ANTIOCH COLLEGE

ANTIOCH COLLEGE VILLAGE

charrette report

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credits

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ANTIOCH COLLEGE

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introduction

What is the Antioch College Village?

Antioch College is considering developing a new multigenerational housing community on its campus, preliminarily called "Antioch College Village" (ACV). The idea emerged as the College has grappled with the future of its educational mission and its need to find a model for fiscal sustainability. Utilizing the College's land and other physical resources, the concept is designed to support a community of lifelong learners who also help to support the College. Residences will be physically woven into the fabric of the college campus and residents will have access to the College's educational and cultural resources. ACV is also conceived as a paradigm of environmentally responsible living.

Several initial goals were established for this new settlement, which include:

- enable the most environmentally sustainable lifestyle possible through design;
- create walkable and bikable places—connected to nature and accessible to students and residents;
- include a variety of housing types and tenancies to increase options for Yellow Springs living;
- increase the number of families who will use our schools and help spread our tax burdens;
- leverage Yellow Springs' natural strengths as a destination for those who want to live in an intimate environment of arts and education;
- add new residents that help support the College and nearby downtown businesses;
- build a diverse community of lifelong learners.

From March 1-5, 2015, a team of planners, designers, and sustainable design experts conducted a "charrette", seeking input from students, faculty, and college representatives as well as the greater Yellow Springs community to refine the above goals and develop a plan for Antioch College Village. This report summarizes the planning process, urban design vision, and sustainability studies that resulted from that collaborative design effort.

Top: Main Building (also known as Antioch Hall), Antioch College

Middle: Downtown Yellow Springs

Bottom: Antioch campus reforestation area

Properties owned by Antioch College (2015).

TOUCHSTONES

Prior to the charrette, a set of touchstones were established to guide the planning and design process. As the vision for Antioch College Village evolves, these touchstones can be used to evaluate progress and test decisions; this will help to ensure the final plan is true to the original goals.

Antioch College Village will:

Establish a new paradigm for higher education by

- contributing to the financial sustainability of the College
- linking adult learning and participation with College life
- providing an alternative lifestyle for “next chapter” individuals
- nurturing cultural and intellectual engagement

Exemplify sustainable living through

- carbon neutral energy use
- preservation and enhancement of water resources
- sustainable farming and food production
- compact pedestrian and bike oriented environment

Enrich the community with

- options for a diverse, multigenerational population
- provisions for healthy, active aging in place
- connections to each other, the town and the natural environment
- channels to support the Yellow Springs local economy

The Living Community Challenge

Antioch College Village is being designed to meet the requirements of The Living Community Challenge (LCC), the most advanced measure of sustainability in the built environment possible today. LCC provides a roadmap that helps planners and developers rethink how they design community-scale projects.

The core aspirations underlying the Challenge are for communities to actively support the health and vitality of the ecosystems of which they are a part and for the built environment to actively support human health, happiness and well being. The 20 criteria of LCC – which address Place, Water, Energy, Health & Happiness, Materials, Equity, and Beauty – were used to guide the work of the charrette and will continue guide decisions as the development evolves.

Place clearly articulates where it is acceptable for people to build, how to protect and restore native ecological assets, and encourages pedestrian-oriented neighborhoods supported by local food-systems. Water realigns how people use water, supports community water independence/resilience, and treats water as a precious resource without which life could not exist. Energy signals a new age of planning, wherein – by design – all of a community's energy needs are met through local, renewable, carbon-free resources. Health & Happiness focuses on the physical elements that must be present to support a robust, healthy community filled with happy, productive people. Materials drives design choices toward an economy that is non-toxic, non-polluting, and transparent. Equity correlates design and development decisions in ways that foster inclusive community. And Beauty recognizes the need for beauty as a condition precedent to achieving sustainability – we treasure and preserve those things that we care about.

Given the current state of our economy, the principles underlying the Living Building Challenge may be aspirational, but the criteria are real. They offer communities a giant step toward living in harmony with, and within the limits of, their local ecosystem. Antioch College Village aims to embody this challenge.

antioch college village charrette

Designing in Public

The vision for Antioch College Village summarized in this report evolved over a period of five days, as a multidisciplinary group of planners, urban designers, architects, and sustainable development experts worked with college leadership, students, and the Yellow Springs community. The purpose of the charrette was to articulate goals, priorities, and desirable design attributes, and to create a physical master plan.

On Sunday, March 1, community participants gathered for a Charrette Kick-off and Hands-on Design event. The event started with a "food for thought" presentation to introduce members of the planning team and describe the challenge for the week. The large assembly then divided into small groups of approximately 8 – 10 participants. Participants were asked to work collaboratively and imagine "what if", and help to plan for the future. The groups actively covered many topics, with participants discussing options and exploring alternatives. Each table had a facilitator to lead them through the exercises, and a map of existing conditions on which they illustrated ideas and wrote notes about what they'd like to see as a part of future development. At the end of the evening, one person from each table made a short presentation of their table's "top three ideas." The planning team took notes on the presentations, and also collected handwritten notes from table scribes that documented the conversations.

Group brainstorming over maps was not the only activity; attendees also filled out idea cards, participated in keypad polling, and were able to write their own ideas on feedback forms. Each table was also given a poster that contained ten goals, all important considerations for future development at Antioch College. Each participant was given only five dots, and asked to rank their top priorities. Many ideas received dots, but the most often identified priorities were housing variety and affordability. The goals exercise, table maps and notes from this initial session were kept in the studio all week, so the team could continually check back to review the community input as it was incorporated into the plan.

Top: Sandy Wiggins of Consilience LLC, the consultant team leader, addresses the crowd and explains the project objectives, including the Touchstones and Living Community Challenge.

Middle: Participants discuss and rank their priorities.

Bottom: At the end of the event, one person from each table recapped their main ideas to the entire assembly.

Participants at the Hands-on Design Session

Goals & Priorities

Hands-on Design Session participants were each given five dots, and asked to select their personal priorities from a series of preliminary goals -- the results are summarized below. Participants could also write in additional goals; common responses included affordable housing, financial sustainability, and diversity of age and income.

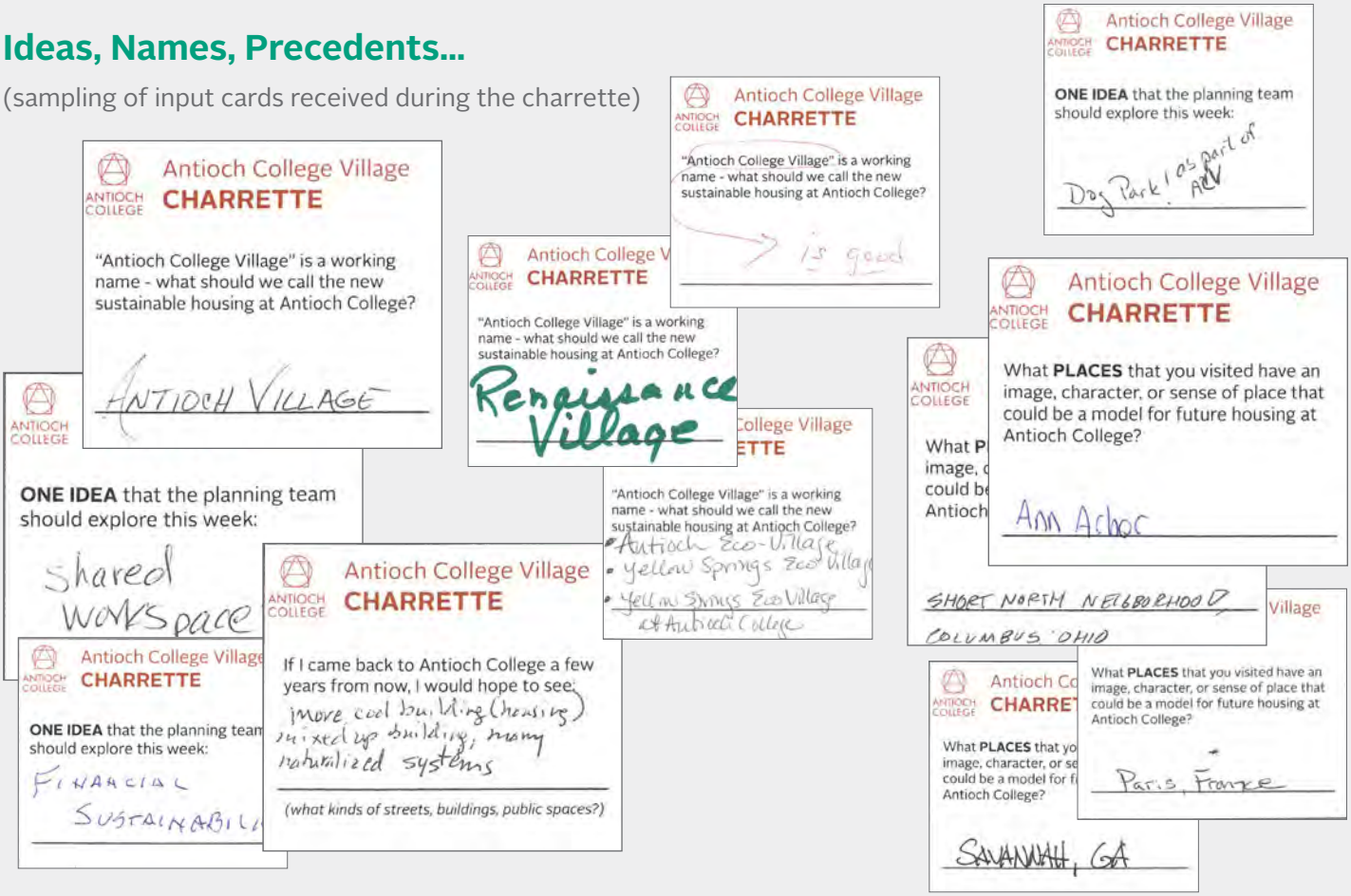
Of many potential goals to pursue, which are **MOST IMPORTANT TO YOU**:

enable **environmentally sustainable lifestyles** through design	include a **variety of housing types and tenancies**	create **walkable and bikable** places	provide **connectivity with nature**	utilize **green building & site design systems** (for energy, water, etc.)
69	77	53	47	69
increase the number of families who will use our **schools** and **spread our tax burdens**	**leverage our natural strengths** as a destination for those who want to live in an intimate **environment of arts and education**	add new residents that help **support nearby downtown businesses**	provide financial **support to the college**	build a diverse **community of life-long learners,** and **increase the interaction** between the college and community
33	33	36	48	67

other (**your ideas here!**):

Ideas, Names, Precedents...

(sampling of input cards received during the charrette)



Three Big Ideas

At the conclusion of the Hands-on Design Session, each table summarized their conversations into "three big ideas". The results are summarized below, with common themes highlighted in green.

1: Affordable diverse housing via a land trust model where the college maintains ownership, combination of rental and homeownership

2: Mixed housing stock, developed on scattered infill sites, including creative housing like artist live/work lofts, bike paths, nature extension, cohousing and consideration of green space

3: Formal definition, demarcation of campus via beautification, art, gardens, fountains, streetscaping

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1: Pilot housing project both sides of North College between Xenia and Livermore. Close N. College to cars, farmers market location

2: Cohousing between Whiteman, President and ex-student union

3: Use empty field on Center College

1: Variety of housing types & tenancies, cohousing, artist lofts, affordable universal housing

2: Diverse community of lifelong learners between college and community, proximity to downtown and library a priority

3: Environmental sustainability, green design, south-facing bldgs

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1: Different types of housing, closer to town

2: Community space, dojo, cafe, learning space

3: Adaptive reuse of community and private space

1: Relationship and connectivity with the Glen

2: Emphasis on redevelopment and reuse of buildings versus consuming open space, variety of locations

3: Revitalize South College corridor, help wellness-library-science-theatre feel less isolated from rest of campus

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1: Multi-type sustainable housing scattered thru community/campus

2: Complete access to larger community and green spaces with ample public bathrooms.

3: Work on small green spaces and tree replacement

4: Numerous connecting hiking and walking paths with paths for golf carts, rickshaws, additional paths for horses

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1: Variety of housing, mixed-income, cottages, rowhouses, densely populated apartments, cohousing, access to library & downtown

2: Bike network thru campus and housing

3: Artist cohousing near art bldg; performing arts center where Songtag Fels is now

4: Green space and community garden space integrated.

1: Sustainable infrastructure, model for other institutions, communities, educational opportunities beyond Yellow Springs

2: Diverse housing, multigenerational, multi options, affordable

3: Financial opportunities for students, provides employment opportunities, incubator, small business, art-related endeavors.

4: Destination "resort" housing opportunities

5: Extend North College to Corry Street, gateway to Glen

1: Integration of housing types throughout, within walking distance of downtown and recreation amenities; prioritize workspaces for student groups, reuse existing art building

2: Maintain architectural vistas such as the Main Building (both sides)

3: Improving walkable infrastructure all over campus (including repairs, expansion and lighting), include Livermore and College St

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1: Parking (student, visitor), car share system to diminish cars

2: Dogpark: important for canine health, community social space

3: Relationship of village residence to study, matriculating students

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1: Include variety of housing types and tenancies, multi-story apts (max. 3), tiny houses, mixed uses, kinds of housing and living arrangements, senior housing and dense housing, cooperative

2: Utilize green building and site design systems, being mindful of shade from buildings and trees, use of geothermal and solar

3: Build diverse community of lifelong learners, increase number of families, social interaction and greater tax base

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1: Design is important!

2: Build an inclusive and diverse community, affordable (full spectrum), inter generational, communal

3: Create & encourage opportunities for interaction & knowledge transfer

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1: Diversity of innovative, energy efficient "living building" housing using infill, gardens, connected trail, walkways to Glen

2: Conserving open space in front lawn, horseshoe, and golf course

3: Three "College Street" corridors as portal entry to College

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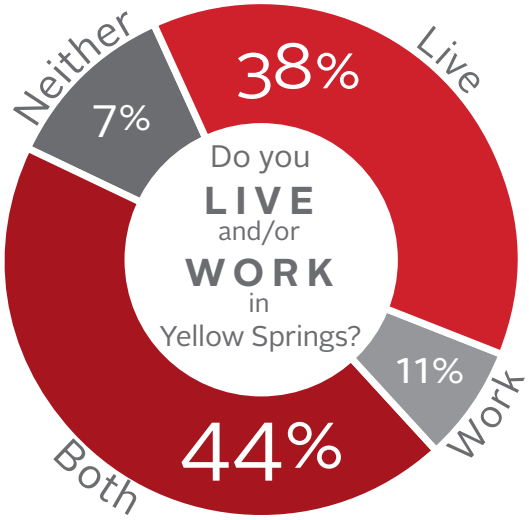
1: Diverse community of lifelong learners

