BUILDING LEADERS 2013 AIA Convention June 20-22, Denver

AIA

MASTER PLANNING FOR NET-ZERO ENERGY AND OTHER INTERTWINED SUSTAINABLE SYSTEMS

Michael Tavel AIA, David Kahn ASLA

Course FR102, Friday June 21, 7:00 AM, LU 1 HSW

OBJECTIVES

Introduce an approach to planning that:

- ***Integrates Energy Conservation and Production***
- ***Intertwines Stormwater with Civic Space***
- ***Fosters Environmental Stewardship and Community Life***
- ***Utilizes Climate Specific Strategies***

ENVIRONMENTAL CONCEPTS

- ***Appropriate Use of Land***
- ***Energy***
- ***Water***
- ***Ecology***
- ***Materials***

SOCIAL CONCEPTS

- ***Community***
- ***Equity, Affordability, and Inclusiveness***
- ***Enfranchisement***
- ***Opportunities for Stewardship***
- ***Health and Well-Being***

LIVING OVER THE STORE:
- For small families, singles, couples, seniors.
- Second and Third story condos upstairs

STACKED FLATS:
- For singles, couples, seniors, small families
- 800-1,000 SF 1BR

GRANNY FLAT:
- For relative, caregiver, or young singles.
- 600 sf 1 BR

LIVE/WORK HOME:
- For families with work at home parent
- 2,000 sf 3BR

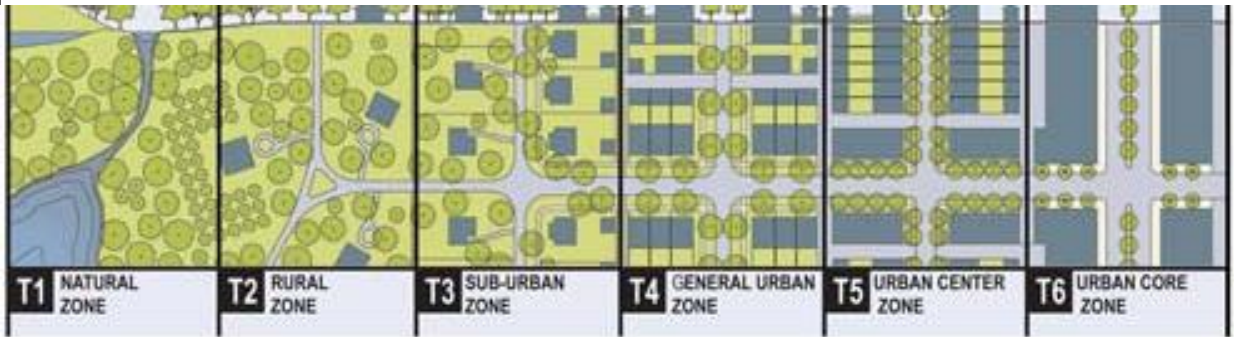
ECONOMIC CONCEPTS

- ***Local Resilience***
- ***Local Economic Relationships***
- ***Efficient and Renewable Use of Local Resources***
- ***Local Food Production***
- ***Financial Viability***

COMPETING PARADIGMS

SMART GROWTH

- *Coordinating Land Use with Transportation*
- *Higher Density =*
  - *Lower environmental impacts per capita:*
  - *Lower CO2 Emissions, lower resource consumption*
- *Sustainability of Infill, as well as Historic Preservation*
- *Brownfields (build in Detroit, not in the West)*
- *Emphasis on North American, East Coast, Urban Form*



LANDSCAPE URBANISM

- ***Emphasis on Process over Form***
- ***Natural processes that underlie man-made environments***
- ***Layering of natural and ecological systems with human systems***
- ***Temporal and successional processes: Cities form a complex ecosystem - a complex web of relationships - that emerges over time***

RE-LOCALIZATION

- ***Local Resilience***
- ***Local Economy***
- ***Local Food (“The Food Shed”)***
- ***Urban Homesteading***

CLIMATE-RESPONSIVE URBANISM

- ***Passive design in urban contexts***
- ***Reducing resource demands through morphology and behavior***

CLIMATE-RESPONSIVE URBANISM

- ***In the era of cheap energy, we have forgotten how to employ passive means to reduce our demand for resources.***
- ***In addition to technology, we need to relearn what was lost, and first reduce our demands through passive design and sustainable practices.***

SUSTAINABILITY AS A PRACTICE

Sustainability is not a technology.
Sustainability is not a public policy.
It is not a morphology, or a system.
It is not these things by themselves.

Sustainability is a practice. A cultural behavior. It is coupled with morphology, systems, technology, and policy.

TRADITIONAL ENVIRONMENTS

For 10,000 years, sustainable systems have been woven into the morphology of urban development patterns.

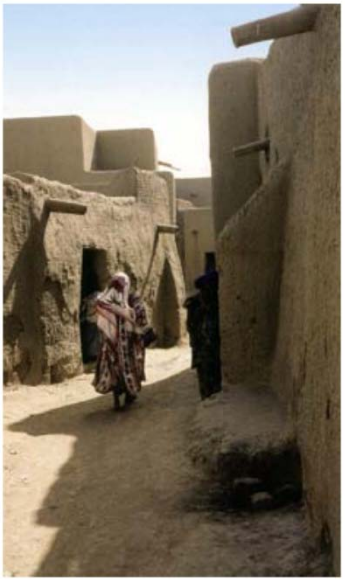
Those patterns were fine tuned for the conservation and harnessing resources, and making a climate habitable.

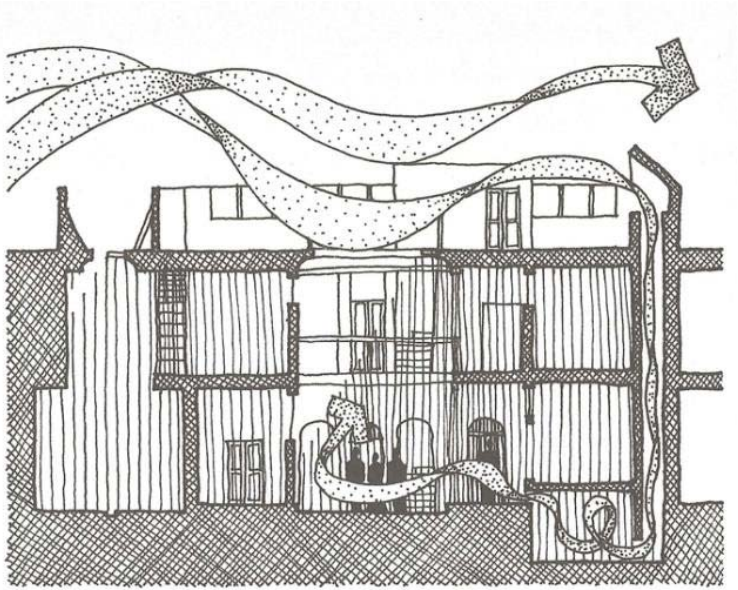
Sustainable systems, and sustainable morphologies, were coupled with sustainable practices.

THE AGRARIAN VILLAGE: A universe of cultural knowledge about Climate, Sun, Water, Food, and Energy

HOT ARID CLIMATES

EVAPORATIVE COOLING
COURTYARDS
NARROW PEDESTRIAN LANES

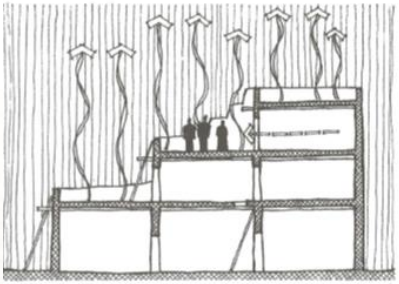




Iraq House Summer Day

DIURNAL CLIMATES

A CULTURE OF CLIMATE, ACCLIMATING TO THE SEASONS



COLD CLIMATES

COMPACT, ATTACHED FORMS

DESIGN WITH CLIMATE

VICTOR OLGYAY, 1960

STRATEGIES FOR PASSIVE DESIGN FOR FOUR CLIMATES:

