Recommendations to

The City of Las Vegas, Nevada

for the proposed

Upper Las Vegas Development Report

2 May 2008

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This report was developed by Rocky Mountain Institute in association with Tate Snyder Kimsey Architects.

Introduction

To accommodate future population growth, the City of Las Vegas is considering the development of 7,600 acres of land north of Moccasin Road. The parcel is currently under the jurisdiction of the United States Bureau of Land Management (BLM). The City plans to nominate land for sale by BLM at public auction. To ensure that the development will be sustainable and commercially viable, the City is developing a land use plan for the area. This report describes the first step toward developing that plan.

On December 6, 2007, the City began the planning process by convening a two-day charrette (or design workshop) conducted by Rocky Mountain Institute (RMI). Participants in the charrette included stakeholders and experts in sustainable community design, energy efficiency, transportation, water, wastewater, stormwater, and green building. The City of Las Vegas is grateful to the participants, who brought considerable energy and talent to find solutions to a unique design challenge. Although there was healthy discussion and debate, there was not always consensus, and therefore the goals and objectives for development of this area as depicted in this report attempt to represent the majority opinions of the group.

Participants

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Goals

The overarching goals of the charrette were to ensure that development of the parcel would:

- Be sensitive to the nearby Paiute community,
- Preserve the integrity of the Las Vegas Wash,
- Protect sensitive paleontological resources,
- Emphasize mixed uses,
- Emphasize energy efficiency, and
- Provide an interface between the built environment and the Desert National Wildlife Refuge.

> According to the U.S. Census Bureau, the year 2000 population of Las Vegas was 478,434, Henderson was 175,381, North Las Vegas was 115,488, and Clark County was 1,375,765. Also, the Census Bureau estimated that between 4,000 and 6,000 people would be moving into Clark County monthly.

In particular, RMI was charged with drafting guidelines for the development of the area based on ideas elicited at the charrette. Those guidelines and associated drawings are contained in this report, and will serve as the foundation of the land-use plan, which will be made available to potential developers who bid on development parcels as they are released for sale over time. Also, to help maintain a site design consistent with the recommendations of this report, the City may maintain ownership of, and easements on, certain portions of the site that are required for public facilities, infrastructure, and rights of way.

This report begins with recommendations that should be considered prior to the transfer of the site in question. It continues with a vision of the site as framed by charrette participants. It then describes specific goals, principals, design ideas, and rough design sketches by charrette participants regarding three issue clusters: urban planning and transportation, energy and architecture, and water and landscape.

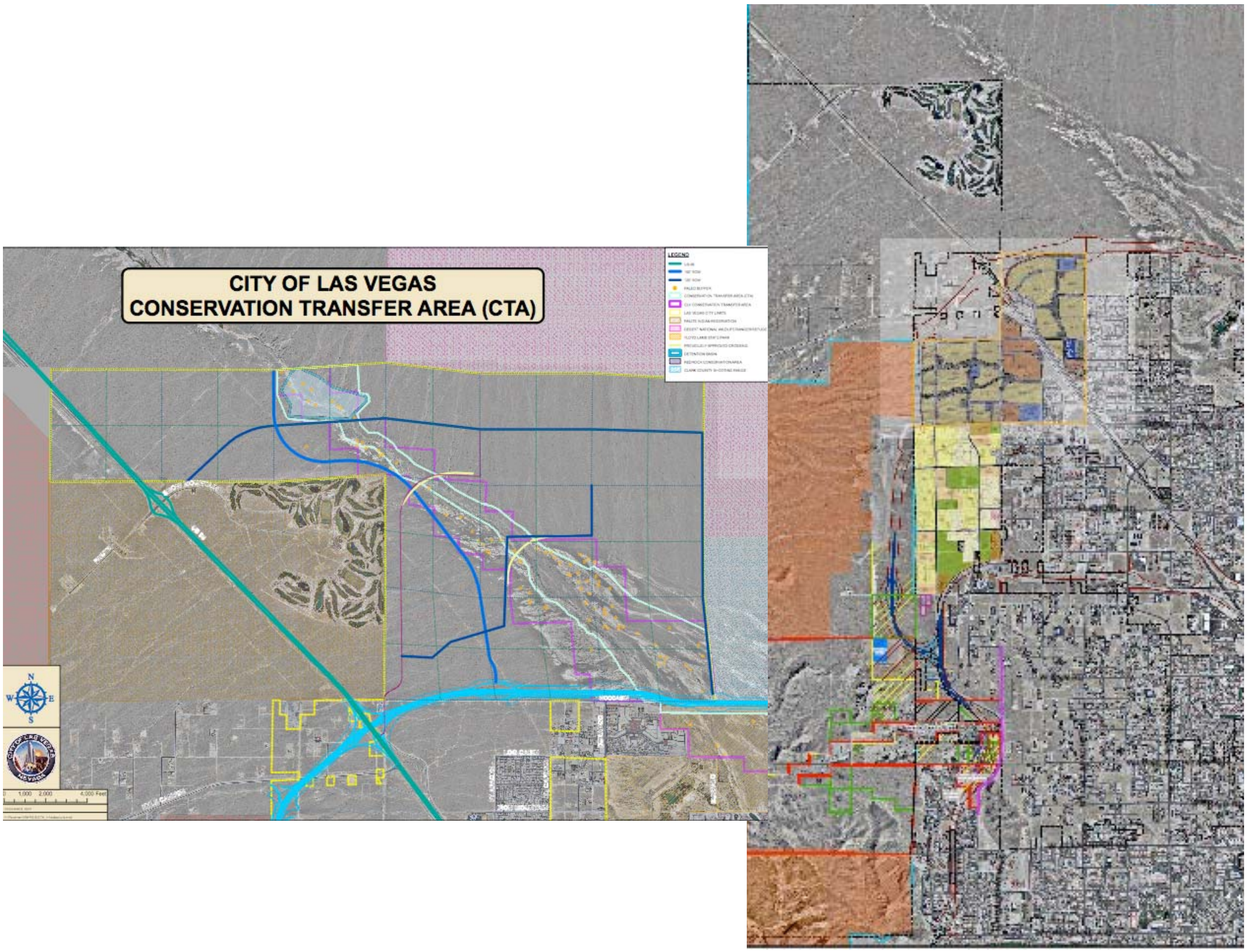


Figure 1: Aerial photos of the site: On the right is the site in the context in northwest Las Vegas. At a larger scale, the photo on the left illustrates the actual site along with the Paiute Reservation, which includes a golf course.

Figure 2: Schematic map of the entire site

Pre-Development Considerations

RMI recommends that the City carefully consider the costs of extending infrastructure and services when determining the future of this site. Nationwide, the costs of public services for an undeveloped site on the urban periphery usually eclipse the tax revenues generated from the new site. The practical fiscal effect of sprawl is generally felt as deteriorating public services in existing neighborhoods or as increased taxes, or both—in effect, hidden subsidies to sprawl. Additionally, developing vacant land on the far reaches of the city compounds heat-island effect, loss of sense of community, ecosystem disruption, and traffic congestion.

As outlined in the smart growth goals and objectives in the Las Vegas 2020 Master Plan, RMI recommends the city quantify the full costs and benefits of developing this site as compared to corresponding costs and benefits of comparable-scale residential, commercial and light-industrial development (infill) closer to the principal employment centers of the City. Las Vegas is achieving many of these objectives with residential, commercial and mixed use development in the downtown area and in mature neighborhoods. A prime example of smart, sustainable growth is the development plan for Union Park in downtown, a national LEED ND pilot project.

Nationally, the best evidence indicates that, as contrasted to sprawl, increasing the density of *existing* communities provides settlement patterns that increase urban diversity, strengthen the feasibility of mass transit, increase community cohesion, and reduce traffic congestion, heat-island effect, ecosystem disruption, and public-service cost per unit, all of which is occurring on a significant scale in downtown Las Vegas.

Once costs and benefits are fully considered and a determination is made to move forward with development of this area, RMI recommends that the Upper Las Vegas area be developed according to the guidelines described in this report.

The City should consider developing the northeast portion of the study area at very low densities, or leaving the area undeveloped, instead concentrating development on the south and northwestern portions of the site. This approach offers several advantages: First, it makes the development more walkable, which increases its financial and social value and its sense of community and reduces its carbon footprint. Second, this approach economizes public-service costs, for example, by eliminating the cost of extending infrastructure across sensitive paleontological areas, where infrastructure costs are unlikely to be recovered through development. Third, it maintains attractive views for residents living in the portions of the site that are developed, increasing the value of these developed areas.

Using Las Vegas Wash as a natural border to development makes geographic sense and will help protect the environmental and paleontological resources of the Wash, and the National Wildlife Refuge beyond. Finally, concentrated density in the southwest portion of the site will increase community interaction, creating a more vibrant community.

The Paiute Tribal Chair and consultants provided valuable input during the charrette. The immediate proximity of the Paiute Reservation to this site and the apparent intention of the Paiutes to further develop the Reservation are compelling reasons for the City to continue coordination efforts with tribal leaders. Coordination efforts should include integration of land use and infrastructure plans. This could be accomplished early in the planning process, for example, in a charrette intended to integrate uses and infrastructure on both sites.

Additionally, the City should scrutinize transportation strategies in which car and truck movement takes precedence over neighborhood quality. The development should reserve a multi-use park-and-transportation right-of-way adjacent to the Las Vegas Wash, and avoid a large (six- or even four-lane) highway in this location that will significantly deter walkability within the community, add noise, reduce the value of nearby homes, and encourage more traffic. Alternative transportation options are outlined in this report.

To be a model for other communities and to ensure compliance with the City's environmental goals, this proposed development should consider national green guidelines, such as LEED-ND and LEED for Homes, which are third-party certified.

In the past, well intended green developers have created and built meritorious developments in many parts of the country, but have ignored the long-term governance of their sites. In effect, they complete their work, assume that inhabitants will carry on their green objectives, and move on, which has led to unfortunate and unsustainable results. In contrast, wise development of this unusual site would include sustainable governance — for example, permanent guidelines, decision criteria, and regulations created by stakeholders for both the construction phase and permanent habitation of this site. In order for this development to be genuinely sustainable and to carry out the remarkable vision defined by charrette participants, RMI recommends that the City begin the process of sustainable governance before the site is purchased by developers, and continue that process through habitation of the site.

Vision for North of Moccasin

Participants in the December 2007 charrette recommended the following goals for this new development:

- Design neighborhoods to be pedestrian friendly and within walking distance of shopping, schools, recreation, and other community activities – situate the needs of daily life within walking distance of one another.
- Design environmentally friendly flood protection.
- Partner with the community and neighbors, especially the Paiute Tribe.
- Generate all electricity consumed on site, which may or may not be connected to the electrical grid.
- Make water efficiency a community priority. Require little or no *net* public water supply. Capture and use rainwater on site. Provide efficient or no irrigation, and use native plants and exotic plants that are compatible with the ecosystem. Reuse water that comes to the site several times
- Protect and celebrate the environmental and paleontological value of the Las Vegas Wash, making these aspects paramount to the design of the development and the lifestyles of the residents.
- Design for diversity, sense of community and sense of place.
- Connect people to nature and, in particular, to the site's unusual ecosystem.
- Provide contiguous native habitat, connected to the neighboring wildlife refuge.
- Provide multi-modal transportation throughout the community and access the city core with extensive public transportation.
- Protect ecological, cultural, and paleontological resources of Las Vegas Wash by:
    - Clearly and creatively defining wash boundaries to prevent destructive human activities in the wash,
    - Educating residents regarding the value of these resources, starting with the earliest development-design stages, and including in sales materials, and school curricula.
    - Incorporating their protection into all community governance and decision-making, including municipal codes, neighborhood-association governance criteria, and home-owners-association rules.
- Preserve aesthetic values.
- Market the financially attractiveness of sustainable design so that developers will want to use it in future development.

Charrette participants also regarded the following goals as important:

- Define goals and set targets to minimize carbon footprint over time, eventually achieving zero carbon footprint (maximizing passive energy solutions)
- Minimize the water footprint
- Provide attainable housing
- Achieve architectural identity unlike the typical Las Vegas speculative housing
- Follow LEED or other comparable energy-performance requirements, (rather than prescriptive technology-oriented requirements)
- Provide ample parks

Participants in the December 2007 charrette divided into three breakout groups that focused on:

- Urban Planning and Transportation
- Energy and Architecture
- Water and Landscape

The balance of this report describes their topic-specific goals, principals, design ideas, and rough design sketches.

Urban Planning and Transportation

The Las Vegas Planning and Development Department and Public Works Department have made a number of excellent steps in their efforts to improve the city. They emphasize accommodating multimodal transportation, including Bus Rapid Transit and commuter bike trails. Based on the ambitious goals generated at the Upper Las Vegas Development Plan Charrette, the city is poised to comprehensively and effectively address difficult planning issues in Las Vegas. The adoption of the following recommendations will produce a regionally significant development model that addresses the issues of urban sprawl and limited ecological resources.

The recommendation for development of this site is to create two to four distinct, walkable, mixed-use villages — rather than uniform-density urban sprawl — on the south and west nodes of the site. Also, to preserve mountain views, minimize impact on nearby wildlife areas and paleontological resources, and avoid excessive cost and damage created by infrastructure crossing the Wash, the northeast node would remain open space, or if developed, a plan for low density development should be prepared for this site.

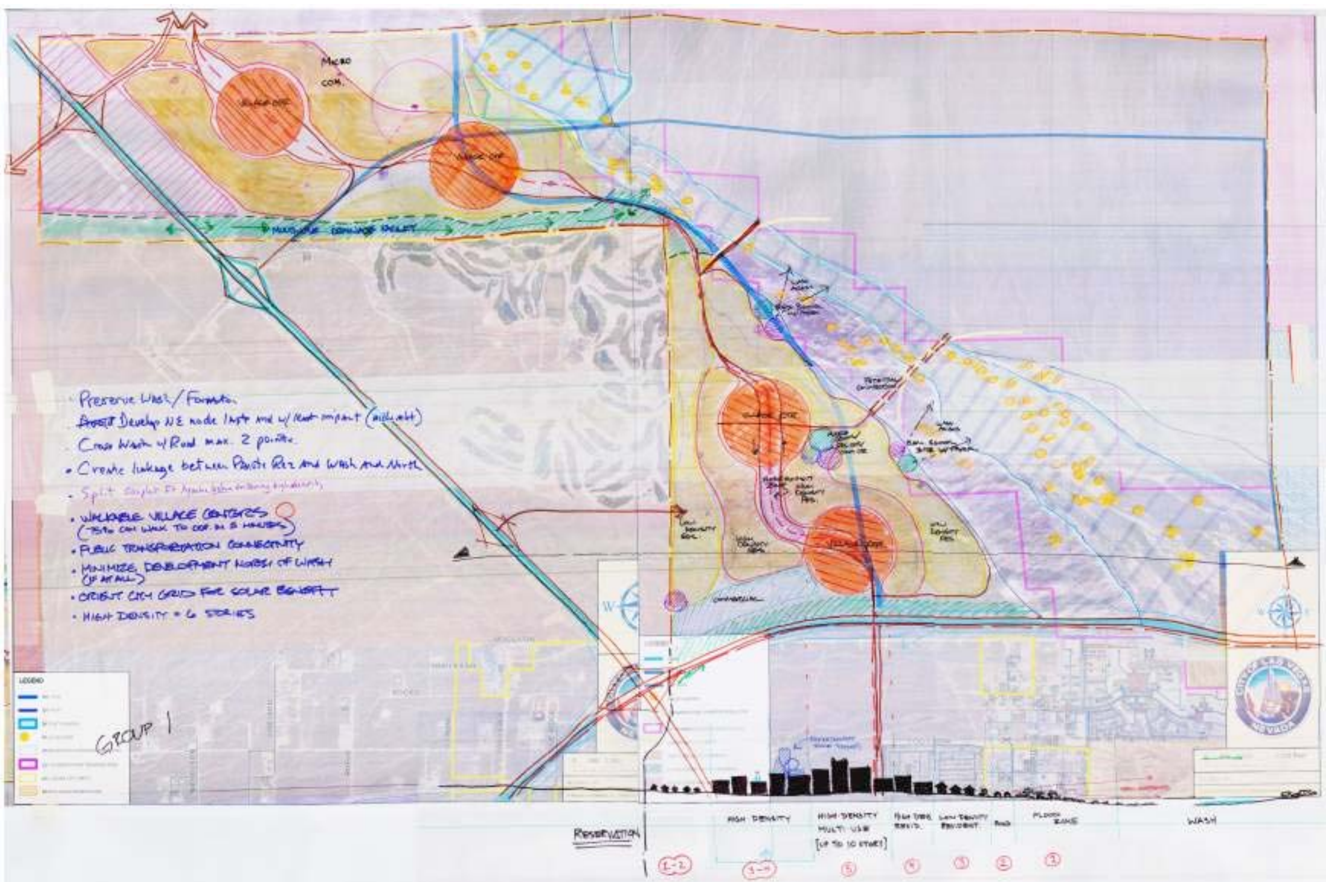


Figure 3: Conceptual Plan for the Entire Site including west node (upper left), south node (center) and northeast node (upper right)

Together, the villages should create an independently viable urban area – a city within a city – that will serve residents' primary needs for habitation, recreation, employment, commerce, and primary education. Additionally, the development's commercial center should serve as regional center, attracting visitors from surrounding areas.

The urban fabric should be diverse, dense, and low-rise (generally less than five stories). Residential typologies should range from detached single-family houses to mid-rise apartments, but should emphasize attached low-rise, high-density in and around village cores. Though we've not performed a detailed analysis, we estimate the site density should average approximately ten dwelling units per acre, which would include significant areas of open space (especially the northeast node), residential neighborhood densities at about ten dwelling units per acre, and densities in the village core densities at 30-40 units per acre.

To create a diverse and visually interesting urban fabric, lots should be sold individually, not in large tracts. Larger developers could be offered packages of individual lots dispersed throughout the development. The city should consider retaining the "master developer" role. Additionally, special zoning-code districts will have to be developed to allow and promote this type of urban development.

To ensure that sacred lands, view sheds, and access corridors to the Wash are preserved; and to ensure compatibility with land uses on the Paiute Reservation, include the Paiute Tribe as a key participant in development planning. The northeast corner of the Paiute Reservation is a "pinch point" on the development site that could complicate achievement of goals related to transportation and the natural, paleontological, and anthropological aspect of the site.

Finally, we recommend that the City design the site using preeminent designers of dense and diverse urban areas in the fields of transportation and urban planning (recommendations included in appendix).

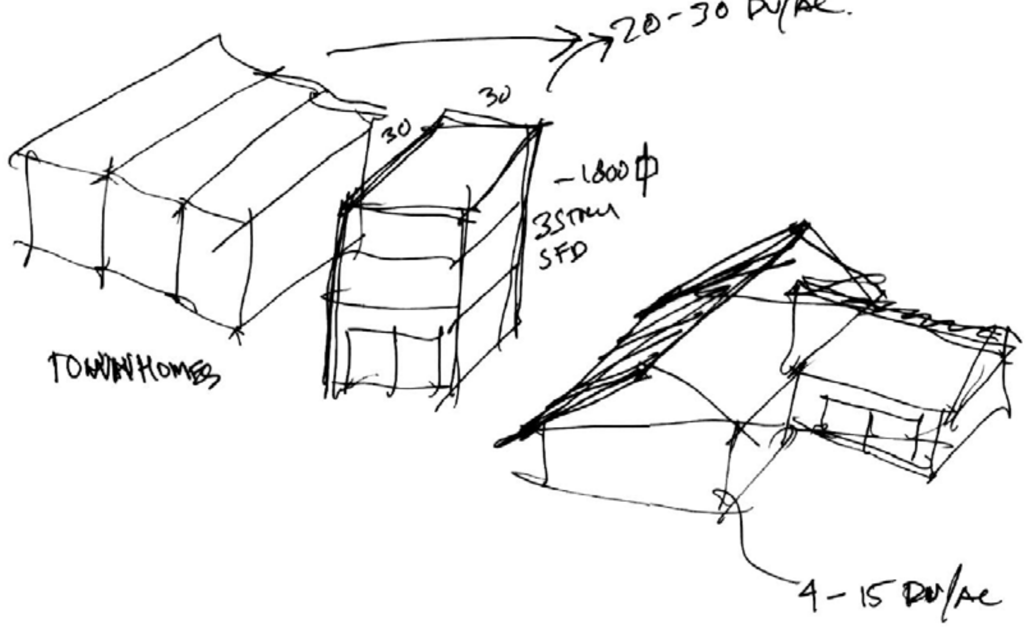


Figure 4: Representative levels of density for the development

Figure 5: Locations of different density levels in the south node of the site

Design Principles for the Site:

- In each village center, create a village square served by bus rapid transit or light rail and located within a 20-30-minute walk of virtually all residents
- In medium-density residential areas, include neighborhood squares with small-scale mixed-use retail served by bus and pedestrian/bike corridors and located within five-minute walk of all residents (1/5 mile).
- Limit building height to six stories in village centers with density gradually declining radially from the centers.

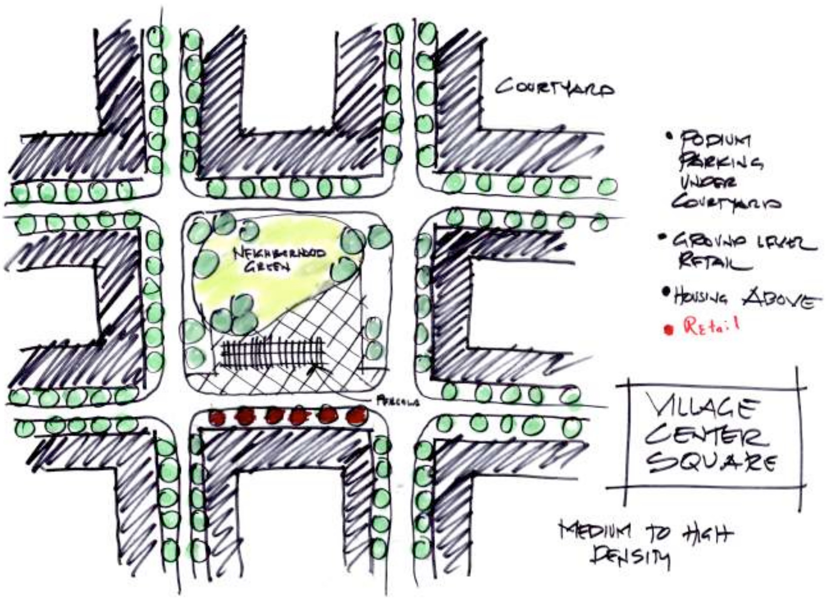
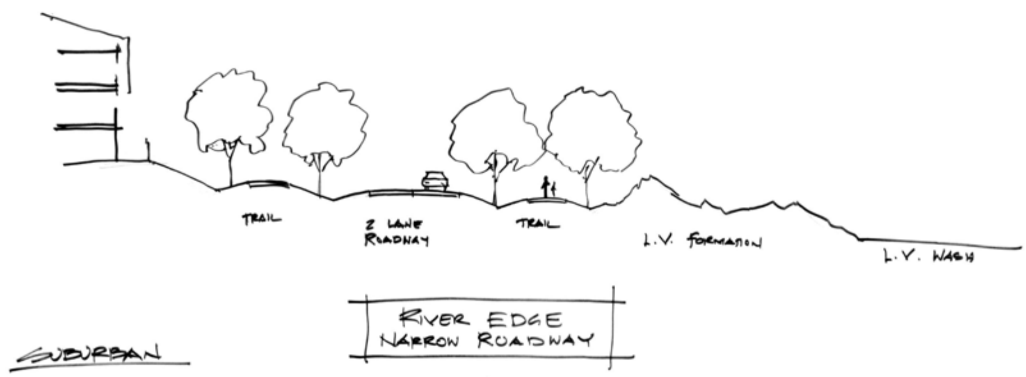


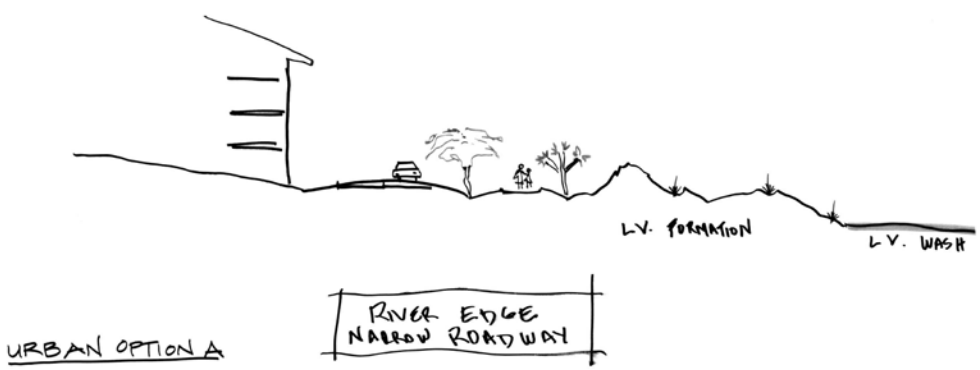
Figure 6: Village-square concept

- o Locate all residential, retail and institutional uses, and park-and-ride facilities, to maximize walkability and minimize use of automobiles.
- o Ensure walking safety in neighborhoods with traffic-calming elements, and design walking and biking paths to be safe and shaded (consider PV or locally-adapted vegetation to provide shading).
- o Minimize impact of development on the northeast node. It is recommended that this be accomplished by concentrating all expected density on the other two nodes or by acquiring another BLM parcel north of the west node that would be developed instead of the northeast node. However, if development is to take place on the northeast node, buildings should have very low visual, dark-sky, and infrastructure impacts, Accordingly they would draw upon a smaller niche market.
- o Ensure diversity by including permanent affordable housing and local business space in all villages and neighborhoods, and by avoiding exclusive and gated neighborhoods.
- o For economic sustainability, create employment centers within the development.
- o Develop public transit, light rail or bus rapid transit, along the village-center corridor and connecting to downtown Las Vegas, the Paiute Reservation and Kyle Canyon.
- o Transform the basis upon which roads are constructed in the development: Rather than building roads to transport automobiles as quickly as possible, design roads to be places for people that integrate (rather than accommodate) multiple forms of transportation.
- o Design multimodal transportation as interlocking transit grids (bus, automobile, bike, pedestrian, and equestrian) providing each transit mode effectively—sometimes separately, sometimes integrated— rather than adding alternative transportation facilities to an auto-dominated design.

- Prioritize transportation modes by first establishing safe paths for walking and biking; second, providing rail or bus rapid transit, and then providing traffic-calmed automobile access.
- Create a hierarchical transportation design such that biking time to the development's center is shorter than driving time (counting parking), and that driving time to the development's center is shorter than driving time to other regional centers. By calming (slowing) traffic and providing limited parking (and charging for the true cost of parking), the commercial core will attract pedestrians (and enhance their safety), increasing its liveliness and success, will be accessible to a larger demographic, and will make alternative transportation a viable and popular alternative to the private automobile.
- Use "dispersed" rather than "arterial" street layouts, per the following description:
  - Dispersed street layouts (typically found in inner cities) form a grid of streets that provide multiple alternate routes and tend to
    - Slow traffic speed and
    - Support safe, multi-modal transportation
  - Arterial street layouts (typically found in conventional subdivisions) combine relatively minor streets, collector streets and major arterials, tending to encourage
    - Through-traffic rather than destination traffic, and
    - Wide, centralized, high-speed main roads

- To optimize auto alternatives, minimize parking except at park-and-ride facilities. Reduced parking increases space for private development and such public amenities as bigger sidewalks, bike parking, and landscaping, rather than storing of private vehicles on public land.
- Design trails to avoid conflicts among pedestrians, bikes, and horses.
- Landscape and shade walkways using plantings, shade structures and photovoltaic panels.
- Minimize infrastructure intrusion into the Wash; cross the Wash with infrastructure only if and where absolutely necessary, at a maximum of two locations.
- Consider including industrial uses on west node in the vicinity of the highway.
- To preserve Paiute tradition, create a means of access, from the northeast corner of the Paiute reservation, to the Wash and areas north of the Wash.
- Define the boundary between development areas and preservation areas of the Wash to preserve the paleontological and ecological features of the Wash, and to minimize flood danger.
- Ensure that development adjacent to the Wash boundary is largely public uses, for example, trails (pedestrian, bike, horse), parks, and schools. In some sections of the boundary (e.g. northeast corner of Paiute Reservation), the public use may be a roadway
- Locate some schools on the Wash boundary in order to develop an appreciation for the Wash among students.