2: Create walkable/bikable places

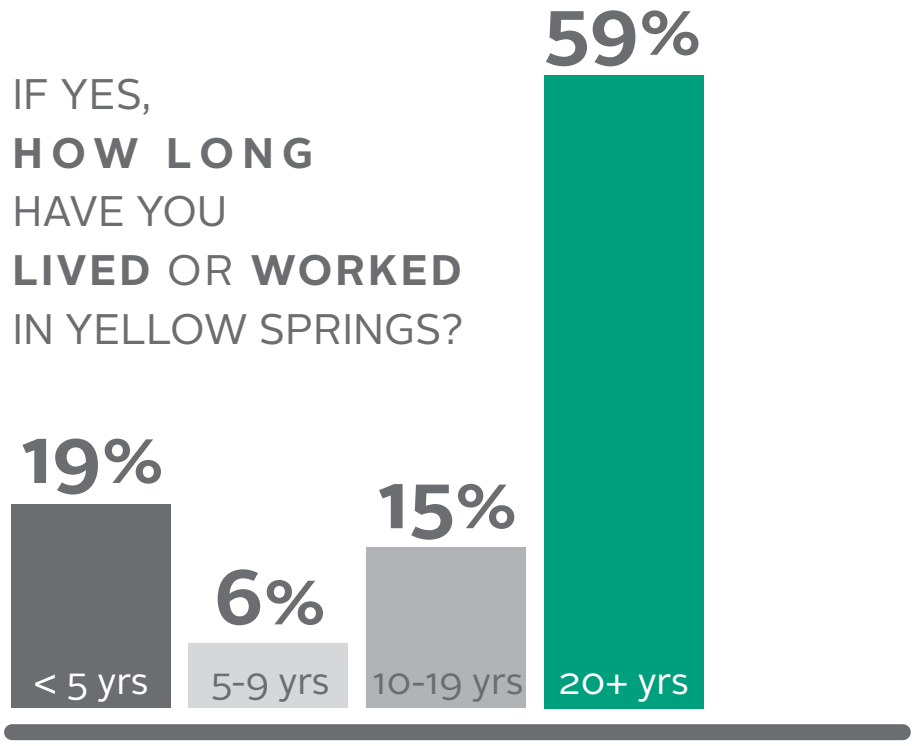
3: Variety of housing

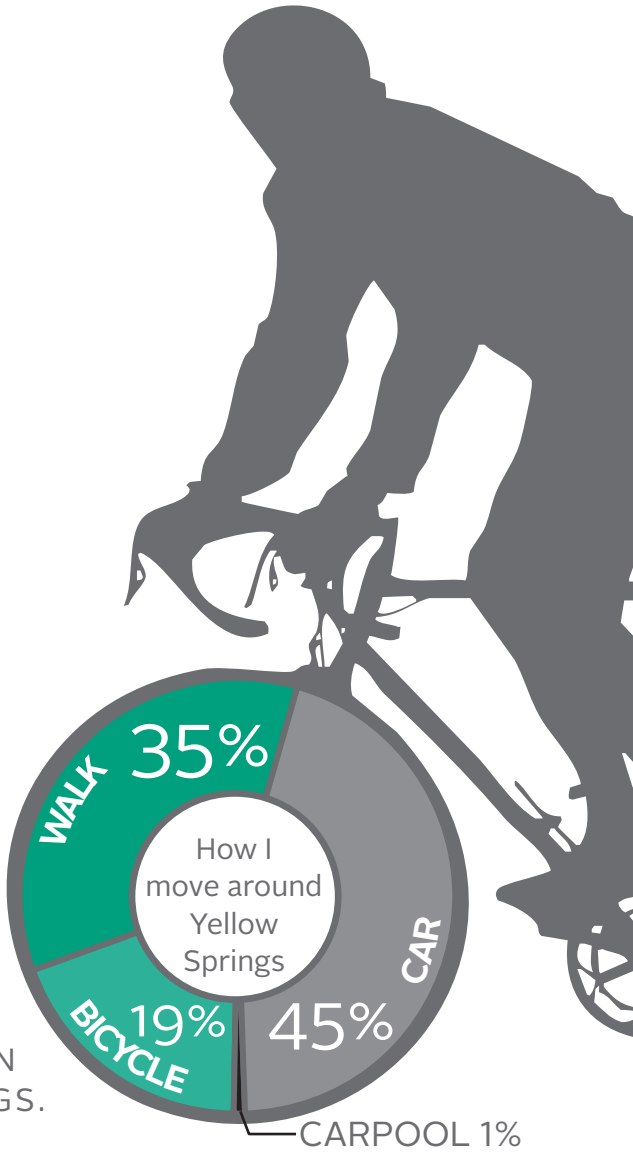
Charrette Keypad Polling Results



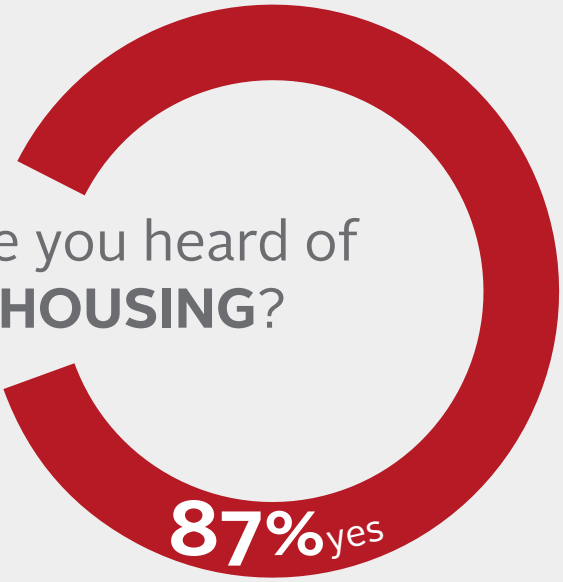
Most attendees lived in Yellow Springs, and more than half worked in Yellow Springs.

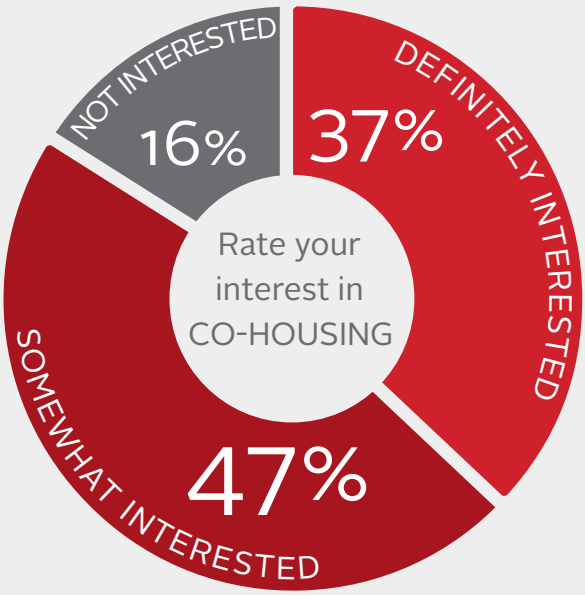
IF YES,
HOW LONG
HAVE YOU
LIVED OR **WORKED**
IN YELLOW SPRINGS?



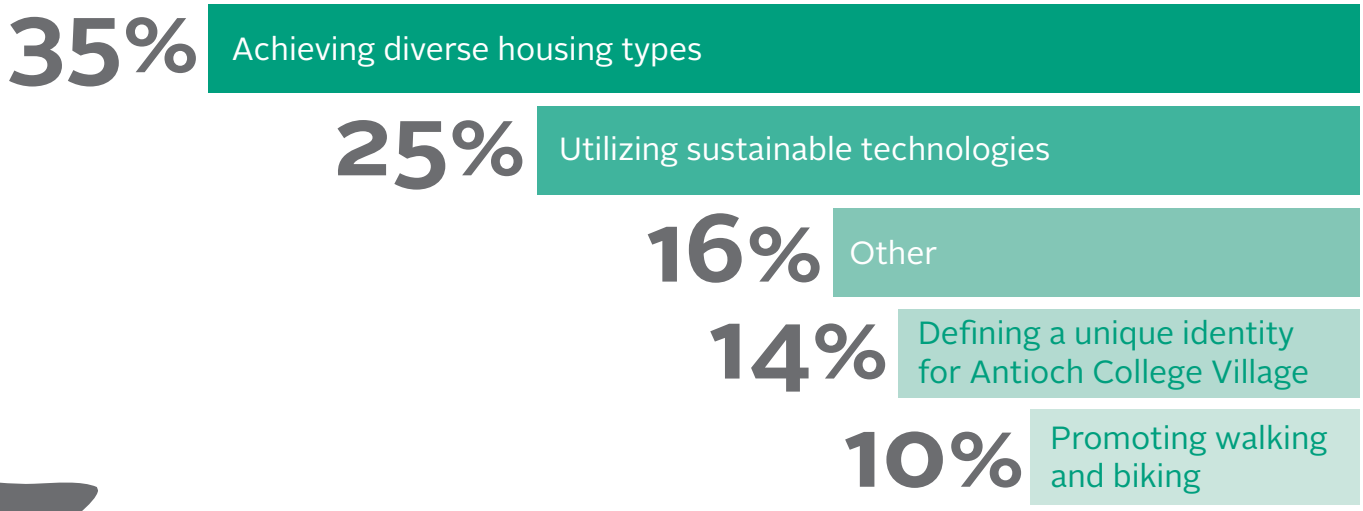


MORE THAN HALF (54%)
DO NOT USE MOTOR VEHICLES
AS THEIR PRIMARY TRANSPORTATION
WITHIN YELLOW SPRINGS.

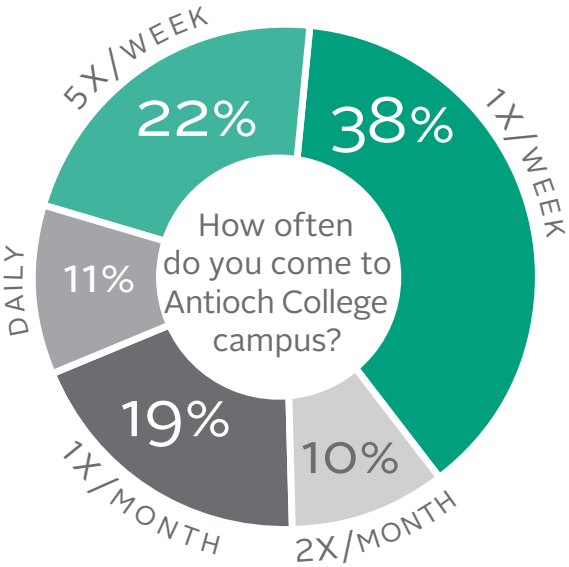




I AM MOST INTERESTED IN HELPING WITH:



Despite the fact that most attendees (89%) were more than 24 years old, most people visited the Antioch College campus once a week or more.



On-site Design Studio & Open House

Following the kick-off event, the design team set up a temporary studio at the Antioch College Wellness Center to synthesize input received and begin to formulate a physical master plan. The process began with a debriefing of the input from the Hands-on Session; the team went back through each table's maps, discussing the main points reported plus information observed in the table's notes and drawings that was not mentioned as part of the group presentation.

The team then began to work, illustrating design ideas and investigating technical details. Stakeholders and experts from the community were invited to participate in meetings on a variety of subjects; the studio was also open for students and members of the public to drop in to talk with the design team and see the plan evolve.

On Tuesday, May 3, an Open House was held at the Design Studio. Community maps from the opening session were on display, as were initial drawings and studies from the design team. Stations were set up for each main focus area (urban design, architecture, water and ecology, and energy), and members of the community were encouraged to circulate to each table to see the work to date, and discuss their ideas with the design team.

At the Open House, visual preference surveys were conducted to gather participants' thoughts on various forms of housing and development. A series of images were shown, and attendees rated each one with "love it", "hate it", or "indifferent" using keypad polling devices. This method was effective in demonstrating preferences of those in attendance, and stimulating conversations about urban form. After each result came on the screen, the group had a short discussion about why they ranked the photo as they did; for example, in one photo that ranked poorly, participants stated they did not like the garage doors facing the street. In another example that ranked highly, participants described the trees and landscaping framing the street as positive attributes.

Top: Planners and engineers from Integral Design Group were part of the design team, focused on sustainable energy solutions.

Middle: Open House at the design studio

Bottom: As planners worked to define overall plan concepts, architects Maricé Chael (pictured) and Christian Sottile designed buildings for specific infill sites.

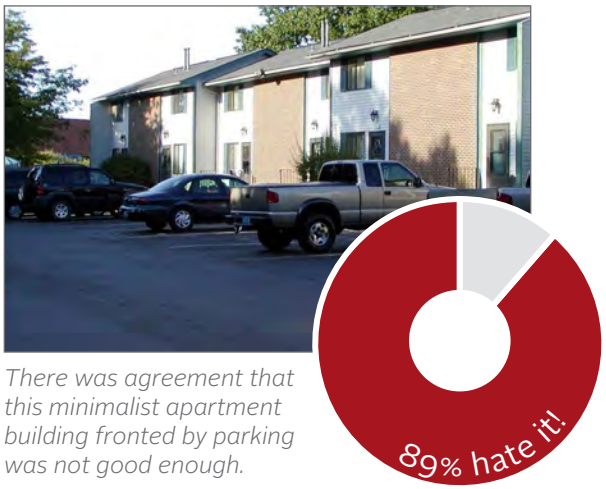
Top: During the Open House, community members, students, and college representatives were able to review the work to date with the design team and give feedback.

Bottom: Victor Dover leads Open House attendees in a round of keypad polling to rate various building development forms.

Visual Preference Results – Open House

(sampling of input received through keypad polling)

Love it! | Hate it! | Indifferent

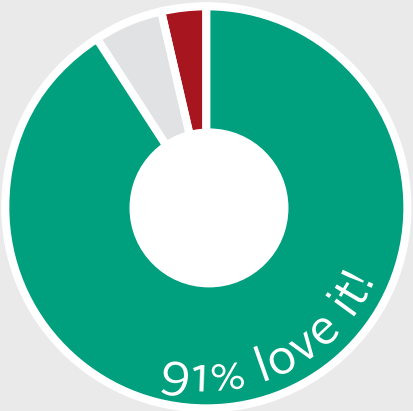


There was agreement that this minimalist apartment building fronted by parking was not good enough.

Participants did not like this image; small street trees and lack of street presence were among the reasons stated for the response.

Townhouses with garage doors on the front facade did not score as well as street-oriented units.

COHOUSING

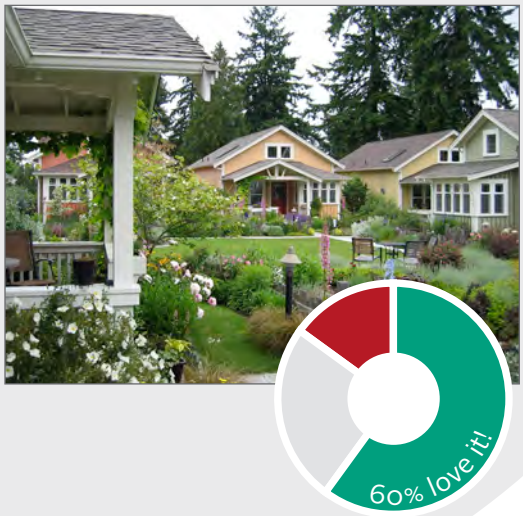


Open house attendees overwhelmingly approved of cohousing imagery, shown to the right; conversely, students polled had mixed feedback.

Visual Preference Results – Students

(sampling of input received through keypad polling)

This photo was polled twice; the first time, it was captioned as a single family home. The second time, the same photo was captioned as a multi-unit apartment building. In both the student and open house sessions, the apartment option had many more positive responses.



Students had mixed feelings about this tiny house, which scored well among participants at the Open House.

Small Group Meetings

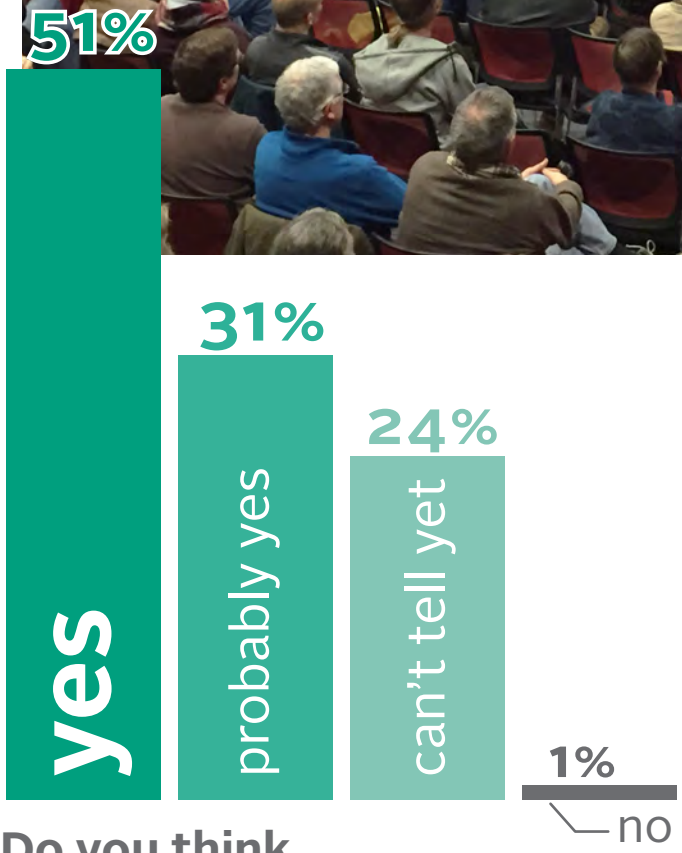
During the charrette week, a series of small group discussions were held at the design studio. Some of the meetings were based on specific topics, such as sustainable design, housing, and schools; other meetings were held to get the input of specific stakeholder groups, such as downtown business owners, neighbors, and Antioch students. At each meeting, stakeholders with interest in the discussion topic were invited to attend; the session was also open for any interested community members to participate as well.