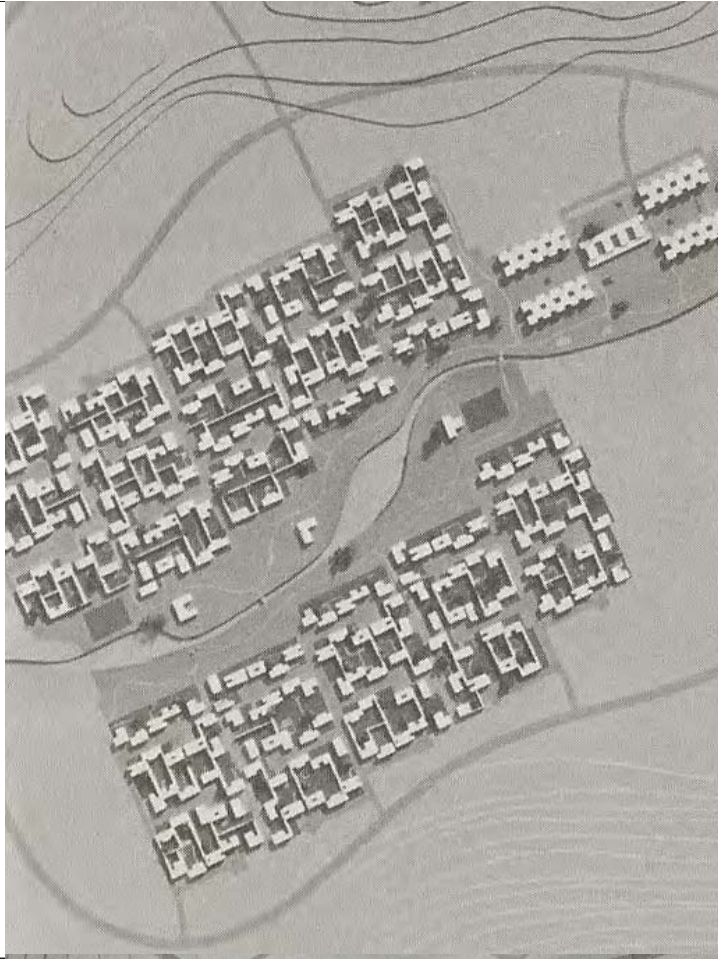
1) ***COLD***
2) ***TEMPERATE***
3) ***HOT ARID***
4) ***HOT HUMID***

He looked at a passively designed morphology for the built environment of the suburban world that was envisioned as the predominant future back in 1960.

HOT ARID CLIMATE

PHOENIX

1) *Breezes do not cool you. Evaporation and shade cool you*
2) *Block out the sun from heating the human environment*
3) *Courtyards*
4) *Slight east-west elongation*
5) *Minimize east and west exposure*
6) *Windows should be small, and shaded*



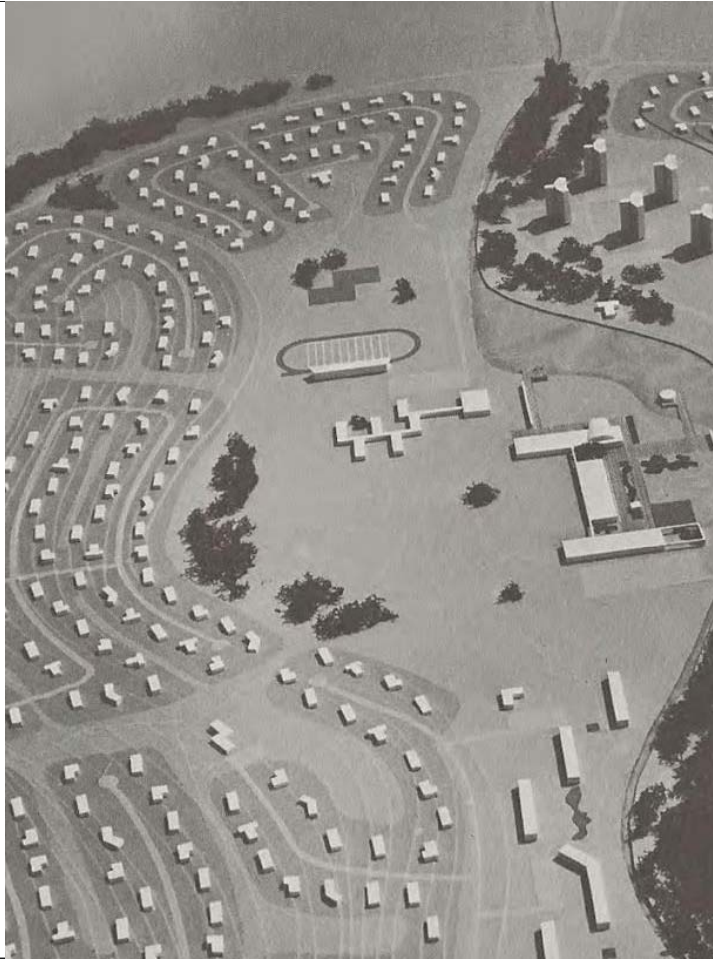
COLD CLIMATE
MINNEAPOLIS

1) *Compact Structures*
2) *Attached Structures*
3) *Slightly elongate east to west*
4) *Shelter against winter winds*
5) *Capture winter sun*
6) *Small windows except on south*
7) *Deciduous trees for summer shade.*

TEMPERATE CLIMATE

NEW YORK CITY

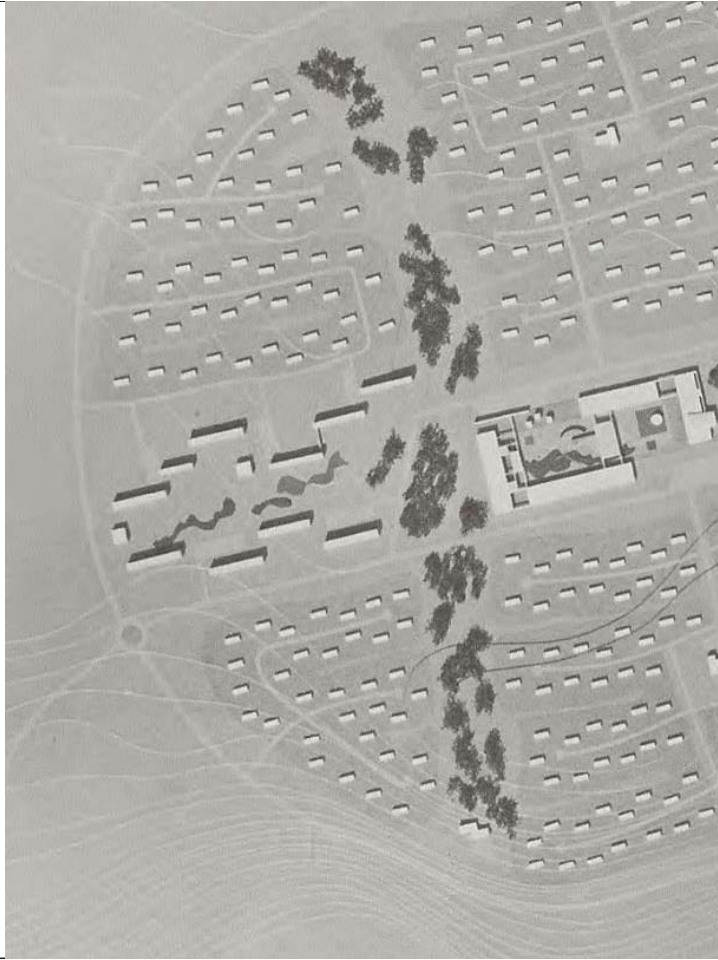
1) *Buildings open to south and southeast, closed to west*
2) *Elongate east to west*
3) *Cross ventilate in summer*
4) *North-South Wings ok for capturing summer breezes*
5) *Shade trees on east and west.*
6) *Outdoor living.*



HOT HUMID CLIMATE

MIAMI

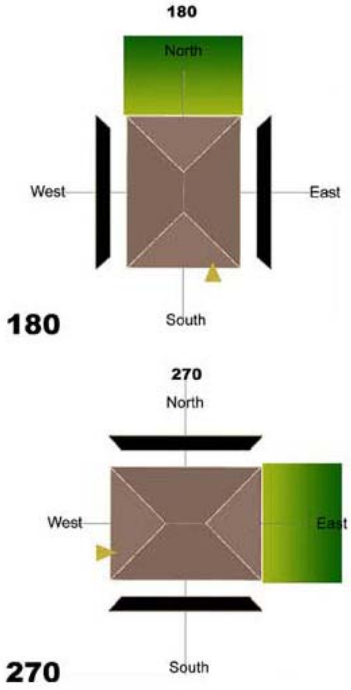
1) ***Maximize breezes for cooling***
2) ***Separate and stagger buildings to capture breeze***
3) ***Minimize walls and maximize overhead shade from roofs and trees***
4) ***Block east and west sun***
5) ***Minimize surface area of building facing east and west***



Study by BIRA (Building Industry Research Alliance)

Stretching the same rectangular suburban home in an east-west orientation, versus north south, reduced annual heating and cooling loads by 70% in San Diego, and 30% in Sacramento.