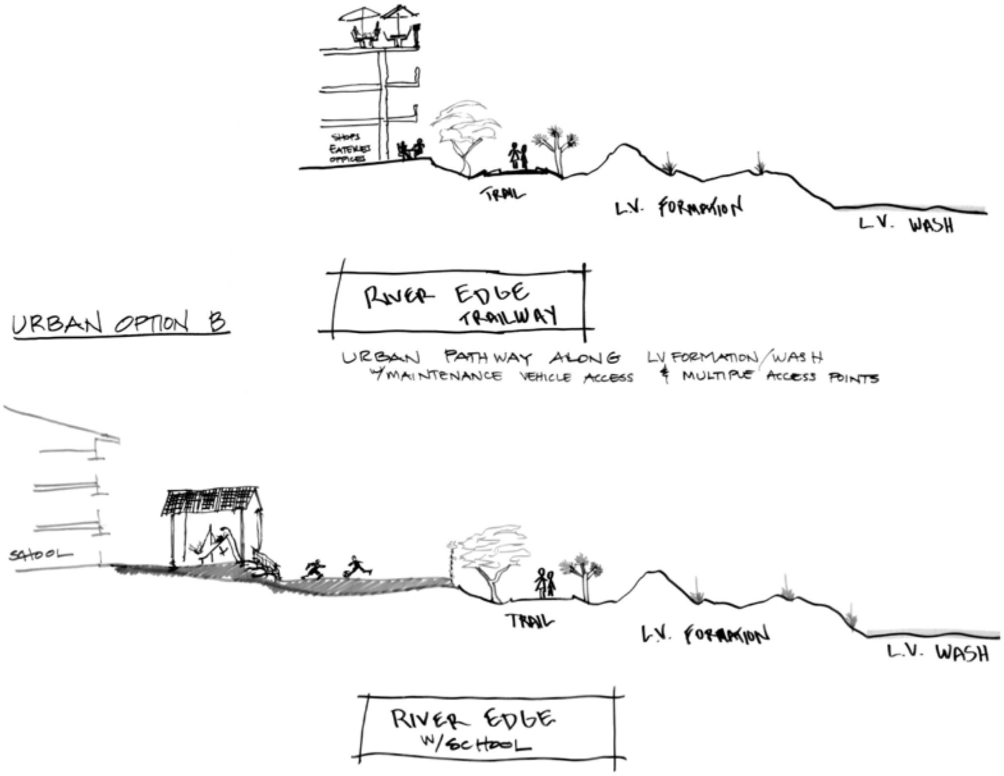


Figure 7: Edge design could vary along the length of Las Vegas Wash

- o Design the principal roadway as a boulevard with four traffic lanes and possibly two back-in diagonal parking lanes, and with a substantial median strip that serves as pedestrian sanctuary, traffic-calming device, and landscape corridor. This boulevard will likely be an extension of Fort Apache Road. To accommodate immediate and potential future public needs (for pedestrian and bicycle trails, open space, potential roadway expansion and other public uses) reserve 150 feet for this right of way.
- o Design the secondary north-south roadway (to the west of Fort Apache) as a two-way boulevard with two back-in diagonal parking lanes, but with two traffic lanes.
- o Size the roadways based on traffic calming and estimates that account auto-use disincentives, including public transit and walkability of the site's design (refer to Appendix B).
- o Where the principal roadway (Fort Apache) nears the Paiute Reservation, consider elevating the road to create under-passes for wildlife and drainage.
- o Scatter parks throughout residential areas and along the Wash.
- o Use native vegetation and well adapted, non-invasive exotic plants in landscaping.
- o Design all exterior lighting on the site to preserve the darkness of the night sky.

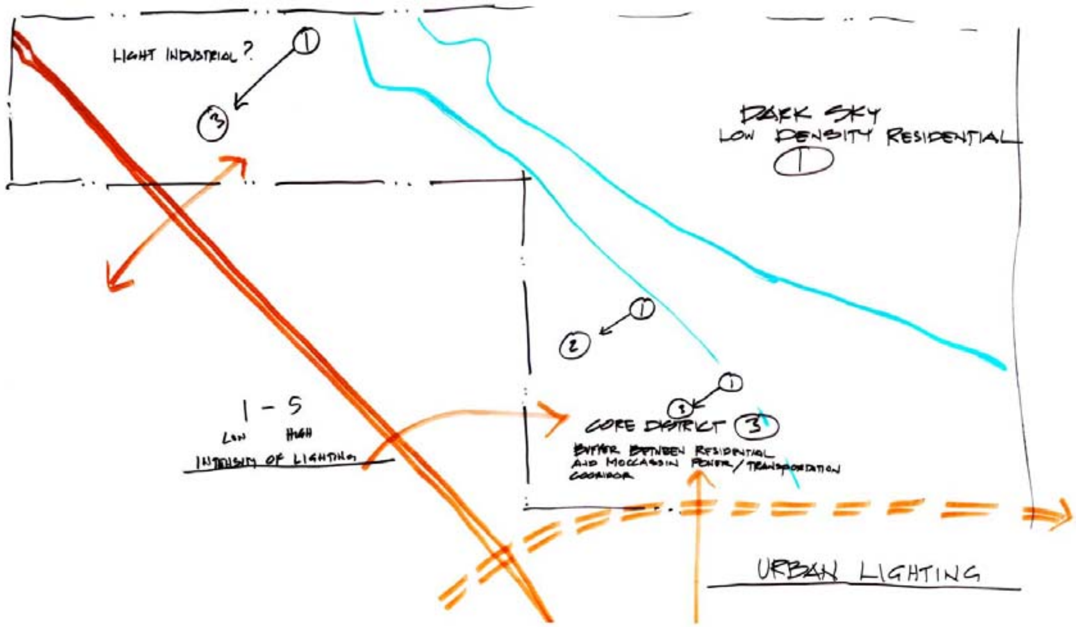


Figure 8: Lighting levels should be different in different part of the site

- Phase development, starting with the south node.
- To optimize solar orientation, while providing summertime wind-current flushing of streets, orient the transportation grid orthogonally rotated fifteen to twenty degrees west of due north (see Appendix B).
- Design streets to be as narrow as acceptable in order to increase shade and calm traffic (but orient them such that houses can gain solar access to rooftop solar systems).

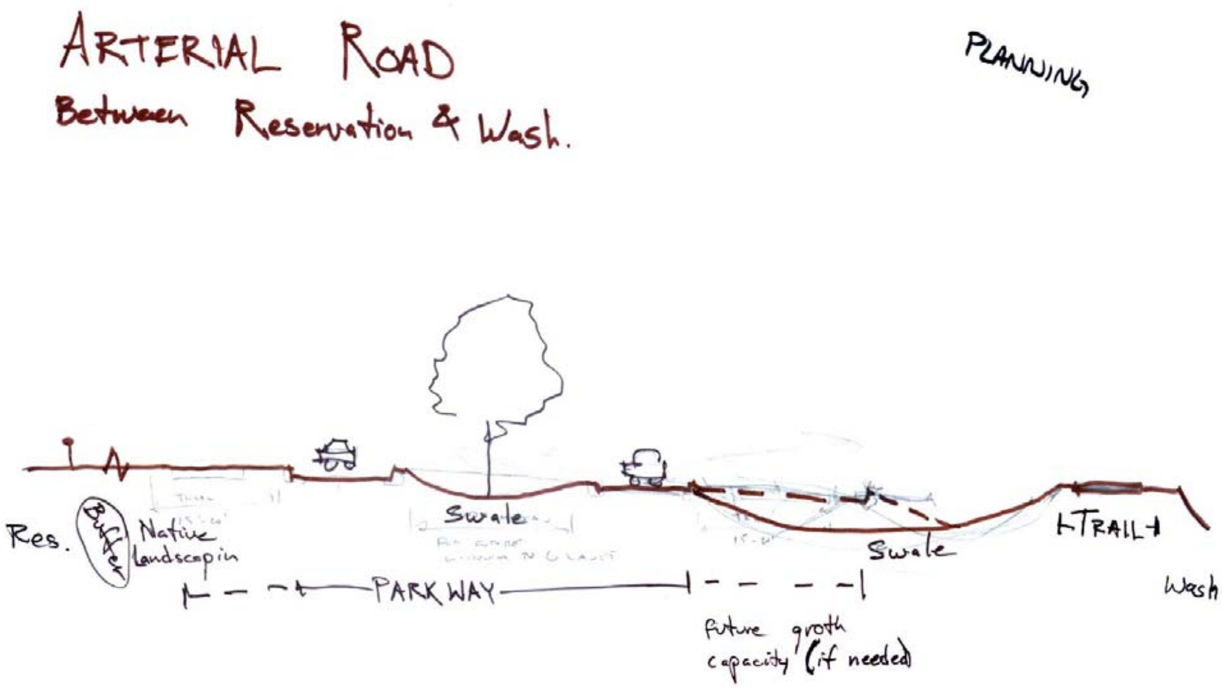
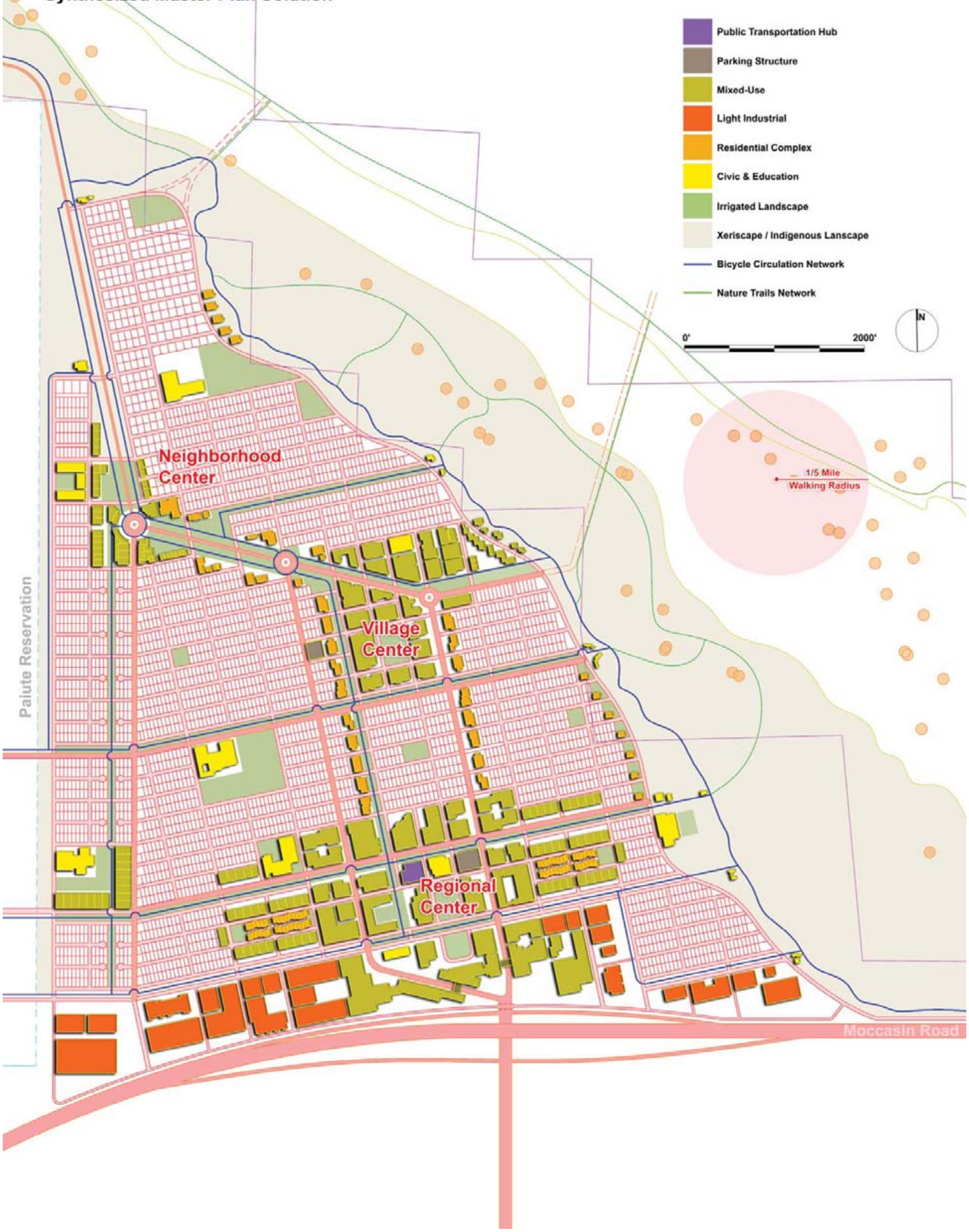


Figure 9: Roadway option at the pinch point between Paiute Lands and Wash

Detailed design of the site should include particular attention to the key "pinch point" of the site at the northeast corner of the Paiute Reservation. This pinch point provides for wildlife movement and traditional access to the Wash by the Paiutes and will also need to accommodate multi-modal transit options. Therefore, the entire corridor should be set aside as public right of way to allow for a creative and sustainable design that achieves these objectives. For instance, a low-speed two-to-four lane road with walking and biking trails could accomplish this objective.

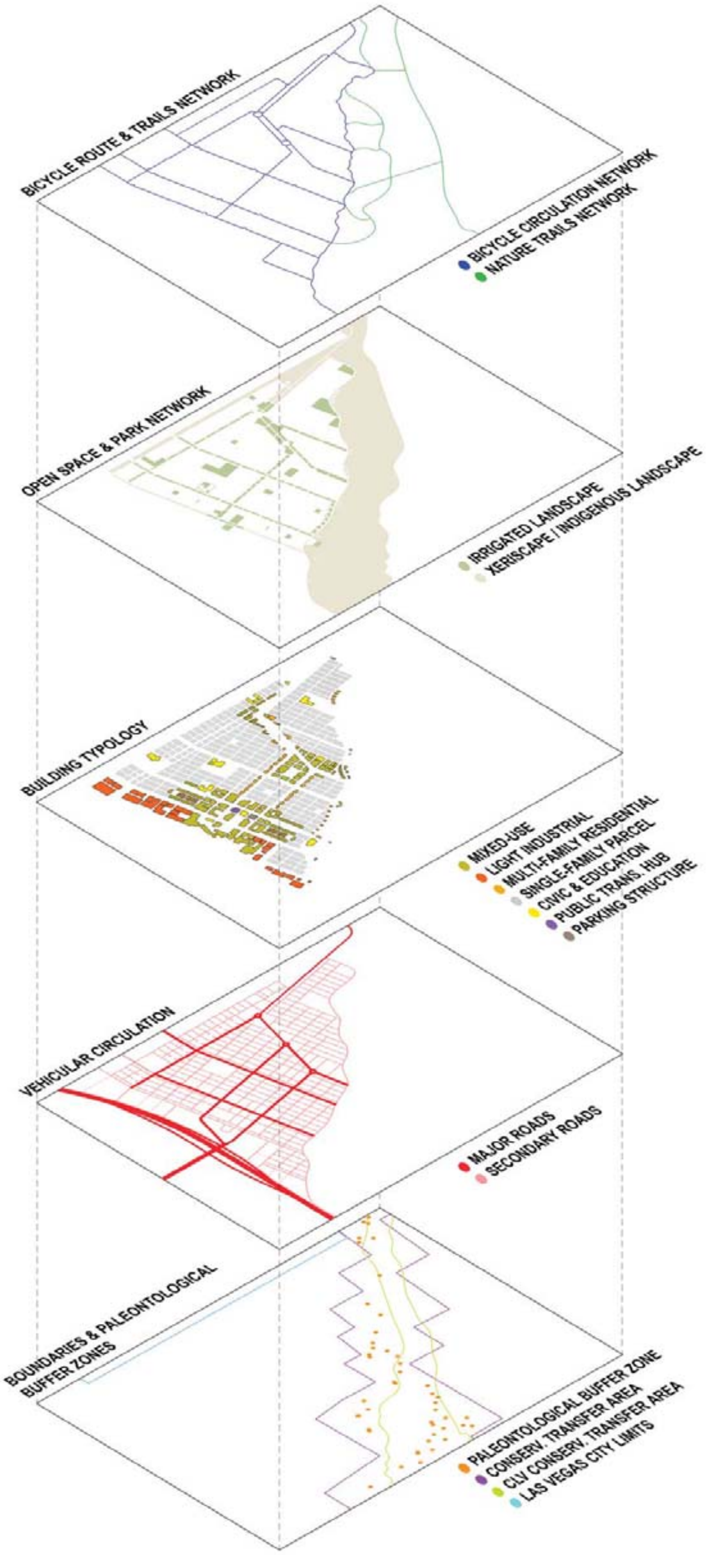
Plan Diagram

Synthesized Master Plan Solution



Land-Use Breakdown Diagram

Synthesized Master Plan Solution



Bicycle Route & Trails Network

Through an integrated greenway, a hierarchical transportation design enables commuter bike travelers to reach the heart of the business districts in less time than by using vehicular surface streets. In addition, multi-use parks and publicly-accessible walking and biking trails along the Wash strengthen its function as a boundary.

Open Space & Park Network

The SMPS provides residents with a multitude of connections to the neighboring wildlife refuges and contiguous native habitat via an integrated greenway belt that permeates the development. A mix of irrigated landscape and xeriscape / indigenous landscape, the greenway integrates natural systems deep into the master plan's developmental footprint. The belts control the flow of stormwater runoff toward the Wash, while purifying the runoff via constructed swales and wetlands. Moreover, recreational parks are scattered throughout the residential districts and along the Wash.

Building Typology

An overarching recommendation from the charrette was to develop two to four distinct, walkable, mixed-used business districts. The SMPS plans for three – each varying in scale and offering a diverse choice in housing and amenities. The districts are designed to stand as independently viable urban areas – cities within a city – that will serve residents' primary need and more. The number of stories within the districts will decrease as one travels away from the district's core. Beyond the districts, the development will primarily feature single-family units.

Vehicular Circulation

Within the development, the principal roadway (Ft. Apache) is split (from the Regional Center to the Village Center) into a pair of two-lane, one-way streets before the street enters the Neighborhood Center district. All roadway sizes are based on traffic estimates and were kept to their minimum allowable widths with allowance for expansion where necessary.

Boundaries & Paleontological Buffer Zones

As a result of the consensus to begin development within the southern-most sector of the considered parcel of land north of Moccasin Road, the SMPS only considers this particular region. An overarching recommendation from the charrette was to the Las Vegas Wash as a natural border for all development. As there was strong opposition amongst numerous charrette attendees regarding the development at the northeast sector of the site and to the northwest of the Wash, such development is not considered here.

Land-Use Breakdown

Synthesized Master Plan Solution

Bicycle Route & Trails Network

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Land-Use Breakdown

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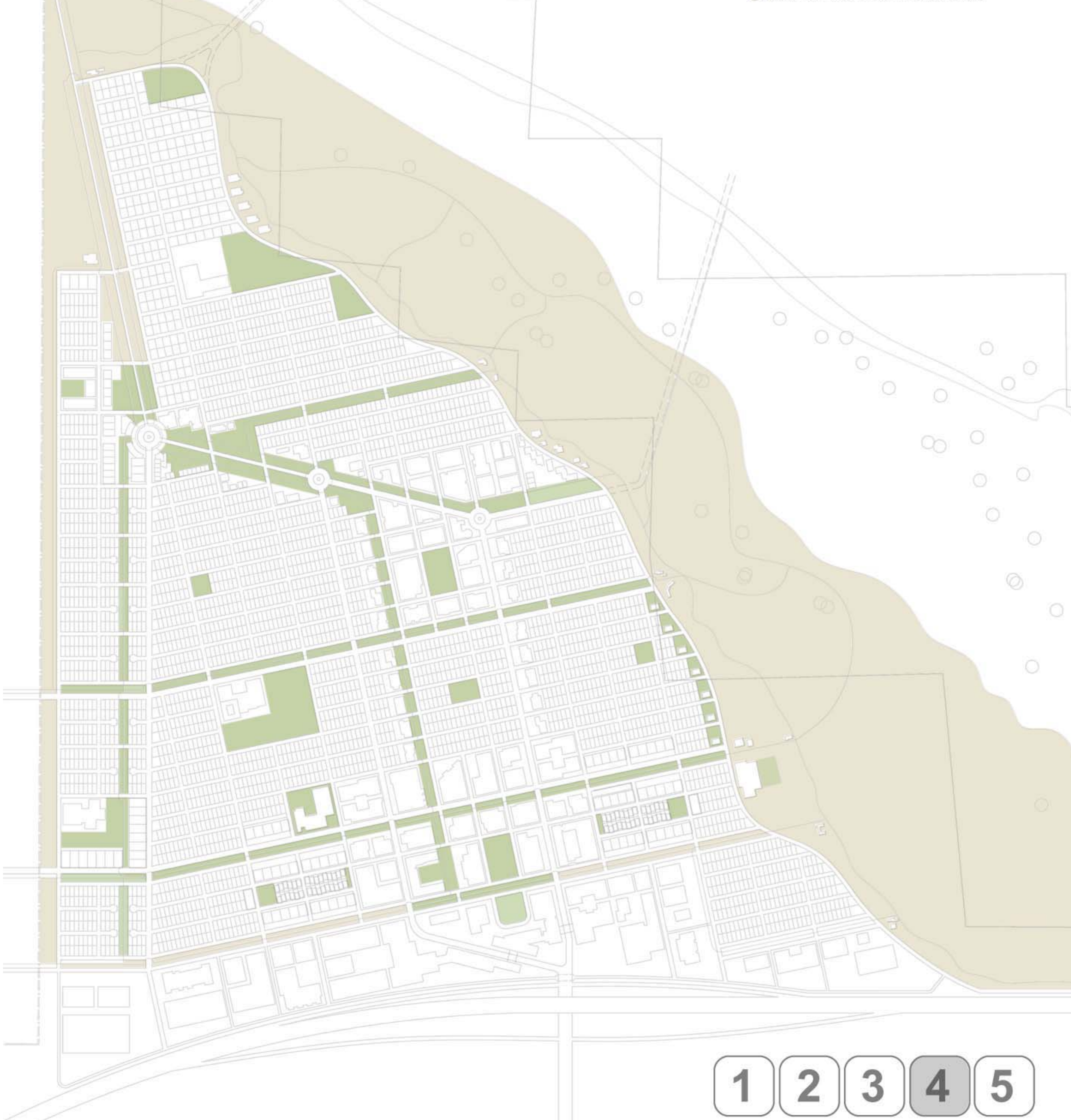

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Land-Use Breakdown

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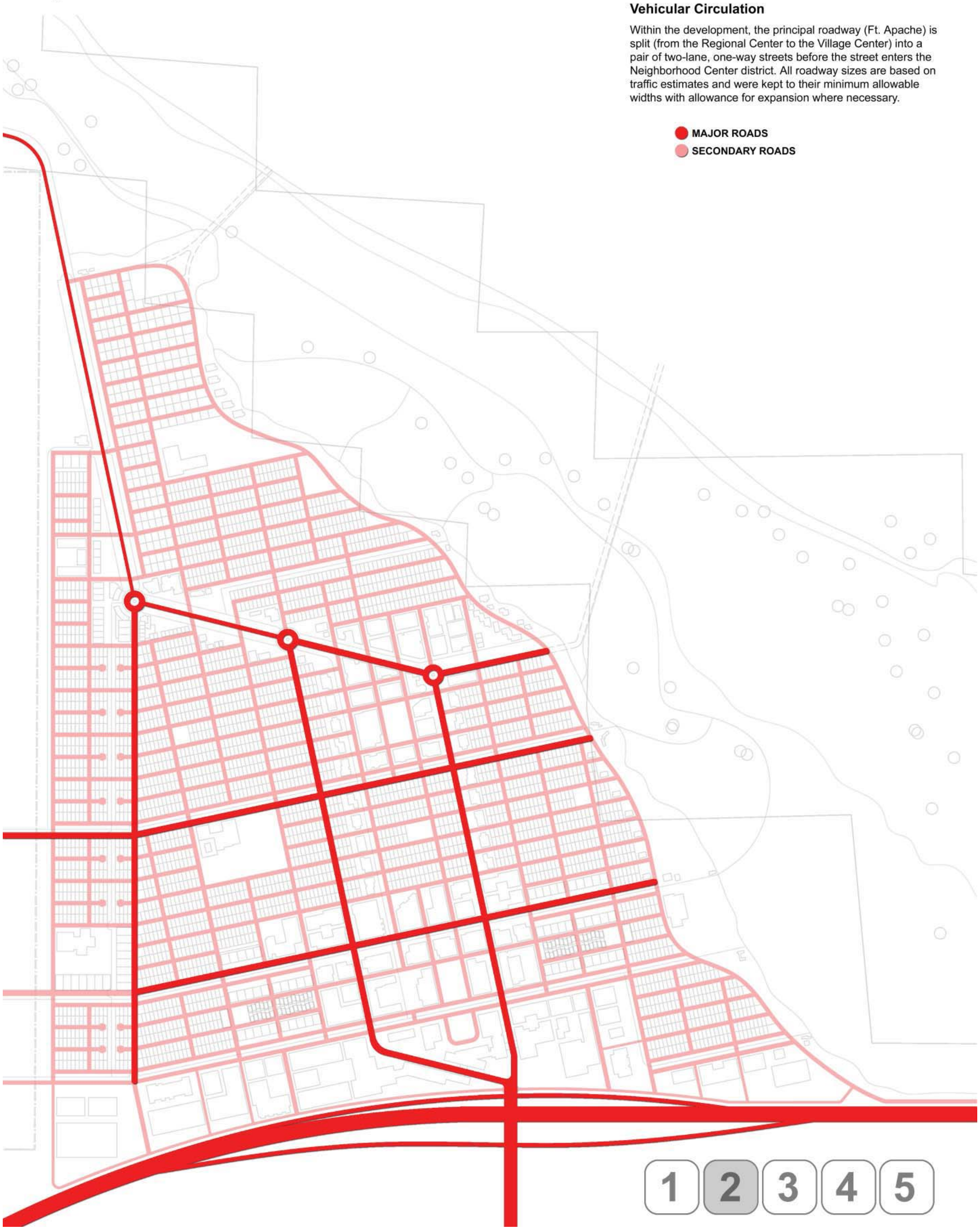