Each meeting provided key insights for the designers, who were able to learn about common aspirations and concerns, and test ideas in-progress to gather feedback in real time. At the student session, the visual preference survey exercise from the Open House event was repeated, giving a unique insight to their urban design preferences. The meetings also provided an opportunity for community members with similar interests to brainstorm with the design team and help define the key attributes of the plan.

Top: Group discussions were held on various topics, such as sustainable design and housing opportunities.

Middle: One of the small group discussions focused on feedback from students, who participated in person and via skype.

Bottom: Visitors to the on-site studio review work underway.



Do you think this draft vision is generally on the right track?

Work-in-Progress Presentation

At the end of the charrette week, the design team held a presentation to share the draft vision with the community. Illustrative plans, renderings, and architectural studies demonstrated the possibilities for new development. The presentation included a summary of concepts explored for site ecology, water and energy systems.

At the end of the presentation, 82% of attendees answered "yes" or "probably yes" when asked if they thought the draft vision was on the right track.

a draft vision

A Community of Lifelong Learners

A primary objective of the design charrette was to look holistically at the Antioch College campus and determine the best locations for new sustainable, multigenerational housing, and also to examine the possibilities for innovative site and building design. The ideas presented in the following pages summarize the vision that emerged. These drawings should be considered a "draft"; as new information comes forward (and as key stakeholders and the community have more time to scrutinize the plans, drawings and renderings), this vision will certainly evolve.

There are some features in the historic campus fabric that are fundamental: the inimitable outdoor room shaped by the buildings of the horseshoe; the east to west thrust along the North and South College Street axis forming a pedestrian and psychological connection between the heart of campus and Glen Helen Nature Preserve; the reforestation efforts on the eastern side of Main Building; and the Livermore Street "boundary" between multmodal neighborhood streets and the nonmotorized campus. These features were picked up and reinforced through this planning effort.

The idea of establishing a community of lifelong learners at Antioch College has been underway for several years. A campus Master Plan prepared by MacLachlan, Cornelius & Filioni illustrates a series of yellow boxes on certain opportunity sites, a placeholder for the idea that select sites could be used for new housing. The Master Plan evaluated the existing building inventory to determine potential reuse, using the following criteria: historical importance; ability to be repurposed; worthiness of dollar investment; and adaptability to carbon neutrality. As the historic heart of campus, North Hall, South Hall, and Main Building (also known as Antioch Hall) were obvious priorities for renovation. The future of other buildings are not so clear. For example, Spalt Hall and Songtag Fels could be future redevelopment sites.

The diagram to the right isolates a series of infill parcels, currently under college ownership, that are not envisioned to be needed for future campus use such as classrooms and dorms; this array of sites can become the Anitoch College Village. Vacant parcels, such as those along North College Street, are the priority for new high quality development.

Overall Plan: Key Recommendations

- **a** Potential Antioch College Village infill sites are located on campus edges, where Antioch meets the Village of Yellow Springs.
- **b** East–west circulation on the North College and South College Streets extended are reinforced through building and landscape interventions.
- **c** Livermore remains an important edge to the non-motorized heart of campus.
- **d** New Campus and Village buildings align with, and respect, the edges established by historic buildings in shaping outdoor rooms (such as the "horseshoe").
- **e** Current master plan initiatives, such as reforestation east of Main Hall, the farm, food forest and geothermal fields on the south campus, and proposed new dorm sites are integrated and coordinated with the Village plan.
- **f** Proposed buildings are larger and attached close to campus (where there are buildings of similar form and scale) and smaller and more detached closer to existing single family homes.

***Master Plan, Big ideas**. Antioch College ownership is shown in crimson; the sites with the best potential for Antioch College Village are shown in a darker shade. Primary axis to be respected and reinforced by the plan are highlighted.*

New Antioch College Village Plan *incorporated into overall campus Master Plan by MacLachlan, Cornelius & Filioni.*

View from above North College Street, looking south. *From this view, the diversity of housing types, including tiny cottages, rowhouses, and larger apartment buildings of the proposed Antioch College Village is visible in the foreground. Centralized parking allows for compact arrangement of buildings on each parcel, oriented to frame streets, pedestrian passageways, and mid-block greens. Architectural features form a gateway that defines the transition from the vehicular portion of the North College Street axis to the pedestrianized campus beyond.*

Defining the Settlement Pattern

As the opportunity sites for the Antioch College Village (ACV) infill became apparent, the planning team began to look closely at individual sites, and strategize on the physical form of new housing. What types of buildings are possible, how do they relate to streets and open spaces, and where are parking and service areas? In addition to the design of infill housing on identified lots, the team also explored design retrofits for adjacent streets and public spaces to support the vision.

The resulting vision and plan has a combination of small buildings and larger ones, mid-block green spaces and small intimate walkaways. On the periphery where the College meets the Village of Yellow Springs, buildings are small and detached, a scale similar to surrounding single-family homes. Approaching Livermore, buildings become more attached and of a larger scale, compatible to existing campus structures.

Parking is consolidated to a select few mid-block locations; this arrangement provides the necessary amenity and access, and also opens up the development parcels to innovative layouts. In the draft vision, tiny cottages, larger rowhouses, and apartment buildings enfront streets and a fine-grained network of pedestrian passageways that lead to edible landscapes, gardens and mid-block greens. This provides a series of experiences for residents and visitors to explore, and the diversity of new development desired by charrette participants.

If college property is to be utilized for new housing, it must be done in a way that generates revenue to allow Antioch to do the things it needs to for students and for learning. Maximizing potential on opportunity sites, such as capitalizing on the views to the Main Building and horseshoe from upper floors of new buildings at the Songtag Fels site, is an important part of the solution. Additionally, new greens, tree-lined streets and pedestrian passages shaped by buildings, can help reinforce the primary public spaces of the campus, and continue to add value. The network of quality public spaces will link new residents with college facilities, fostering multigenerational participation in campus educational and cultural activities.


legend
Existing Campus Buildings
Proposed Campus Buildings
Proposed Antioch College Village Buildings
WHITEMAN
XENIA AVE.
NORTH COLLEGE
WEST HALL
CSK CENTER
CENTER COLLEGE
LIVERMORE
NORTH HALL
SOUTH HALL
SOUTH COLLEGE
c
f
e
b
g
j
d
h
k
i

A Closer Look at the North Campus: Key Recommendations

- **a** Charrette participants voiced a desire for a community dog park to be part of new improvements; an ideal location is on this parcel, where the college meets the Village at its northern boundary.
- **b** To support a high level of walkability, streets can be right-sized and repaired. The draft plan envisions less pavement for vehicular lanes, with recovered space utilized for street trees, sidewalks and bioswales.
- **c** New buildings are used to shape public spaces, including streets, pedestrian walks, and public greens.
- **d** Mid-block greens can be designed to incorporate areas with existing large trees, in order to preserve canopy and provide tranquil gathering spaces.
- **e** Parking is located behind buildings in select mid-block locations. If parking is not required on each parcel, unique site design solutions with a variety of building types and orientations are possible.
- **f** A network of pedestrian passages provide an alternative way to move between streets and open spaces.
- **g** At the termination of the vehicular portion of North College Street, a gateway marks the entrance to the pedestrian campus zone.
- **h** A new dormitory is proposed on the Spalt Hall site; this new structure should align with North Hall to shape the "public room" of the horseshoe.
- **i** The Songtag Fels site provides unique opportunity with proximity to the horseshoe. The ground floor of a new street-oriented building can be a dining hall that is shared space for students and community members; upper-floor units can have the "postcard view" of the Main Building.
- **j** There is an important formal quad space emerging between North Hall and the former student center that needs reinforcing. This area should be lined by the fronts of buildings, preserve existing mature tree canopy, and incorporate functional landscape features such as bioswales.
- **k** The horseshoe, defined by Main Building, is the "postcard image" of Antioch and the college's "brand" created through historic architecture. Respecting this important public room is an important urban design objective. The walls of the new buildings and trees should continue to shape this public space; the uses and function of new buildings is less important.

Multifunctional Gathering Spaces

New mid-block greens are an important component of the draft vision. Framed by the fronts of buildings, these high quality spaces can be used for community gathering and recreation, to capture and preserve existing large-canopy trees within the block, for community gardens, as well as for stormwater management. A variety of housing types can front the green, including tiny cottages, rowhouses, and apartments. Mid-block greens such as this can be the central organizing feature for a new cohousing community that offers a variety of housing sizes and options to fit a variety of lifestyle needs. The greens are linked by pedestrian passageways that lead to surrounding streets, forming a complete pedestiran network of high-quality public space. Parking areas are located adjacent to new housing, screened from view by buildings. In addition to the inherent sustainable features such as diverse housing types and walkable urbanism, new housing will also utilize technologies such as green roofs and solar panels integral to south-facing slopes. The implementation of sustainable-design features and technologies has been planned and integrated from the onset, so that systems work within, and complement the urban design vision.

Pedestrian Streets

A unique aspect of the proposed settlement is integrating a network of mid-block pedestrian streets. By consolidating parking to a few locations, the entire parcel can be open to new development; by utilizing small building footprints, a proper orientation of buildings fronting new passages can be achieved. This importantly provides "eyes on the street", with front doors and porches giving these pedestrian streets a public character. Incorporating gardens, edible landscapes, and public art can also provide interest and charm.

Precedents: The Cotton District

The Cotton District, in the college town of Starkville, Mississippi, provides a useful precedent for the Antioch College Village in two key ways. First, it proves that truly agreeable mixed income housing—with great variety and a high degree of dignity—can be accomplished on infill sites, by private developers focused on creating value for investors. Second, it offers instruction about the technique and benefits of mixing small cottages with larger structures in a tightly wound, walkable composition.

The Cotton District was slowly developed by Dan Camp over a 25-year period, and primarily includes small-scale rental housing. The neighborhood was regenerated after a steep decline that began with the closing of the cotton mill that was once its anchor. Camp hired local workers and trained them in carpentry and other trades, and attracted residents that were drawn to the character of the place and by the chance to participate in their unique community. The result was that they built up the social equity and local economy in parallel with building up the real estate.

The fundamental components of the neighborhood are its simple cottages, which are arranged along block perimeters and around courtyards, and denser apartment buildings which resemble traditional large houses. There are also full-size single-family homes, attached rowhouses, and eventually Camp added mixed-use, multi-story Main Street buildings. The diminutive cottages, however, set the tone because of their eye-catching, folksy designs. Despite their small square footages, the cottages are full of small-is-beautiful character.

Precedents: Back to Campus Dining

Nationally, there is an emerging trend in college towns to create shared space between students and community members that welcomes people back to campus. This has traditionally happened for large gatherings such as sporting or cultural events. Today, many student centers and dining facilities also incorporate amenities for alumni or community members to enjoy.

Michigan State in East Lansing is one example that can be looked at as a precedent. The campus contained a series of nondescript dormitories in need of an upgrade. The buildings were brought up to code in an interesting way by using glass, crystalline additions and towers for new stairwells, adding new life and interest to the aging structures. A new dining hall was constructed in one such addition, a joint effort of the residence hall and hospitality school. The school recruited top chefs to run the facility, and opened the doors to community members as well as students. Today, the Brody Dining Hall is a staple of student life as well as a favorite destination for Sunday brunch or dinner out for community members.

There is a similar opportunity at Antioch to create a shared community dining experience as a part of development of the new housing at Antioch College Village. The facility should be located at a central location with easy access for students, alumni and community members. The Songtag Fels building occupies prime real estate that could be repurposed for this use. At the intersection of Center College and Livermore Streets, a community dining hall at the ground level of a new building would have the desired centralized setting. Outdoor dining on the front sidewalk can overlook the horseshoe, providing a memorable experience.

Implementation Questions: Phasing, Parking

During the charrette, several basic questions emerged: What will be done, and how fast can it be done? Does this all work, what about the economics, what about the parking?

The vision identifies several sites at the periphery of the college's land holdings as the most promising to be used for new, sustainable housing. Many of these are vacant today, such as the sites along North College Street that were former dormitory sites. Other sites, such as the Songtag Fels parcel, have existing buildings which could be repurposed, or could alternatively become redevelopment sites. The number of sites identified might be overambitious; some of these sites might be removed from consideration upon further analysis. Conversely, other sites might become available.

What is certain is that development of the Antioch College Village will likely happen slowly, over many phases, letting each new phase learn from what worked well in the previous one. The number of units shown on the illustrative plan add up to a substantial amount (estimated at 290 - 340 units). The college may decide to do some of them now, and reserve some sites for future development.

An initial market analysis was completed to study the potential for new multigenerational housing at Antioch, which found an apparent demand for 160 units in the next five years. This could be the first phase of development; future phases could be sized based on the success of the first.

On- and off-street parking areas, specifically for the use of Antioch College Village development, have been designed into the master plan. Approximately 350 spaces are shown; this is all new parking, and does not include any existing Antioch lots. It is assumed some units will have dedicated spaces, while other unit types may have reduced parking ratios for residents that utilize shared vehicles and other travel modes such as walking and biking for daily needs.