Rules of thumb supported by peoples' energy bills.



PASSIVE DESIGN

SOME CONCLUSIONS:

This is a huge body of regional knowledge that should be learned and researched.

We can learn much by researching traditional environments around the globe, in climates similar to those in which we practice.

We need to give regional passive design strategies a clear vocabulary, and incorporate it into our work as sustainable systems.

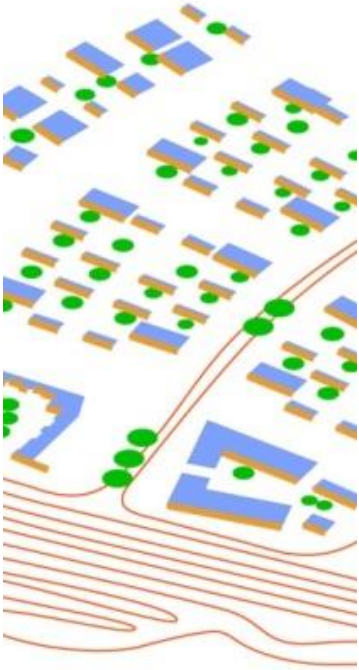
INTERTWINED SUSTAINABLE SYSTEMS:

INTERTWINED SUSTAINABLE SYSTEMS:

ENERGY CONSERVATION:
Passive cooling and heating

ENERGY GENERATION:
Active Solar or Ground Source

STORMWATER OPTIMIZATION:
Water Quality and Passive Irrigation



INTERTWINED SUSTAINABLE SYSTEMS:

FOOD PRODUCTION:
At Community and Private Scales

ECOSYSTEMS AND HABITATS:
Natural and Constructed

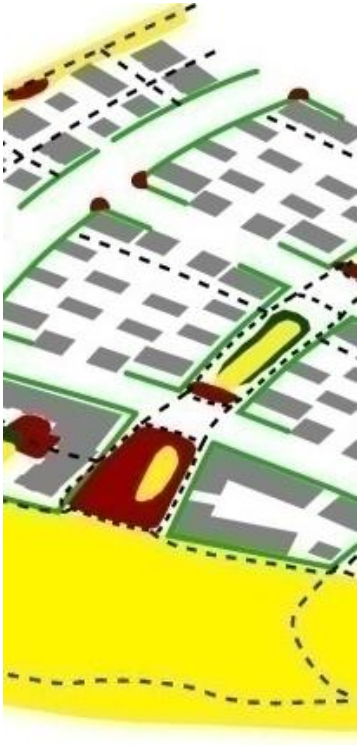
SOCIAL ENVIRONMENTS:
Supporting Community and a Culture of Stewardship

INTERTWINED SUSTAINABLE SYSTEMS:

CIRCULATION AND CONNECTIVITY:
Walking, Biking, and Integrating Modes

DIVERSITY OF HOUSING OPTIONS:
Supporting affordability, and a diverse population

MIXTURE OF USES:
Local Work and Services



BedZED

South London – Built 1998-2002, Bill Dunster, Architect

- *82 Unit Mixed Use Zero Energy Development*

Energy & Resources

- ***East-West Layout for maximum solar exposure***
- ***North-South Spacing for solar access***
- ***Compact & Attached***
- ***Super-insulated, air tight building envelope***

Energy & Resources

- ***South Facing Conservatories for Living Spaces***
- ***South Facing Gardens***
- ***Photo Voltaic Panels on south facing roofs***

Energy & Resources

- ***North Sloped Roof-scape for Work Spaces***
- ***Green Roofs Built into North Slopes***
- ***Wind Driven Ventilation with Heat Recovery System***
- ***90% reduction in space heating***

CIRCULATION & CONNECTIVITY

- ***Driving Lanes and Parking on Periphery***
- ***Pedestrian Interior Space***

CIRCULATION & CONNECTIVITY

- ***Electric Vehicle Charging Stations***
- ***Car Sharing Program***
- ***Train, Bus, & Tram Links***

SOCIAL ENVIRONMENTS

- ***Community Facility***
- ***Café,Gallery, Event Space***
- ***VegZED Food Co-op and Farmer's Mkt.***
- ***Yoga, Tai Chi, Drama, Dance, Exercise Classes***

SOCIAL ENVIRONMENTS

- *20 DU/Acre*
- *Mix of unit sizes and prices*
- *Affordable and market rate, for sale and for rent.*
- *27,000 sf office*
- *Green Lifestyle Officer*

DAS SONNENSCHIFF - “Solar Ship”

Freiburg, Germany - 2004, Rolf Disch, Architect

52 Unit Mixed Use Net-Plus Energy Neighborhood

ENERGY & RESOURCES

- ***Buildings Aligned East-West***
- ***North-South Spacing for solar access***
- ***Compact & Attached***
- ***Super-insulated, air tight building envelope***

SOLAR LAYOUT

- ***South Facing Shed Roofs***
- ***Solar Panels double as Sun Shades***
- ***Solar Overhangs***
- ***South Facing Landscapes***

CIRCULATION & CONNECTIVITY

- ***North-South Vehicular Lanes***
- ***Parking on Periphery***
- ***East-West Pedestrian Passages***
- ***Sheds and Hedges Screen Lanes for Privacy***

COURTYARD MICROCLIMATES

- ***Sheltered from Wind, Sound, and Traffic***
- ***Network of Lanes, Pathways, and Social Spots***
- ***Create Intimate Neighborhood***

ECONOMIC VIABILITY

- ***Mixed-Use Solar Ship***
- ***Natural Food Store***
- ***Pharmacy***
- ***Offices and Retail***
- ***9 Rooftop Dwellings***

ECOLOGY, STEWARDSHIP, AND INDOOR/OUTDOOR LIVING

GREEN ROOF GARDENS

- *Open to South Facing Outdoor Rooms*
- *Passive cooling, water retention, food and habitat*
- *Rain Water and Grey Water Recycling for Irrigation*

GREENSBURG GREEN NEIGHBORHOODS

Greensburg, Kansas
By a collaborative team led by Michael Tavel

Meeting the needs of
seniors, children, and non-nuclear families

SUSTAINABILITY & COMMUNITY

CHILDREN & FOOD

SENIORS & NEIGHBORS

AFFORDABILITY

NET-ZERO ENERGY
(THE PASSIVE HOUSE)

WATER & GARDENS

THREE INFILL SITES/TYPES

GREEN MARKET:

- Farmer's market hall on Main Street facing the new city park.
- Living over the store: with upstairs condos.
- Passive solar and net-zero energy.
- Community Garden and outdoor living in the back.

GREEN YARDS:

- Net-zero energy, passive solar, modular homes.
- Vegetable gardens and outdoor living protected from wind by hedge rows.
- For medium, large and extended families.
- Room to expand. Accessible ground level bedroom. Granny Flat out back.

GREEN VILLAGE:

- A town within the town: a city block rebuilt as an intergenera-tional, sustainable community.
- Seniors, extended families, single moms, young folk.
- Common and private vegetable gardens.
- Community Building, Elder Care Center, and play areas.
- Net-Zero energy, passive solar, modular homes.

FAMILIES

CHECKERBOARD HOMES:
- For families and extended families
- 1,700 sf 3-4BR
- Optional Ground Level Bedroom
- Extra bedrooms in basement
- Optional Granny Flat in Back Yard

SENIOR COTTAGE:
- For couples, singles, small families.
- 900 sf 1BR, plus basement
- Ground level bedroom
- Extra bedrooms in basement

LANE HOUSE:
- For families including single parent families
- 1,600 sf 3BR
- Extra bedrooms in basement

LIVING OVER THE STORE:
- For small families, singles, couples, seniors.
- Second and Third story condos upstairs from the Green Market, and the Community Building on the Green Village.
- Average size 800 sf 1 & 2BR

STACKED FLATS:
- For singles, couples, seniors, small families
- 800-1,000 SF 1BR

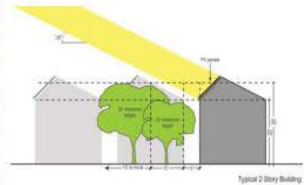
GRANNY FLAT:
- For relative, caregiver, or young singles.
- 600 sf 1 BR
- Flat over garage behind Checkerboard Home

LIVE/WORK HOME:
- For families with work at home parent
- 2,000 sf 3BR
- 400 sf Ground level work space can also be used as guest suite or family room.