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Land-Use Breakdown

Synthesized Master Plan Solution

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Summary

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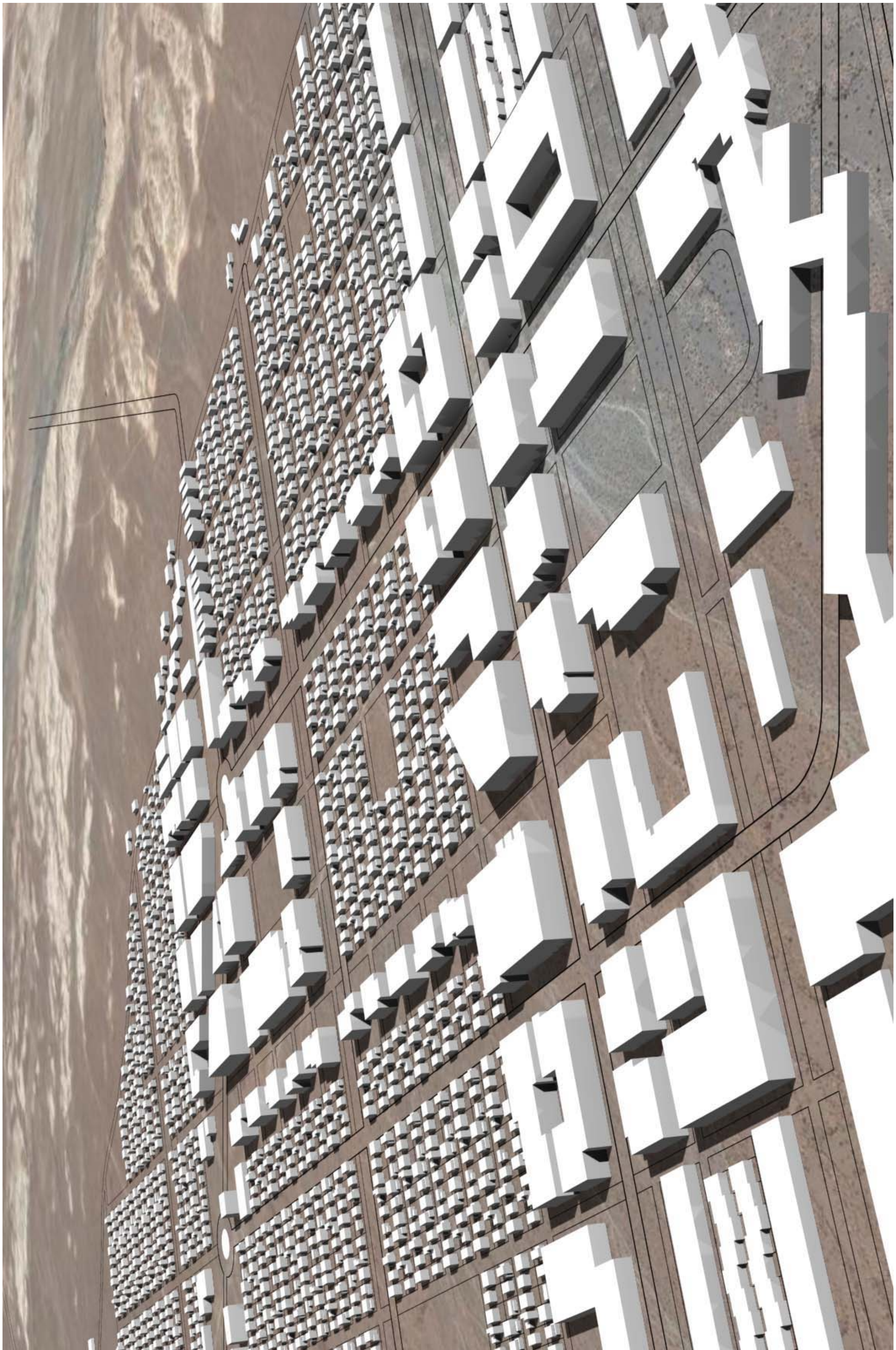

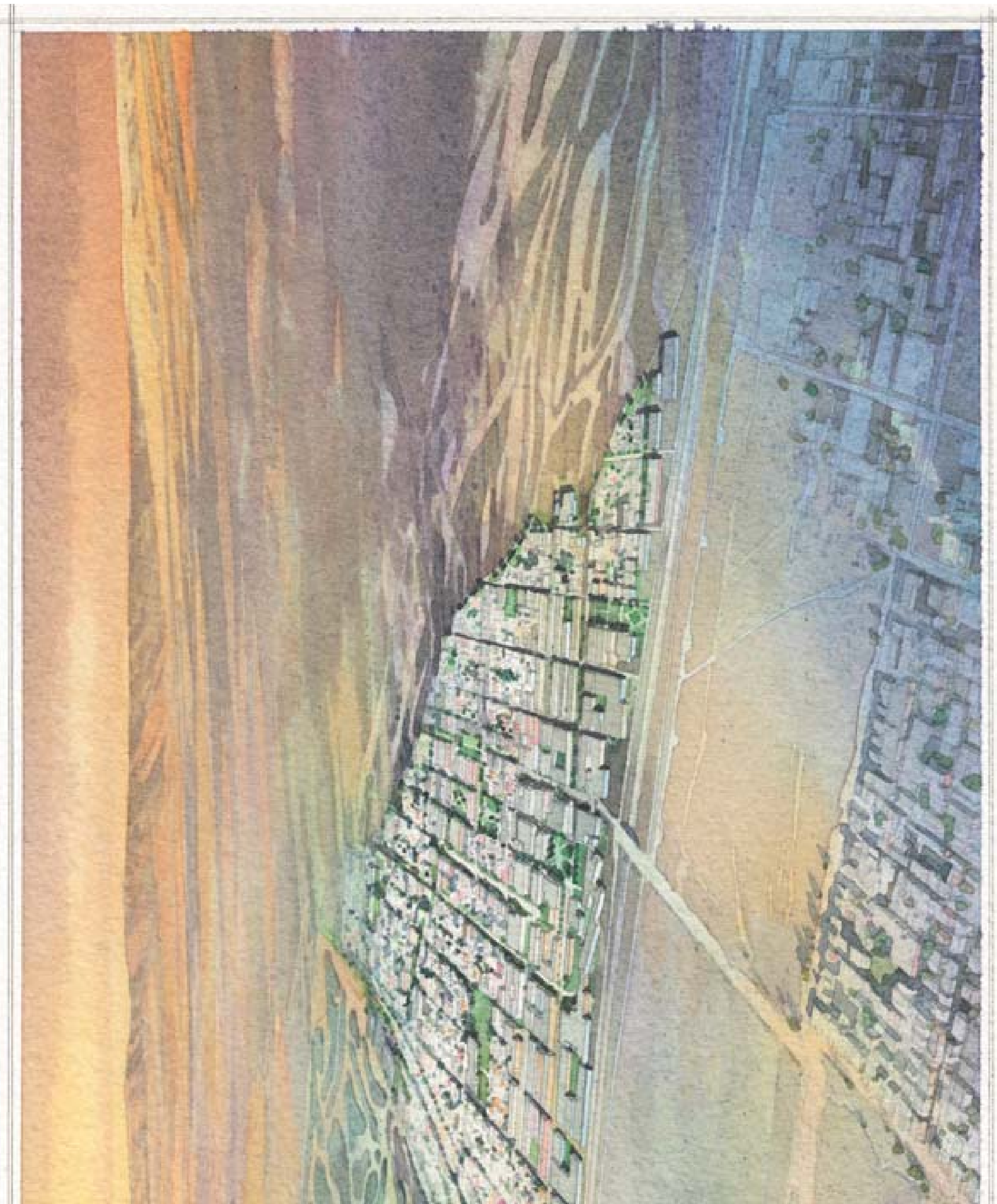

The south node of the site, depicted above, should be densely developed prior to developing other areas of the conservation transfer area. Key design elements of this recommended master plan include:

- The large undeveloped Las Vegas Wash bordered by trails for multiple uses.
- A two-lane road meandering parallel to the trails along the wash with significant buffer space between the trails and the road. In some places, this buffer is filled with housing, commercial (primarily restaurant with some retail), schools, parks, and interpretive exhibits. However, in all cases, the public-access trail is preserved along the wash.
- East-west greenbelts that run through the development and link to the Wash open space.
- Three community centers: A regional center close to the intersection of Fort Apache and North Moccasin roads, a smaller village center in the physical center of the development, and an even smaller neighborhood center to the north.
- Mixed-use development in all of the community centers.
- Industrial development along North Moccasin Road, which includes accessory offices. Note that the "showroom" fronts of the industrial buildings could front on the road parallel to North Moccasin to the north, creating a livelier street, while employee parking and employee entrances should be at the back of the buildings, along North Moccasin.
- Two north-south boulevards with landscaped medians: One is the extension of Fort Apache, a four-lane boulevard (with right-of-way for potential expansion for multi-modal public use) that RMI recommends becoming a two-lane north of the upper neighborhood center. The other is a parallel two-lane boulevard to the west merging into the larger boulevard at a traffic circle.
- Transit centers (which could be express bus stops or rail stops) associated with each of the community centers.

Energy and Architecture

This new development's greenhouse gas footprint should be 80% smaller than the Las Vegas norm.[1] Participants felt this objective was lofty, but could be achieved by setting targets over time for building design and energy efficiency, and by generating clean, renewable power.

Regarding buildings: Their developers will be required to meet this performance objective in any creative way they can, or by following a prescriptive formula, which could be exemplified in experimental and model homes, and which could include energy-efficiency design, daylighting, and passive and active solar. Green building standards, such as LEED or Green Globes, should be required for all development.

Regarding power supply: The greatly reduced electricity demand that results from these building measures can then be fulfilled with such on-site power production as solar electric, solar thermal, and geothermal, and a micro-grid strategy (a local electric grid associated with its own local power generation) that could be developed in conjunction with Nevada Power Company and other utilities. Electric-utility strategies include eliminating substations and using combined cooling, heating, and power for industrial uses. Maps describing the solar and geothermal potential for the region are provided in Appendix A.

> According to the U.S. Department of Energy, the average US home uses 10,656 kWh/year, or 29kWh/day, but energy consumption varies greatly by region. Las Vegas households average about 11,722 kWh/year, or 32 kWh/day.[1] By comparison, Greenpeace states that an average European household consumes, 4,667 kWh/yr[1].

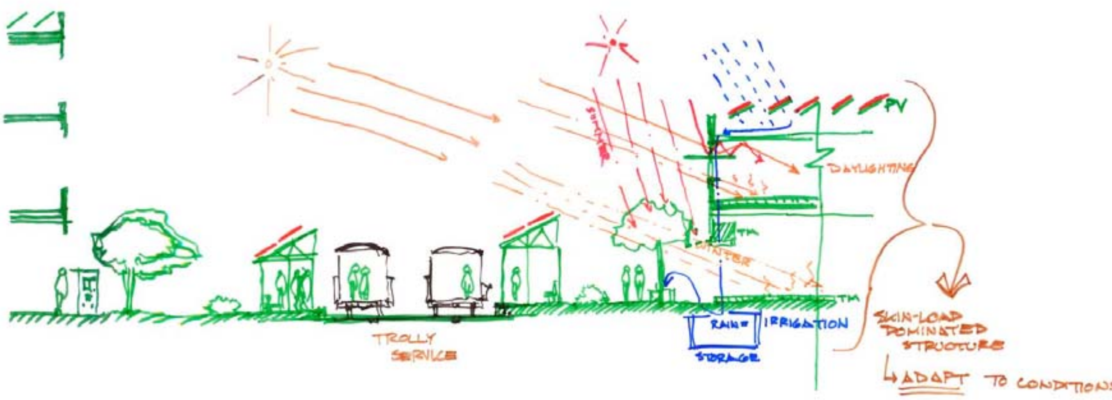

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Figure 11: "Stealth green:" Green design, solar-energy generation and water collection could be integrated into the architecture so that it is relatively unnoticeable.

[1] Examples of such reduction levels exist and are listed in the Appendix

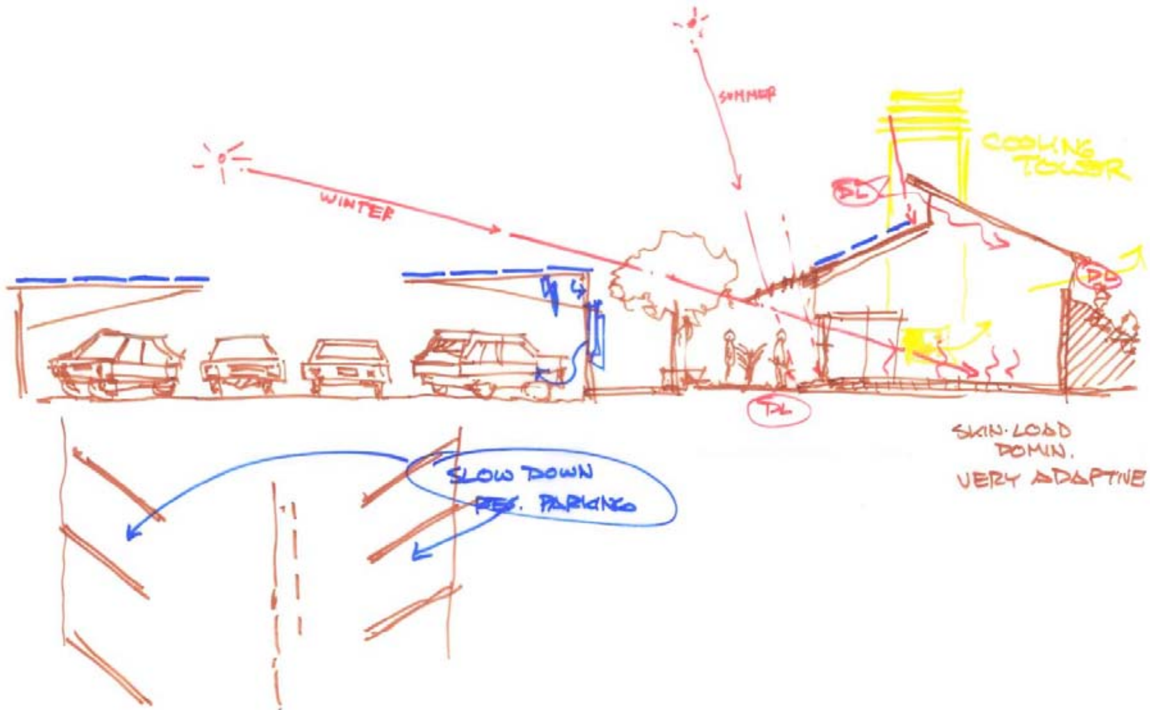

Figure 12: “In your face green:” passive-solar buildings, photovoltaic arrays producing power for plug-in-hybrid-electric cars, and cooling towers would make “green” design very noticeable.

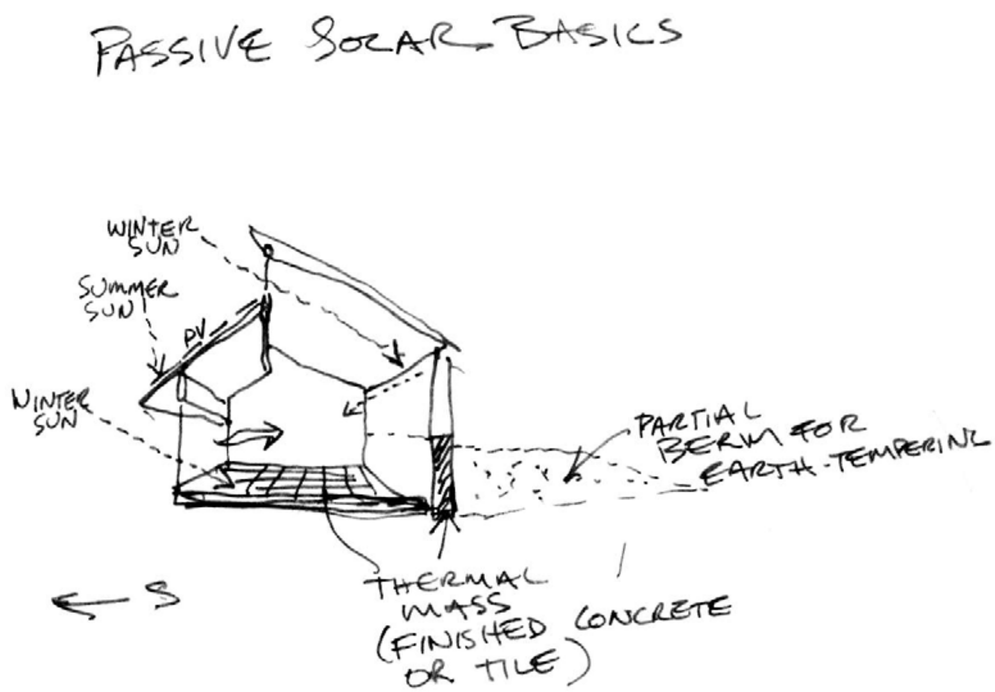

Figure 13: Basic passive-solar design

Energy and Architecture Recommendations

- o Implement basic green building design
    - Local materials
    - Passive solar
    - Efficiency
    - Daylighting
- o Encourage innovation and design creativity by allowing developers, architects and builders to meet performance standards in their own innovative ways, rather than implementing prescriptive standards that require certain technologies that will become outdated. Performance standards should improve over time.
- o Establish a minimum level of energy efficiency
- o Encourage energy self-sufficiency with a community-wide "micro-grid" strategy (a local grid with local electricity production).2
- o Establish a minimum building standard with third party verification
- o Achieve an 80% reduction in greenhouse gas (on-site) footprint. Note that this objective will require exceeding LEED standards with regard to energy efficiency and/or renewable energy production.
- o Design for solar access for all homes and buildings to collect solar energy
- o Implement solar thermal (at least for domestic hot water; solar-water space heating could be optional) on all buildings; bulk purchasing and installation of solar water heating systems could greatly reduce their cost.
- o Minimize waste generated by development and habitation of this site, including construction waste
- o Avoid light pollution: Minimize street and other outdoor lighting. Hood outdoor fixtures to direct the light where it is needed for wayfinding while preserving the dark night sky.
- o Maximize the number of residential units on this site that are permanently affordable
- o Develop designs that are conducive to such future energy technologies as plug-in hybrid vehicles and advanced solar-electric systems.
- o Maximize the efficiency of water use and include the energy required for pumping and treating water in the site's energy budget. Given the significant energy associated with delivering water to the site, reducing water use will also significantly reduce this development's energy use.
- o Orient the site's street grid to maximize solar benefit.
- o Wire all parking garages for plug-in vehicles.
- o Maximize energy efficiency on the entire site, which will reduce the number of electrical substations.

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[2] Connecting its micro-grid to the regional grid would provide North of Moccasin backup and overflow capacity (at much lower cost than on-site backup generation or storage); however, this connection may mean that the micro-grid would be required by the utility to be shut down in the event of a regional grid failure, due to safety concerns. Thus, even when the community's own power supply and grid may be intact, it may not capture the benefit of running during a regional power outage, negating the added reliability advantage of the micro-grid and regional grid combination.

- Based on data from existing city residents, estimate the energy that will be used by site residents for transportation. Then seek ways to reduce that number through site design and with the transportation system that serves it. Then, to achieve a carbon neutral development, offset the carbon emissions that cannot be avoided through efficiency.
- Strive toward achieving a “net zero” metric in the community, in future development stages if not immediate ones. “Net zero” can be defined as zero net carbon emissions (actual emissions minus offset emission credits), or it could be defined as net zero non-renewable energy use (again, any fossil fuel use would have to be offset).

Implementation Issues

With its new-found emphasis on green design and sustainability, Las Vegas is evolving into a greener spot in the middle of one of America’s fastest developing, yet most resource-challenged, geographic areas. From hotels and resorts to school buildings to government facilities, every construction project undertaken in this desert oasis is accepting the green-design challenge. And literally billions of dollars are at stake.

- Las Vegas currently ranks 11th in the nation in green buildings per capita.
- Nearly 50 Las Vegas buildings – including commercial offices, schools, health care facilities, government buildings, a fire station and a library – are LEED-registered.
- The green building craze has affected all sectors of the Las Vegas construction community and is especially evident in the hospitality, education and government sectors.
- With billions of dollars of construction projects currently underway, Las Vegas is in the midst of a building boom that will allocate millions of dollars to the green-building market.
- Las Vegas is developing a well trained workforce in green design and construction that will assure the city’s green design standards are implemented in the built product; the City should continue to prioritize workforce training programs to assure its building energy efficiency and renewable energy goals are met.
- Both design standards (e.g., material specifications, building orientation and massing) and construction standards (e.g., erosion control and construction waste recycling) must be implemented. Rating systems are available that address both.
- The City should develop protocols for measuring performance towards achieving energy- and CO2-related objectives. Base the protocols on performance metrics for all categories of energy use. Seek verification by a third party
- The City should develop model homes that demonstrate efficacy and marketability of energy goals, and experimental strategies.
- The developer should pursue this site’s energy goals and objective in coordination with Nevada Power
- The City should document the employment effects of its energy-efficiency and renewable-energy goals in order to demonstrate the economic-development value of these strategies.

Design Details for the 80% Greenhouse Gas Reduction Goal:

Reduce the energy demand 50% through:

- o Efficient, climate-appropriate design of buildings and building systems
- o Passive and active building-integrated solar systems (enabled by protected solar access).
- o Achieving the remaining greenhouse-gas- footprint reduction with district solar-electric (photovoltaic or "PV"), concentrated solar power (CSP) plants, geothermal power, or other clean, renewable electricity production technologies. (See Appendix A for discussion of these technologies and their applicability to Las Vegas.)

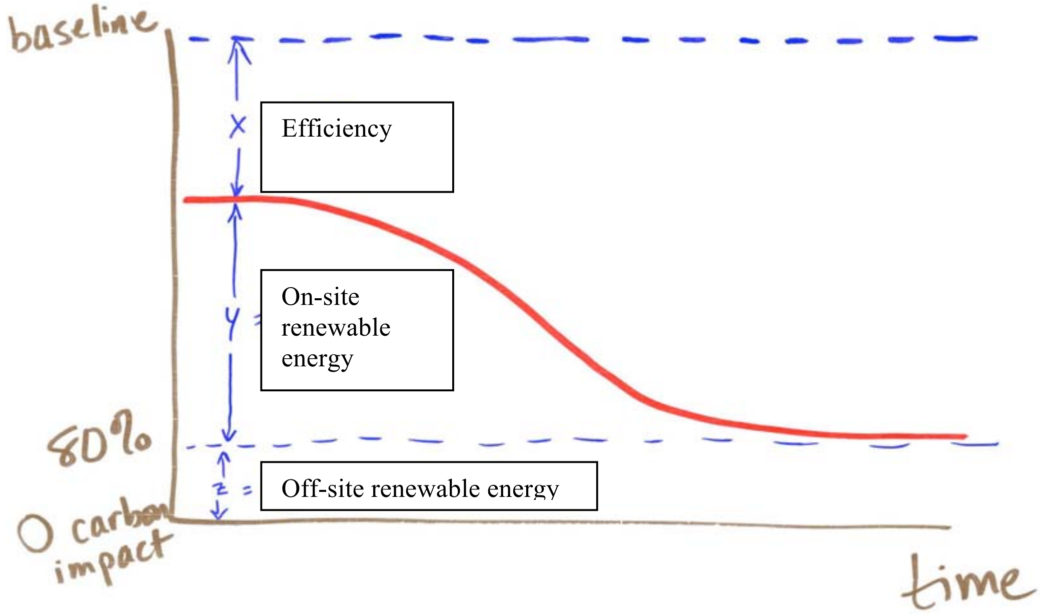


Figure 14: This graph shows that for homes built right away, efficiency may meet a 50% reduction in fossil fuel energy use (compared to Las Vegas average). An additional 30 to 50% reduction could be achieved by using primarily on-site, but possibly some off-site renewable energy sources. As energy efficiency technologies improve over time, future homes would require less renewable energy production to meet the zero-carbon-impact goal. A plan should be implemented to phase in higher efficiency requirements over time, such as requiring 50% better than Las Vegas average now, 65% by 2015 and 80% by 2020. There could also be incentives to retrofit existing systems to meet the new standards over time.

Purchasing traditional renewable energy credits (RECs) does not guarantee that any new renewable power supply is actually developed (one may simply be getting "credit" for existing renewable energy); therefore, we recommend that the developer of North of Moccasin invest in actual renewable energy construction projects, rather than buying RECs, to achieve the carbon offset requirements.

There was significant discussion in the charrette about whether affordable housing goals could be achieved when 80% higher efficiency may require a 10% cost premium. However, the Noisette community in South Carolina provides a successful precedent—it requires that affordable units meet LEED standards; and those units are being built (See Appendix C). Also discussed was whether there is a ready service industry in Las Vegas to affordably support these systems. This challenge should be seen as a big economic development opportunity, considering the large scale of this project. As designs are created, the demand for services can be quantified and mobilized by local and state economic development people.

Energy Supply for the Site

Guidelines

- Reduce the number of required substations from three to one
- Build a combined cooling heating and power (CCHP) station using the savings achieved by eliminating the two substations
- Use renewable sources for the CCHP plant, such as solar thermal, geothermal or biomass in order to meet the net-zero carbon target.

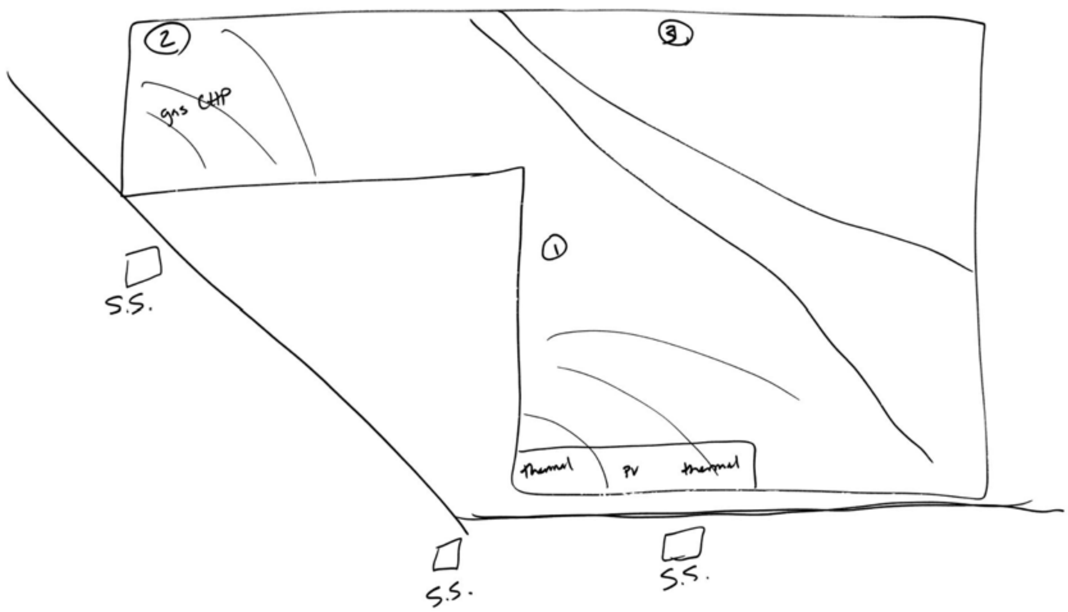


Figure 15: Recommended energy supply strategies and development densities in each of the developments three nodes

Recommended energy supply strategies and development densities in each of the developments three nodes (Refer to Figure 15)

- South Node (#1):
    - High-density areas
        - Parking garages covered with solar-electric and solar-thermal equipment, which also shade cars in the upper level of the garage
        - Solar-thermal district heating and cooling loops
        - Thermal cooling to offset twenty to twenty-five percent of cooling demand
        - Brightest outdoor light level
        - Parking spaces in garages and homes include electric plugs where plug-in hybrid vehicles take on renewable electricity and store it in their batteries. Later, when fuel-cell based hybrid-electric vehicles

become available, the vehicles will supply electricity to the grid while sitting in the garage.