Parcels under consideration for new multi-generational housing as a part of Antioch College Village, *highlighted in crimson over the illustrative master plan.*

On- and off-street parking *provided adjacent to Antioch College Village development. Approximately 350 parking spaces are illustrated on the draft master plan.*

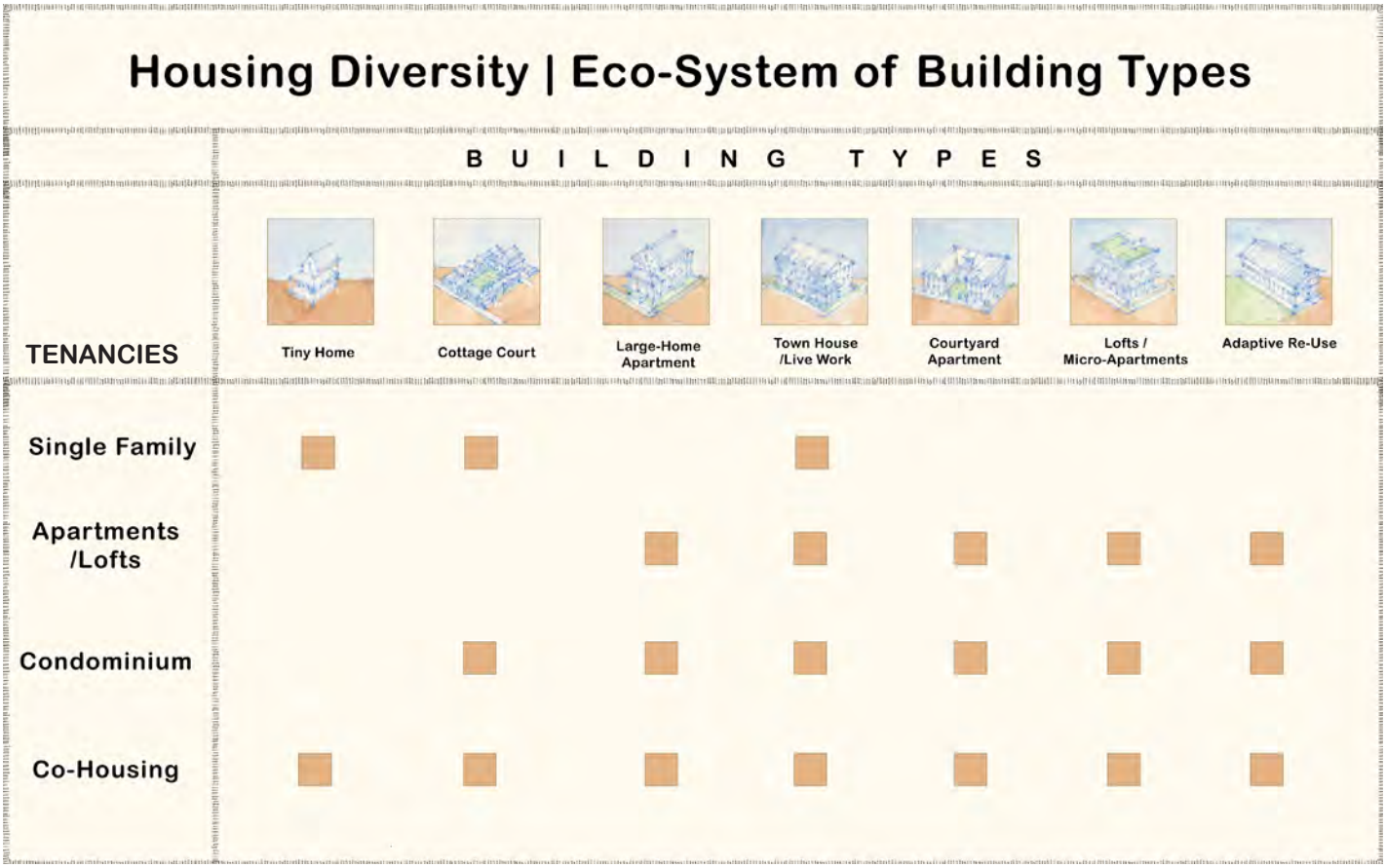
Dedicated Antioch College parking areas, *highlighted in red. The parking for new residential areas is in addition to existing college facilities.*

architectural studies

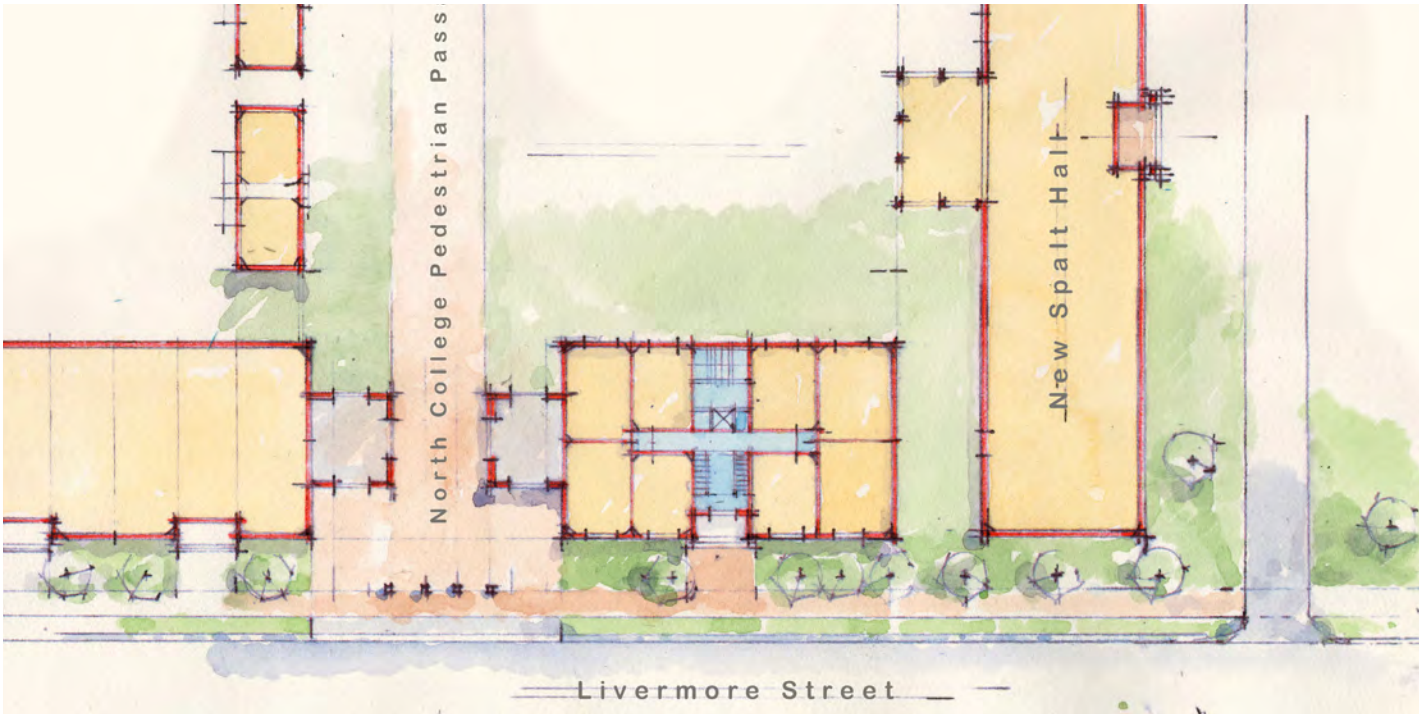
Throughout the charrette, the design team worked closely with members of the public to identify a vision and master plan, outlining opportunities to integrate a variety of housing types within the Antioch College campus. As this vision emerged, the planners collaborated with architects who were focused on designing specific building types for potential infill sites.

Charrette participants expressed the desire for a greater variety of housing in Yellow Springs. A more diverse stock of housing options would better accommodate residents of all ages. Citizens also communicated a desire for housing designed and oriented to facilitate walking and biking to daily destinations.

The back-and-forth coordination between architecture and urbanism throughout the charrette week resulted in overall plan concepts that include some larger buildings, which can help to reinforce the main axis on Livermore Street, as well as tiny houses, that can add diversity and interest within the same block. A series of building types, ranging from large-home apartments to tiny houses, were created for the infill properties that were identified on the plan. Each type has a distinct character and size, and can also have a different leasing arrangement. The following pages describe the various architectural studies in more detail.



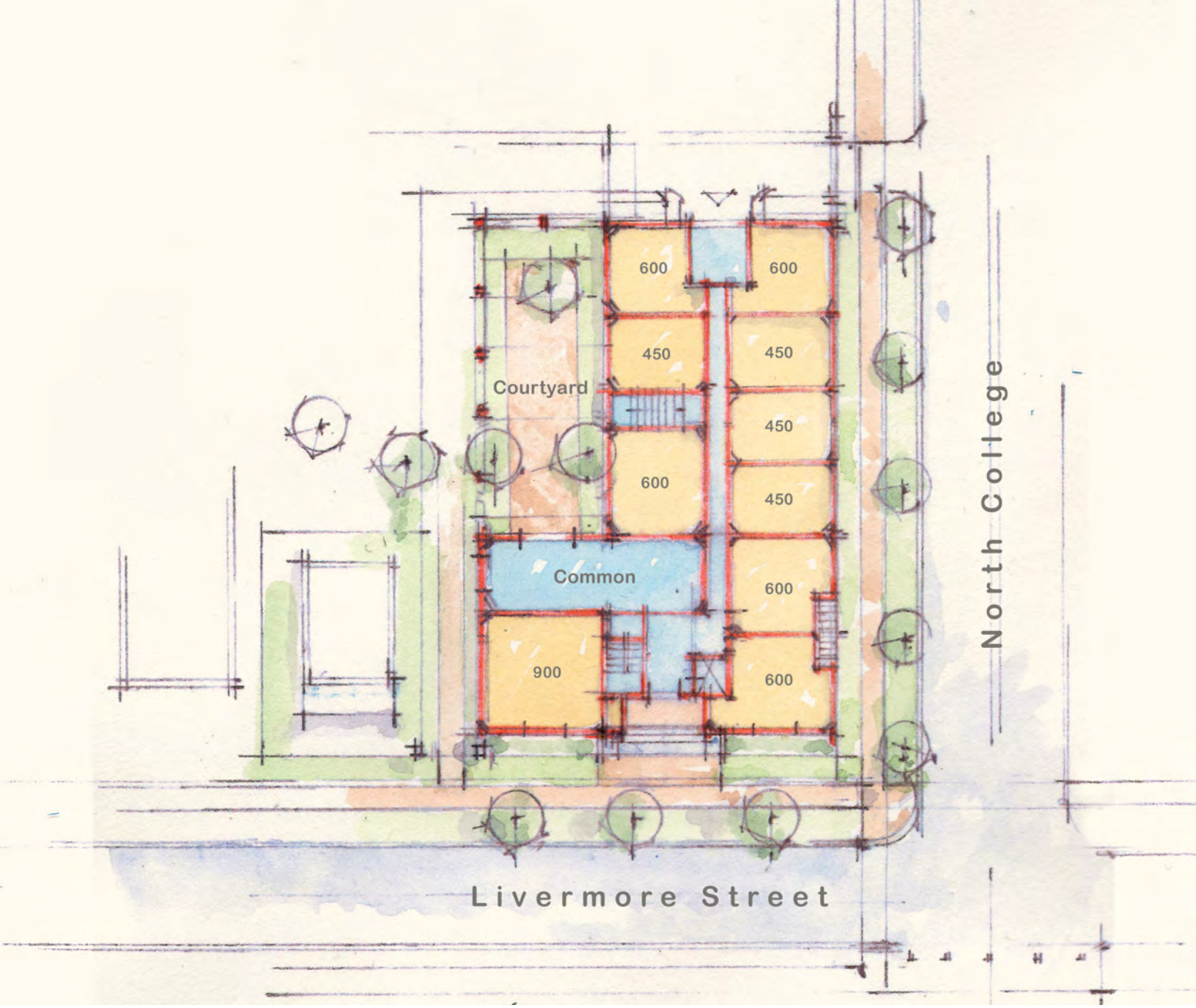
A wide variety of housing types are essential for a complete community. A range of housing options allows people of all ages and incomes to live within the same neighborhood. An Eco-System of Building Types was developed during the charrette in response to the community's desire for inclusive development that can accommodate various housing needs.



Apartment Building

The Apartment Building type is an example of a larger structure that helps define primary street frontages. It is also comparable in scale to many of the existing academic buildings on the college campus. An Apartment Building has flexibility to accommodate a variety of unit sizes while maintaining a unified street facade. Studio apartments, as well as units with one, two, or three bedrooms, can comfortably fit within a singular building. This mix of housing is essential for a truly diverse neighborhood and provides potential living spaces at a variety of price ranges.

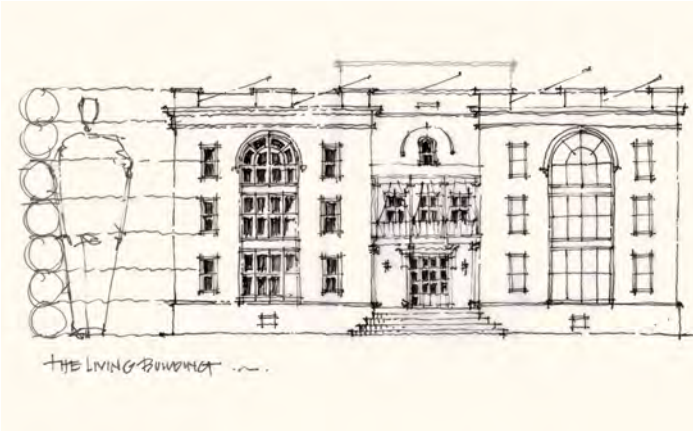
The "Equity" petal within the Living Community Challenge explains that a neighborhood with inhabitants of all ages and incomes is truly a complete neighborhood. The opportunities for learning and interaction are optimal in places like this; the citizens of Yellow Springs echoed this sentiment when outlining the vision for future development.



Courtyard Building

Like the Apartment Building type, a Courtyard Building typically has between six and twenty units, with different sizes and configurations all within a singular building. The units are arranged around a small, central courtyard which maximizes light and ventilation for each residence.

The outdoor courtyard space is often a shared common area that functions as a popular amenity to inhabitants. Reflecting the goals discussed in the Living Community Challenge, the courtyard is designed to take advantage of available local resources, and provides a place for active and communal events.



The Living Community Challenge says that we should design buildings that work with available local resources and reflect life. Buildings and proportion are actually a reflection of human form.

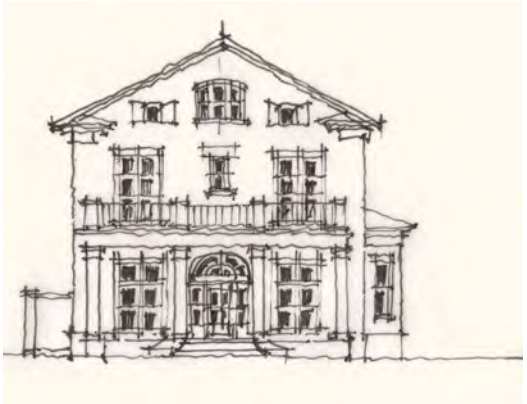
Rowhouse

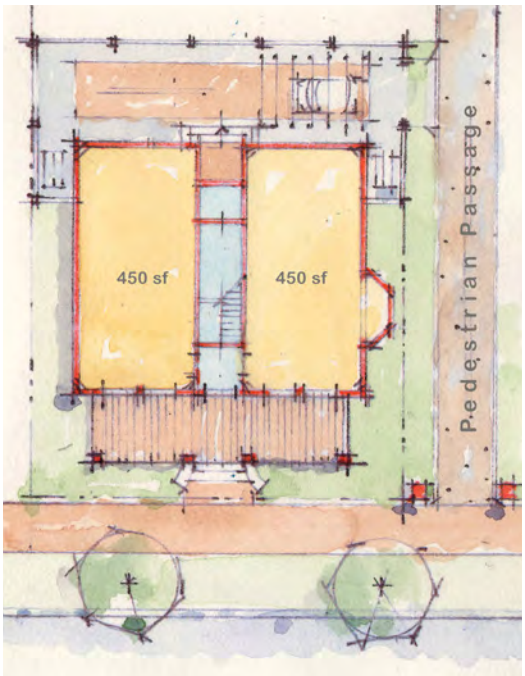
A Rowhouse is typically a single-family dwelling, attached to abutting dwelling units. At Antioch College Village, rowhouses can be arranged together as a stand-alone development, or can be arranged around a central green that also includes Tiny Houses and Apartments.

Large Home Apartment Building

The Large Home Apartment Building is a historic type that fits within the local character and neighborhood fabric of Yellow Springs. Large Home Apartments are smaller in scale than Apartment Buildings and have many of the same qualities as a single-family detached home. These typically contain between two and six residential units, and often have generous accomodations for small families. Front, rear and side yards are shared amongst residents, often with individual parking or garage areas located along the alley.

Located in historic towns and villages throughout the country, the Large Home Apartment Building is a diverse housing option that can be created new, or created through renovation to an existing building. Large homes that were previously used for only one family, can be adapted and reused to accomodate multiple families, while maintaining the same exterior character.



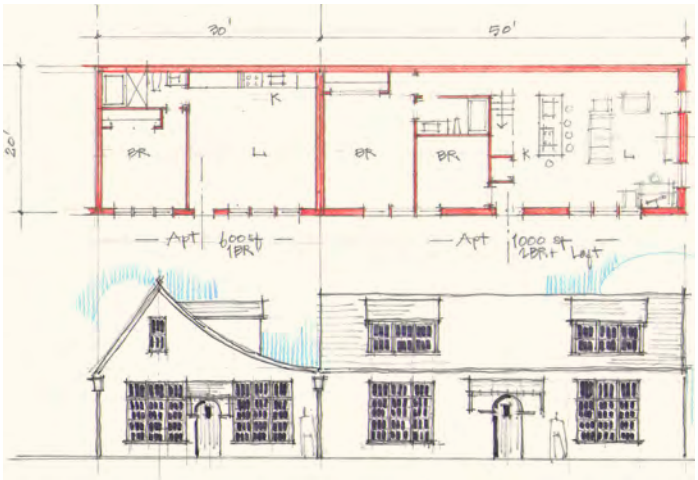


Cohousing

During the charrette, community members expressed their interest for living in Cohousing. Coupled with the already distinct local character of the Antioch College campus and its surroundings, this housing type would strengthen an already unique environment for living and learning.