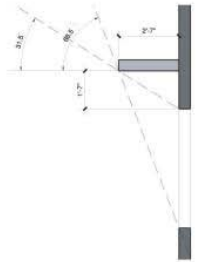
NET-ZERO

PASSIVE SOLAR SITE PLANNING: Stretch buildings out east to west. Space buildings for winter passive solar gain. Shade east and west sides with deep porches and deciduous shade trees.

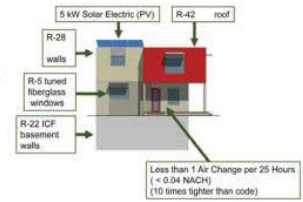
PASSIVE SOLAR BUILDING PLANS: Minimize doors an apertures to the north. Shade south facing windows from summer sun. Shade east and west windows with deep porches. Service spaces to the north, living spaces to the south. Air lock mud room entries.



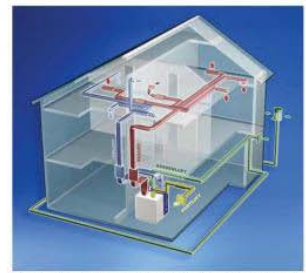
COORDINATE ROOFTOP ACTIVE SOLAR ACCESS WITH LANDSCAPE DESIGN. Photovoltaic panels must stay clar of small mid-day shadows even in winter.



OPTIMIZE OVERHANGS OVER SOUTH-FACING WINDOWS TO BLOCK SUMMER SUN, BUT LET IN WINTER SUN.



HIGH PERFORMANCE, AIR-TIGHT BUILDING ENVELOPES. Factory-built, modular construction is air-tight, combining glue with fasteners.



GEO-ASSISTED ENERGY RECOVERY VENTILATORS (HRV) can replace the furnace in a home with such small heating and cooling loads. Incoming air is tempered by earth tubes. A ground source loop provides cooling in summer, and heating in winter with assistance of a heat pump.

GREEN MARKET

NEW PARK

PHOTOVOLTAIC PANELS

PASSIVE SOLAR APARTMENTS

FARMERS' MARKET HALL AT GROUND FLOOR

PLAY AREA

GREEN

COMMUNITY GARDEN

GARDENER'S COTTAGE

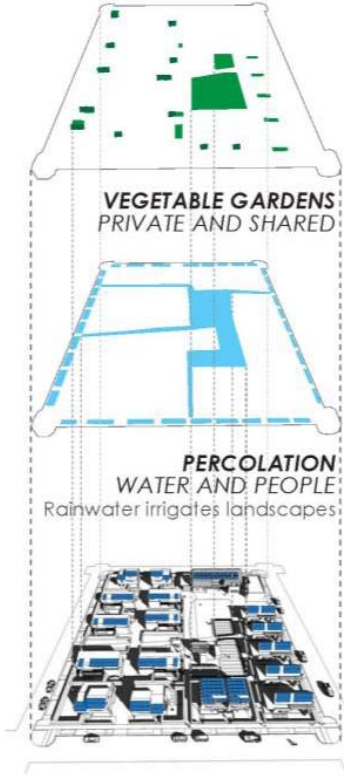
FAMILY APARTMENTS

GREEN YARDS

GREEN YARDS

- GRANNY FLAT
- CLOTHES LINE
- FRUIT TREES
- OUTDOOR EATING
- PORCH LIFE
- COMPOST AND POLLINATING BEES
- WIND-BREAK HEDGE ROWS PROTECT OUTDOOR LIVING FROM THE WIND
- VEGETABLE GARDEN
- OUTDOOR EATING
- PV PANELS
- PORCH LIFE
- WIND-BREAK HEDGE ROWS
- FRUIT TREES
- STREET TREE RAIN GARDENS

GREEN VILLAGE



VEGETABLE GARDENS
PRIVATE AND SHARED

PERCOLATION
WATER AND PEOPLE
Rainwater irrigates landscapes

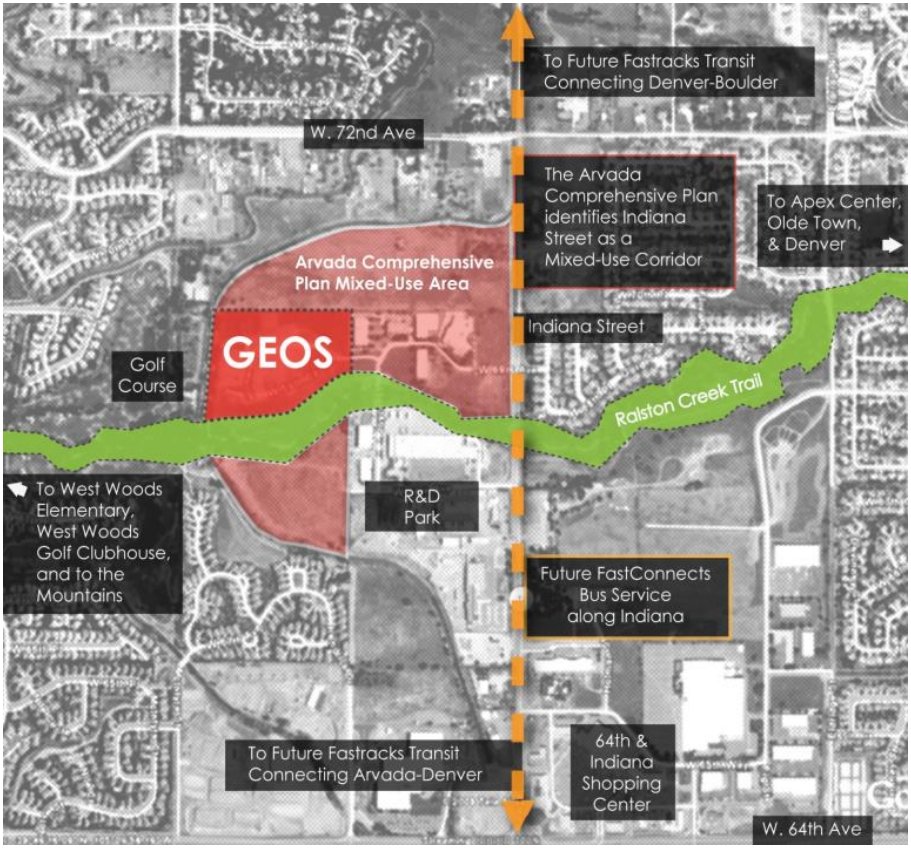
SOLAR
PASSIVE AND ACTIVE
Buildings spaced and oriented for passive heating and cooling

GEOS NET-ZERO ENERGY NEIGHBORHOOD,

Arvada, CO

Michael Tavel Architects and David Kahn Studio

Mixed-use neighborhood that incorporates sustainable systems, and supports opportunities for sustainable living.


To Future Fastracks Transit Connecting Denver-Boulder
W. 72nd Ave
The Arvada Comprehensive Plan identifies Indiana Street as a Mixed-Use Corridor
To Apex Center, Olde Town, & Denver
Arvada Comprehensive Plan Mixed-Use Area
GEOS
Indiana Street
Golf Course
Ralston Creek Trail
To West Woods Elementary, West Woods Golf Clubhouse, and to the Mountains
R&D Park
Future FastConnects Bus Service along Indiana
To Future Fastracks Transit Connecting Arvada-Denver
64th & Indiana Shopping Center
W. 64th Ave

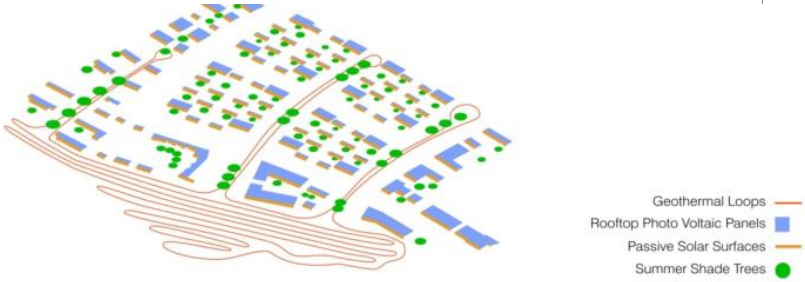
Net-Zero Urbanism

Urban Density optimized with Passive Solar Orientation

High performance "Passive House" building strategies

Energy comes from Photovoltaics and Ground Source Loop Fields.