  - Low-density areas
    - Solar electric and solar thermal water heating integrated into buildings
    - Darkest outdoor light level
    - No buildings near transmission lines

- West Node (#2):
  - Light-industrial areas
    - Gas-fired combined cooling heat and power (CCHP)
    - District cooling
    - Brightest outdoor light level
    - Flat-roofs of industrial buildings are sites for solar-electric equipment.
- Northeast Node (#3):
  - Low-density areas
    - Energy-self-sufficient community that is tied to the grid because is sometime supplies power to the grid
    - No substations
    - Solar electric and solar thermal integrated into buildings
    - Darkest outdoor light level

Water and Landscape

Water Use

Limiting the water consumption of a green development in the desert city of Las Vegas is desirable. Targets for water consumption should be driven by compliance with the Southern Nevada Water Authority's Water Smart program, recognized as a leading water conservation model by EPA. Moreover, because pumping water from Lake Mead consumes significant energy, reducing water use will also reduce energy use.

> The average American household uses 100 gallons of water per person per day. Europeans use 37 gallons per person per day. The United Nations High Commission for Refugees estimates that humans *need* a minimum of 7.9 gallons of water per person per day (1.3 gallons for drinking and cooking, 6.6 for hygiene), less than 1/10th the US average.

This reduced demand for potable water could be supplied in several creative ways. One option worth exploring is to use water rights from the Floyd Lamb Park for new development in the area, and, in exchange, supply the pond with graywater. Another approach is to target no net increase in water consumption. This is achieved by water savings both on and off the sites of the new developments through such measures as replacement of inefficient fixtures and water-consumptive lawns — measures well known in Las Vegas, which has plenty of experience with water-efficiency programs.

Resource and Ecosystem Protection

The riches of paleontological and anthropological resources, plant and animal habitat, and the ecological service of flood protection all coalesce with sacred Paiute burial sites in the areas in and around Las Vegas Wash. Today, unauthorized motorized recreation threatens these resources. Therefore, one of the key goals of any intervention on this land is to preserve these resources *better than* they are being protected by current efforts. A related goal is to provide recreation and human connection to Nature in the Wash in ways that are compatible with, and protect ecological, paleontological, archeological, and cultural resources.

Principles

- Protect the Las Vegas Wash (hydrologically, culturally, biologically, and archeologically)
- Implement water-reuse measures
- Connect people to Nature in ways that are compatible with Nature
- Protect the aesthetic values of the unique ecosystem of this site
- Provide wildlife habitat "connectivity"
- Create defensible barriers to protect the Wash
- Design public areas for multiple uses
- Reduce CO_2 production associated with water use
- Create an extremely conservative water budget

- o Focus on water conservation at the small-scale site level to minimize water importation—first reduce use, then reuse graywater, then collect rainwater.
- o Integrate large water-supply systems
- o Design wastewater systems to separate graywater and blackwater; irrigate landscaping and recreation fields with the graywater
- o Disallow misuse of water (such as open-hose car washing)
- o Develop a management and enforcement strategy to ensure compliance with water-efficiency regulations.
- o Consistent with current policies of the water utility, promote lifestyle changes regarding water usage through advertising, slogans, education and monetary incentives for efficiency and conservation.

Policies and Guidelines

Stormwater Goal: No net Qualitative or Quantitative Impact

Principles:

- Design the entire site for stormwater retention
- Reuse stormwater for irrigation
- Use stormwater swales instead of pipes, where appropriate.
- Create multiple-use recreation and stormwater facilities (*e.g.,* ball fields set at a lower elevation that serve to filter stormwater)
- Use porous pavement for non roadway hardscape areas.
- Preserve native vegetation as much as possible and revegetate disturbed areas after construction.
- Manage storm drainage flows with swales, open channels, detention and retention facilities and other best management practices
- Establish municipal requirements for rainwater capture and grey water reuse, such as grey water use for irrigation, and filtering requirements to protect community health.
- Design roads and other hardscapes to capture or infiltrate, and treat micro flows (rainwater).
- Design pubic parks to use stormwater as an amenity.
- Provide underground cisterns for water storage

Water Efficiency Goal: Thirty-seven gallons per capita per day (average European use, even where there's plenty of water)

Principles:

- Set performance standards (but provide examples of prescriptive designs that meet those standards--fixture types, xeriscape landscape, turf limits, etc.)
- Develop awareness of need for and value of efficient use of water
- Create a competitive marketplace by comparing a conventional development to state-of-the-art development
- Create performance-based incentives
- Charge different rates for indoor and outdoor water use (require multiple meters be installed to facilitate this).
- Require preservation of natural landscape.

- Mandate xeriscape landscape, except in public use recreation spaces.
- Irrigate with greywater in the most water-conservative manner (encouraging drip irrigation and other water conserving practices).

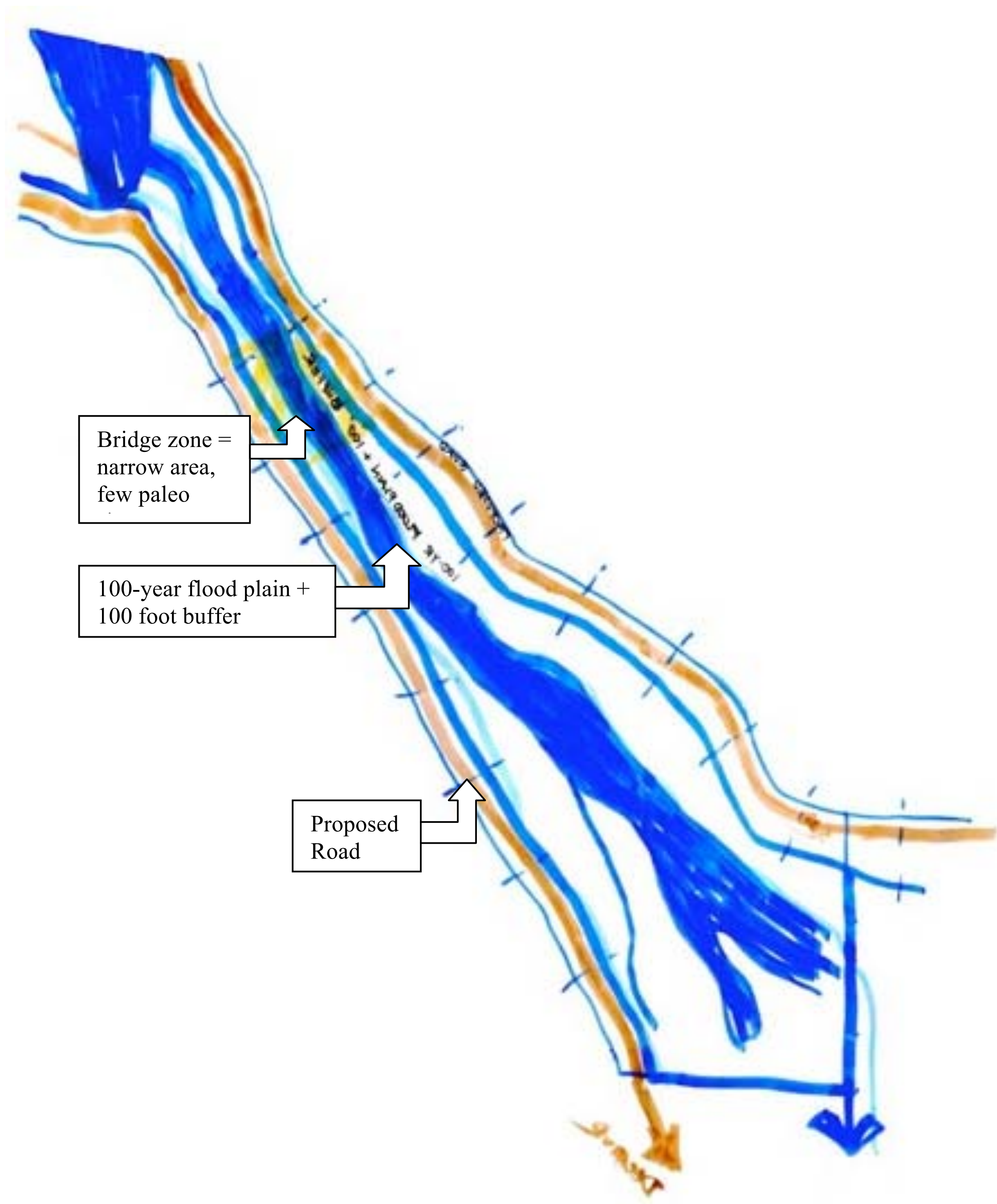


Figure 16: Three-tiered storm water strategy concept: The wash is the main regional conveyor of stormwater; its undeveloped area should include the 100-year flood plain

plus a 100-foot buffer. Also, bio-swales should be created on both sides of any roadway running along the wash. These will protect the wash from polluted runoff from the development by collecting and filtering runoff.

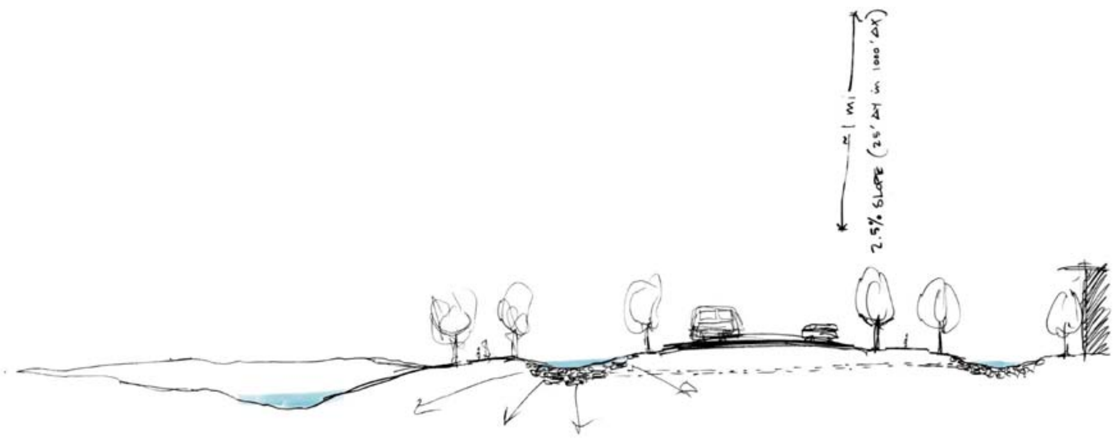


Figure 17: Three-tiered storm water strategy concept

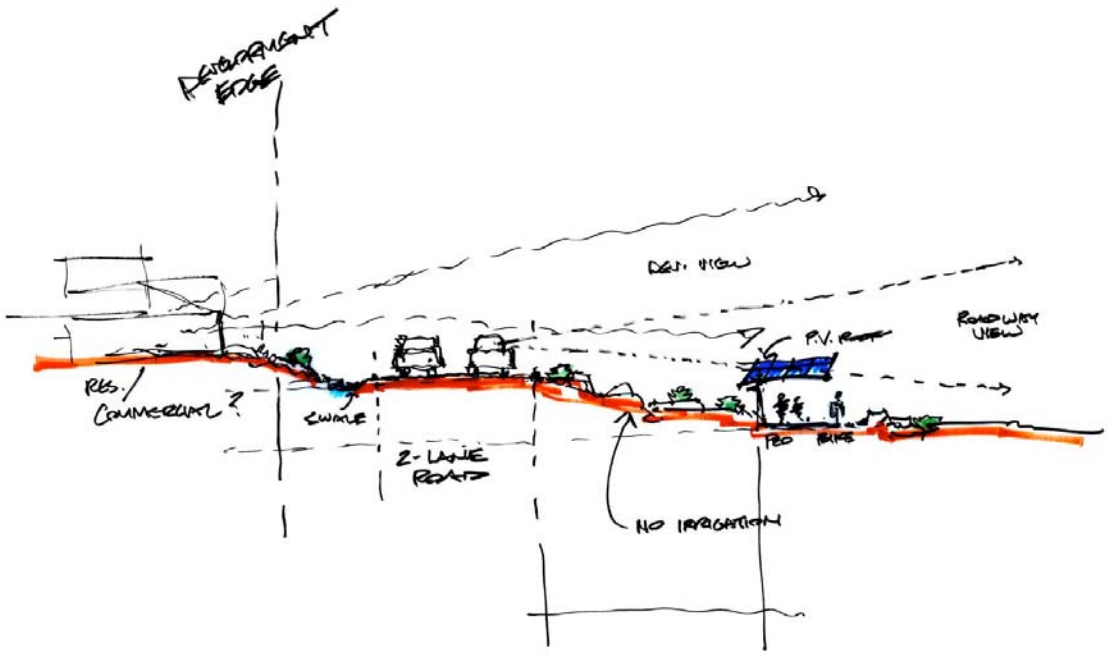


Figure 18: Integration of green systems bordering the wash: Stormwater swales adjoining the roadway, un-irrigated xeriscape buffer areas, and recreation facilities shaded by solar-electric panelized roofs.

Why Protect Las Vegas Wash

Protection of Las Vegas Wash, in turn protects:

- Natural features including wildlife habitat and diversity, and the National Wildlife Refuge north of the Wash
- Flood plain capacity
- Paleontological sites
- Cultural resources, especially related to Paiute tradition.

How to Protect Las Vegas Wash

- Determine its actual boundaries, possibly based on the 500-year flood plain.
- Require full archeological and paleontological inventory and protect the resources that are found
- Protection must be driven primarily by design; fences and policing alone are not effective or practical.
- Population density near the Wash creates more "eyes on the Wash."
- If both sides of Wash are developed, then it should be spanned at narrow points with minimum-impact bridges, which do not conflict with paleontological sites or flood capacity. Also, provide parallel utility corridors on both sides of the Wash to minimize crossings
- Design nearby roads to protect the Wash, but place human powered uses (*e.g.,* trails, parks) closest to the Wash. This layering will buffer the Wash further, while providing more human interactions with the natural landscape.
- Use roads, also, to protect the Wash from runoff pollution through the use of swales and pipe systems.
- To ensure water quality and to minimize Wash-channel grading, create a buffer (purification) system (a swale on the uphill side of any bordering road and an additional swale on downhill side – creating three parallel water conveyors, small swale, big swale, Wash).
- Locate the upstream detention pond to minimize ecological impacts to the area.
- Direct upstream flows into existing drainages for flow into the Wash.
- Require that new developments include stormwater management plans with no net increase in peak flow in Wash.
- Create an urban-recreation interface with a nature trail system to help protect the Wash and its resources by providing eyes on the Wash.
- Separate pedestrian and bicycle traffic from equestrian paths
- Provide easements that would allow for future stormwater detention areas (perhaps in park areas) in case future development necessitates it.
- Require extremely sensitive flood protection systems that are sized to handle potential future peak conditions (such as 500 year floods), while protecting environmentally sensitive areas.

Principles — Multi-Use Public Spaces

- Allow evening uses for school fields
- Develop parks as boundaries to the Wash
- Provide a public gathering place in every pocket park

- o Cluster facilities to encourage synergistic uses (such as meeting areas and youth recreation facilities).
- o Consult multiple agencies when selecting and designing multi-use public spaces.
- o Distribute amenities (such as large parks and neighborhood parks) throughout the site

Programming of Parks & Trails along the Wash and throughout the development

Trails:

- Skating trails
- Cycling trails
- Equestrian trails
- Walking trails

Linear Parks:

- Multi-use turf play areas
- Picnic areas
- Sport courts (basketball, handball)
- Game areas (bocce, horseshoes, etc.)

Larger parks:

- Sport fields (baseball, soccer, volleyball, etc.)
- Leisure services facilities
- Aquatic center (water-conservation is key)

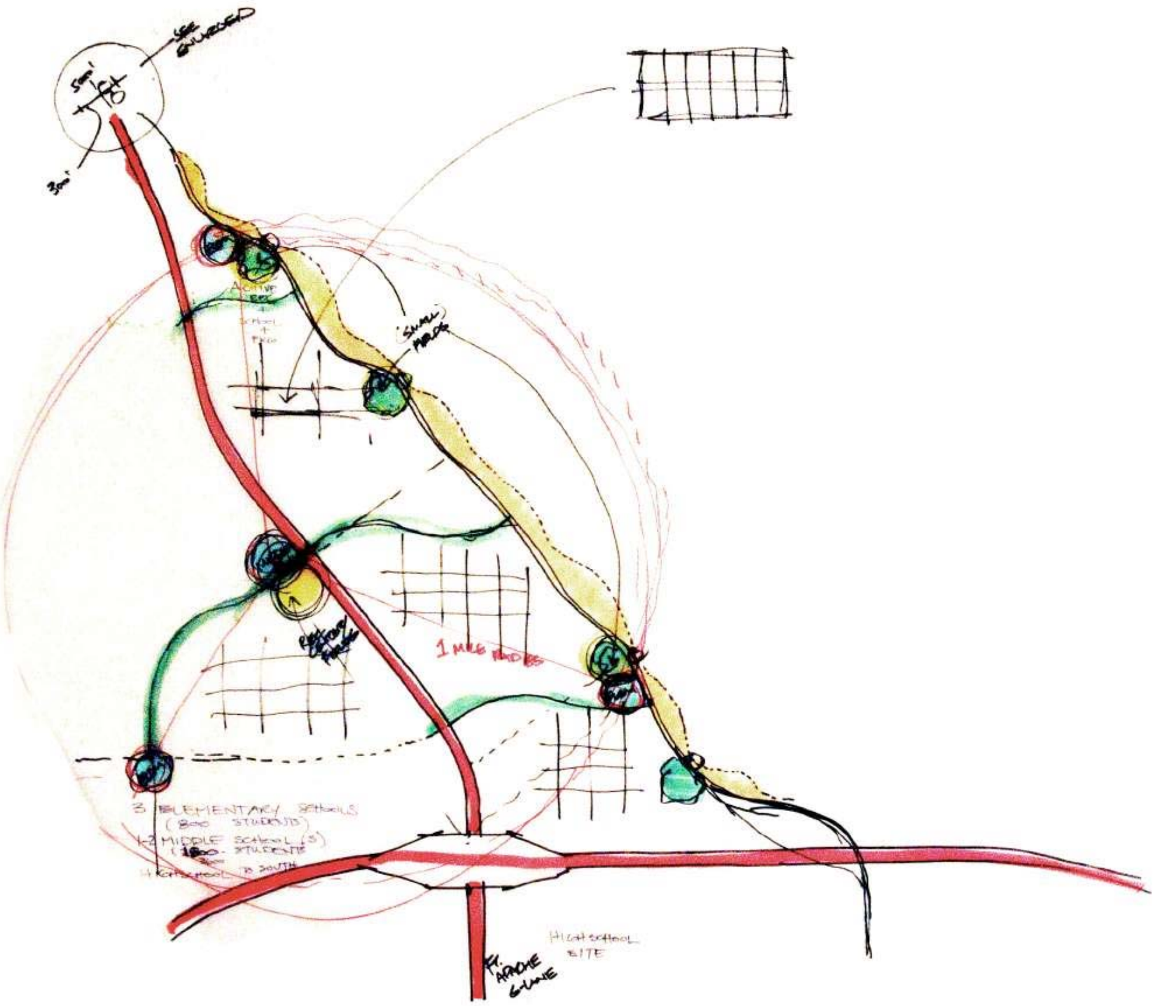


Figure 19: Amenity distribution, showing schools with associated fields, small and large parks/recreation centers, and greenbelts connecting the wash to the distributed parks

Conclusion:

The recommendations in this report define a remarkable development with many sustainable attributes. The development protects and celebrates the resources of Las Vegas Wash, is compatible with the neighboring Paiute community, provides a community with ample opportunities for conducting daily activities by foot, bike or transit, offers affordable housing and employment opportunities within the community, is energy-, water- and resource-efficient, and achieves net carbon-neutrality with the addition of on-site renewable energy sources.

Though this development prospect is attractive, if human activity on this parcel of land is to be genuinely sustainable, two key considerations should be pursued prior to development: First, the current housing market should be analyzed to determine appropriate timing for this development. Second, the City should rigorously analyze the fiscal implications of two alternatives: Development of this peripheral Greenfield site compared to increasing density close to the community's employment centers.

If the City then decides that development of this site should go forward, it should establish rights-of-way or City ownership of lands identified for public and community uses. Also, it should begin to establish sustainable governance of the site, including permanent guidelines and decision criteria for imminent and future construction, for habitation of the site, and for collaborating with the Paiute community.

If this development is to genuinely demonstrate sustainability, it should follow national certification guidelines, and go beyond these guidelines, particularly in the areas of energy efficiency, renewable power production (and associated emissions reductions), and water conservation. The development could achieve 100% net renewable power production by building on-site renewable power and by collaborating with Nevada Power to build renewable energy facilities nearby. Nevada offers several options for renewable energy production, including solar, wind and geothermal. Similarly, in addition to strict water-efficiency policies on the site, the development could save or reuse water elsewhere in order to reach a net-zero water-consumption goal.

The development should consist of multiple "villages," each provided with lively multi-use public spaces, easily and quickly accessible to everyone in the village. To be both attractive to resident and more sustainable, the village cores should be dense (up to 40 units per acre and five or fewer stories in height) with density decreasing radially from the core. Permanently affordable housing and business space should be provided, and jobs should be created within the development.

The development should prioritize transportation modes: First, it should establish safe routes for walking and biking, carefully designed as the fastest way to get to and around the village center. Second, it should provide rail or bus rapid-transit. Third, it should offer traffic-calmed vehicle access and limited downtown parking.

The site's native ecology — its habitat, and its paleontological and anthropological resources, particularly in the wash —should be protected and celebrated. Night skies should be kept dark. Development should be avoided in the 500-year floodplain (or the 100-year-floodplain plus 100 feet around the wash). Access, views and experiential opportunities should be provided to connect people to the natural ecosystems, and possibly to paleontological research sites.

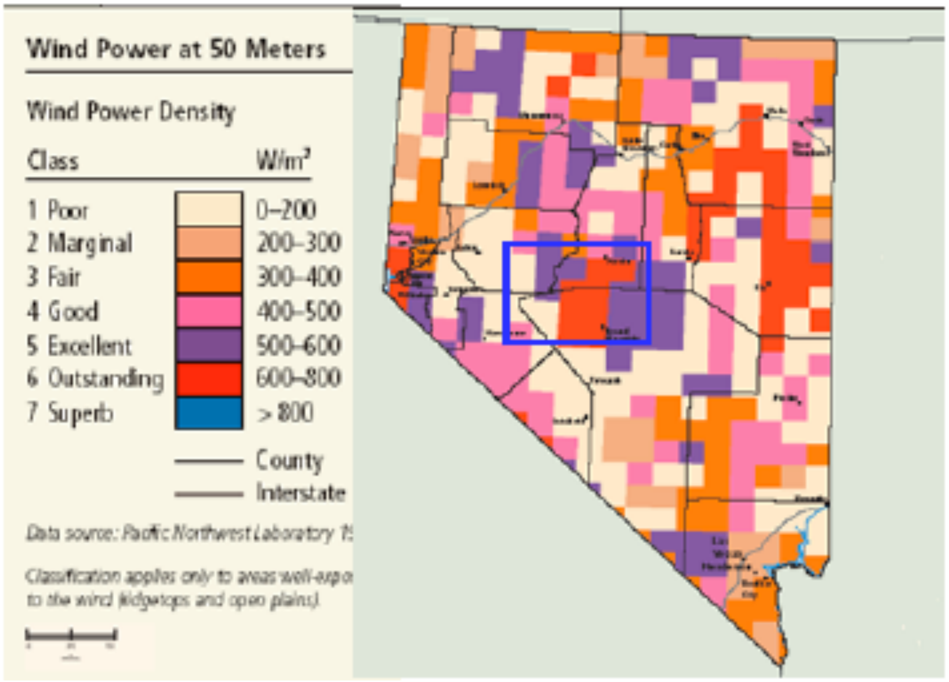
Buildings should be aesthetically pleasing, made from local materials, employ passive solar and shading principles, and provide natural light and views. Building-design innovation should be encouraged with performance standards, rather than prescriptive requirements, which should be minimized. Community-level energy measures should include garages wired for plug-in vehicles and combined cooling heating and power in industrial areas.

Using such strategies as stormwater collection, multi-use recreation and water-retention facilities, and permeable pavement, the development should result in no net impact on water quality or quantity. Efficient use of water should be ensured by performance-based incentives in addition to prescriptive requirements such as no private irrigated lawns.

Finally, through education and marketing, the development should promote lifestyles that incorporate green principles, such as water and energy efficiency, walking and bicycling, and appreciation of the ecological, archeological, and paleontological resources of the site.

APENDIX A:
Renewable energy potential

Wind Potential in the Las Vegas area



Source: Pepper, Darrell, "Assessing the Wind Energy Potential for Nevada," *Energy Symposium,* August 15-16, 2007, Las Vegas, NV.
http://osep.unlv.edu/ESy2007/PresPepper.pdf

Depicted in the map above is wind power at an elevation of 50 meters. Although Las Vegas itself is located in a marginal area for wind energy, there is excellent potential in a region to the west, as shown.

Wind power is the conversion of wind energy into electricity using a wind turbine. A wind farm is a collection of large wind turbines located in close proximity—for obvious economic reasons, wind farms are located where the wind resource is particularly good. By contrast, small wind turbines (whose cost and power production is a fraction of that of the large wind turbines) are typically located at the point of electricity use, such as on or near a building itself.

Solar Potential in the Las Vegas Area

Source: http://nationalatlas.gov/articles/people/a_energy.html#three

The map above shows annual average daily solar radiation per month, using a flat-plate collector facing south at a fixed tilt equal to the latitude of the site. Las Vegas gets an average of 6.5 hours of sunlight per day, making it one of the best locations in the country for harvesting solar energy.

Solar water heating system (medium temperature solar thermal collector); source: azsolarcenter.co

Low and medium temperature solar thermal collectors capture solar energy in a liquid medium circulating through the collector. These collectors can be used to heat swimming pools, to produce domestic hot water and for space heating, but they are not used to produce electricity, as are high-temperature solar thermal collectors described below.

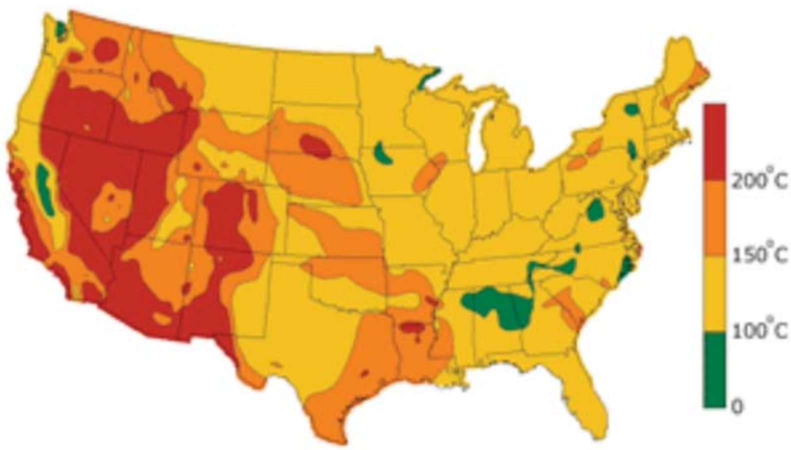
High temperature solar thermal collectors, such as this concentrated solar power (CSP) plant shown here, use mirrors or lenses to concentrate solar radiation and raise the temperature of a fluid high enough that it can be used in a heat engine to produce electricity. Because the energy can be efficiently and inexpensively stored as heat, prior to conversion to electricity, the CSP plant can reliably produce electricity day or night, and during periods of cloud cover.