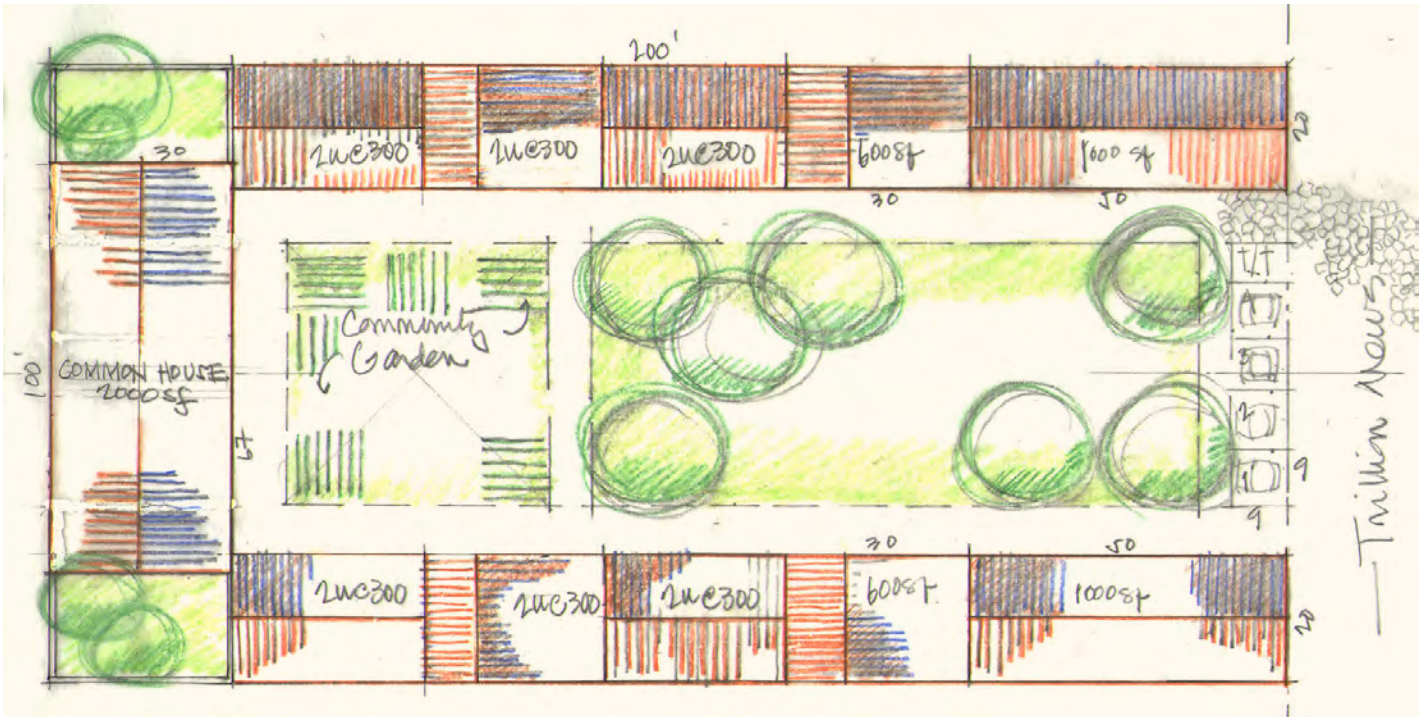
Cohousing involves a series of private homes, arranged around shared community spaces, such as a gardening area or a communal kitchen. Facilities and appliances, like a swimming pool or a lawnmower, are also shared. This creates a sense of community where responsibilities are intentionally distributed between individuals and families.

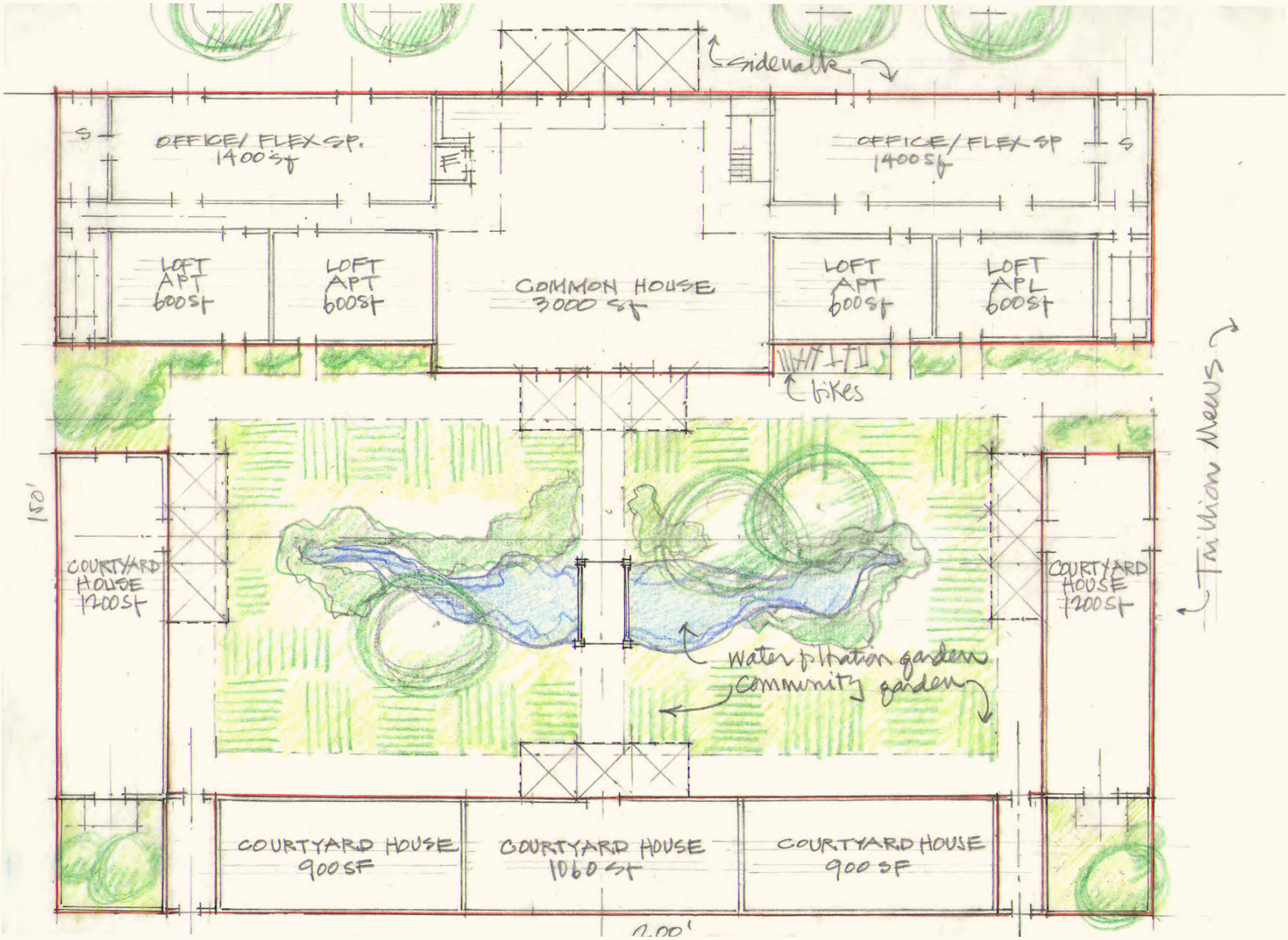
There are ample benefits to living in a Cohousing arrangement—including affordability and an improved quality of life. With shared facilities and communal spaces, the cost of living per unit is significantly decreased. In addition, smaller unit sizes are much more feasible. For example, a personal kitchenette is sufficient in a Cohousing unit when there is a larger kitchen available in the common areas. More importantly, Cohousing encourages an active social and civic life. The design and intent of development of this type fosters interaction among all residents of all ages.

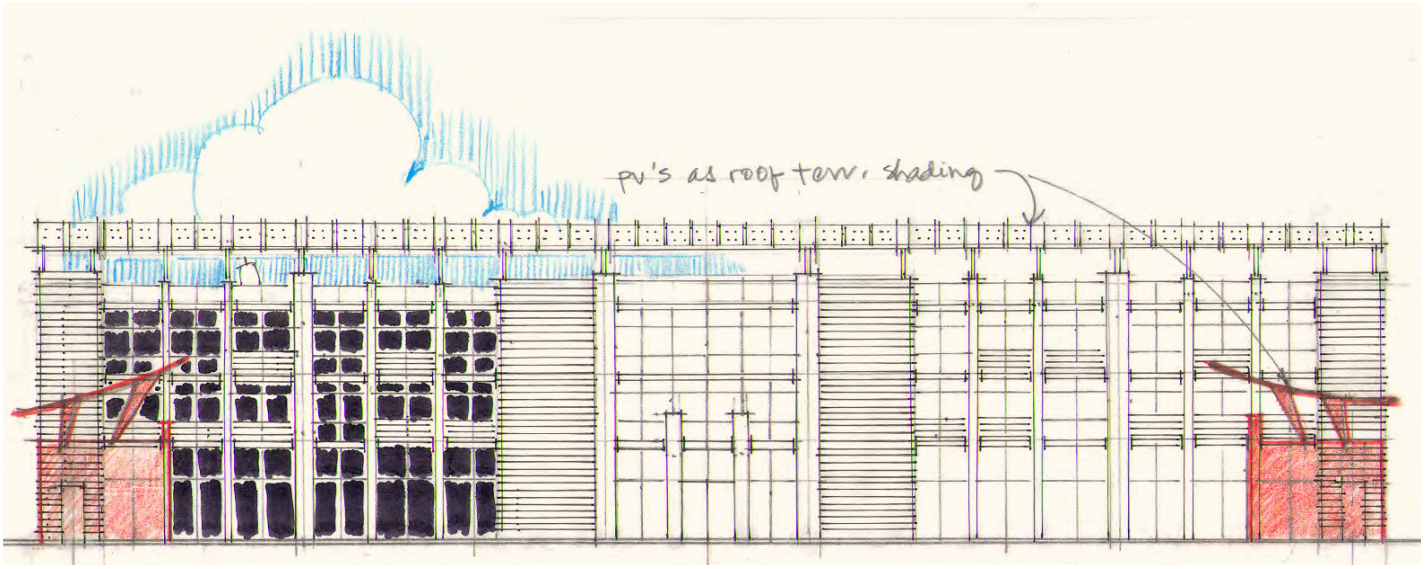


Cohousing units can be varied in size, ranging from 300 square feet to 600 square feet, to units as large as 1000 square feet.

In the below sketch, "Smart Car" sized parking spaces are provided on-site; these provide two spaces for every one standard space, and can help to reduce the area designated for parked cars, resulting in more space for communal activities.





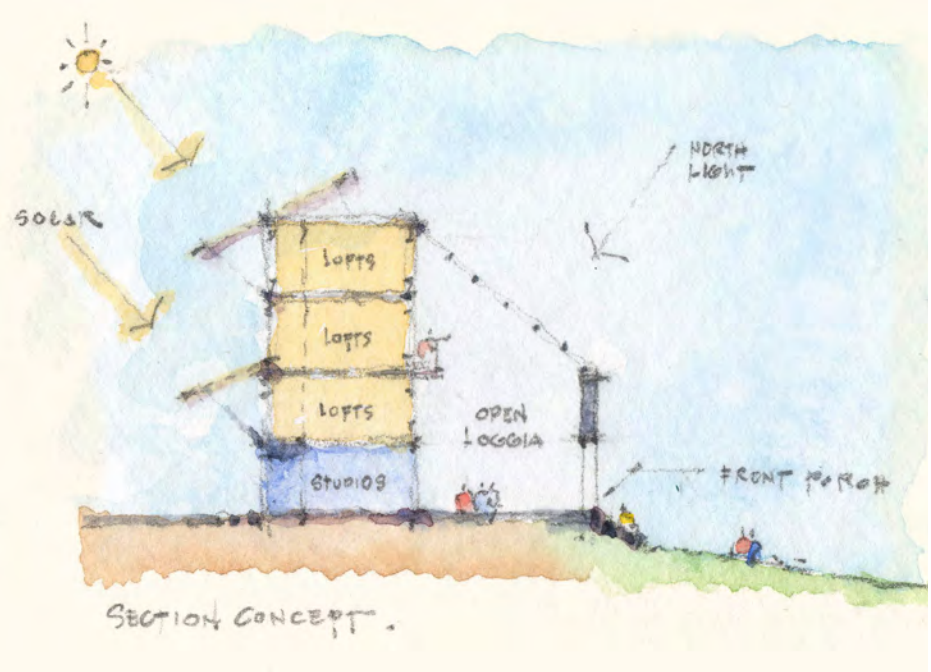


Cohousing communities occur in a variety of forms, including a collection of small cottages, or as a larger apartment building.

Art & Technology Building

The Art & Technology Building is a local icon. Current and previous students from the college relate to its distinct history and celebrate its identity. In addition, it is situated in a location that defines a primary east-to-west connection, from the heart of the campus to the beginning of the Glen Helen Nature Preserve. It is also visible along Corry Street as people approach the western edge of campus.

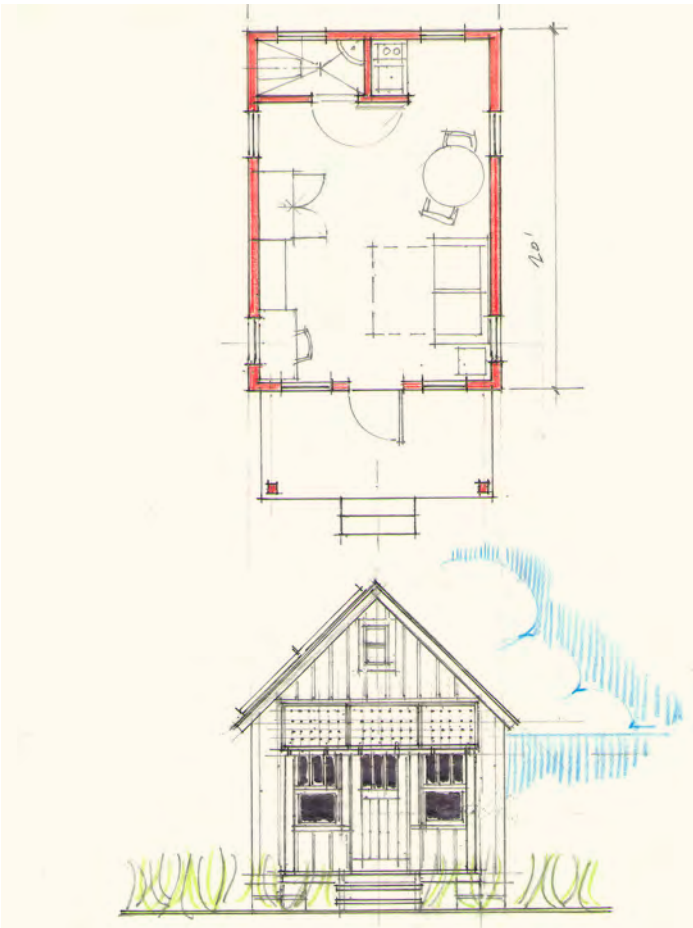
In order to re-use and preserve the building, the design team studied potential future building forms for the historic structure. One idea capitalizes on the big, skylit portion of the building and presents a re-design that opens the space below, creating a shared space for new inhabitants. the redesign would facilitate the use of sustainable energy technologies, such as cross ventillation and solar collection. Future uses for this space could include art studios or galleries, live-work units, exhibit or classroom space for the nearby theatre, or a general gathering area for students.