***There are no natural gas lines.**



Civic Stormwater

Rain Gardens in every yard and courtyard

Street Tree Rain Gardens between sidewalk and curb

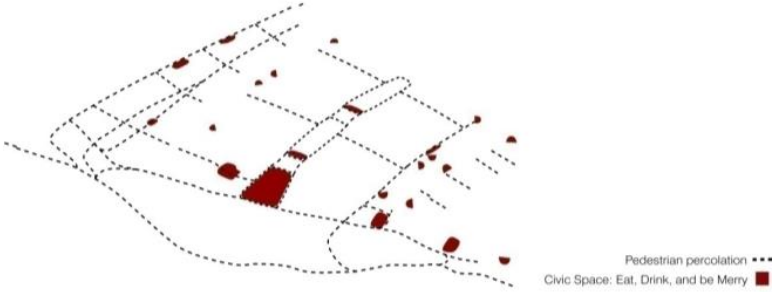
Percolation Parks threaded through neighborhood

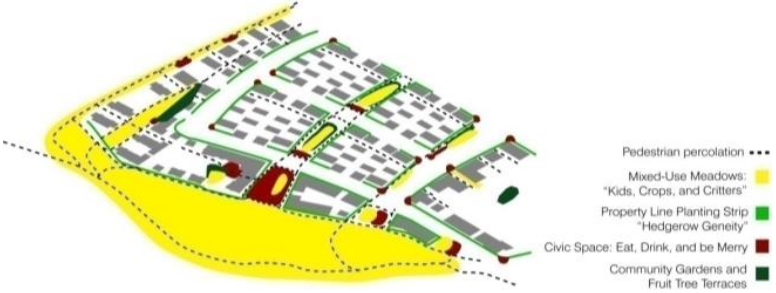
Community Stewardship: "Be The Resource"

Integrate contact with nature into everyday life

Agriculture at private and community scales

A diverse path and plaza network that fosters a walkability, community and outdoor living





Views Looking West of Regional Greenway and of Site

Design Process: Site Reconnaissance

Identifying a site's qualities and potential

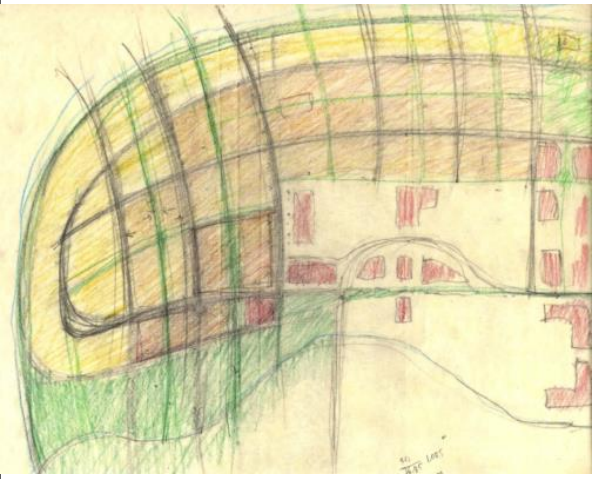
Special Places:

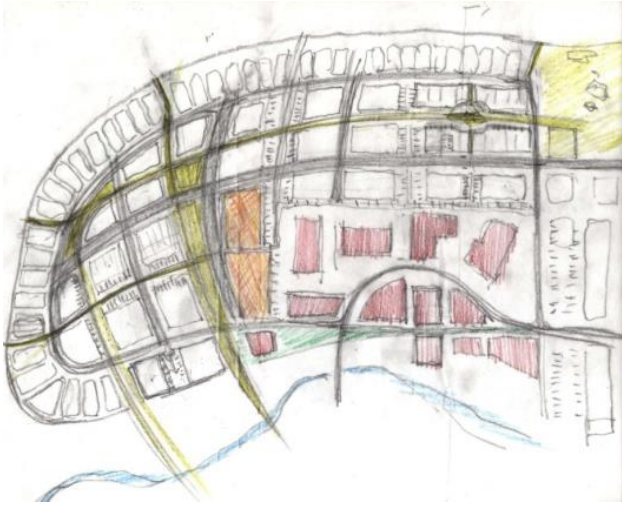
View from the top of a small bluff overlooking the lower floodplain

The creek

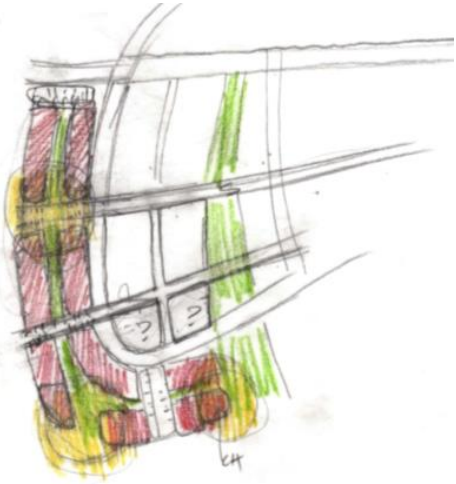
Mapping of Systems

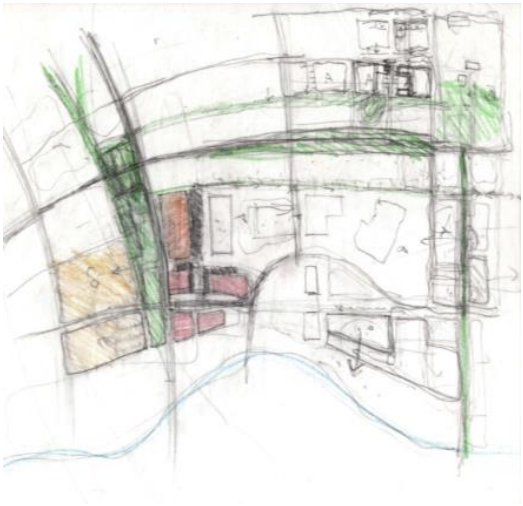
Latent site qualities articulated in design sketches. Flow of circulation, water, and land uses





Frameworks of drainage and positive open space.





Solar Spacing and Drainage Ways

Mixed Uses, Developable Lots, Blocks, Zoning, Parking…

Solar Development Pattern Research: Looking Internationally

BERLIN

LA PAZ

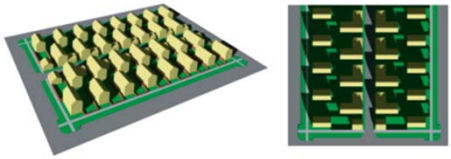
ASUNCION

DENVER

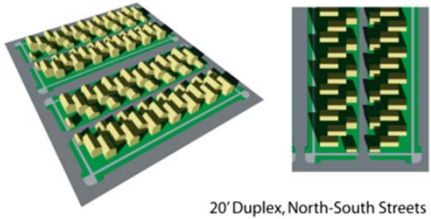
Geos Plan Based on Traditional Development Pattern

DENVER'S HIGHLAND NEIGHBORHOOD

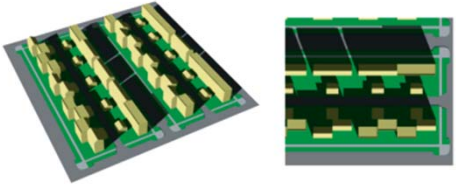
Integrate Passive Solar & Optimize Solar Orientation with Urban Density