Parabolic Trough Concentrated solar power (high temperature solar thermal collector); source: Wikipedia.org: Solar Thermal Power

Solar photovoltaic array; source: SolarCity.com

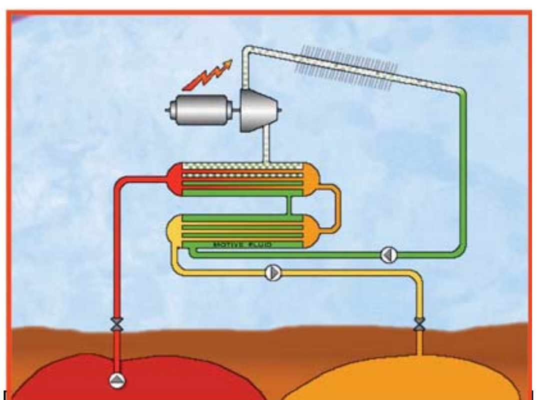
Photovoltaics (PV) harness solar energy by converting light directly into electricity. A PV array, such as the one depicted here is an assembly of connected PV modules, each of which is made up of solar cells that convert solar energy into direct current electricity. The power produced can be used immediately (converted first to alternating current), supplied to the grid, or stored in batteries for future use.

Geothermal Potential in the Las Vegas Area



Source: http://nationalatlas.gov/articles/people/a_energy.html#three

Depicted in the map above are estimated subterranean temperatures at a depth of six kilometers. High subterranean temperatures make Nevada one of the best areas in the country for geothermal power. Of note, California, Hawaii, Utah and Nevada already have operating geothermal power plants.



Ormat Air Cooled Binary Geothermal Power Plant; source: Ormat Nevada, Inc.

Geothermal power plants generate energy by tapping into the heat of the earth's core. According to the University of Nevada (University of Nevada Cooperative Extension Fact Sheet-04-70), the State of Nevada has more potential for geothermal energy production than any other state.

APPENDIX B:
Development Strategies: Best Practices

This appendix is an assemblage of best-practices and strategies to help developers, designers, and builders achieve the recommendations included in the body of this report. While they are not requirements or suggestions pertaining to specific locales within the Development north of Moccasin Road, they are the type of strategies that must be employed to successfully transform the Development into a sustainable and vibrant community. These strategies are the product of substantial research and interviews with sources ranging from a Goldman Sachs real estate investment professional and the NJ Department of Transportation to citizen urban advocates and the former mayor of Bogotá, Colombia.

General Development and Placemaking Strategy

- Design to create places (placemaking). Roads, intersections, plazas, and parks are the civic commons - the physical manifestation of our society - and should thus be designed as *places for people* not conduits for traffic. Similarly these spaces should not be the manifestation of "context sensitive [automobile-oriented] solutions."
- Case studies such as Copenhagen, New York City, and Bogotá, all show that people won't start biking and walking spontaneously. If the environment is anti-bike and anti-pedestrian, people will retreat to their cars. Developers and planners must create viable, fast, and comfortable transportation alternatives and people-friendly streetscapes, only then will people use diverse modes of transportation. Developers and planners must *create* a demand for alternative and public forms of transportation.
- Creating good public space takes time and fine-tuning.
- Use "engineering judgment" to deviate from the Federal Manual of Uniform Traffic Devices/Green Book/AASHTO etc.
- Design streetscape to serve the elderly, disabled, and children. If you ask yourself, "would I want my kids there?" the answer should be "yes" throughout the development. Because America is a democratic civil society, developers and planners should prioritize public use of the commons over privatization. Designing for cars disenfranchises large portions of the population, including the young, old, and poor. While a car costs many thousands of dollars, walking is free, and a bike costs only tens or hundreds of dollars making it accessible to the young and the poor.
- When popular public pedestrian areas are viewed in aggregate, parking and vehicular transportation are nearly always difficult. This is *not* because impeding auto traffic creates great places. Instead it is because a vibrant place, one that is designed *for* pedestrians, is not able to accommodate adequate vehicular traffic. There simply is not enough space in a streetscape designed for humans to accommodate unencumbered vehicular traffic. People who must travel by automobile to these places are willing to adjust to slower travel and parking times because they are attracted by the quality of the destination. Ultimately, high-density, walkable streets create a thriving, prosperous commercial district.
- The Development north of Moccasin Road should be a microcosm of a city. Basic services must be provided within short travel times using a variety of modes of public and non-motorized transportation.
- Zone the Development to provide an equal number of beds and jobs. Communities such

as Sonoma Mountain Village, and the Bedford Zero Energy Development use this kind of strategy as a cornerstone of economic sustainability.

- Construction phasing must create and maintain transportation connectivity for all modal networks.
- Redesign the Moccasin beltway as a boulevard. Sell excess land to pay for bus rapid transit (BRT) or light rail now, not in the distant future.

Connectivity of transportation networks

- Bus, bike, and pedestrian networks must serve all commercial nodes.
- Car access to the commercial center and residential neighborhoods should be present but limited.
- Make biking, busing, and walking more convenient than driving.
- Create high connectivity between BRT and all other transit modes--local bus, pedestrian, bike and carpool.
- All commuter networks (BRT, bike, and automobile) should connect the development's commercial center to surrounding neighborhoods and the Las Vegas city center. This network should include a separate corridor for BRT (similar to that at the University of Minnesota) from the commercial center to the beltway with little or no signals or other impediments. Create substantial traffic-calming for auto traffic into and out of the Development to encourage residents to take advantage of local services instead of traveling to more distant competitors, which will exacerbate congestion, pollution, and energy use.

Pedestrian-specific strategies

Seven Dials Court, UK

- Provide larger sidewalks in high-traffic areas to accommodate increased pedestrian load as well as on-sidewalk seating and trees. Provide sidewalks on all non-modally-integrated roads.
- Integrate modes of transportation on low traffic-volume roads by eliminating sidewalks so that all users are on the same plane.
    - This forces people to use common sense instead of conventions to navigate the street, slowing down traffic and putting people on a level playing field with cars, eliminating the "side" in sidewalk.
    - This does not mean just getting rid of the sidewalk! It means designing the *road* as a sidewalk.
    - A successful example is Seven Dials Court, United Kingdom
- Use pedestrian buttons and magnetic loop detectors for bicycles at all signals with magnetic loop detectors for cars. At automatic cycle signals, include a pedestrian cycle without button activation.

- Daylight corners. Remove parking at corners and "bell" sidewalks.
- Use mid-block cut-throughs for bikes and pedestrians , such as in the center of the 450-foot blocks. This enriches the urban landscape, and contributes to non-motorized connectivity.

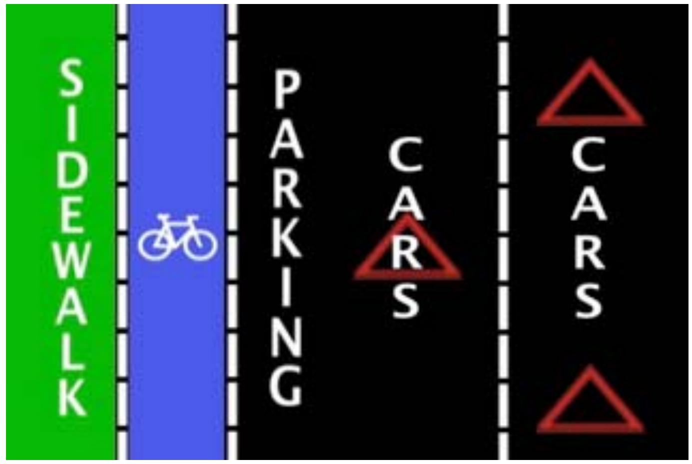
Integrated streetscape: Addison New Urbanist Community

Bicycle-specific strategies

- Bike infrastructure must be constructed at same time as automobile infrastructure.
- Create Bike Boulevards.
    - While bike *paths* should be integrated into green space, Bike *Boulevards* should be integrated into the grid to serve commercial nodes and neighborhoods and should connect to green space corridors.
    - Bike Boulevards should form a network that, along with bike paths serves all destinations such as schools, commercial areas, and parks.
    - Divert vehicular traffic off of Bike Boulevards using diagonal diverters, limited access, etc.
    - Don't put a stop sign on every block! Design a Bike Boulevard as an arterial for bikes. Put two-way stop signs to halt cross traffic.
    - Incorporate signage for way-finding and demarcation.
    - Put huge bicycle stencils on the street to inform cars that they are on a Bike Boulevard. Berkley California uses approx. ten by twenty-five foot stencils.
    - Case studies show that conversion of standard streets to Bike Boulevards increases property values and popularity of the converted streets.

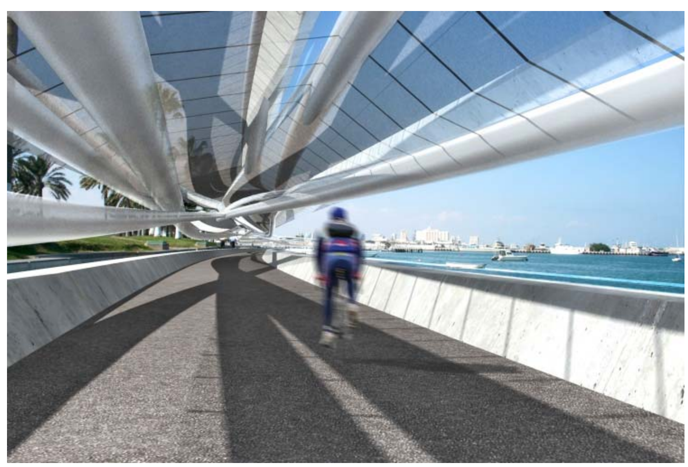
A very simple diagonal diverter

- Create separate bike lanes.
  - This should be used for high traffic-volume roads.
  - At a minimum, *all* bike lanes should be separated by a painted two- to three-foot-minimum buffer.
  - Far superior is a physical barrier such as an island, bollards, car parking, or a curb.
  - Use bike traffic lights for key bike corridors. Consider a bicycle-only traffic-light cycle for key points, such as a terminus of a bike path.
  - "It is not a bike lane unless it is safe for an eight-year-old child," according to Enrique Penalosa, former mayor of Bogotá, Colombia, who created a half-million-rider-per-day BRT system and miles of bike trails.
  - For reference review bike infrastructure in New York City, Montreal, Boulder, and, generally, in Europe.
- Provide on-street bike parking, instead of on-sidewalk.



Parking used to separate bike lane from busy travel lanes


Physically separated bike lanes in Bogotá


Concept design for a covered, water-cooled bike trail in Qatar

Public transportation strategies

- Build BRT at project outset!
- Separate bus lanes on arterials even where there isn't BRT (ex: Roaring Fork Valley near Aspen, CO).
- Build BRT infrastructure with platform dimensions, lane widths, etc. such that conversion to light rail can occur with addition of rail bed and electric lines only.

Automobile-specific strategies

- The "Design vehicle" for streets should be a short delivery truck, small garbage truck, and small fire truck, not a semi. Adequate access should be provided, but access widths should be kept to a minimum. This is usually best accomplished imperially rather than using rules of thumb.
- Employ extensive traffic-calming measures.
  - The goal is to slow cars and to prioritize pedestrians
  - Devices should be permeable to bicycles, emergency vehicles and public transportation vehicles.
  - RMI recommends narrow automobile travel and parking lanes. Lanes should be 12 feet or under with narrower lanes on non-arterial and residential streets. Columbia Missouri's street standard is 28 feet for residential streets, which includes two lanes of traffic with parking on both sides. Additionally, testing in the development of Laguna West, Sacramento CA found 12-foot travel lanes fully adequate to accommodate passing emergency vehicles.
  - Additional strategies include: speed tables/bumps, tabled crosswalks, traffic circles, diagonal diverters, jogs, alternating on-street parking from one side of the road to the other.
- Slower cars make a kid-friendly, safer development.
- Avoid or prohibit one-way streets. Although they increase traffic-volume carrying-capacity, they lead to higher vehicle velocities and create an environment that is not conducive to non-motorized and pedestrian transportation.
- All roads should be designed to limit traffic speed by *design*, not by *regulation*. Large lanes without traffic-calming encourage high vehicle-velocities, decreasing safety and multi-modal accommodation.
- Arterials should be designed to handle greater traffic *volumes*, though not at higher speeds. Arterials designed for 20 to 30 mile-per-hour vehicle velocities will make these streets viable commercial districts and livable residential neighborhoods, turning arterials into community assets rather than detractors that must be buffered and walled off.

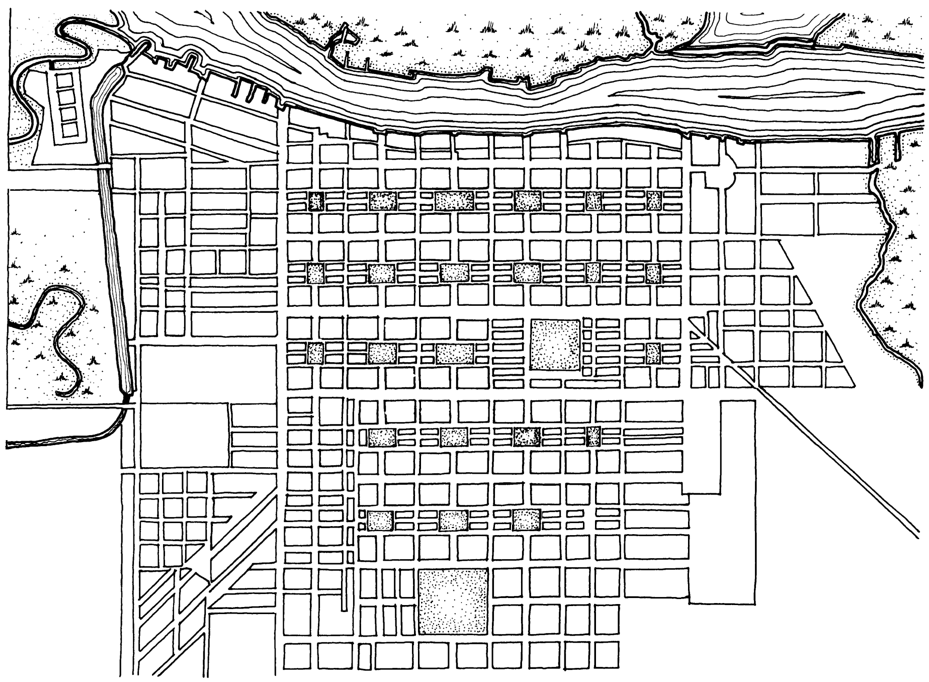
The commercial core

- It should consist of at least five to eight blocks of pedestrian-dominant landscape such as a pedestrian mall or pedestrian dominant district.
- Consider prohibiting cars on the central commercial street(s), possibly allowing buses (ex: Denver, Boulder, etc.)
- On-street parking should be provided on some streets in the commercial core to provide easy auto access through the first phases of development. However, at build-out, most auto parking in the commercial core should occur behind buildings or in structured parking to encourage auto users to park and move around the commercial core on foot. Commercial parking should be combined with a park-and-ride facility (ex: Transit Oriented Developments).
- Walking distances from parking lots or structured parking should be equivalent to distances from parking to Las Vegas casinos and shopping malls.
- Some streets should be designed to be convertible to pedestrian-only use for festivals or a permanent pedestrian environment (ex: "festival streets" in Portland OR and Bogotá, Colombia)

- Streets should be narrow for placemaking and thermal comfort.

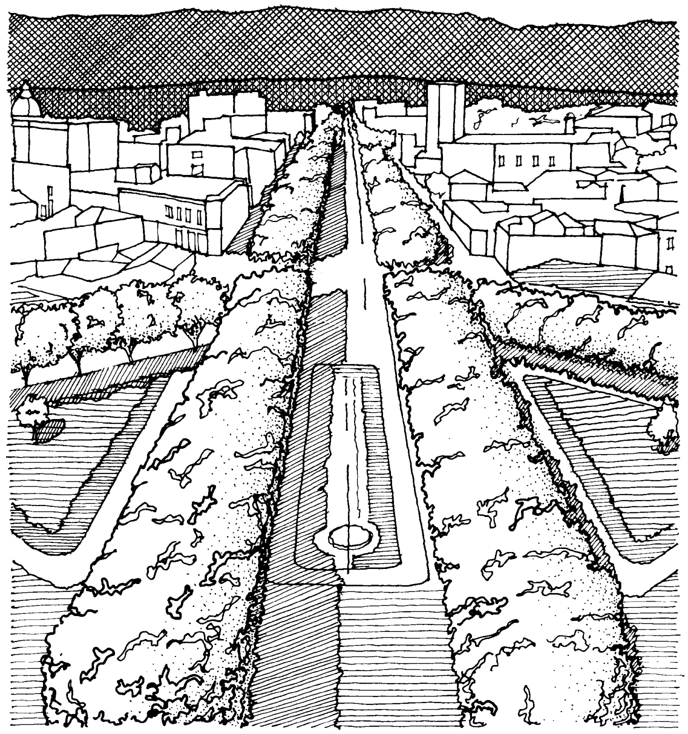
Urban Fabric/Pattern

- The urban fabric should be heterogeneous and small-grained to create a vibrant community. Vary lot size and shape, permitted uses, and street cross-sections and connectivity.
- Create live/work and small-scale commercial developments on many block corners, not just in commercial core and neighborhood commercial nodes.

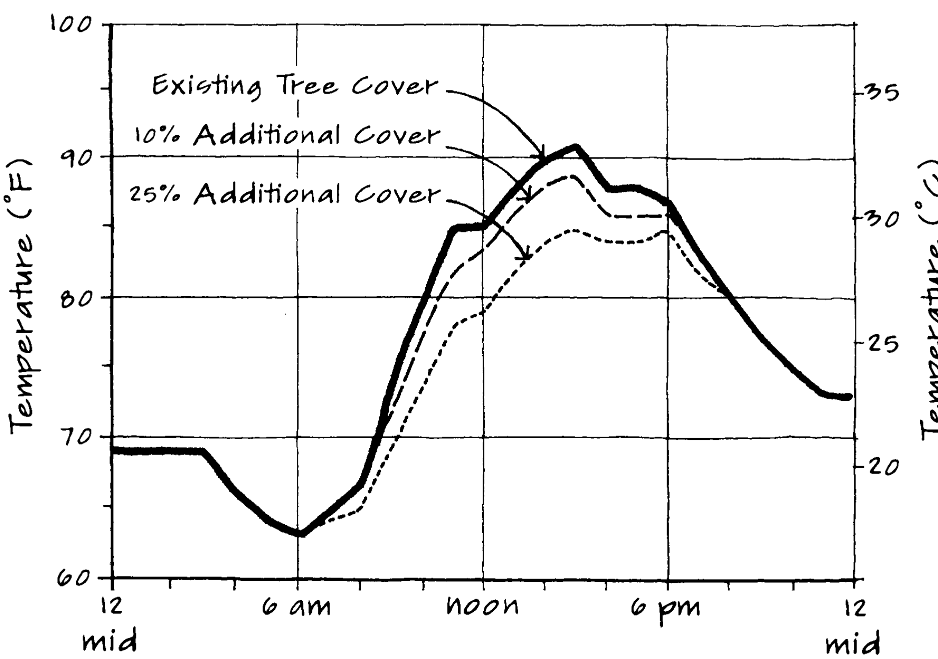


Plan of Savannah, Georgia, 1856, James Oglethorpe

- Create festival streets (ex: Portland Oregon).
    - Design them for everyday use, but to be easily closed for community functions
    - Eliminate curbs and light poles, while allowing plantings and bike racks
    - Create a flat streetscape from building to building
- Create "Green Fingers," green-space and non-motorized transit corridors that penetrate residential neighborhoods. These corridors moderate temperatures in neighborhoods and increase quality of life.



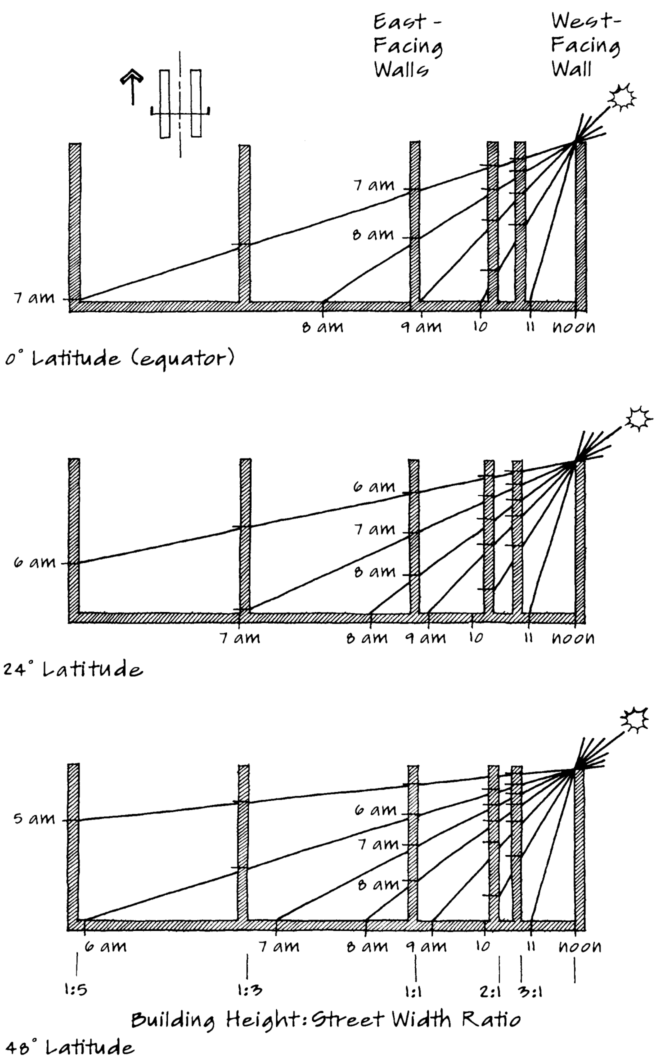
Shaded Boulevard, Belo Horizonte, Brazil



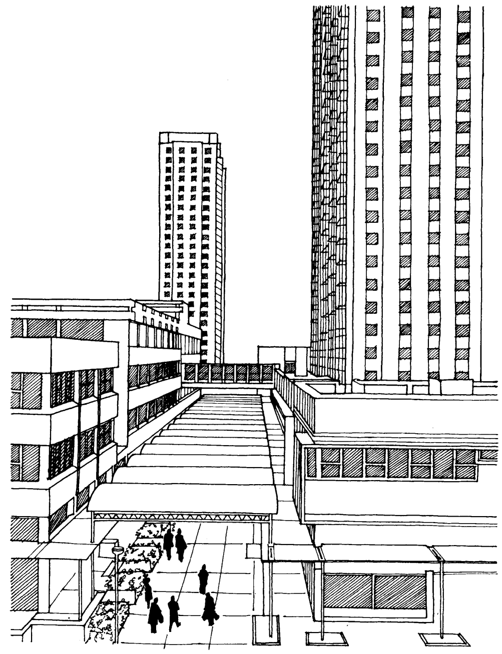
Cooling Due to Tree Cover, Phoenix
Redrawn from Akbari et al. (1992).

- Shade streets to moderate temperatures and decrease the heat-island effect. This can be accomplished through a combination of tree-shading, shade structures, and proper ratios of street-width to building-height. Additionally, appropriate building-height to street-width ratios create "outdoor rooms" that are human-scale and comfortable. This ratio should remain in a range between 3:1 and 1:1.

Ideal building height to street width ratios



Impact of Cross-Section on Shading Patterns, North-South Canyons on Jun 21



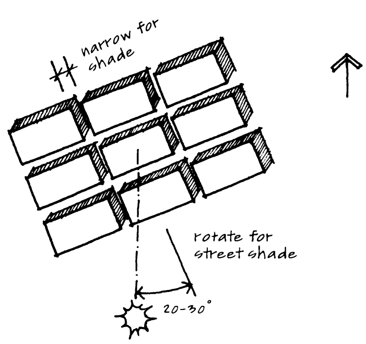
View of Roof Over Mall

Shopping District, Edmonton Green, London

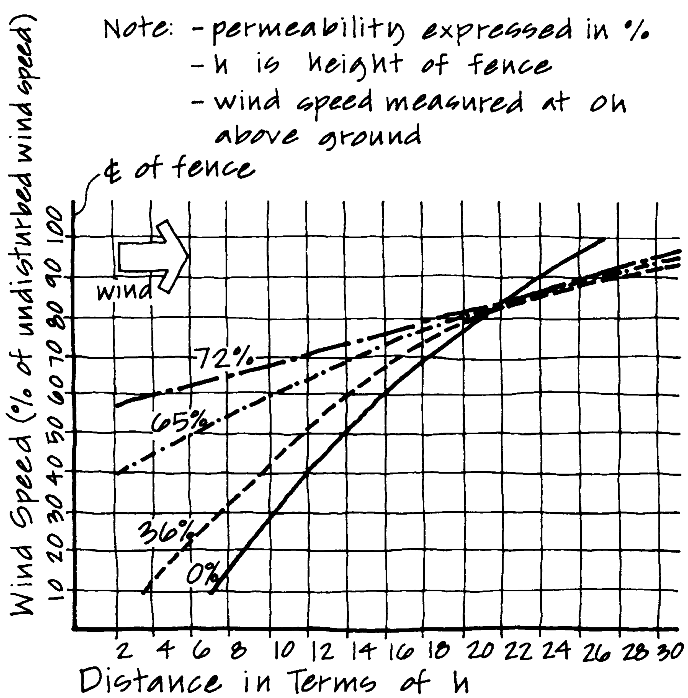
PV panels and fabric provide shade for pedestrians and cars

- With narrow public streets, interior courtyards can provide private exterior space. These courtyards remain more thermally comfortable than expansive open space, while at the same time they provide a source of cool air for passive building ventilation.
- Grid orientation should respond to climatic issues including seasonal sun angles, temperatures, and winds. In a hot arid climate, orientations for both skin and internally thermally loaded buildings should favor shading as opposed to heat-gain. To accomplish optimal building orientations, the street grid should have narrow north-south streets with wider east-west streets and should be rotated from cardinal directions to increase shading.
- Additionally, residential blocks should be elongated to the east and west for solar access and to limit solar gain on east and west building facades. Also, impermeable fences should be discouraged or prohibited to increase wind speeds for building ventilation.

A courtyard provides a shaded playground for children



Hot-Arid



Reduction in Wind Speed From Fences

Sun, Wind & Light, 2nd ed. ©2001 John Wiley & Sons

Concerning Developers

- Developers who are chosen for this project should be experienced at developing in urban areas so they understand inherent premiums and the value of transportation hubs. They should have experience creating Transit Oriented Developments.
- Developers who meet the above criteria should be brought in as soon as possible to work with the city to ensure that planning work coincides with buildability.

APPENDIX C:
Development Strategies: Case Studies

Las Vegas, the American West, as well as developed and developing world communities are rethinking the planning and building of cities. The proposed development north of Moccasin Road in Las Vegas is part of this movement to design livable, local, vibrant communities. The following is a survey of excellent projects and the lessons they teach that could inform development north of Moccasin Road.

