tried to move a pot full of wet soil, you know how much
weight water can add.

2. **Access**: How are you going to get your materials and supplies in and out? If you
live in an apartment, make sure you are allowed to use the elevator. Some
municipalities require multiple access/exits and possibly exit lighting, fire
alarms and emergency lighting.

3. **Water**: Will you be able to run a hose out to the roof. Watering cans can
become a nuisance and containers require a lot of water. Consider installing rain
barrel and drip irrigation.

4. **Sun Exposure**: Are you shaded by nearby buildings or the terrace above you?
Even fun sun can be a problem, when plants are sweltering on top of concrete.

5. **Heat**: Besides the sun beating down on the roof, there is ambient heat being
reflected from the roof surface, surrounding buildings, streetcars and metal
exhaust and utility structures. You will probably want to provide some sort of
shade, if not for the plants, then for you.

6. **Wind**: Wind can whip down straight urban streets, especially on high rises. You
may want to consider some type of wall or fencing. If so, you will probably need
to check your building code again for required heights and structural stability.
This is especially important when building safety barriers for kids and pets.

7. **Privacy**: neighboring buildings surround many rooftops. If your rooftop garden
will be in full view, you may want to plan for screening. You can plant a hedge of
evergreens, run vines up a trellis wall or simply tuck under an umbrella table.

8. **Electrical Wiring**: Electricity isn't essential, but it sure makes things easier. If
you are planting on enjoying your garden at night, candles are the best lighting
for weeding.

9. **Storage**: There's a lot of paraphernalia associated with gardening: tools,
fertilizer, compost, buckets, etc. Space is limited on a rooftop and it's hard to camouflage a storage area. Shelves will suffice. Some rooftop gardeners opt for narrow closets. Another option is bench seating with built in storage, to do double duty.

10. **Cost:** Last but not least, how much are you willing to spend. You can start small and add on, buying more pots and plants (and soil) as you go. The real expense comes when you want to start hardscaping and building on the roof. Laying tiles or stone, building raised beds and boxes, adding lighting and furniture can all start to add up. Plus, you may need more structural work to support them.

If the majority of the Garland downtown buildings had rooftop gardens, in addition to all the added benefit of food production, more visitors would be attracted to our downtown area. How many small towns in Texas today have city squares surrounded with rooftop gardens?

**VARIATION OF ANOTHER WAY TO USE EXISTING BUILDINGS AS GROWING SPACES—VERTICAL GARDENS**

**Green Walls are another way to use space for growing food in urban areas. We might consider establishing some green walls in our downtown area as well.** *(The examples that follow are not intended as endorsements for this company but rather as examples. They are several manufacturers of these panels. In fact, if enough interest for local food is generated in our community, we might even establish such companies here in Garland—just another way to grow our local economy.)*

The Green Wall Panel system developed by GSky is the most sustainable and comprehensive vertical garden system in the industry. The flexible, modular system can be used in both interior and exterior living walls, in any climate.
The system has 5 main components:

1. **Stainless Steel Mounting Frames**: the plant wall frames can be mounted on concrete, CMU, and metal or wood frame structures.

2. **Stainless Steel Panels**: standard panels are one foot square or panels can be custom sized to fit any design or wall size. They can also be removed for inspection as needed.

3. **Non-Soil Structural Growth Medium**: the patent-pending non-eroding growth material promotes strong root structure that ensures plant longevity and lower maintenance than loose soil systems.

4. **Plants**: our plants are pre-grown into the panels to ensure health, longevity, and beauty.

5. **Remote Irrigation/Fertilization System**: the 24/7 remote monitoring system by GSky is a computerized vertical drip irrigation system with temperature, moisture and freeze-thaw sensors.

To speak to a Project Development professional, call us at **800-581-9946**, or [contact us](#) online.

*Note: These vertical green walls can be in door as well as out door. Instead of decorative plants, food-producing plants should be used.*
The VersaWall is best suited for interior spaces where its versatility makes it ideal to meet the needs of many different living wall applications. The system can cover an entire wall surface or become a beautiful framed piece of living green art. The design opportunities are endless.

**VersaWall System Components:**

**Trim, Edges & Gutters:** available in a wide selection of materials and finishes to complement the surrounding décor.

**Plant Trays:** made of 100% recycled material and are mounted to a waterproof backing that is attached to the structural wall.

**Plants:** carefully selected, custom grown, and acclimated to best match the environment conditions of the wall.

**Irrigation System:** customized to work within your particular application, and remote monitoring is standard on select VersaWalls.
Water Supply: can be sourced through direct plumbing or re-circulated through a self-contained system.

Ambius is a certified specifier, installer, and service provider of GSky Plant Systems, the most widely recognized and respected brand in the industry.

SmartWall

SmartWall System Components:

Cabinet Enclosure: the cabinet is available in a selection of finishes to match your decor.
Plant Trays: the trays we use are made of 100% recycled material.
Foliage Plants: the plants are chosen to thrive in your specific environment.
Self-Contained Irrigation System: the programmable timer on the irrigation system allows us to customize your watering schedule.
New York restaurateur John Mooney has redefined the concept of farm-to-table with his amazing rooftop hydroponic garden. The food served at the Bell, Book and Candle is largely sourced from Mooney’s vertical farm, located a few flights of stairs above his Manhattan restaurant. Climb those stairs, and you won’t find an ounce of soil—Mooney’s entire operation is based on vertical hydroponics, a relatively young form of agriculture that remains a frontier for food science.
Hydroponics is the cultivation of plants in nutrient-rich water. There are many different styles of hydroponic gardening, but most use less than 10% of the water used in traditional agriculture. Hydroponics also provides faster growth rates, with some hydroponic plants growing at twice the rate of soil-based plants. Mooney uses a commercial product called Tower Gardens to grow his plants vertically, re-using the life-giving nutrient solution with little waste. These tower gardens use a form of hydroponics called aeroponics, a system which sprays a nutrient-rich mist at plant roots instead of submerging the roots into the solution. The result is quick yields, intensely flavored vegetables and very little waste.

The tower gardens Mooney uses are available online for $499 per unit. Those curious about hydroponics can also build DIY systems from plans available online or with their own ingenuity. We at TheCoolist built a pair of aeroponic systems using PVC fence posts and large plastic containers. We’ve got tomatoes and cucumbers growing in solution-filled buckets, using a technology called “deep water culture”. It’s surprisingly easy, fruitful and entertaining– a way to experience the future of farming firsthand.

John Mooney’s Bell, Book and Candle restaurant is helping to pave the way to a more sustainable and tasty food future. While the farm-to-table movement is still in a stage of advent, hydroponics allows chefs like John Mooney to place that farm on a roof or even indoors under grow lights. It’s not the convenience that chefs ultimately love, it’s the thing that gets diners into their restaurants– taste. [images via urban gardens]