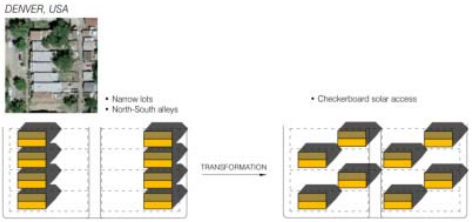
Checkerboard Single Family



20' Duplex, North-South Streets

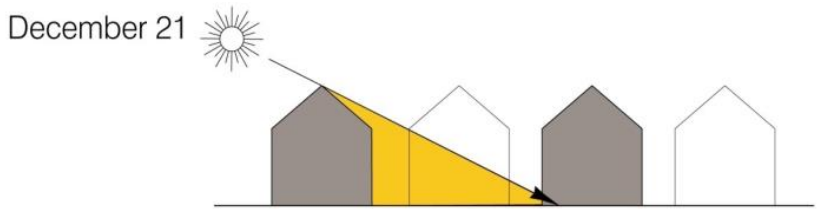


35' 3-Story Townhouse or Live/Work
or 2-Story Townhouse over Flat

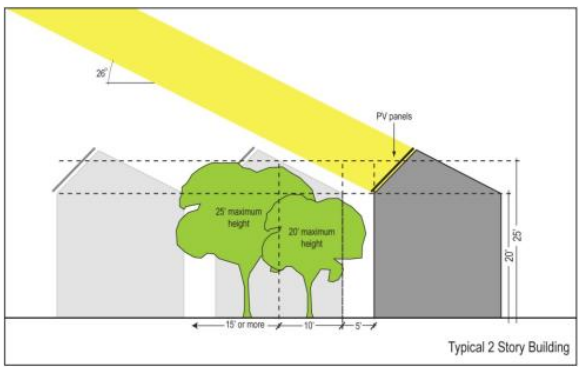


TRANSFORMATION DIAGRAMS

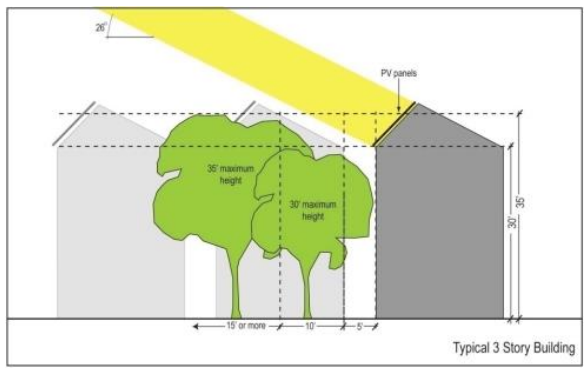
Integrate Active Solar:
Coordinate Tree Heights with Active Solar Access



HOMES SPACED-APART FOR WINTER PASSIVE SOLAR GAIN



Typical 2 Story Building



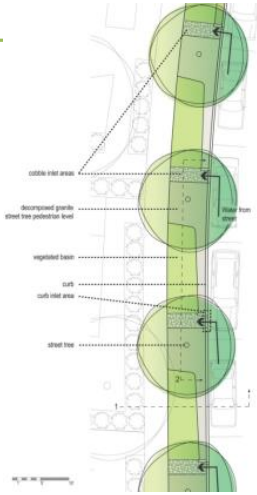
Typical 3 Story Building

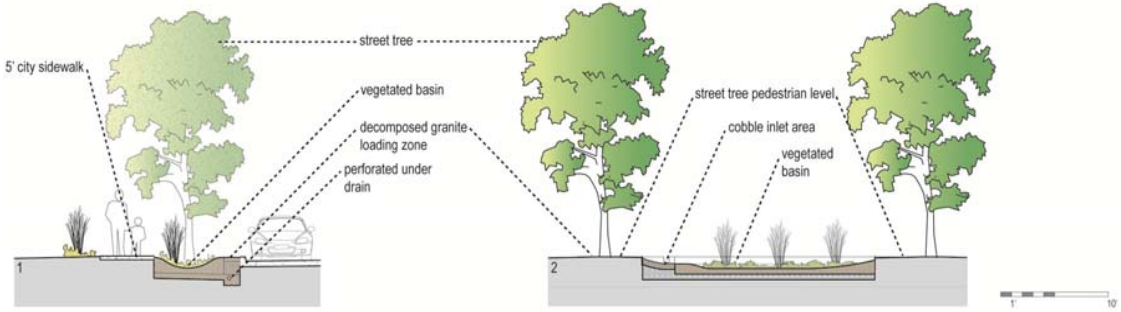
Master Land Use Plan

Bio-Civic Realms

Network of Social Spaces

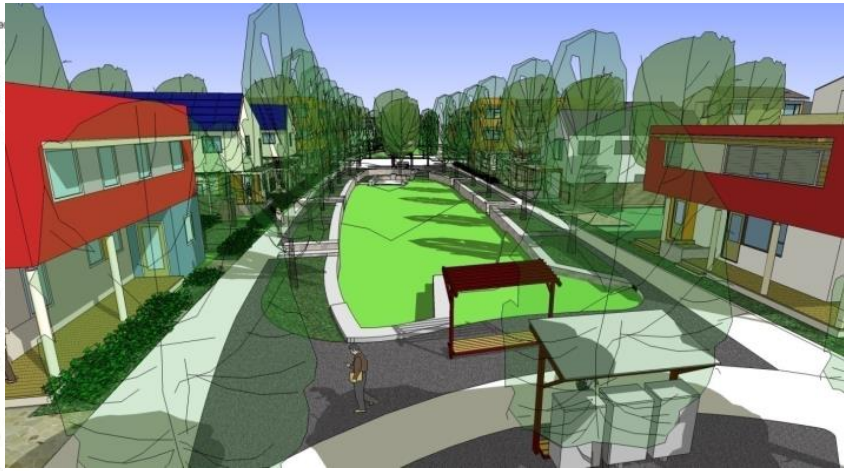
Street Tree Rain Gardens: Stormwater Streetscapes



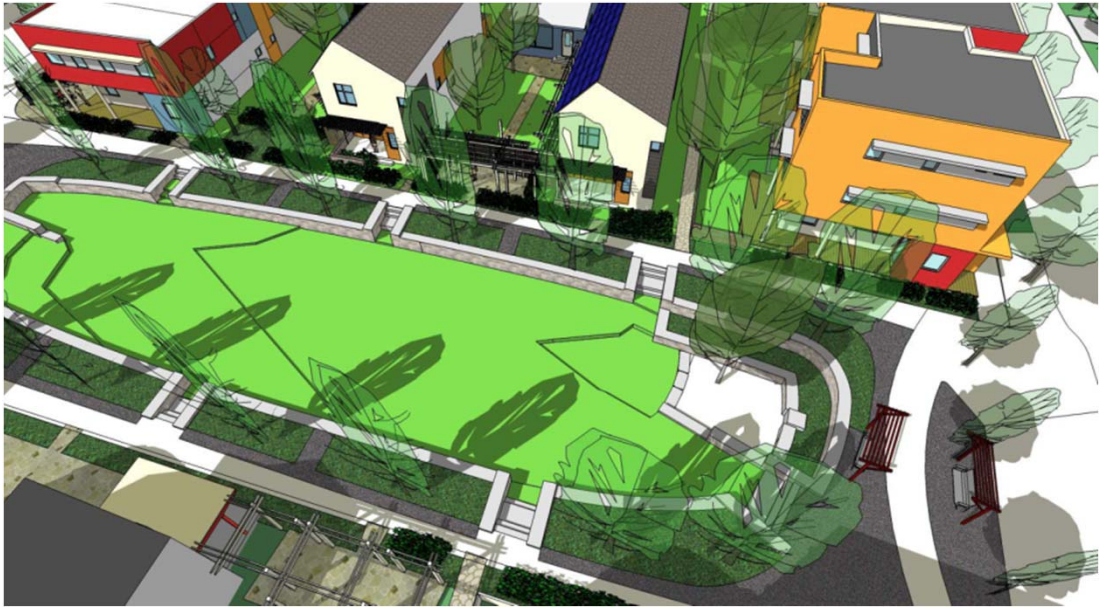


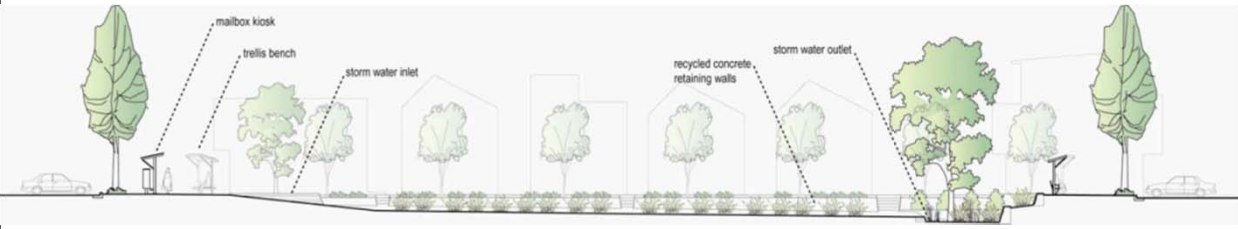
Percolation Parks: Rain, Snow, & Community Life