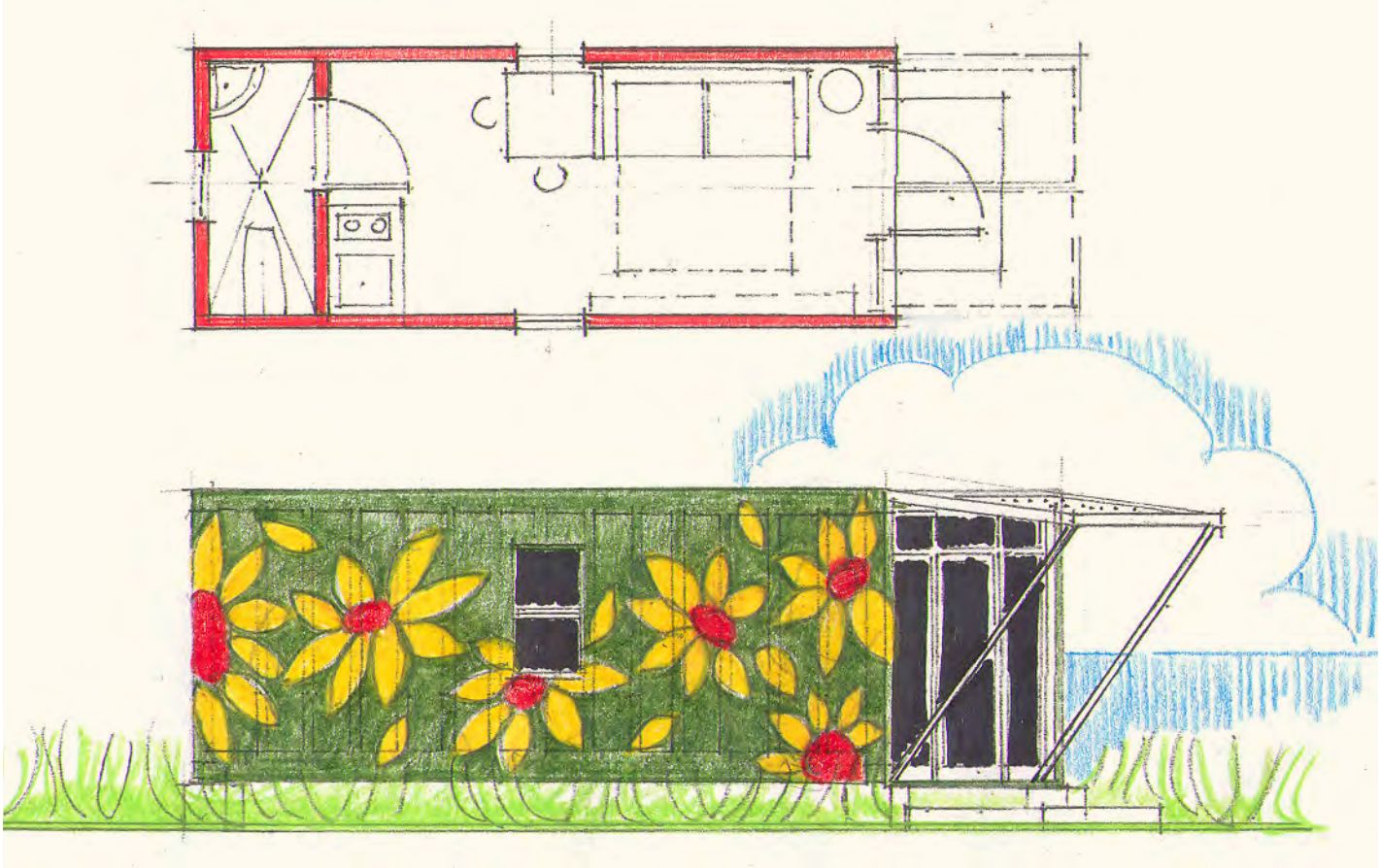


Tiny House & Container House

Tiny Houses are living units, designed as small as 160 square feet, that are optimal for anyone that desires a simplified life. A recently popular phenomenon, Tiny Houses are dialed down in size and in price, but they are not dialed down in dignity; the units may have high floor-to-ceiling proportions and quality finishes like adjacent larger structures, but at an affordable price point.

Container Houses are similar to the Tiny House, but are constructed out of re-used shipping containers. In Antioch, these could be provided in the south campus area. Although these could be permanent residences, they could also be used as temporary accommodations for overnight stays, for artists and eco-warriors who want to experience the Antioch lifestyle.





Architectural Precedents

tiny house





cottage





rowhouse | live-work





cohousing





large home apt.





apartment bldg.





lofts | micro apts.





adaptive reuse





ecology and water systems

An Introduction

Antioch College Village (ACV) is envisioned as an eco-village community that seamlessly incorporates residential living for lifelong learners and families on the Antioch College campus.

Sustainability and resilience, as well as the concept of living communities, are central tenets of this new development. Besides being patterned on living systems this community is being built within the context of a dynamic living ecosystem, one that is characterized by streams, wetlands, forest and open space, as well as the urban context of the Yellow Springs Community and the existing Antioch College campus. The campus itself is characterized by open spaces, mature tree canopy, pasture, streetscapes, formal quadrangles and the built environment of classroom, facilities, and residential buildings.

The eco-village concept provides an opportunity for a radically new approach to growing a diverse and resilient campus community, combining economic, cultural and environmental sustainability. Biohabitats' responsibility in this planning process is to uncover and examine the historic and existing natural resources on the Antioch College campus in order to inform and influence the residential development patterns of ACV in a way that promotes enhanced and optimized ecological and hydrologic function while supporting the needs of the community.

Infill development is a primary consideration for the required residential development footprint of ACV, in order to preserve open space and natural resource areas.

The question becomes: How can we focus the development footprint in areas that are previously developed, in order to conserve and preserve ecological resources on campus. Living (or green) infrastructure is the approach suggested here, a way of designing and enhancing natural spaces as part of the functional campus infrastructure. This approach reaches beyond the conventional pipe or structural solutions for certain processes, while integrating activated open spaces with preserved or enhanced ecological spaces that provide important habitat for wildlife.

This narrative summarizes the ecological and hydrologic data and observations for the entire campus and then considers the best opportunities for integrated design within the focus area for the proposed Antioch College Village. It takes into account the dialogue and feedback the planning team received during the Design Charrette held on March 1-5, 2015 at Antioch. There is much potential for the existing natural systems and the ecological legacy of this campus to create a new residential community on the Antioch campus that supports functional, productive, and sustainable landscapes that tie into broader natural resources outside of the footprint of this development.

Antioch Hall in winter framed by mature tree canopy

Pollinator plants are an important consideration in green infrastructure design

A "daylighted" pipe brings water back to the surface and provides a landscape amenity and improved habitat

Green roofs provide multiple benefits: native habitat, stormwater management, increased energy efficiency in buildings

Green Infrastructure

A green infrastructure approach stresses the importance of a functioning natural system as an integral element in the developed landscape. Having green infrastructure as a foundation for planning requires transitioning from conventional engineering, landscape design, and water management practices that may contribute to the degradation of the natural environment, to practices that perform important ecological and hydrologic functions while providing users with functional spaces.

Green infrastructure includes: converting turf to natural vegetation; managing, preserving, and restoring healthy forest stands and ecological corridors along streams and waterways; the integration of stormwater management features as part of a "functional landscape"; integrating vegetation into building architecture in green roofs and living walls; integrating cisterns and other water capture and reuse systems; permeable pavement and other alternatives to impervious surface; natural outfall designs; the integration of renewable energy and transportation planning; carbon sequestration as a consideration in management of vegetation; and the inclusion of edible landscapes or urban agriculture as well as other programming decisions.

Developing a strong and resilient green infrastructure network involves examining, interpreting and building upon the inherent patterns in the landscape, in an effort to build a site's capacity for regeneration. This approach involves a strong focus on connectivity, adaptability, and designing for stacked benefits at multiple scales. It also stresses an appreciation for historic function balanced with an understanding that in some locations natural function may not return in its original form, and instead a new functional living system with natural characteristics may be introduced.

With this in mind the team considered both the regional and campus-scale ecological and hydrologic systems that can inform the development of Antioch College Village within the campus.

Landscape Ecology

No place is ever entirely disconnected from its surroundings and from an ecological perspective there are processes at multiple scales that help define a place and provide for its long-term success. Ecological networks, broad-scale patterns, and processes that help define a space. By considering the ecological lens of place, both from a regional, as well as from a more localized perspective, one can plan for a more resilient future.

Understanding both the broader landscape ecological patterns along with more specific site characteristics provides a more holistic understanding of the landscape legacy as well as existing ecological function. Through a review of existing data for the region, including soils, geology, topography, land cover, and hydrology, one begins to see patterns that are borne out on the site. From these patterns and the associated ecological processes we can begin to develop more strategies for a resilient community development.

The rolling loamy plains landscapes that define this region of Ohio are characterized by beech forests, oak-sugar maple forests, elm-ash swamps, as well as widespread agriculture[1]. River and stream valleys carve through old growth forests and farmlands, formed by the meltwater of the Wisconsinan age glacial melt (formed over 20,000 years ago). The stormwater runoff that originates in the Village of Yellow Springs and on Antioch's campus flows east and enters Yellow Springs Creek near the namesake Yellow Springs (designated by the National Park Service as a National Natural Landmark). This creek then flows south to join the Little Miami, which also serves as the main supply of drinking water for the village. The Little Miami, which eventually makes its way to the Ohio River, is an ecological gem in Southwest Ohio, the first designated State Wild and Scenic River in the state, which was later designated as a National Wild and Scenic River.[2]

Antioch College's campus in Yellow Springs is found along the eastern edge of the Mississippi Flyway, one of the major migratory flyways that spans North America. Numerous birds travel along this flyway during their annual migration, often stopping along the way at appropriate habitat areas to find food and take shelter. With the presence of Glen Helen Preserve along the eastern edge of Antioch the campus has the potential to play an important role in providing expanded habitat opportunities for migratory birds and other wildlife in the region. In fact the Preserve is recognized as the top hotspot for birding in Greene County, Ohio, with over 180 bird species documented.[3]

THERE ARE A MULTITUDE OF ECOLOGICAL PROCESSES THAT HELP DEFINE A SPACE

Other regional ecological resources beyond Glen Helen Preserve include John Bryan State Park, which runs along the Little Miami river corridor, Clifton Gorge State Nature Preserve, Clifton River Road Preserve, and the Little Miami State Forest Preserve. All of these together provide a rich selection of habitat that can always be strengthened and bolstered through stewardship of neighboring resources like the campus and other larger landholdings.[4]

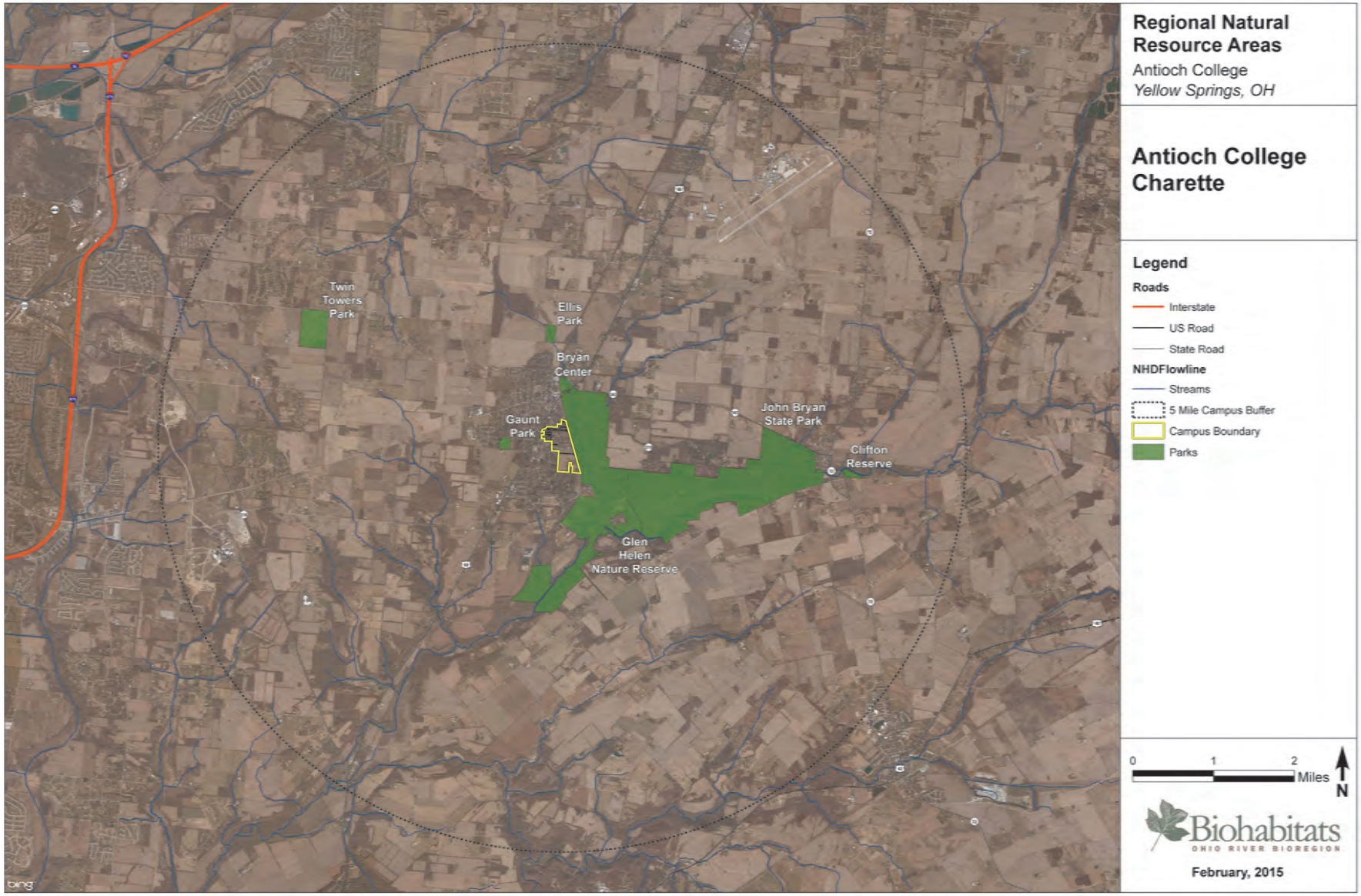
The mapping for this assessment was presented during the Design Charrette at Antioch (and included as an appendix to this document).

1 Physiographic Provinces of Ohio: http://www.people.iup.edu/kpatrick/Great%20Lakes/Ohio%20Physiography.pdf

2 Hedeen, Stanley. The Little Miami: Wild & Scenic River Ecology & History. The Little Miami Conservancy. http://littlemiami.com/LITTLE%20MIAMI%20RIVER%20ECOLOGY%20AND%20HISTORY.pdf

3 http://ohioebirdhotspots.wikispaces.com/Greene+County

4 naturepreserves.ohiodnr.gov/



Regional Parks and Preserves within 5 miles of the Antioch College campus

Campus Resources

Soils and Geology

The dominant soils on campus are Miamian Silt Loam and Milton Silt Loam. The soils are rated as Hydrological Soil Group C, and while not ideal for water infiltration (A and B soils are better for stormwater infiltration), what water does infiltrate eventually filters through the soil and into the groundwater.[5] The geology is limestone dolomite, which is an indicator of karst topography.[6] There is evidence of sinkholes on the farm portion of the campus, further indication of karst characteristics.[7] This is an important detail associated with future stormwater management consideration which will be covered in the following chapter.

Erosion at one of the outfalls from campus in Glen Helen Preserve

Hydrology

As noted above, the rainwater that falls on Antioch's campus is conveyed in pipes and overland swales to the east, where it empties into Yellow Springs Creek. Therefore all contaminants, eroded soils, invasive plant species, and pollutants the water picks up along the way are flushed into Yellow Springs Creek, and consequently into the Little Miami River. There are issues with erosion at the outfalls to the creek, noted during rapid field reconnaissance in February, as well as on campus stormwater management trouble spots and localized flooding. There are also issues with invasive species in the waterways, as well as in disturbed areas within Glen Helen Preserve including lesser celandine (*Ranunculus ficaria*), Japanese stiltgrass (*Microstegium vimineum*), English ivy (*Hedera helix*), Japanese knotweed (*Fallopia japonica*), garlic mustard (*Alliaria petiolata*) and Asian bittersweet (*Celastrus orbiculatus*). Slowing, filtering, and controlling stormwater flows through integrated landscape practices can help address these problems in a way that also enhances the aesthetics of the landscape and the ecological function.