"It is possible to think in another way. As long as we provide for many cars, we will have many cars. If we provide for fewer cars…we will have fewer cars. [By accommodating fewer cars] now many cities are considerably better than they were twenty years ago."

-Jan Gehl
Danish planning and urban design expert

1. COMMERCIAL DEVELOPMENT

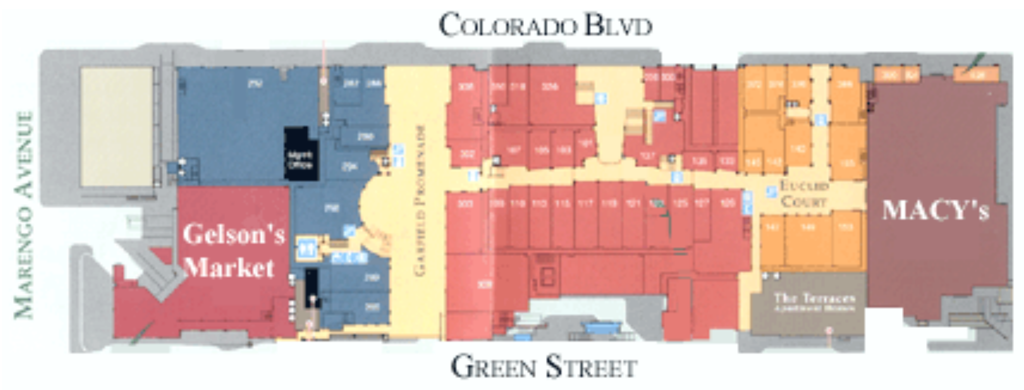
Paseo Colorado Shopping Center, Pasadena CA

- Mixed-use, "urban village" area consisting of retail shops, restaurants, theaters, and residences (lofts and apartments)
- Two department stores, one full-service grocery, one pharmacy, more than thirty shops and restaurants, one theater
- More than 400 rental units located in the four stories above the retail shops
- Three underground structured parking garages located at the edges of the block under buildings
- Wide central pedestrian promenade with divergent walkways connecting to outside streets, courts, and terraces
- Located along a light rail line and near 4 bus routes
- Walking distance to many other major downtown amenities

Music in the promenade's plaza

Apartments are located above the terraces and retail spaces

This downtown development is an excellent example of a successful pedestrian outdoor mall in a hot, automobile dominated context. Three parking garages are located underground on the corners of the block. This parking, along with close proximity to a light-rail stop and several bus stops, allows good access to the area while maintaining the development's focus on pedestrians and community gathering. An open-air promenade connects retail shops, with a small plaza for gathering. In hot dry climates, this design works well, allowing people to leave their air-conditioned cars and walk through a naturally cooled outdoor mall. Natural ventilation, such as wind scoops and focused air flows, along with shading devices, such as arcades, trellis systems, and tall buildings (in relation to street width), provide respite from the sun and create inviting areas to relax and shop. A similar outdoor shopping mall is being planned for Summerlin, Las Vegas.



Plan of the Paseo Colorado showing retailers, plazas, and promenades

Map of downtown Pasadena showing the many cultural and commercial amenities surrounding the Paseo Colorado

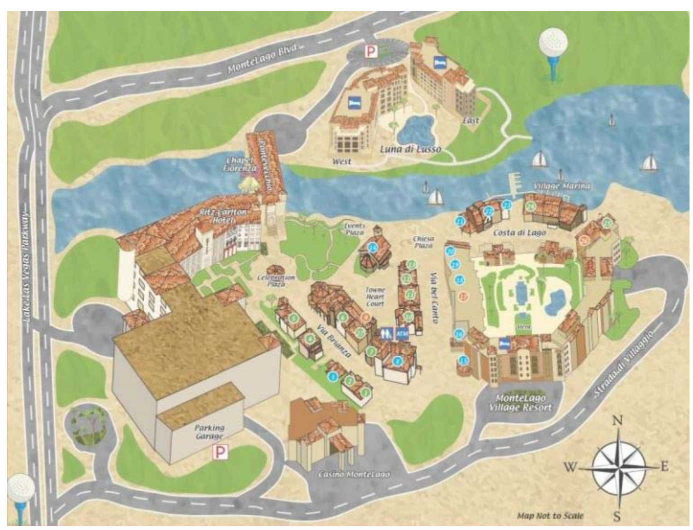
Monte Lago Shopping Center and Resort, Las Vegas NV

- Pedestrian oriented, demonstrating the demand for and success of pedestrian environments in Las Vegas
- Mixed use, -including lodging, retail, dining, and recreation
- Narrow streets shaded by buildings and shading structures
- Structured parking at exterior

Situated 17 miles from the Las Vegas strip on the shore of Lake Las Vegas, Monte Lago is patterned after a Mediterranean town. Visitors park on the exterior and visit the shops, cafes, restaurants, and casino traveling down cobblestone pedestrian streets punctuated by piazzas and fountains.

Mixed use pedestrian shopping environment with shade generated by narrow streets (high building height to street width ratio)

Additional shade provided by awnings, umbrellas, and arcades



Map of Monte Lago showing pedestrian infrastructure with vehicular access at *rear* and structured parking at exterior

Third Street Promenade, Santa Monica, CA

- Another example of successful human-scale development within a larger automobile-dominated context
- Downtown retail area of Santa Monica
- Three blocks closed to vehicles, for pedestrians only
- Connectivity to larger community--shuttles to all shops and nearby hotels, seven parking garages
- Vibrant public life combining a mix of uses and activities--regular community markets, vending carts, street performers, and places to sit

Lively street life on the 3rd Street Promenade

Created in 1989, this development, is a great example of a pedestrian focused outdoor shopping mall in a hot and arid climate. Similar in many ways to the Paseo Colorado, it is focused on a pedestrian promenade, lined with retail. A mix of people, including small vendors and street performers, are invited to mingle on this path creating an exciting activated public space. Community events, such as farmers markets, create additional diversity of users. Many benches and other areas to sit are provided along the three blocks of the Promenade, allowing people to gather, relax, shop, eat, and people watch. With a variety of mass transit in the area, cars are not necessary: the Promenade provides a human-scale intimacy, which is impossible in an environment scaled for automobiles. This project is successful because it provides a rich variety of experiences within a small area and gives a unique identity to the area.

Although the street is relatively wide (1:2), amenities such as planted medians, street vendors, and covered sidewalk seating create a comfortable and vibrant pedestrian commercial district

2. RESIDENTIAL

Katy Lane, Prospect New Town, Longmont CO

- Neighborhood-scale pedestrian urban space and residences within a New Urbanist community
- Seven town homes clustered along a bent 15-foot wide walkway with their on this central walkway
- Access to garages from exterior edges
- Close proximity to neighbors ameliorated by designing unique residences
- Building to street ratio of 2:1, similar to medieval street proportions, creating shade and a sense of protection from the elements, while promoting interactions among residents

This project as an example of wonderfully inviting medium density residential development, with about a dozen dwelling units opening onto a shared narrow inner street. These clusters foster social interactions, while providing shade most of the day. Of note is the ratio of building height to street width, which is 1.5:1 to 2:1. This type of clustered housing, used in areas throughout the city, can create points of identity and community without being overbearing or monotonous.

Human-scale residential street

Automobiles access the rear of residences, while the central pedestrian walk connects front doors to the adjacent pocket park

Katy Lane courtyard

A similar pedestrian-focused development in Aspen, Colorado with a traditional architectural style. Note the much broader streets - a 1:3 building to street width ratio.

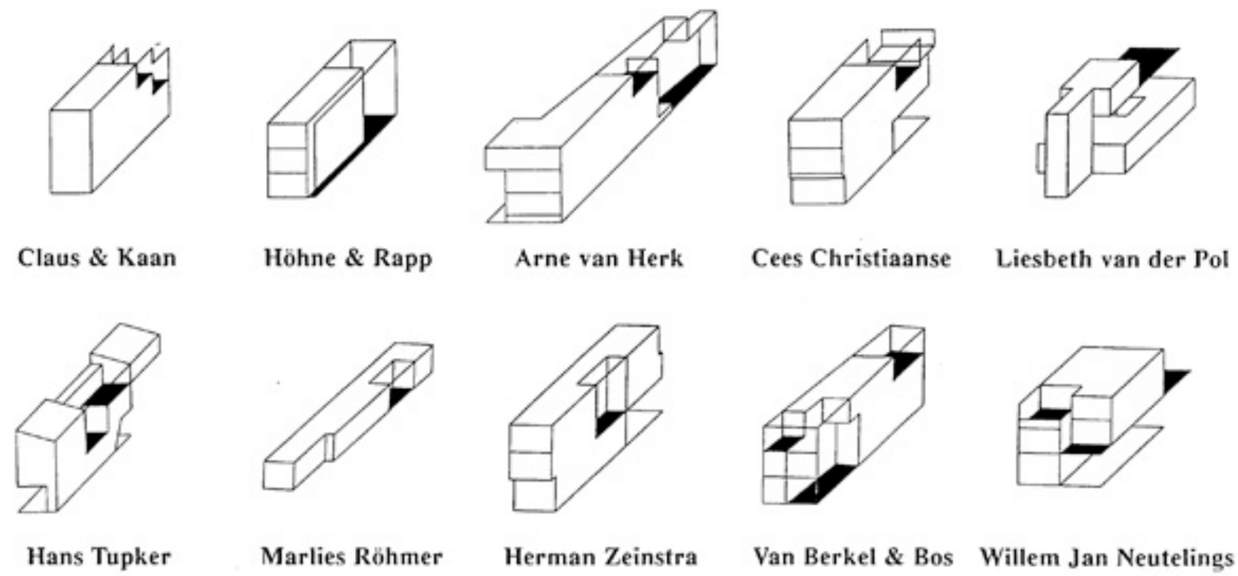
Borneo Sporenburg Housing, Amsterdam

- Diversity of styles generating lively streetscapes
- Adjacent parcels developed by different designers
- Very dense development without overcrowding
- Mix of single- and multi-family low-rise and mixed-use mid-rise blocks

40 units per acre with a comfortable, spacious streetscape

Two peninsulas in the eastern part of the Amsterdam docks were developed for water-related activities and 2,500 low-rise dwelling units, with a density of 40 units per acre. A key aspect to the development's success is the three-story, ground-accessed houses designed by over twenty different architects, each following practically the same building alignments and conditions. Housing type and building massing are relatively consistent, while architectural expression varies as no two adjacent lots are designed by the same architect. By repeating such a great variety of dwelling units with maximum architectural variation, an animated street elevation emerges. At a larger scale, a balanced relationship exists between the repetition of the individual dwellings, the roofscape and the great scale of the docks. The housing blocks are punctuated with large mixed-use buildings, which form landmarks among the neighborhoods of houses. 'The

Whale,' with its prominent kink in the roof and zinc scales, is one of two large residential buildings on Sporenburg, accommodating 194 residential units and 12,000 square feet of offices.

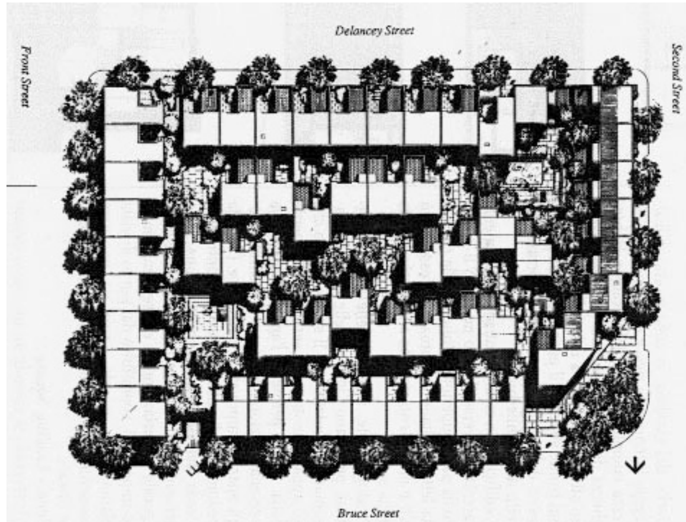


Massing diagrams of the various architectural solutions for the Borneo row-housing lots. A given design was never repeated side-by-side. Instead each design could be replicated in other locations within the development to take advantage of economies of scale (mass production) without creating monotony.

Arial photo of the development shows dominant low-rise, high-density development, punctuated by larger mixed-use buildings and open/green space.

Housing Typologies: Low-Rise, High-Density

- Low-rise buildings (three to four stories), allowing residents to have private exterior space and feel “close” to the street
- High-density (15-40 dwelling units per acre), using land and infrastructure efficiently, housing sufficient numbers of people around commercial nodes to sustain them and create lively and safe streets



Plan showing a Danish low-rise, high-density development, note attached housing with ample green space

An urban fabric characterized by low-rise buildings and a high-density of dwelling units has been pervasive since humans began building cities. Despite this building typology’s widespread historical prevalence, contemporary resurgence of the typology can be attributed to experimentation in state-funded and subsequently privately-funded housing projects in Denmark in the second half of the Twentieth Century. Analysis of these projects shows that low-rise, *low*-density developments become difficult to implement on a city-wide scale because of the excessive expense and difficulty inherent in providing adequate services and transportation infrastructure at low densities. On the other hand, *high*-rise, high-density development can often dissociate residents from both the street and one another, allowing dangerous neighborhoods to develop. Additionally, after providing adequate open space surrounding high-rise residential towers, these developments frequently were no more dense than *low*-rise, high-density projects.

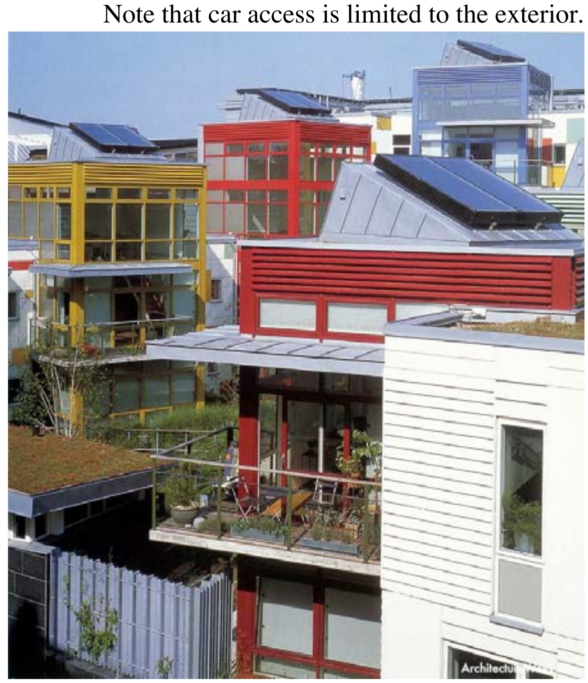
"Montage" in Palo Alto, California. One of the winners of a 2003 AIA Housing Award. Photo: Tom Rider

Thus low-rise, high-density (L-R, H-D) residential development has (re)emerged in Europe and North America as the most successful, livable, and efficient urban living typology. These developments provide residents comfortable living space, private exterior space, personal relationships to neighbors, and access to nearby parks, open space, and businesses.

An example of *detached* L-R, H-D development in California

Torpedo Hall Apartments, Copenhagen, Denmark
67 apartments surrounding an interior courtyard

A solar-oriented California L-R, H-D development. Note that car access is limited to the exterior.



Tango, a L-R, H-D housing project in Malmö, Sweden. Both private and semi-private/shared outdoor space is provided. Photo: Werner Huthmacher

3. PLANNING

The Noisette Community, North Charleston SC

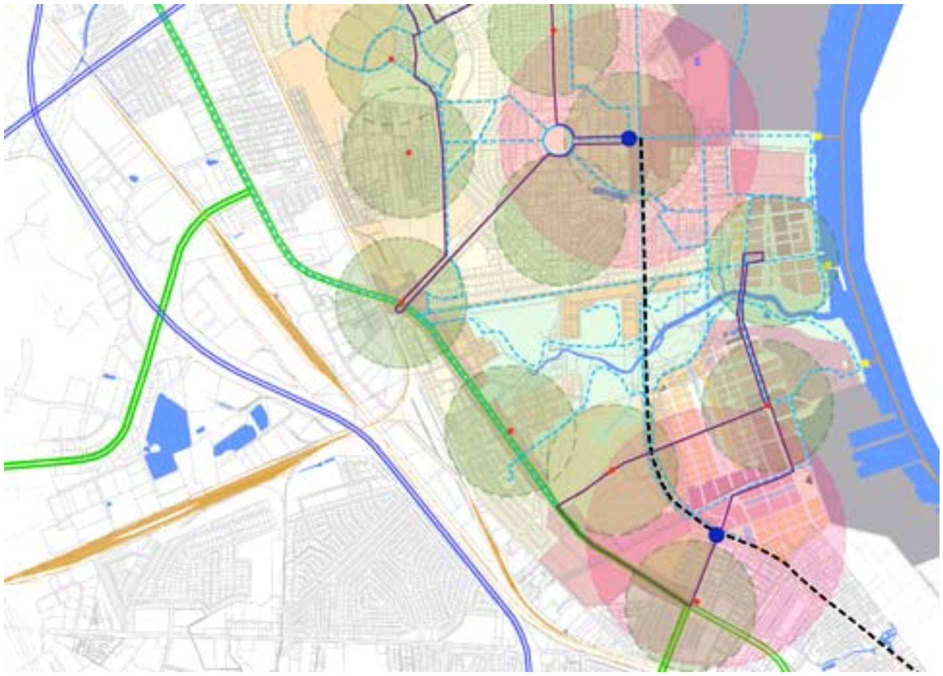
- Integration ofecology, community, and economy
- High environmentalachievement *and* affordability
- Created through a public/private partnership
- 3,000 acres along the Cooper River and Noisette Creek
- 10,000 new and rehabilitated homes
- Six to eight million square feet of commercial space

Noisette's downtown district with a traffic-calmed boulevard

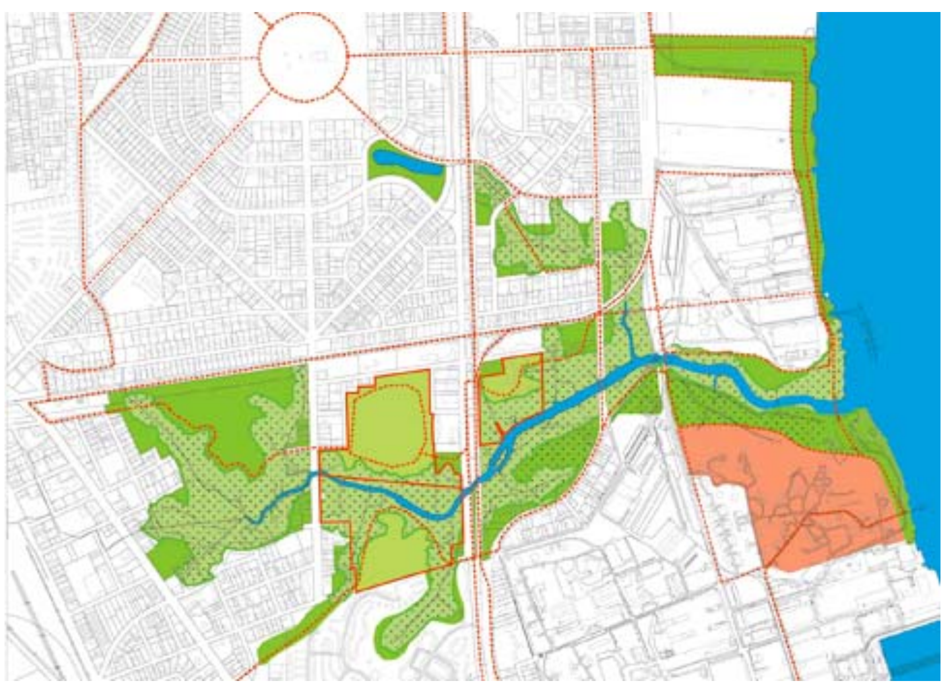
"The major objective for North Charleston is to offer an alternative to urban sprawl by setting the benchmark for smart growth, reclaiming the waterfront for public use." [1] The Noisette Community in North Charleston is creating this alternative through a comprehensive reexamination and recreation of standard development practices. "The master-plan includes sustainable development guidelines for parks, zoning, density, movement systems circulation (vehicular, bicycle and pedestrian), parking, energy-efficient utilities, ecological restoration, landscaping and watershed management." Basic services are provided within easy walking distances for all residents. The Leadership in Energy and Environmental Design (LEED) rating system is being used throughout the development. The LEED for Homes rating has already been implemented in Noisette's affordable housing without causing a cost premium. The plan equally represents social needs, environmental responsibility, and economic vitality.

North Charleston's Montague Avenue. New transit oriented development is generating a renaissance in the area, with new businesses locating in previously vacant buildings

[1 and 2] http://www.bnim.com/fmi/xsl/portfolio/index.xsl#a-15



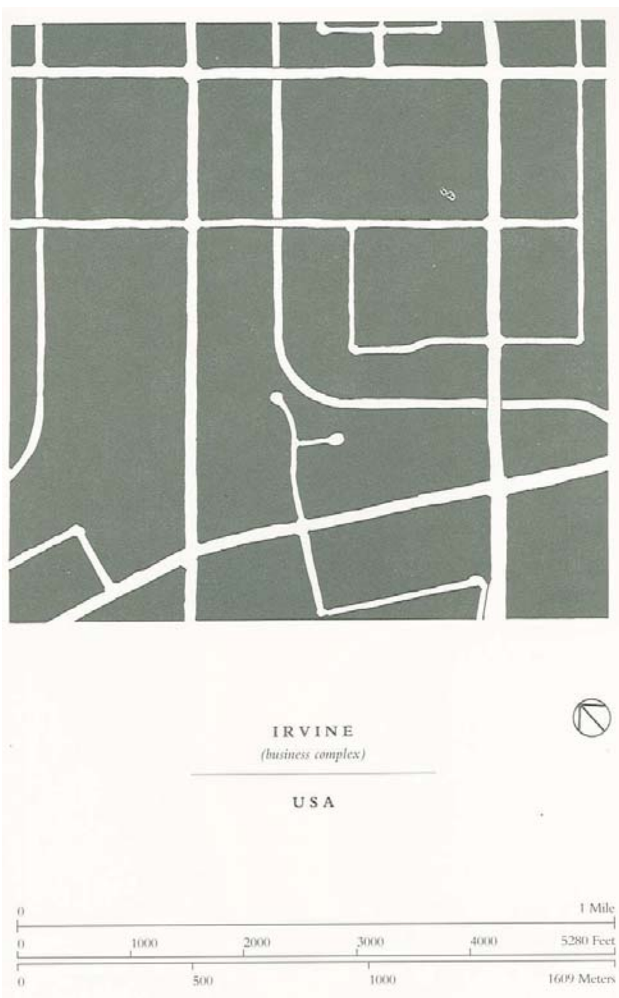
Plan of the Noisette Community in North Charleston showing the two major commercial centers and smaller neighborhood commercial nodes, each with circles indicating easy walking distances. The interface between these walking circles and public transportation networks are also indicated.

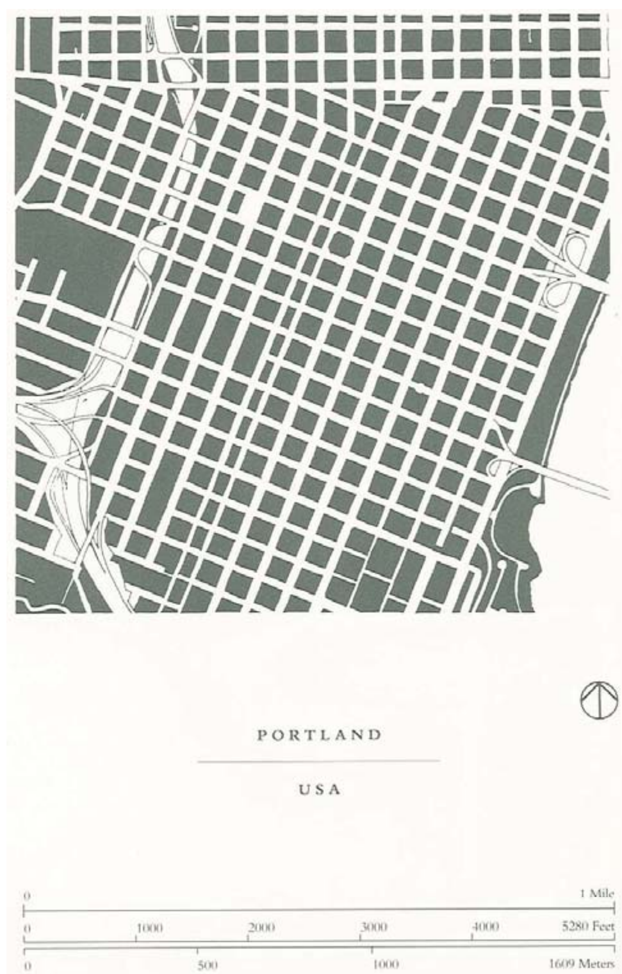


Plan of the Noisette Community in North Charleston showing areas of ecological restoration and parkland. Also noted are non-motorized transportation corridors.

Grid Density and Connectivity: Portland OR vs Irvine CAA tight grid with a high level of connectivity is best both for vehicular and non-vehicular transportation, as well as for neighborhood livability

The size and the shape of city blocks influence the character of the neighborhood significantly. In addition to the climatic concerns discussed in the previous appendix, grid density and connectivity are of special concern when creating a human-scaled, livable neighborhood. A high level of connectivity means more route options from point A to point B. Through the use of cul-de-sacs and small residential streets, combined with large arterials, traditional suburban neighborhoods limit vehicular traffic in front of homes. However, the resulting grid has a very low level of connectivity and a large scale. This works reasonably well to funnel traffic to (often congested) highways, although it also makes non-motorized and public transportation both difficult and unpleasant. As an alternative, a tight grid dominated by through-streets provides many parallel routes between any two points. This level of connectivity and scale is conducive to walking as well as vehicular transportation. Typical suburban arterials are so large-scale that they are unpleasant for pedestrians and inhabitants of nearby homes. Congestion or accidents on centralized arterials can easily cripple the transportation network. A tight grid disperses traffic and allows it to respond dynamically to resistance and change.





Highway removal: San Francisco, New York, and Portland OR

The following case studies show that highway removal (or not building urban highways) *does not* contribute measurably to congestion in the long term; instead it eliminates vehicle trips, which reduces traffic congestion and is good for the environment.Replacing linear, singular, tributary highways with dispersed, redundant boulevards and grid systems creates a more resilient transportation system and contributes to, instead of detracting from, neighborhood financial health and livability. The research of traffic engineer Rick Chellman in Portsmouth NH, indicates that an urban grid generates less than half the vehicle trips of a suburban grid system.

Embarcadero Freeway after the earthquake prior to demolition


Embarcadero Boulevard after freeway demolition

Embarcadero Freeway Removal

San Francisco

The freeway was damaged in the 1989 earthquake and was replaced with a boulevard. Surrounding property values were reported to increase 300 percent following the construction of the boulevard. The new roadway includes trollies, pedestrian walkways, bike paths, and four automobile lanes. The resulting change in traffic carrying capacity resulted in less traffic, not in gridlock.


Octavia Boulevard and parks

Central Freeway Removal

San Francisco

The freeway was damaged in the 1989 earthquake, was completely demolished in 2003 and has been replaced with Octavia Boulevard and neighborhood parks. Sale of excess land paid for improvements. Extensive traffic calming accommodates large traffic volumes without killing neighborhoods (traffic moves well according to SF traffic engineers) - local commercial areas flourished as a result of the freeway removal. The roadway cross-section includes: a central median, two narrow lanes, median bike and local traffic lane, parking, sidewalk, buildings.