Neighborhood Greens: Community Scale and Utility



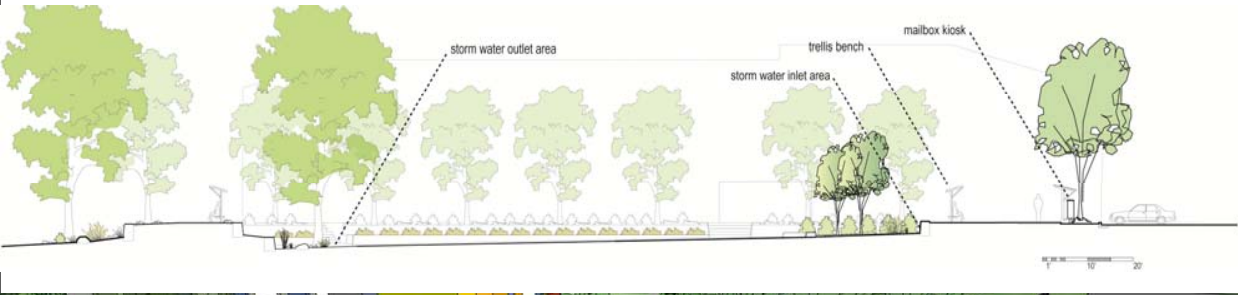
Fruit Trees Terraces and Community Gardens





Food, Gathering, Ecology, Stewardship

Town Squares: Mixed Use Community Space



Layers of Use and Inhabitation

Ecology, Commerce, Community, and Events

The Checkerboard Blocks

CHECKERBOARD BLOCKS SUBAREA

Vision

The checkerboard blocks are an innovative arrangement of homes, lots, alleys, and paths that is rooted in many precedents. The design is the result of research on how to optimize solar orientation with density. The blocks have a density comparable to townhouse and duplex development -- but with superior solar access. The plat is based on historical city layouts common to this region and as found in Denver. Alleys and streets run north-south and lots are generally 25' wide with narrow 20' wide houses.

Buildings, however, are repositioned on the lot in order to optimize solar orientation, provide south-facing outdoor spaces, and minimize north-facing outdoor spaces and north facing windows and entrances.

SOLAR ACCESS

This leads to alley houses – another type found in older neighborhoods of Denver that gain solar access over adjacent yards. The alley houses alternate with homes that are close to the front of the lot.

The checkerboard blocks are also based on 20th century European and South American housing of similar densities:

- Buildings may have a very close and intimate relationship to the front of the lot.
- Side yards are minimized and private outdoor space is repositioned as courtyards or outdoor rooms.
- Townhouses, stacked flats, and live work units are wide rather than narrow in order to improve solar access. And they have small south-facing patio-scaled yards that may front onto public ways.

At the checkerboard blocks, what would be the central north-south street is replaced by a common green. The common green type has been built in numerous Colorado New Urban neighborhoods and can be found at Stapleton in Denver, Bradburn Village in Westminster, and Prospect New Town in Longmont. The greens at Geos go one step further; they integrate social gathering with the natural flow and filtering of stormwater.

Homes around a common green: The Poplar Project in Boulder, Colorado by Wolff Lyon Architects

Urbanism

DENSITY
Maximum 92 total dwelling units.

SOLAR ACCESS
On December 21st at a time chosen by the developer between 11:00 am and 1:00 pm, with an assumed mid-day south sun angle of 26 degrees from horizontal, no building may cast a shadow on the habitable portions of other buildings except for:

- The bottom 4' of exterior walls of such buildings as measured from grade, or the bottom 3' as measured from grade level finish floor elevation.
- The first ten feet of habitable space adjacent to a tuck-under garage or carport.

If nearby buildings to the north are not yet built, then a similar building should be assumed to exist 30' north of and parallel to the north property line of the parcel being designed.

MAXIMUM LOT COVERAGE

- Maximum lot coverage is limited by the interaction of other regulations on this subarea including solar access, maximum dwelling units, parking rations, and setbacks and frontage.
- In addition, the maximum lot coverage may never exceed 60% for either an entire block or half-block.

Setbacks & Frontage

Front Setback at streets that run East-West: ❶

- 1' minimum setback.
- 15' maximum setback at south side of Street A and Street B.
- 35' maximum setback at north side of Street B and Street C.

Frontage at streets that run East-West: ❷

- A minimum of 65% of the frontage between the minimum and maximum setbacks must contain building.
- 4' Property Line Planting Strip:
  1. Minimum 70% planted at residential uses, 50% at live/work uses.
  2. 30% maximum of length of planting strip may be walkable surface at residential uses, 50% at live/work uses.
  3. 50% maximum length of planting strip may contain buildings at or above grade.
  4. 20% maximum length of planting strip may contain porches or entry stoops.

Frontage and Setback at Streets or Greens that run North-South:

- Minimum setback to building or porch is 4'.
- Maximum setback: None. See solar access regulations.
- Porch requirements: One covered exterior space of minimum outside dimensions of 8' wide by 6' deep is required along public-facing façade of each ground level unit. Cover may be a trellis.
- 4' Property Line Planting Strip:
  1. Minimum 70% planted at residential uses, 50% at live/work uses.
  2. 30% maximum of length of strip may be walkable surface at residential uses, 50% at live/work uses.
  3. Optional hedge or 42" max height fence allowed at rear of 4' strip.

Rear setbacks at alley: None. See solar requirements. Stagger buildings to permit sun to reach yard of property to the north.

Sideyard setbacks at property lines adjacent to single-family checkerboard lots.

- 0' at east-west running prop line north of structure.
- 3' at east-west running prop line south of structure.

Locate buildings to maximize solar access and outdoor spaces adjacent to interiors which can receive some winter south sun.

PARKING
Parking is only permitted directly off of the alley. No other parking lots or curb cuts are permitted.

Ⓐ North Central Green
Ⓑ South Central Green
Ⓒ North East Green
Ⓓ South East Green
Ⓔ Checkerboard Live/Works
Ⓕ Checkerboard Single Family Alley House
Ⓖ Checkerboard Single Family Front-of-lot House
Ⓗ Property Line Planting Strip
Ⓘ Alley
Ⓙ Through-block pathway

geos
EARTH. SUN. HOME.

MICHAEL TAVEL ARCHITECTS
ARCHITECTURE AND URBAN DESIGN

DAVID KAHN STUDIO
LANDSCAPE ARCHITECTURE
URBAN DESIGN

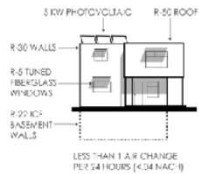
Sustainable Homes are "Not Too Big"

Net-Zero Energy

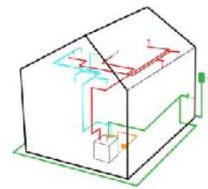
NET-ZERO ENERGY

1/3 ENERGY USE REDUCTION THROUGH **PASSIVE SOLAR ORIENTATION**

1/3 ENERGY USE REDUCTION THROUGH **HIGH PERFORMANCE SHELL**



1/3 ENERGY USE REDUCTION THROUGH **ERV MECHANICAL SYSTEM**



A FOSSIL FUEL FREE, CASH FLOW POSITIVE PASSIVE HOUSE

Passive Solar Orientation Reduces Natural Gas Use by 1/3
- Stretch buildings and homes out east to west
- Minimize apertures to north
- Solar overhangs on south
- Deep porches and deciduous trees at east and west

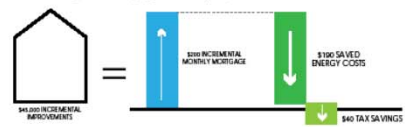
High Performance Building Shell Reduces Natural Gas Use by 1/3
- Air Tight -- less than 0.04 Natural Air Changes per Hour
- SIPs construction with R-50 Roofs, R-30 Walls, R-5 Windows

ERV Mechanical System Reduces Natural Gas Use by 1/3
- No Furnace needed for the passive house.
- Geo-Assisted Energy Recovery Ventilation (ERV)
- Constant Fresh Air with minimal energy loss
- Earth Tubes further temper incoming fresh air and provide cooling
- Ground-Source Loop with Heat Pump provides Heating, Hot Water

No Natural Gas Needed; Therefore, No Natural Gas Lines

Solar Photovoltaic Panels Generate 100% of Electricity Needs
- 5KW system per home
- The passive home uses 35% less electricity
- Photovoltaics panels offset the remaining 65% of consumption
- Neighborhood is grid-tied. Electricity Consumption is Net-Zero.