Lesser celandine is an invasive plant species found in floodplain forests where it forms extensive mats that impede the growth of native species

5 Natural Resources Conservation Service. Custom Soil Resource Report for Greene County, Ohio. Antioch College Soils. United States Department of Agriculture. Downloaded February 25, 2015 from USDA Web Soil Survey.
6 USGS: http://mrdata.usgs.gov/geology/state/.
7 Correspondence with College staff during field assessment.

Vegetation

Mature tree canopy is a defining feature on the Antioch Campus. The mature woodland surrounding Antioch Hall is a defining aesthetic and ecological feature that creates a sense of place and also connects the campus to Glen Helen Preserve. In fact, the landscape around Antioch Hall was noted as a particularly sacred space during the planning charrette conversations, with many participants noting the beauty and iconic character of the space. This iconic landscape is also currently the site of forest restoration activities associate with the current master plan, in order to enhance connections to the Preserve. Sugar maples that dot the campus also play a key role in the permacultural legacy of the college community, providing functional and productive landscapes in the interstitial spaces between buildings and campus walkways. One priority will be to preserve and enhance this existing mature tree canopy as new campus development moves forward.

Mature canopy trees are part of a diverse selection of native plants which provide many advantages and ecosystem services. Besides the obvious aesthetic value, they provide benefits including shade and cooling in the hot summer months, wildlife habitat, increased infiltration and interception of stormwater, microbial habitat within their intricate root systems, air filtration, and carbon sequestration. The National Tree Benefit calculator notes that one 18" DBH sugar maple tree can provide an economic benefit of $84.00 annually and a 24"DBH sycamore can provide upwards of $79.00 annually.[8] Multiply that by the number of trees on campus and one starts to see the incredible economic benefit of mature woodland on the campus.

A tree survey of the entire campus should be conducted in order for the college to know the health, age, and overall species selection currently seen on campus.

A campus aerial from 1973 showing the extent of tree canopy and the vegetative connection to the Preserve (in the background)

Forest restoration is already in progress on campus, to improve connections with the native forest in Glen Helen Preserve, which once stretched across most of the current campus landscape

8 National Tree Benefit Calculator: http://www.treebenefits.com/calculator/ReturnValues.cfm?climatezone=Lower%20Midwest

The Antioch College campus in 1957 (approximate extents of current campus outlined in yellow), with an interpretation of ecological patterns in blue (water) and green (forest)

As seen in this 1957 aerial, ecological features on campus tie directly to Glen Helen Preserve and the most prominent feature is the mature tree canopy. The wooded landscape around Antioch Hall serves as an extension of the tree canopy found on the Preserve, and the drainage patterns seen on the farm property to the south of main campus show overland flows of rainwater, as it finds its way to Yellow Springs Creek. There is the potential to tell the story of the ecological and hydrological legacy on campus through preservation and enhancement of these resources.

As noted above, Glen Helen Preserve is an important ecological resource for the Antioch campus as well as the region. Dominant tree species include bitternut hickory (*Carya cordiformis*), white oak (*Quercus alba*), sycamore (*Platanus occidentalis*), black walnut (*Juglans nigra*), and red oak (*Quercus rubra*).[9] The Preserve includes an outdoor education center, a raptor center, and the Glen Helen Ecology Institute. In light of these existing resources, the campus can act as an extension of the Preserve, a living laboratory and an ecological buffer for

9 As noted in exhibit A of the Glen Helen - Little Miami River Protection Project Clean Ohio Conservation Fund District 11 NRAC - Round 7 Application.

the natural resources housed in the Preserve. The campus landscape can be maintained in a way that supports the overall function and health of the Preserve through best practices that include integrated stormwater management that serves to reduce some of the effects of uncontrolled runoff on the stream; control of invasive plant species; specification of native plant species for all new landscape designs; and cultivation of a diverse palette of native plant species that serve to strengthen the capacity and function of the campus landscape. The plans for the growth and expansion of the campus farm with its pollinator trails, productive gardens, pasture, and edible forest plantings can all be integrated into a holistic plan for an ecologically functional and sustainable campus landscape, including Antioch College Village.

Beyond best practices for landscape management, the landscape can be a space for the study and understanding of native ecological processes and stormwater treatment practices, through monitoring, adaptive management, and research. Landscape spaces can be designed and programmed for flexible uses that include outdoor classrooms, impromptu gatherings and formal ceremonies. The campus is the connective tissue between the Preserve and the village of Yellow Springs, a place where experience is informed by a deeper relationship between landscape and community.

The campus farm provides another layer of landscape function, as it celebrates a tradition of productive agriculture, organic farming, and permaculture on campus. This space has been a living lab for the students already, as well as providing ingredients for the food prepared in all of the campus dining halls. As part of the current master planning effort being completed by MacLachlan, Cornelius & Filoni, Inc. (MCF) there is a plan to increase the size of the farm on the southern portion of campus and add grazing animals. This will increase the productivity of the landscape and the ecological function, if designed with existing resources and drainage patterns in mind. The existing drainage swales and sinkholes on the southern campus should be considered carefully as the future planning efforts continue. A vegetated buffer along existing surface drainage swales can help filter runoff and minimize erosion, which may become an issue with the addition of more grazing animals within the vicinity of the swales.

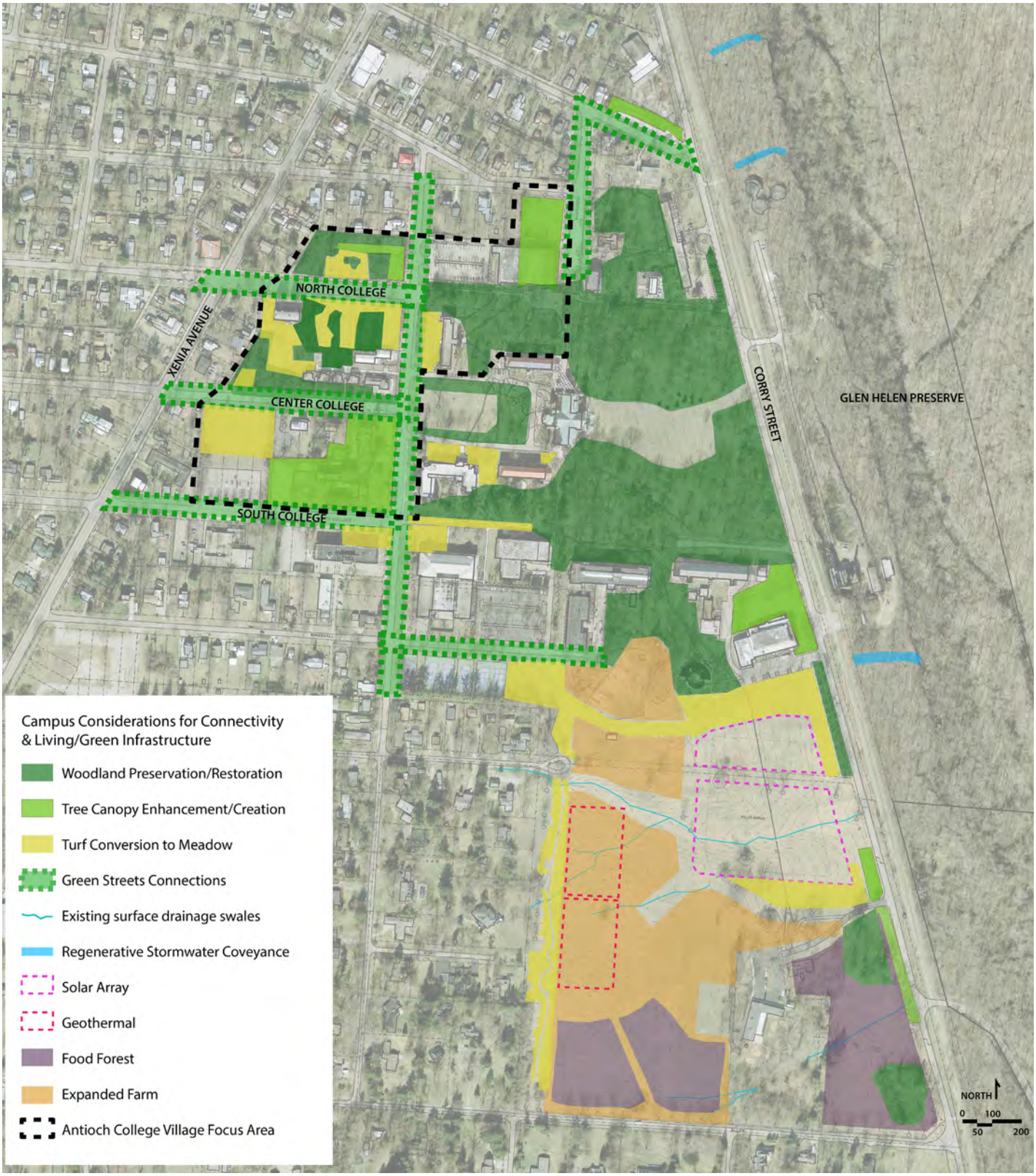
The south campus portion of the MCF master plan, showing the expansion of the campus farm (figure by MacLachlan, Cornelius & Filoni, Inc.)

Ecological Opportunities

ACV, and the broader Antioch Campus, have the opportunity to strengthen broader ecological connections, embracing the bones of the existing ecological features including mature tree canopy, productive landscapes and surface drainage patterns, and enhancing the function of the campus landscape, integrating living infrastructure that provides multiple benefits and creates an aesthetic that connects with the ecological context of place.

There are many opportunities for green infrastructure implementation to enhance landscape connectivity and function on campus as well as within the area slated for Antioch College Village (see figure on facing page):

- Woodland preservation and restoration around Antioch Hall, as well as north and south of the main green along Corry Street, and enhanced tree plantings along Corry Street. This would include the enhancement of the native plant palette to include a wide variety of mid-canopy, understory, shrub, and groundcover vegetation.
- Tree canopy enhancement and creation in areas where native trees can replace aging nonnatives, additional trees in areas that could be reforested to help support dense infill development, interstitial spaces and locations where buildings may be removed and woodland canopy connections could be made. This would include the enhancement of the native plant palette to include a wide variety of mid-canopy, understory, shrub, and groundcover vegetation.
- Turf conversion to meadow, to help support a change in maintenance regimes away from mown turf and toward native pollinator gardens of mixed herbaceous and shrub species. Considerations for phased development and integrated landscape conversion are discussed in more detail below. Some areas of turf conversion will also host integrated vegetated stormwater treatment practices like rain gardens, bioswales, and bioretention. These may be designed along paths, building foundations or other locations with drainage issues.
- Green streets – integrated stormwater treatment in improved streetscape design that includes edge plantings of native vegetation, curb extensions with bioretention, native foundation plantings, enhanced tree canopy along streets using a mixed native palette, and integrated paths for safe bike and pedestrian access.
- Preserve and enhance existing drainage swales to promote function, during the continued expansion of the farm on south campus.
- Regenerative stormwater conveyance or some other type of restorative design technique at the existing stormwater outfalls in Glen Helen Preserve can help stabilize those areas and provide further opportunity for stormwater treatment and filtration before it enters Yellow Springs Creek.
- Productive landscapes, including the food forest and the expanded farm can incorporate native vegetation both as productive agricultural components and buffers along the edges.
- Further considerations for integrated stormwater management will be provided in the following sections of this summary.



Green infrastructure opportunities, with the Antioch College Village focus area highlighted

Phased Implementation

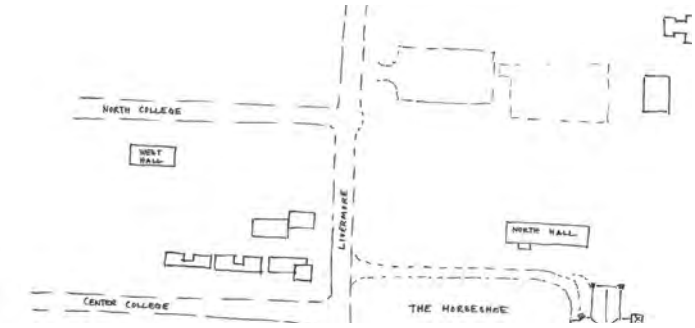
The potential build-out scenario for the residential dwellings of AVC is envisioned to be completed over the course of a series of phases, starting with a small footprint within the vicinity of the corner of Livermore and North College Avenue. A phased implementation of this project can realize opportunities for increased ecological function through the conversion of certain late-buildout spaces to functional landscape. As the first phase of implementation begins undeveloped land parcels on campus that may be slated for future development can be converted from turf to mixed native meadow plantings, creating small parcels of native pollinator habitat in lieu of the less functional and aesthetically-uninspiring turf treatment. These spaces can also function as edible landscapes and locations for herb gardens and beekeeping, which may be curated by residents or by the college's farm. Over time these spaces may either be developed, as needed, or mature into even more diverse and functional native landscapes that tie into the ecological fabric of the campus.

The sketches featured here show the existing buildings and then a series of proposed development phases for Antioch College Village residential buildings (in pink), starting with the site at the corner of North College and Livermore Streets. Proposed areas of turf conversion to functional ecological landscapes are shown in light yellow (corresponding to the color palette shown on the prior page) and preservation and enhancement of woodland canopy over is shown in green.

Phase 1

Phase 2

Phase 3



Current building and paved surfaces

Full buildout

Functional Landscapes

The eco-village can include integrated landscape features that improve ecological and hydrologic function and connectivity, creating a seamless connection between the campus and Glen Helen Preserve. The examples below, from other institutions, show potential landscape gestures that can be considered at Antioch.

Woodland Enhancement

Wetland and Water Amenities

Permaculture/ Gardens

Bioretention/Swales integrated with Paths/Sidewalks

Native Meadow

Regenerative Stormwater Conveyance/ Swales

Functional landscapes are integrated into the campus fabric to provide enhanced habitat, productive garden spaces, and stormwter management

Landscape management and maintenance practices can promote ecological function. The following are the preliminary management zones based on the campus landscape committee recommendations:

Zone 1 – Main Hall

- Formal/manicured landscape aesthetic

Zone 2 – Campus Proper & Antioch College Village

- Lower Maintenance- low mow turf
- Native herbaceous/meadow patches
- Rain gardens
- Restored biodiverse woodland structure (canopy, midstory, shrub, groundcover, herbaceous, etc)

Zone 3 – Nature Transition

- Lower intensity/Less Formal
- No-mow
- Ecological learning
- Restored biodiverse woodland structure (canopy, midstory, shrub, groundcover, herbaceous, etc)

Zone 4 - The Farm

- Productive and grazing landscapes
- Meadow and pollinator plantings around garden plots
- Riparian plantings along sensitive drainage areas

Zone 5

- Main Lawn
- Turf – conventional mow regime

A suggested native plant palette is included in the presentations that were developed for the charrette (and included as an appendix to this document).

integrated water strategies

An Introduction

Stormwater, wastewater and drinking water are all closely linked to the health of Yellow Springs Creek, Little Miami River, and the communities they serve. All water falling on, being used, or generated from the greater Antioch Village Community flows through the Little Miami River Watershed. Understanding how it is captured, stored, released, used, reused, distributed, and discharged in the watershed is critical to creating effective sustainable water systems that enhance the community.

Water Balance

Our first step in identifying potential water strategies for a project is to assess the health of watershed by examining and understanding its water balance. Often we examine this question at multiple scales. While it is often easier to understand the water balance of a single building or block of buildings, it is often more meaningful to understand the water balance of the largest relevant scale, in this case the Antioch Campus and Village of Yellow Springs. It is also important to understand the variability of a water balance, such as how wet or dry seasonal conditions affect its balance or how student attendance has a significant impact on water moving through the community.