West Side Highway Removal
New York City
The freeway collapsed in 1973 due to dilapidation. Traffic diverted at first, then adjusted to barely measurable changes in vehicle speeds on nearby arterials – 80,000 vehicle trips per day disappeared according to Sam Schwartz, former NYC Department of Transportation Chief Engineer and Traffic Commissioner!

Mt. Hood Freeway Defeat
Portland OR
A proposed freeway project was completely approved by decision-makers when the affected communities organized against the freeway and defeated it. Instead, the city spent allocated funds on a light rail system and parks (it just finished spending reallocated money in the early 2000s). Rather than suffering from freeway-induced urban blight, affected neighborhoods are now popular walkable and bikable communities. As a result Portland also removed Riverfront Expressway in the 1970s with similar success. Similarly, Pioneer Square (downtown central square and transit plaza) was created instead of a planned parking garage. Now the creativity of Portland traffic engineers is devoted to traffic-calming and livability. “To make a livable city, you can’t think of cars first.”

Other Highway Removal Projects
Milwaukee WI. Toronto, Ontario. Niagra Falls NY. Paris, France. Seoul, South Korea. Planned projects: NY, NJ, OH, DC, TN, Montreal, Tokyo.

Octavia Boulevard, note the fairly narrow travel lanes separated by medians. 4 regional lanes along with 2 separated local lanes.

Former Portland Waterfront Freeway now green space

APPENDIX D:
Building Design Strategies

An important goal of participants in the December charrette was to produce a greenhouse gas footprint at least 80% smaller than the Las Vegas norm. Discussions of how to achieve this goal on a planning scale are located in other appendixes and in the body of the report.

This appendix is a reference guide for home builders, contractors, and architects. It presents building-design strategies necessary to create comfortable, salable houses and light-commercial buildings within the parameters of a reduced footprint. These strategies are best suited to buildings whose thermal energy loads are primarily skin-dominated, in contrast to most large office buildings, high-rises, etc., where thermal energy loads are internally dominated by computers, occupants, lighting, etc. Because every building is unique, it is impossible to prescribe the exact strategies that will achieve an 80 percent footprint reduction, however through the appropriate implementation of the ideas extracted from case studies and individual strategies presented here the requisite footprint reduction is readily achievable.

Design Process
There are many ways to reduce building energy use (and therefore building carbon emissions). However, using the following prioritized list of strategies is the most energy- and cost-effective approach:

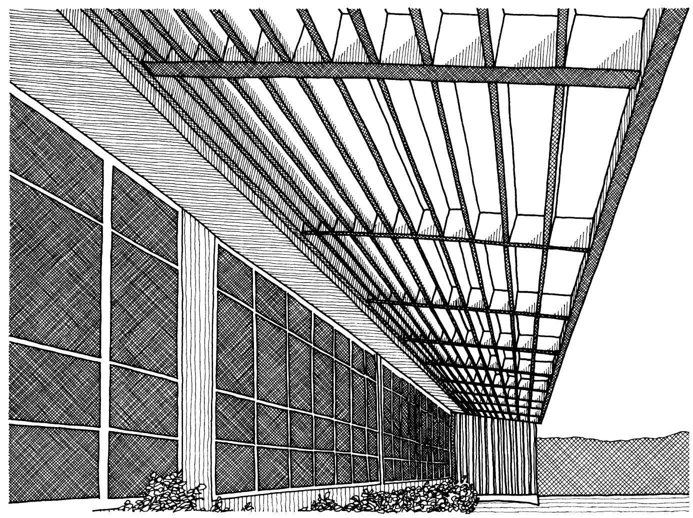
1. Passive strategies (an efficient building envelope, passive conditioning, daylighting)
2. Efficient active systems (heating, cooling, lighting)
3. On-site renewable energy production
4. Off-site renewable energy production (including “Renewable Energy Credits”)

The above measures are arranged in order of decreasing impact and increasing cost, however they should be integrated for maximum impact, rather than carried out as successive steps. For example, such passive strategies as increased insulation and proper roof overhangs result in reduced energy use, which allows downsizing or eliminating of the heat-ventilation-and-air-conditioning (HVAC) system, which in turn will result in lowest cost and greatest environmental achievements.

The Las Vegas Climate
In general, the Las Vegas climate is characterized by long, hot summers and moderately cold winters. Though summer temperatures frequently exceed 100 degrees Fahrenheit, a significant number of days also require heating. In fact, the Las Vegas heating load is only about 30% smaller than the cooling load. However, due to large expanses of concrete and other heat-absorbing materials, the heat-island effect generates extremely hot micro-climates in urbanized areas.

Due to the interior-continental climate and the rain-shadow effect from mountain ranges west of Las Vegas, moisture is relatively absent from the Las Vegas climate. Precipitation averages about four inches annually, with only one to three rainy days per month. However, high-intensity storms tend to cause flooding events. Additionally, low humidity causes large diurnal temperature swings usually between 20 to 40 degrees Fahrenheit (where heat-island effect is not dominant).

Las Vegas experiences frequent moderate winds, usually out of the southwest to northwest, which are valuable for ventilation in the Spring and Fall, but may be insufficient alone to cool hot summer days. While the extreme heat that characterizes the Las Vegas climate presents a challenge for passive thermal control in buildings, a number of climatic assets such as large diurnal and annual temperature swings, abundant sunshine, and low humidity can be harnessed to greatly reduce or eliminate the need for mechanical HVAC systems.



Sunshine School, Fresno, California, Horn & Mortland

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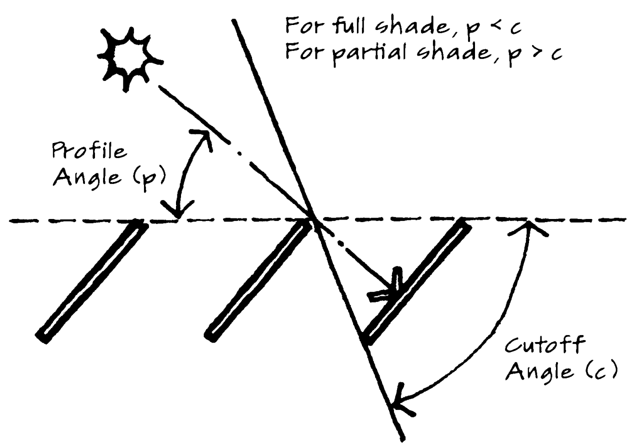
Shading strategy for south-facing windows



Geometry of Overhead Louvered Sunshades

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Passive Strategies

In general, passive conditioning strategies will be most cost-effective. Additionally, with good passive design, the need for active systems or renewable energy will be greatly reduced.

Limiting Heat Loss/Gain

An efficient building envelope, incorporating high R-values and airtight construction, will hold coolth and warmth and require less passive or active thermal control. Additionally, daylighting and use of efficient lighting and appliances will decrease unwanted interior heat gain.

Key Strategies

- Appropriate building massing. For example, avoid large east and west facades to limit unwanted heat gain and glare, while using compact massing to create low surface-area-to-volume ratios
- High R-value windows, doors, walls, roof, and floor
- High Albedo (high solar reflectivity) roof and exterior finishes.
- Summer shading of windows. For example, use properly sized overhangs, awnings, or exterior louvers
- Daylighting spaces
- Efficient lighting and appliances

Passive Cooling

Overview

A number a cooling strategies are well-suited to the Las Vegas climate. Among them are evaporative cooling, high thermal mass, ventilation, and high mass with nighttime ventilation. The chart at right depicts the range of comfortable temperatures (D) and the ability of various passive strategies to bring uncomfortable exterior temperatures into a comfortable range indoors. A combination of the strategies mentioned above can effectively condition spaces in Las Vegas, even when outdoor temperatures exceed 110°F.

Evaporative Cooling

Evaporative cooling alone can decrease air temperatures by as much as 18°F. Directly cooling building surfaces by spraying them with water effectively limits heat-gain, however due to water scarcity in Las Vegas, other more efficient ways of harnessing evaporation for cooling are depicted here.

Key Strategies:

- Direct evaporation (ex: evaporative cooling towers)
- Indirect evaporative cooling systems

Evaporative cooling tower, Desert Living Center

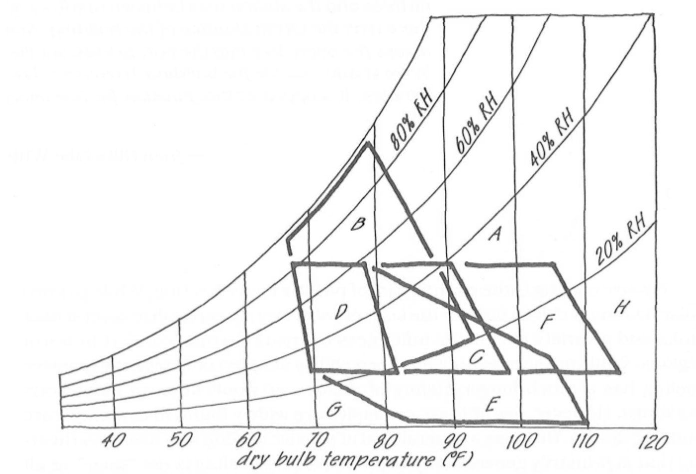


Figure 14.1: Psychrometric chart showing extensions of comfort zone with various passive cooling strategies: (a) conventional dehumidification, (b) ventilation, (c) high thermal mass, (d) comfort zone, (e) evaporative cooling, (f) high mass with nighttime ventilation, (g) humidification, and (h) conventional air conditioning. *(Based on Milne and Givoni, 1979; modified for the ASHRAE, 1989, comfort zone.)*

Environmental Control Systems:Heating, Cooling, Lighting F. Moore

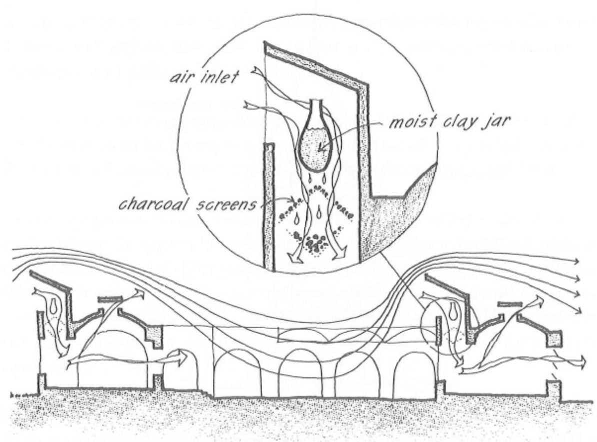
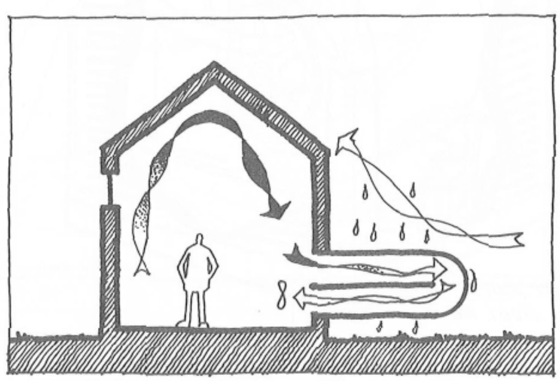


Figure 17.4: Ventilation/evaporation system in girls' primary school in New Gourna, Egypt (H. Fathy, architect). Air is drawn in through wind catches past damp, porous water jars and down through wetted charcoal screens where it is cooled 18°F below ambient temperatures. *(After Fathy, 1973.)*

Environmental Control Systems:Heating, Cooling, Lighting F. Moore



Closed loop indirect evaporative cooling system: evaporatively cooled surface chills building air

Environmental Control Systems:Heating, Cooling, Lighting F. Moore

<u>Thermal Mass</u>

While thermal mass does not reduce or dissipate overall heat-gain, strategic use of materials with high thermal mass (such as stone, brick, concrete, and soil) can dampen and delay diurnal or even seasonal temperature swings. When combined with other cooling strategies such as nighttime ventilation, evaporative or radiant cooling, thermal mass can store coolth to temper high daytime peak temperatures.

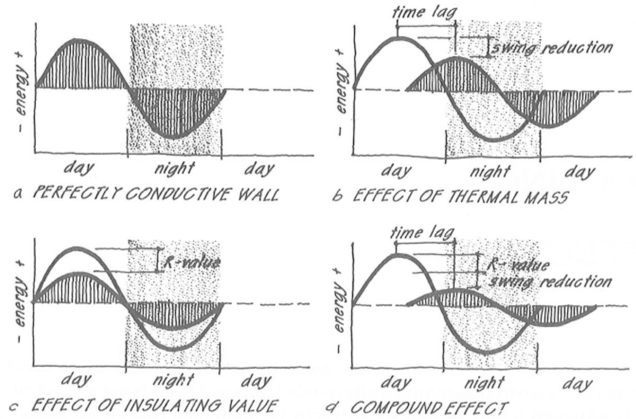


Figure 18.2: Effect of thermal mass and insulation on interior temperature: (a) conductive, low-mass envelope (high swings, no lag), (b) high-mass envelope (e.g., uninsulated masonry; time lag plus reduced swings), (c) insulated, low-mass envelope (reduced swings, no lag), (d) insulated, high-mass envelope (e.g., masonry with exterior insulation; time lag with greatly reduced temperature swings). Notice that in every case, the average temperature remains unchanged. *(After Howard and Fraker, 1990.)*

Key Strategies:

- Insulated interior thermal mass used to diminish and delay diurnal temperature swings
- Nighttime flushing
- Earth tubes or ground-source thermal exchange to store winter cold for summer use
- Berming/earth sheltering buildings

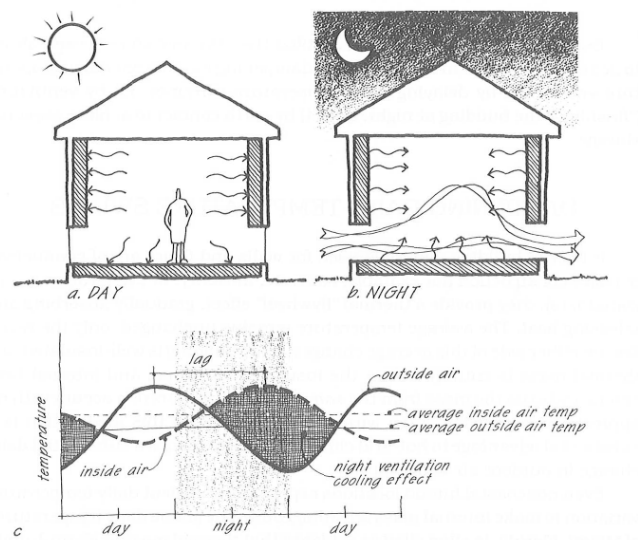
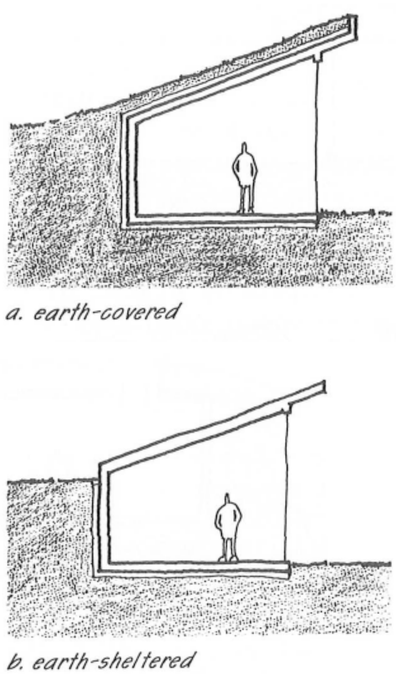


Figure 18.3: Night flushing: (a) day charging cycle — heat absorbed by thermal mass no ventilation to prevent daytime gain, (b) night discharging cycle — heat removed by, thermal mass and exhausted by ventilation of cool night air, and (c) effect on daily temperatures.



Covering and sheltering structures with earth creates thermal storage capable of moderating daily and weekly temperature swings

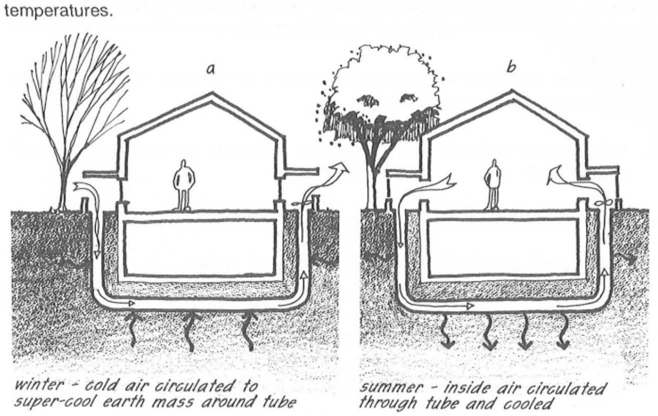


Figure 18.17: Closed-loop earth-tube-cooled residence, Cincinnati, Ohio (F. Moore, architect); (a) winter "discharging" cycle supercools earth mass, and (b) summer cycle is "closed-loop" circulating indoor air through the tubes and back to the interior again.

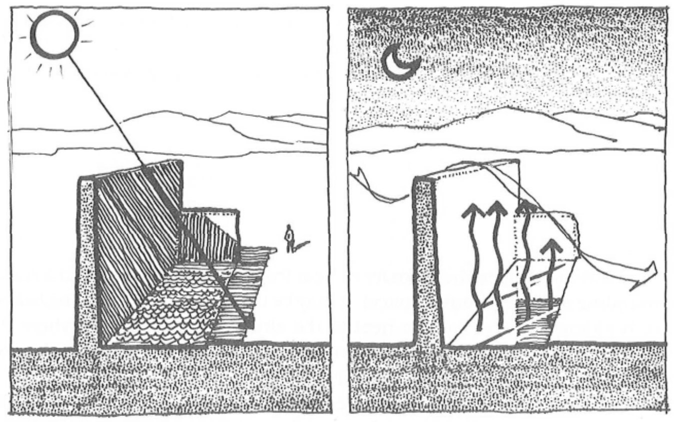
Environmental Control Systems: Heating, Cooling, Lighting

Radiation

Every day the earth gains a considerable quantity of energy in the form of solar radiation. Each night an equivalent quantity of energy is radiated back into space. This nighttime radiation is moderated by the earth's atmosphere. Moisture in the air is one of the factors that increases the insulative value of the atmosphere. This is why the coldest nights are usually clear while cloudy nights tend to be warmer due to the insulative "blanket" of clouds. Greenhouses capture daytime solar radiation, which results in higher interior temperatures. Inversely radiant cooling strategies *avoid* solar heat-gain and maximize night time radiant heat-loss. Because the night sky is effectively absolute zero (-460°F) moderated only by the atmosphere, radiant cooling can achieve interior temperatures *colder* than even nighttime air-temperature lows.

Key Strategies:

- Expose mass to night sky, also shade from sun
- Cool pool systems *move* cool mass from exposure to night sky to living space (could also expose mass to sun in winter for passive heating)
- Collect air cooled by radiant mass (courtyard)



An Iranian ice pond. Daytime solar-gain is completely eliminated by shading from adjacent walls while exposure to night sky is maximized to increase nighttime radiation loss. Although some heat is conducted through the ground and air, these ponds were capable of creating a layer of ice several inches thick over a winter's night, even when temperatures did not dip below freezing.

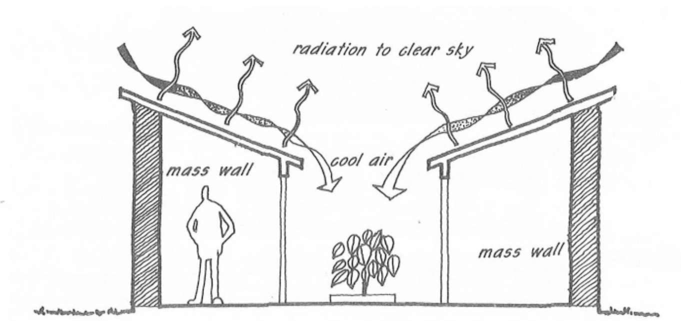


Figure 16.3: Courtyard which combines radiantly cooled convective air "drainage" together with massive exterior walls to delay conductive heat transfer. *(After Trombe, 1967.)*

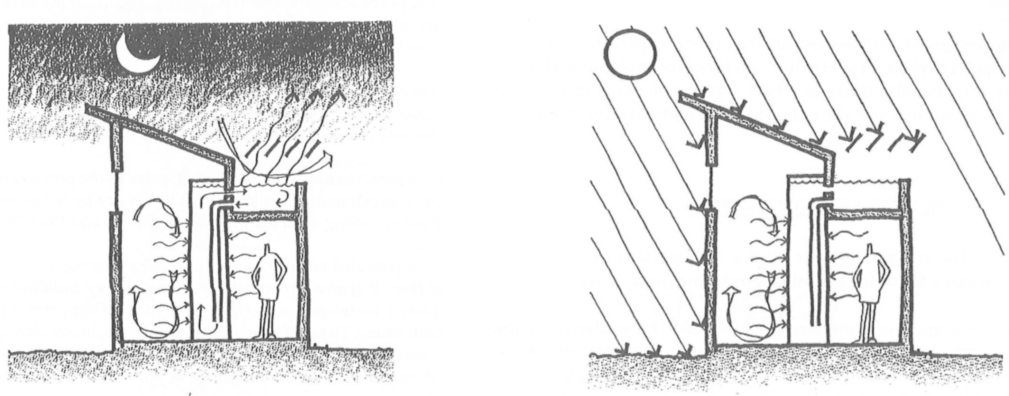


Figure 16.7: Cool pool building: (a) day, and (b) night cooling operation.

Environmental Control Systems:Heating, Cooling, Lighting F. Moore

Ventilation

Ventilation can reduce building temperatures in concert with other cooling strategies such as thermal mass and evaporative cooling or through replacement of hot inside air with cooler outside air. Additionally, fresh moving air *feels* cooler than stale static air. As an example, during hot Mediterranean afternoons, people cluster in shady plazas and courtyards. While temperatures in these shady outside areas are not significantly different than interior temperatures, the breeze and the psychological effect of open space create a more comfortable environment.

In the Las Vegas climate, ventilation alone can effectively cool interior space in April, May, September, and October. During the hot summer months, sufficient wind velocities are present for effective ventilation, but high outside air temperatures prevent ventilation alone from satisfying cooling needs. However, when combined with other strategies such as evaporative cooling, ventilation can effectively contribute to cooling throughout the summer. Additionally, passive ventilation of uninhabited space, such as wall cavities and attics, can dramatically reduce the transmittance of solar heat gain to inhabited space, decreasing the need for other passive or active cooling strategies.

Key Strategies:
- Ventilation of uninhabited space (attics and walls)
- Cross ventilation of inhabited space
- Use exterior low pressure pockets and the "stack effect" to drive passive ventilation
- Passive ventilation combined with evaporative cooling and thermal mass

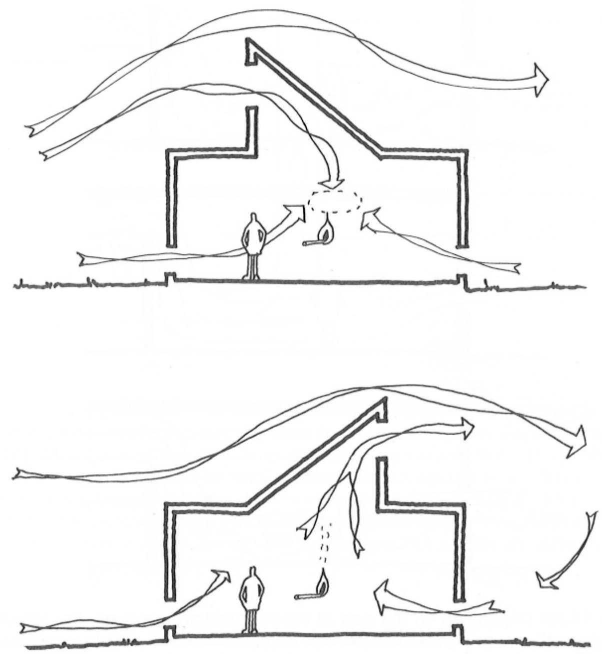


Figure 15.27: A high window acting as a windscoop inlet together with a low outlet must overcome the stack-effect tendency of the warm inside air to rise; reorienting the windscoop to leeward reinforces the stack effect and increases airflow.

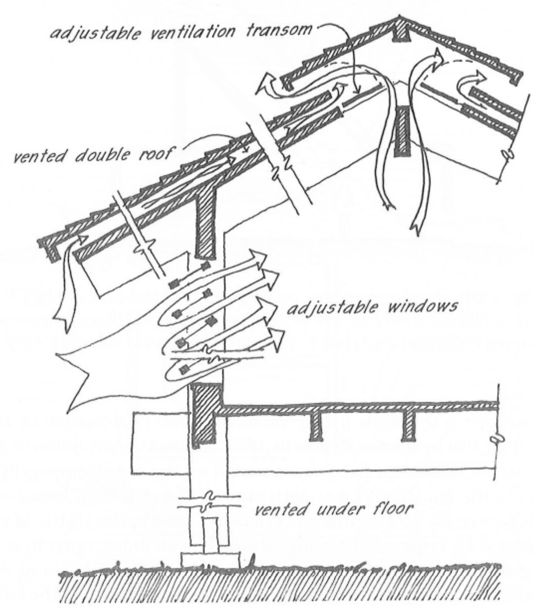
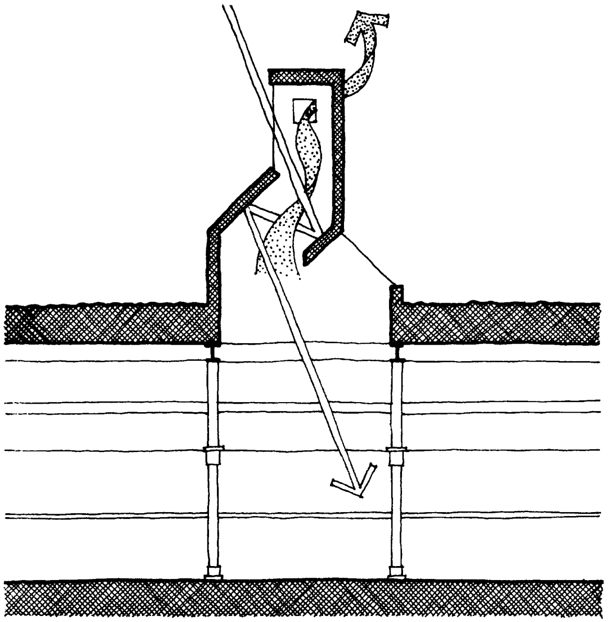


Figure 15.34: A roof-venting strategy for a contemporary house in south Florida that incorporates both adouble roof and cupola for ventilation cooling; note adjustable transom detail for controlling ventilation at ridge. *(Redrawn from Malt and Ripoll, 1981, by permission.)*

Environmental Control Systems:Heating, Cooling, Lighting F. Moore



One University Plaza, Roof Monitor

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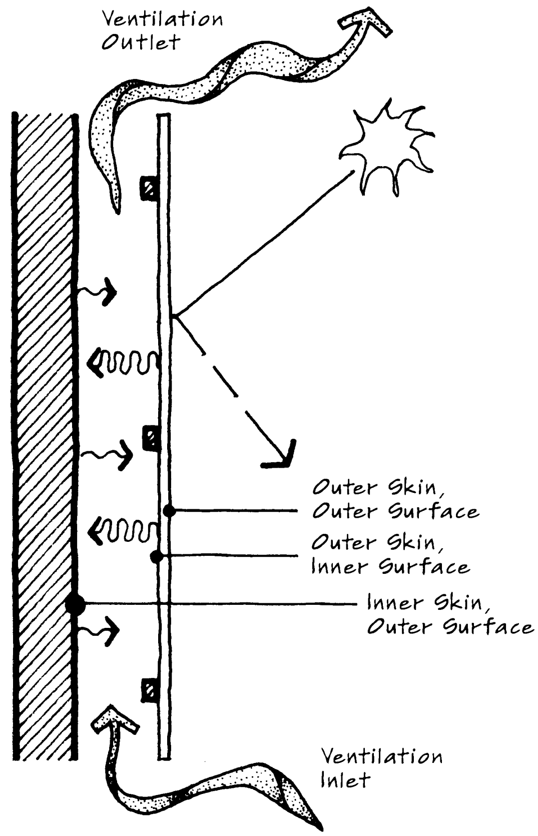
Above: The roof monitor uses the stack effect to pull hot air from the top of the space. Admitted sunlight provides daylight to spaces below while warming interior surfaces of the tower, accelerating passive ventilation.