Making Net-Zero Cash Flow Positive
- Green Technologies add $200 to monthly mortgage
- Energy Savings $190/month
- Tax savings on mortgage interest $40/month



Checkerboard Live/Works

Townhouses or live/work homes with ground level home offices are permitted in these locations.

A wide townhouse layout permits solar gain to side-by-side bedrooms and side-by-side living spaces.

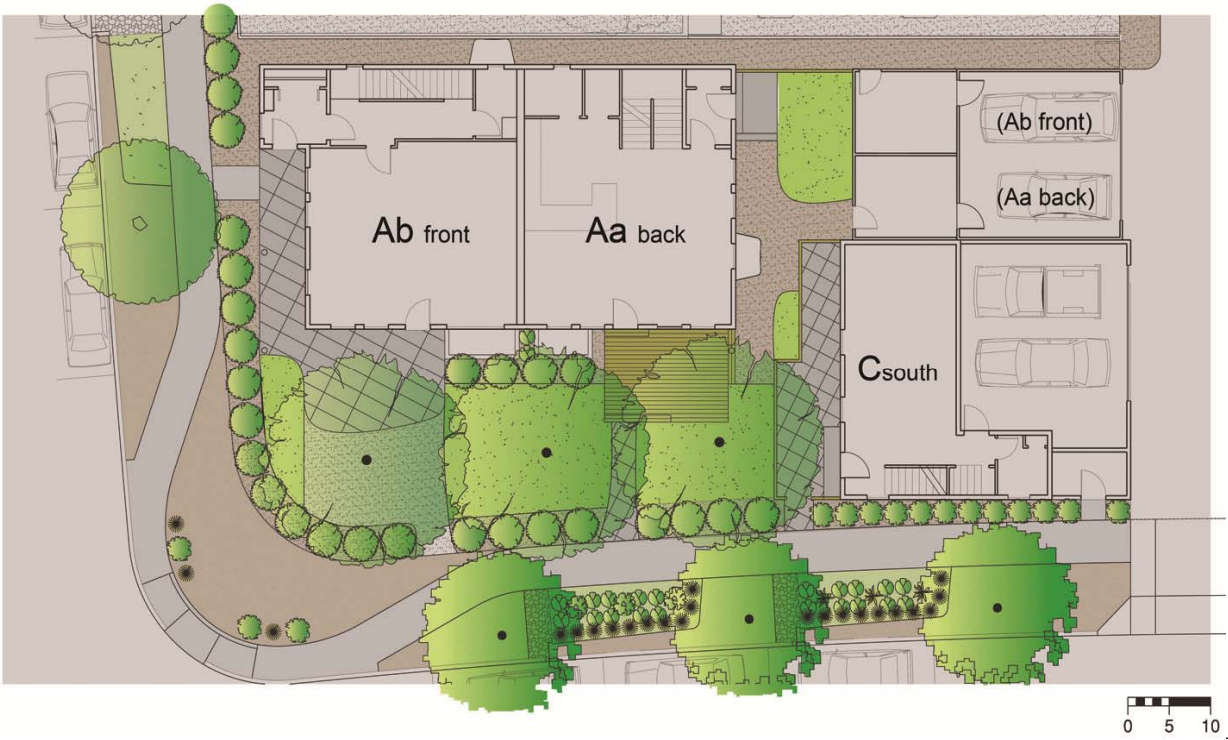
Service spaces are to the north.

Doors and windows to the north are minimized.

Windows and overhangs are optimized for passive solar heating and cooling.

Homes open to sunny, south-facing yards.

Live/Work Site Plan



Live/Work homes with south-facing patio yards

Checkerboard Single Family

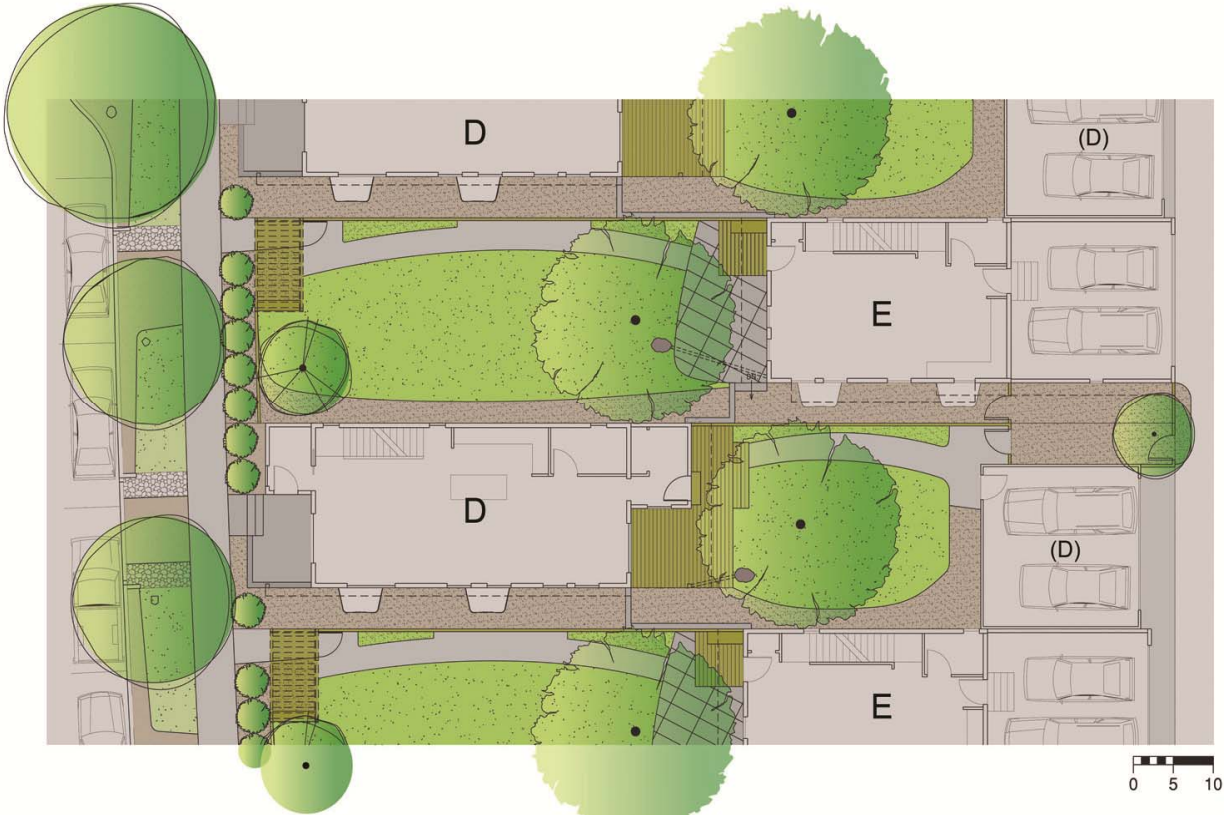
Every other home is either an alley house, or at the front of the lot.

Yards are shaped like courtyards.

Doors and windows to the north are minimized.

Windows and overhangs are optimized for passive solar heating and cooling.

Private Landscapes at Checkerboard Homes



Public Fronts of Single Family Homes

Checkerboard Intertwining

Public Frontage at Checkerboard Homes

CONCLUSION

Planning for Net-Zero Energy and Intertwined Sustainable Systems involves:

- ***Thinking across multiple paradigms***
- ***Coordinating systems to strengthen one another.***
- ***Using passive, climate-specific strategies to reduce resource demands first.***
- ***Considering sustainability as a practice, and how design supports a culture of stewardship.***
- ***Acknowledging that places are like a complex ecosystem, and develop over time.***