Right: Ventilation in a double skin wall system



Diagrammatic Section of Double-Skin Wall

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Passive Heating

<u>Overview</u>

While there are many mechanisms to dissipate heat passively, there is essentially only one way to gather heat passively: collection of solar radiation. The Las Vegas climate is well-suited to passive solar design with clear skies for 44 to 66 percent of days during the heating season, while fully overcast days peak at only 36 percent in January. Consistently sunny skies combined with low relative humidities mean a relatively constant and substantial solar heat resource. With proper capture, storage, and retention of this heat, active heating systems should not be necessary in Las Vegas.

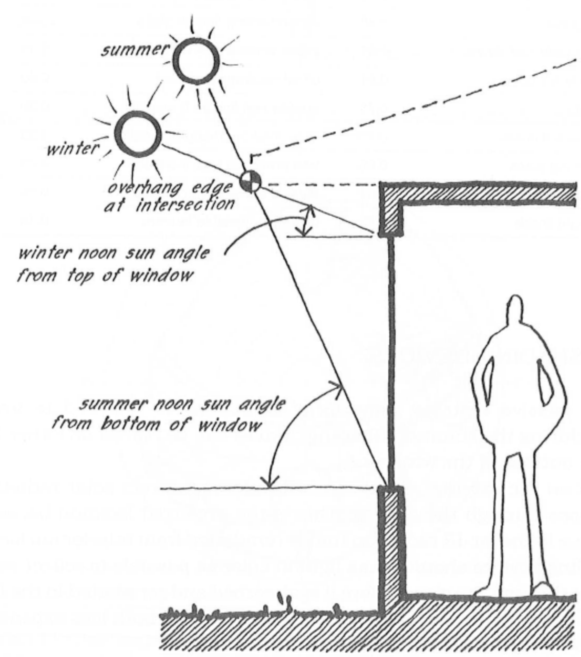


Figure 5.12: Calculating an overhang above a south-facing window.
Environmental Control Systems:Heating, Cooling, Lighting

Passive Heating Strategies

The simplest passive heating strategy is *direct gain*: the absorption of solar radiation in living space, such as the warming effect of south facing windows. In the Las Vegas climate, shading strategies must be employed so that windows are shaded during the cooling season to prevent unwanted heat gain. To increase the effectiveness of direct gain and other passive heating strategies, radiant heat can be stored in *high thermal-mass* materials such as stone, concrete, or water. At night, these materials re-radiate solar heat, keeping interior temperatures higher and more constant. *Sunspaces*, such as sun-rooms and attached greenhouses, capture solar radiation in the same manner as direct gain, however opening and closing vents or doors that connect the sunspace to the house provides more thermal control. Similar to sunspaces, *convective air loops* passing through uninhabitable spaces such as Trombe walls or through bodies of high thermal mass like interior walls or floors allow better control over and distribution of solar-gain heat.

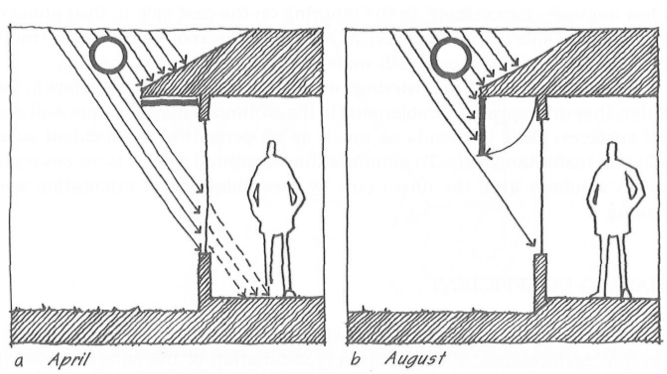
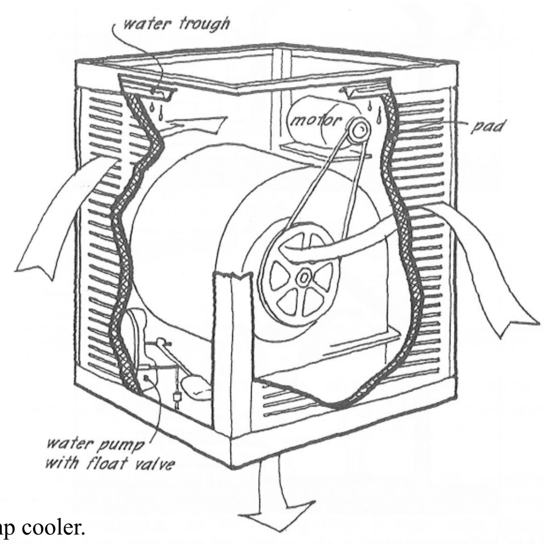


Figure 5.13: A two-position overhang allows solar heating in the spring — April, for example (a), while providing needed shading in the summer — August, for example (b), when the sun path is identical.

Environmental Control Systems:Heating, Cooling, Lighting F. Moore

Active Heating and Cooling, Renewables

With a building envelope that employs a variety of load-avoidance and passive strategies, the need for active conditioning is significantly diminished or completely eliminated. The most cost- and energy-effective active environmental control systems capitalize on passive strategies and are sized for the reduced load generated by an efficient building envelope. Swamp coolers and the emerging Coolerado technology are excellent examples. Both use fan-driven evaporation to cool air. The Coolerado also features a heat exchanger so that supply air is not overly humid. Both systems are as much as three times more efficient than traditional air conditioners. Finally, with an efficient building envelope and efficient active HVAC systems, renewable energy generation - such as solar thermal and photovoltaic arrays - can easily and affordably satisfy remaining energy demands.



Swamp cooler.

Environmental Control Systems:Heating, Cooling, Lighting

Case Studies: Passive Heating and Cooling

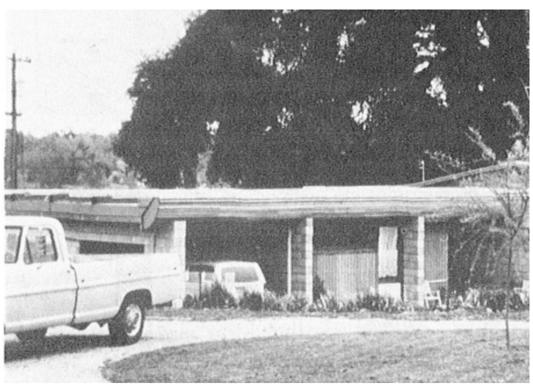
The following case studies demonstrate the integrative process that is critical to the success of passive strategies. Each example incorporates a variety of the strategies discussed above.

<u>The Skytherm House</u>

This Atascadero California house uses radiant heating and cooling of a high thermal-mass roof pond to maintain a comfortable interior temperature without an active HVAC system. Sliding insulation either buffers or exposes the pond to the sun and night sky, according to the season. Additionally, overhangs and fin walls limit unwanted heat gain.

Key Strategies:

- Passive radiant heating and cooling
- Thermal mass



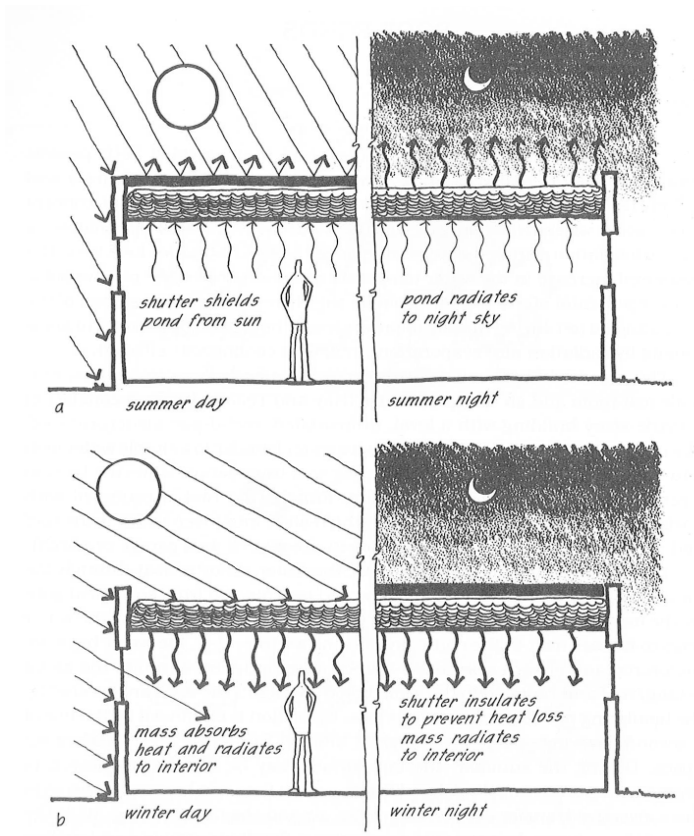


Figure 16.4: Skytherm diagrams: (a) summer operation showing insulation in place over water mass during the daytime and retracted at night, and (b) winter operation showing insulation retracted during the daytime and in place at night.

Environmental Control Systems:Heating, Cooling, Lighting F. Moore

The David Wright House

This Sante Fe New Mexico house uses direct gain, thermal mass, and passive ventilation to maintain thermal comfort. Southern glazing with an overhang, fin walls, and insulating shutters capture solar radiation, which is stored in the exterior-insulated fourteen-inch adobe walls. A supplemental wood stove consumes less than one cord of wood per year.

Key Strategies:
- Direct solar heat gain
- Thermal mass
- Passive ventilation

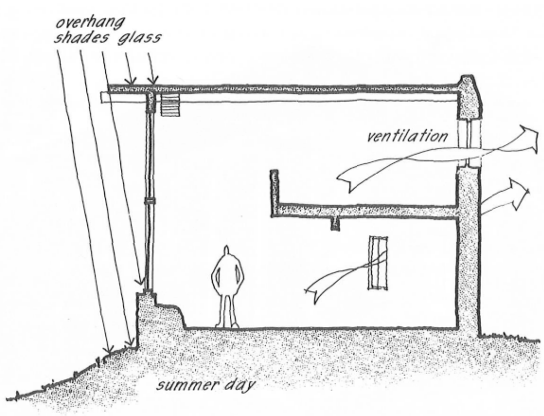


Figure 8.5: David Wright's residence — summer day passive cooling.
Environmental Control Systems:Heating, Cooling, Lighting

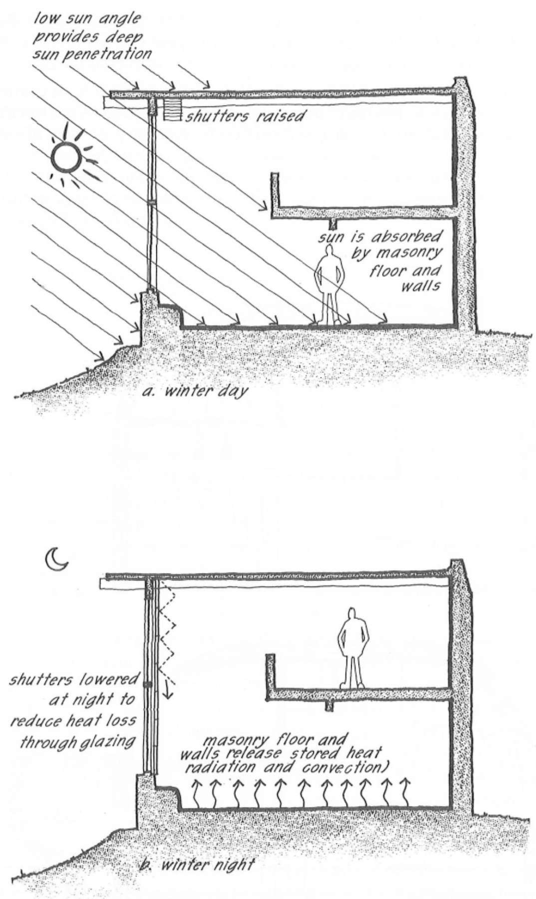


Figure 8.4: David Wright's residence — passive solar heating operation: (a) winter day, and (b) winter night.

UNLV Zero Energy Home

In a cooperative effort, Nevada Southwest Energy Partnership (NSWEP), Nevada Power, Pinnacle Homes, ConSol, and the University of Nevada in Las Vegas Center for Energy Research constructed two 1610 square-foot houses to demonstrate energy efficient residential construction in Las Vegas. The first house was constructed using industry standard techniques and is monitored as a baseline. The second house employed a variety of energy efficiency measures and renewable energy generation to target net zero energy use.

Key Strategies:

- High insulation envelope with radiant heat barriers
- High thermal mass walls
- Overhangs and covered patios to control unwanted heat gain
- Efficient lighting and appliances
- Efficient heating and cooling
- Solar thermal hot water and photovoltaic arrays

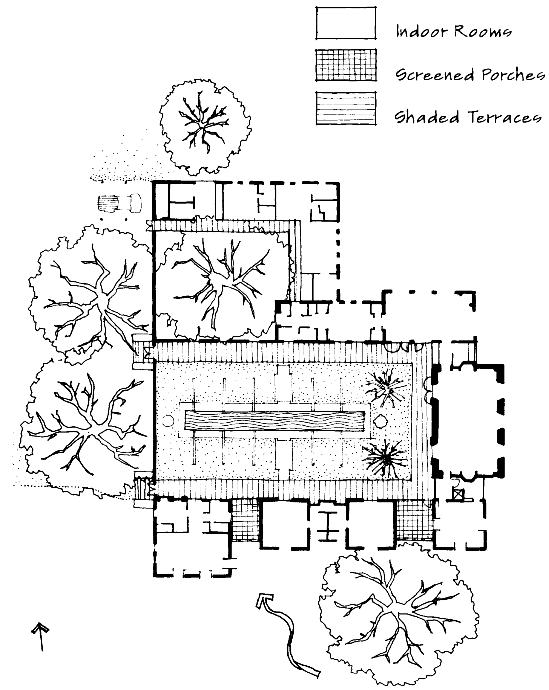
The Zero Energy Home's concrete walls feature both a high insulation value (as high as R-31) and insulated thermal mass exposed to the interior to dampen diurnal temperature swings

On the left, the standard construction baseline house. On the right, the Zero Energy House

El Tule Ranch

This Falfurrias Texas house takes full advantage of its regional- and micro-climate. The house's orientation and massing shades living spaces and promotes infiltration of cooling breezes. Additionally, semi-interior spaces such as porches and shaded terraces are interspersed between indoor rooms to pre-cool ventilation air and funnel air currents to more effectively ventilate the enclosed rooms.

Key Strategies:
- Building orientation and massing limits unwanted solar heat-gain and maximizes passive cooling
- Semi-interior spaces buffer indoor rooms



El Tule Ranch, Falfurrias, TX, Lake/Flato

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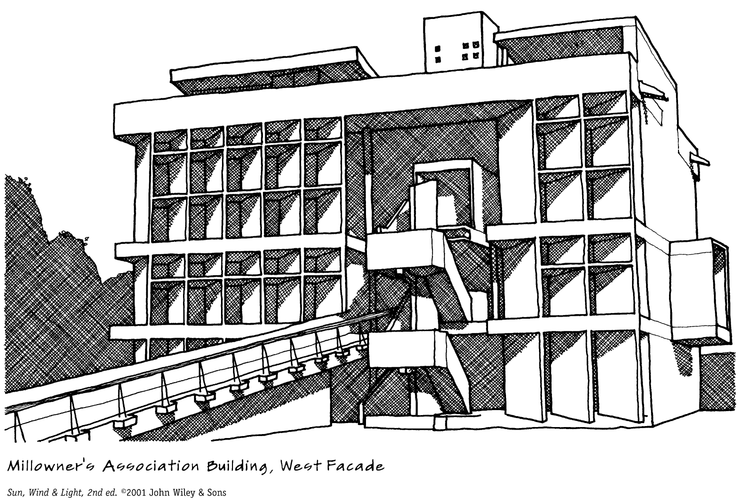
Millowner's Association Building

Le Corbusier's Ahmedabad India office building employs an "egg crate" Bris Soleil both as a circulation space and to shade walls and windows. The combination of horizontal and oblique vertical surfaces effectively blocks out direct sunlight, while emitting diffuse light and maintaining views.

Key Strategy:
- Bris Soleil
- Passive ventilation



Millowner's Association Building, West Facade

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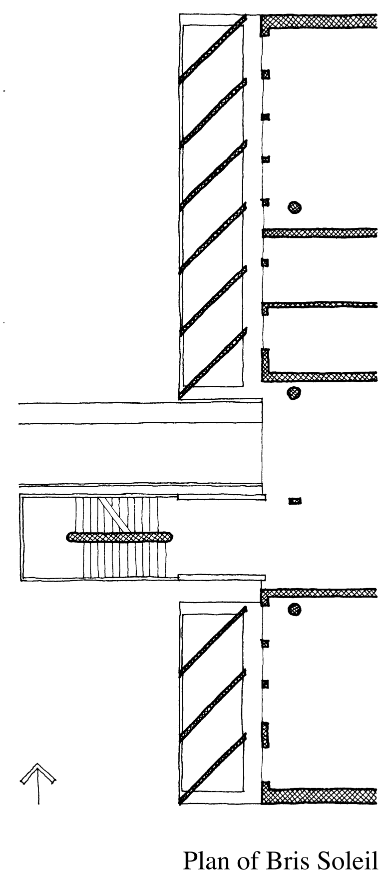


Plan of Bris Soleil

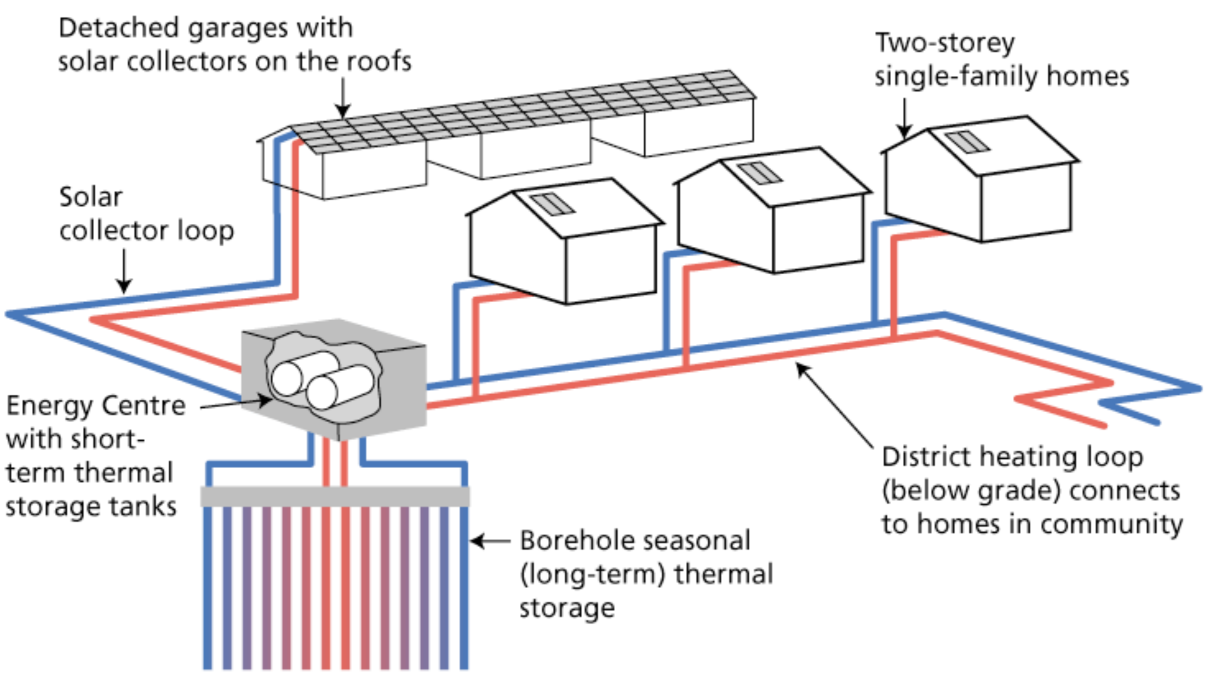
Drake Landing

This Alberta Canada 52-home development has a radically different climate from Las Vegas. However, a number of strategies could be adapted to the development in Las Vegas. Through a better building envelope, Drake Landing homes are 30 percent more energy efficient than conventional homes. Ninety percent of the remaining space heating requirements are met by an active district system that collects solar radiation from garage-top solar panels, stores the heat underground throughout the summer, and redistributes the heat during the winter. An inverse system could function well in Las Vegas. The system would "absorb" winter cold with night sky radiation diffusers and store the coolth underground for summer redistribution.

An arial view of Drake's Landing

Key Strategies:

- Seasonal thermal storage
- District heating and cooling
- Efficient building envelope



Schematic diagram of the district solar thermal system

APPENDIX E:
Synthesized Master Plan Solution

The Synthesized Master Plan Solution (SMPS) is the first iteration in a collaborative effort amongst various project stakeholders to integrate the most prevalent schematic concepts from the preceding charrette.

As a result of the consensus to begin development within the southern-most sector of the considered parcel of land north of Moccasin Road, the SMPS only considers this particular region. Although not a recommendation of the charrette participants, development northeast of the Wash may occur. Therefore, infrastructure of the SMPS is designed to receive two major vehicular arterials that span the Wash at points where ecological harm may be minimized. Conversely, the SMPS does anticipate future development in the northwest sector of land. As a result, a minimized arterial is designed to cross the "pinch point" between the Wash and the Paiute reservation.

The SMPS embodies the prevalent and compelling large-scale development solutions to come out of the charrette. The following description defines the SMPS in terms of five primary issues that transcend the preceding schematic efforts.

1. Protect and Celebrate the Las Vegas Wash
Essentially, the SMPS treats the Las Vegas Wash as a natural border for all development.

Multi-use parks and publicly-accessible walking and biking trails along the Wash strengthen its function as a boundary. For reasons of public surveillance and access, the development reserves a two-lane transportation arterial adjacent to the Wash's lining of parks and publicly-accessible trails. To further protect the Wash, strategically designed swales run along this street. The plan leaves the northeast portion of the site undeveloped in order to preserve the natural beauty and functionality of both the Wash and the mountains beyond. As access to this ecosystem is highly valued by the Paiute community, the planned arterial separating the reservation from the Wash is minimized. A subtle increase in population density near the Wash further provides "eyes on the Wash," which may incorporate a neighborhood watch program that focuses on the Wash. A school is located on the Wash boundary that opens into the trail system in order to foster an appreciation for the Wash among students. In addition, small retail stores and restaurants are placed along the wash at various locations for both Wash security and to take advantage of the views toward the Wash and mountains.

Provisions in the plan are designed such that if both sides of the wash were to be developed, the Wash will be spanned at strategic points with minimum-impact bridges that will not conflict with the Wash's paleontological sites or flood capacity.

2. Create Three Distinct, Walkable, Mixed-Use Business Districts
An overarching recommendation from the charrette was to develop two to four distinct, walkable, mixed-used business districts. The SMPS plans for three – each varying in scale and offering a diverse choice in housing and amenities. The districts are designed to stand as independently viable urban areas – cities within a city – that will serve residents' primary need and more.

The first district, or node, will be located on the south end of the development, just north of Moccasin Road. Termed the *Regional Center*, this district will be the most dense of the three districts. It is envisioned as the development's primary point of entry. This node will feature an appropriately sized gaming complex, major retail stores, commercial facilities, light industrial buildings, and at least one Civic Center. The Regional Center will function as a regional service hub – drawing in visitors from surrounding communities and beyond. The second district, the *Village Center*, is centrally-located in the overall plan and is meant to serve the surrounding neighborhoods. A community destination, it will feature primarily three-to-four story mixed-use and residential structures. The smallest of the three districts, the *Neighborhood Center*, is separated from the other districts and exhibits one-to-two story small retail stores and neighborhood restaurants. It is the least dense of the three nodes and is intended to be utilized as an area where neighborhood markets may flourish. While exact zoning restrictions will vary between the districts, no building is to ever be built above 6 stories. The number of stories will decrease as one travels away from the district's core. Beyond the districts, the development will primarily feature single-family units.

3. Establish a Multi-Modal, Hierarchical Transportation Network
Modes of transportation will include: automobile, bus rapid transit, and commuter bike and pedestrian trails (via an integrated greenway). Traffic calming elements are provided to ensure walking safety. Strategies such as shorter blocks, "bulbed" street corners, reduced driving speeds, roundabouts, mid-block crossing, and strategically situated alleys and bicycle paths make the streetscape safer and more attractive for pedestrians and bicycle transportation.

Within the development, the principal roadway (Ft. Apache) is split (from the Regional Center to the Village Center) into a pair of two-lane, two-way streets before the street enters the Neighborhood Center district. (This is an alternate scheme that provides the same number of traffic lanes as the single four-lane boulevard described in the report on page 19.) All roadway sizes are based on traffic estimates and were kept to their minimum allowable widths with allowance for expansion where necessary. Through an integrated greenway, a hierarchical transportation design enables commuter bike travelers to reach the heart of the business districts in less time than by using vehicular surface streets. Special attention was also given to the "walkability" of the development's three main districts, where the needs of daily life are provided within 1/5 mile (which is considered to be a typical 5-minute walking distance).

4. Provide a Connection to the Natural Environment
The SMPS provides residents with a multitude of connections to the neighboring wildlife refuges and contiguous native habitat via an integrated greenway belt that permeates the development. A mix of irrigated landscape and xeriscape / indigenous landscape, the greenway integrates natural systems deep into the master plan's developmental footprint. The belts control the flow of stormwater runoff toward the Wash, while purifying the runoff via constructed swales and wetlands. Moreover, recreational parks are scattered throughout the residential districts and along the Wash.

5. Efficiently Use Energy and Other Resources
Overall resource efficiency was a major component of the SMPS. Foremost among various resources was energy. Various components of the development have lent themselves to energy efficiency. The more prevalent among these components is the development's primary street grid – which is oriented 15 to 30 degrees off of due East-

West to maximize solar access while providing summertime wind-current flushing of streets. Parking garages and some on-street parking areas are designed to be covered with solar –electric and solar-thermal equipment. Through the implementation of such features, it is also intended that the SMPS's greenhouse gas footprint be 80% smaller than the Las Vegas norm. Water conservation is achieved, in part, through the specification of low-maintenance indigenous species. Detention ponds may also be integrated into some of the open spaces to collect and use purified water for irrigation purposes.