Approximately, 4,000,000 gallons of water falls as precipitation on the Antioch College and the Village of Yellow Springs community. Depending on the season, weather patterns, and land cover, rain will infiltrate, be used by vegetation, runs off, or is stored. Water that infiltrates or runs off will eventually make it to the surface waters of the Little Miami Watershed or its underlining aquifer. These connected water bodies are interrelated; therefore, ecological conditions may result in surface waters feeding the aquifer, other times the aquifer may feed the surface waters.

The Antioch College and the Village of Yellow Springs has a community potable water service operated and managed by the Village of Yellow Springs. Officials are democratically elected and thus the community has a voice in how the water is secured, treated, and distributed. In recent years, the community voted to not include fluoride additives to the community supply.

Additionally, after studying several alternatives for increasing the community water supply capacity, the community decided not to seek bringing in water from alternative providers outside of the watershed.

Approximately, 400,000 gallons of water per day is pumped from a well field near the Little Miami River. Water is used in the community for potable and non-potable uses. Potable uses include drinking, showering, and cooking. Non-potable uses include flushing toilets, industrial uses, and irrigation. Much of the water supplied to the community is used only once before being discharged to the community sanitary sewer system. The conventional gravity sanitary sewer network is old and experiences significant infiltration and exfiltration issues. Like many communities, wastewater leaks from the sanitary sewer piping and manholes which contaminates the groundwater aquifer. Conversely, when groundwater levels are high during wet weather, it enters piping and manholes which can overwhelm the sanitary infrastructure.

Collected wastewater is processed by a community owned and operated treatment plant to enhanced secondary quality. The treatment plant uses seasonal biological phosphorus removal to reduce nutrients in the wastewater, which is fairly advanced for a rural community of this size. Treated water is discharged to the Yellow Springs Creek, a tributary of the Little Miami River, upstream of the well field that pulls water for the community supply.

This closed loop system is unique for many communities and likely instills a unique ethic of water conservation, preservation, and stewardship. A community survey in recent years identified that over half the respondents identified that 'maintaining local control of local water' as 'very important' or 'extremely important'. Examining the water balance at a community scale, as shown in Figure 1, helps to tell a more complete picture of how the community affects the health of the watershed. It can also be used as a tool to help make further efforts to strengthen the water story of the community. The development of the Antioch Village can include interventions such as improving supply distribution piping to increase pressure and flow capacity, creating new non-potable water system using treated wastewater, and replacement of sanitary sewer infrastructure to reduce infiltration and exfiltration.

Figure 1. A community scale water balance

Net Zero Water

Net Zero Water is more than balancing water inputs and outputs. It is an understanding that the more water is used, reused, or not used in appropriate ways, the more that the water infrastructure will add to creating a healthy robust community. Understanding water quantity and water quality are important when developing strategies to achieve Net Zero Water. We have broken out several key infrastructure frameworks to help articulate concept design strategies for Antioch Village, including stormwater, greywater, wastewater, and source separation.

Strategies to achieve Net Zero Water goals shouldn't preclude other project and community goals. The following design criteria are used as a starting point to developing viable water infrastructure strategies.

Simple to construct - local contractors should be able to build the system without resorting to specialized equipment or contractors. The design should avoid proprietary equipment that requires specially-trained technicians, when appropriate.

Simple to operate - the system should require minimal operator involvement. The design should rely on biologically-robust, low-energy technologies with relatively longer detention times. Mechanically simple systems have fewer pieces of complex equipment that will need to be repaired or replaced.

Simple to maintain - small community and building-specific water systems should be designed to operate using equipment that is readily available from the local suppliers.

Stormwater

Sustainable stormwater management at a neighborhood or district scale requires employing strategies that balance the need to think about the district as a whole and consider large-scale hydrologic connectivity with the need to identify small, discrete locations for treatment. This section will address the reasons for breaking up treatment into multiple small areas, as well as provide concrete examples of appropriate stormwater practices.

As discussed in the previous chapter, the presence of karst topography has implications for implementing storm water practices in Antioch Village. Stormwater infrastructure practices need to be appropriately distributed in order to capture and treat storm water before it concentrates and collects in a large area or volume. Concentrating stormwater in ponds or detention basins can increase the risk of sinkholes and groundwater contamination, and should be avoided.

A first step is to map the existing flow path of stormwater throughout the district and identifying opportunities for small practices along this route. Areas of proposed development will require similar analysis, identifying sources of runoff and places close to the source available

Figure 2. Concept sketch developed during the charrette, showing multiple stormwater practices incorporated into proposed development along North College Street

Figure 3. Preliminary swale sizes associated with proposed development along North College Street

for treatment. When considering storm water at the district scale, identify existing riparian and wetland areas. Increasing the size or improving the quality of riparian and wetland buffers can provide a service similar to filter strips elsewhere in the landscape, reducing surface flow velocities and filtering storm water before entering a waterway. Riparian and floodplain restoration can also improve water quality within the watershed and are most beneficial when implemented at, or larger than, district scale.

At the site or block scale, landscape areas in between buildings requiring pavement for driveways and walkways could implement pervious pavement to prevent the concentration of storm water flowing off of conventionally impervious pavement. Pervious pavement in karst topography will require specific design considerations including a bottom liner, an underdrain and the use of carbonate based rock for the reservoir. Micro-bioretention features (including an underdrain) can also be used to collect a small amount of runoff. Urban bioretention, such as curb cuts or bump-outs can also be used to collect runoff from streets and sidewalks. Again, the design strategy should be to collect a small amount of runoff, opting for multiple bioretention sites rather than one collecting runoff from a large impervious surface. Filter strips located in landscaped areas can be utilized to slow down and treat sheet flow from adjacent impervious or semi-impervious surfaces.

Concept designs during the Design Charrette included potential locations for a combination of practices at the neighborhood or block scale. Figure 2 shows permeable pavement, filter strips, curb extensions and dry swales within a proposed development near North College Street. Preliminary calculations for this area were also done to size and locate swales (Figure 3).

Small scale practices include incorporating practices into the building design and spaces immediately adjacent to buildings. The building roof and walls can be used to capture rainwater and delay its path to the landscape. Ecoroofs, rainwalls, and cisterns used to store rainwater are examples of practices that will help delay storm water entering the landscape. Cisterns have the dual advantage of capturing water that would otherwise become runoff and providing a source of water for non-potable use. Stormwater planters (utilizing an underdrain) used to collect building runoff also allow for evapotranspiration.

Greywater

Water from sinks, showers and clothes washing is considered greywater. This water contains little organic matter and fewer pathogens than wastewater, also referred to as blackwater (discussed below). These characteristics are conducive to decentralized onsite treatment and reuse, allowing the water to be used as a non-potable supply. Greywater treatment and reuse can be accomplished using a wide variety of technologies, yielding water that can be used for toilet flushing or irrigation. Treatment and reuse of greywater is best addressed on a building or neighborhood block scale where non-potable demand is close to where the greywater is generated. An example of this would be to collect and treat greywater from sinks and showers and return it back into the building to provide water for toilet flushing. There are a variety of small systems that would be appropriate to employ throughout the Antioch Village including wetlands, trickling filters, and/or sand filters.

Wastewater

Wastewater, also known as blackwater, can be treated closer to its source rather than sending it to the community wastewater treatment plant. Treating wastewater onsite contributes to the resiliency of community infrastructure because it provides an additional location for treatment other than the centralized treatment plant. Additionally, the treated blackwater can be piped back into buildings to meet non-potable demand and therefore reduce the use of potable resources.

Blackwater treatment often scales most efficiently at the large building, block or district scale. Considerations for an appropriate scale include balancing the quantity of wastewater with capital and energy costs for treatment. Additionally, it is often helpful to treat wastewater from mixed use developments where you generate a more consistent flow of wastewater throughout the day. Treatment technologies appropriate to this scale include onsite systems that range from more passive, low energy use systems with large land requirement to compact systems with a higher energy demand. Onsite treatment can be integrated into the community by making it a visible, functional part of the landscape. Constructed wetlands are one tool that can both treat wastewater and add aesthetic value and habitat to the community.

Source Separation

Water infrastructure that encompasses source separation provides opportunity to conserve water and retain valuable nutrients onsite. Waste that enters our wastewater systems is rich in nitrogen and phosphorus, both of which are important nutrients for plant growth. Two of the source separation techniques that would be appropriate at Antioch Village are urine diversion and composting toilets.

Urine is a small quantity of the wastewater generated in a building; however it contains most of the nutrients in the wastewater generated. Urine diversion devices such as urine diverting toilets and waterless urinals can support a process to create a sterile, bio-available nitrogen and phosphorus fertilizer. Urine can be stored in liquid form or processed to a slow release mineral, called struvite. Either form can be safely land applied to promote plant growth. Composting toilets treat both liquid and solid waste, creating a by-product (compost) that can be used as a soil amendment in the landscape.

These two different source separation techniques may be appropriate at different scales. Urine diversion using waterless urinals or source-separating toilets requires specialized fixtures and a centralized location to collect, store and process, and therefore may only be feasible on the block or neighborhood scale. Composting toilets also require specialized fixtures but can be applied at a smaller scale, at individual homes or at a slightly denser site scale. Both techniques produce by-products that can be used for agricultural applications. Nutrient management plans need to be established to effectively reuse nutrients and should be integrated in the water and solid waste infrastructure.

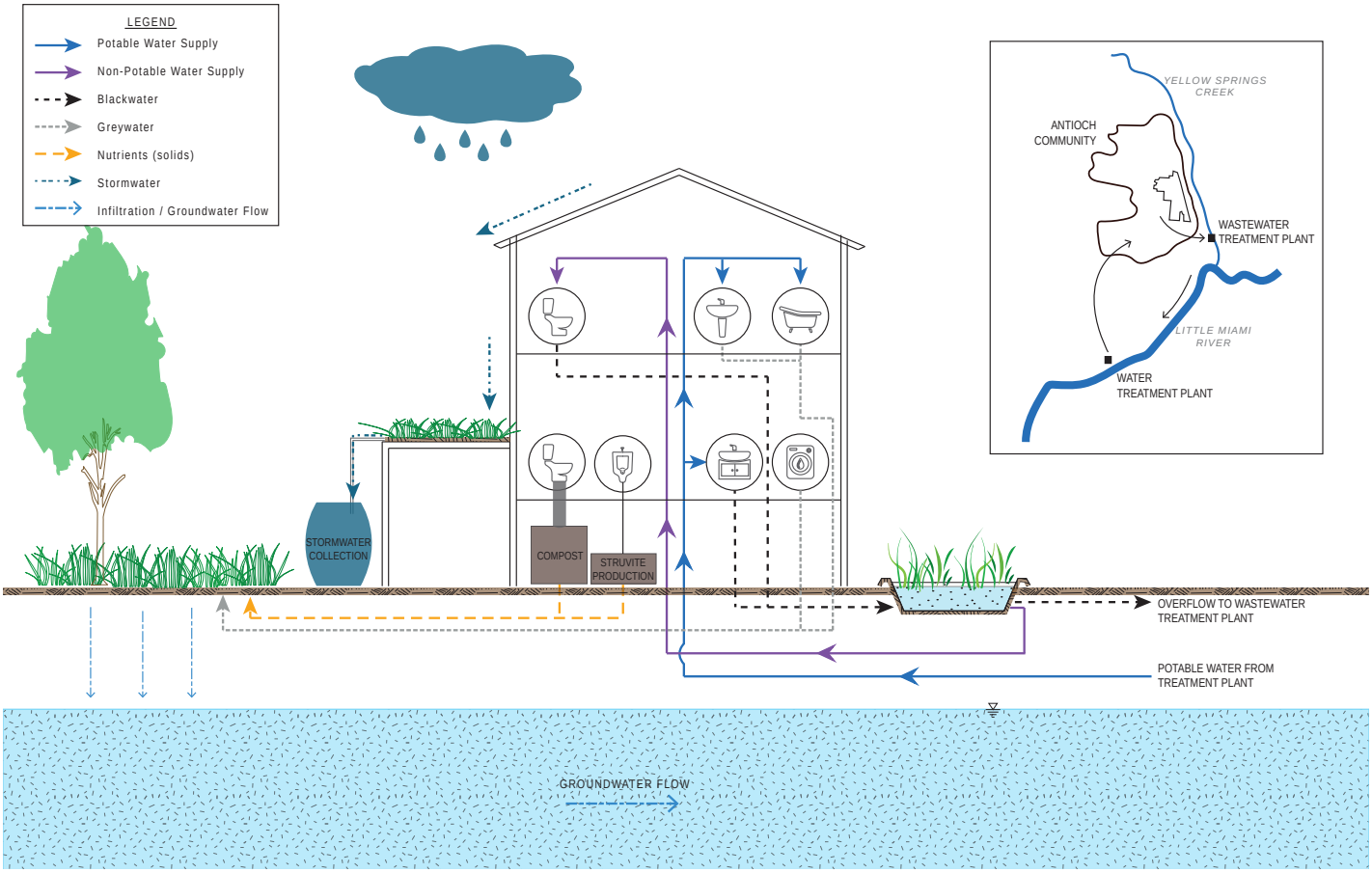


Figure 4. Diagram showing several water treatment strategies and techniques combined to achieve net zero water

energy and sustainability

The energy and sustainability section outlines ideas for the housing development and recommendations on key sustainability structures for buildings, energy targets and on-site energy generation we recommend for the project to keep things on track.

Charrette at Antioch College.

Living Communities Challenge

The Living Community Challenge (LCC) is a program developed by the International Living Future Institute to help planners, developers and practitioners consider deep sustainability at the planning scale. It is a "scaling up" of the Living Building Challenge many similar goals and imperatives. LCC goals include key topic areas of Place, Water, Energy, Healthy and Happiness, Materials, Equity and Beauty, with imperatives for achieving net positive Energy, Net Positive Water, Healthy Neighborhood Design, and Embodied Carbon Footprint. http://living-future.org/lcc

LCC can be certified based on the Master Plan and/or construction. We have reviewed the master plan and have evaluated the feasibility of meeting LCC challenges for the Housing components of the project, and we believe LCC Master Plan certification is likely to be achievable. Please see an annotated LCC checklist included in this report.

Living Community Challenge guide.

	LIVING COMMUNITY CHALLENGE	LIVING BUILDING CHALLENGE 3.0	
PLACE			01. LIMITS TO GROWTH
		SCALE JUMPING	02. URBAN AGRICULTURE
		SCALE JUMPING	03. HABITAT EXCHANGE
			04. HUMAN POWERED LIVING
WATER		SCALE JUMPING	05. NET POSITIVE WATER
ENERGY		SCALE JUMPING	06. NET POSITIVE ENERGY
HEALTH & HAPPINESS			07. CIVILIZED ENVIRONMENT
			08. HEALTHY NEIGHBORHOOD DESIGN
			09. BIOPHILIC ENVIRONMENT
			10. RESILIENT COMMUNITY CONNECTIONS
MATERIALS			11. LIVING MATERIALS PLAN
		SCALE JUMPING	12. EMBODIED CARBON FOOTPRINT
			13. NET POSITIVE WASTE
EQUITY			14. HUMAN SCALE + HUMANE PLACES
			15. UNIVERSAL ACCESS TO NATURE & PLACE
			16. UNIVERSAL ACCESS TO COMMUNITY SERVICES
		SCALE JUMPING	17. EQUITABLE INVESTMENT
			18. JUST ORGANIZATIONS
BEAUTY			19. BEAUTY + SPIRIT
			20. INSPIRATION + EDUCATION

The Living Community Challenge Scorecard and petal requirements.

Energy Efficiency and Building Systems

This section provides sustainability recommendations on the energy use and heating, ventilating, and air conditioning (HVAC) systems as part of the master planning of the future expansion at Antioch College. The college is considering using the Living Community Challenge which will require an integrated design approach to establish and meet energy goals. As such, the work completed highlights energy and HVAC systems which would achieve these targets.

With the right selections of energy efficient designs described in this report, it is predicted that for the housing expansion at Antioch College, net zero water is achievable, and with strategic planning and utilization of the whole Antioch College campus for solar PV installation, net positive energy is achievable as well.

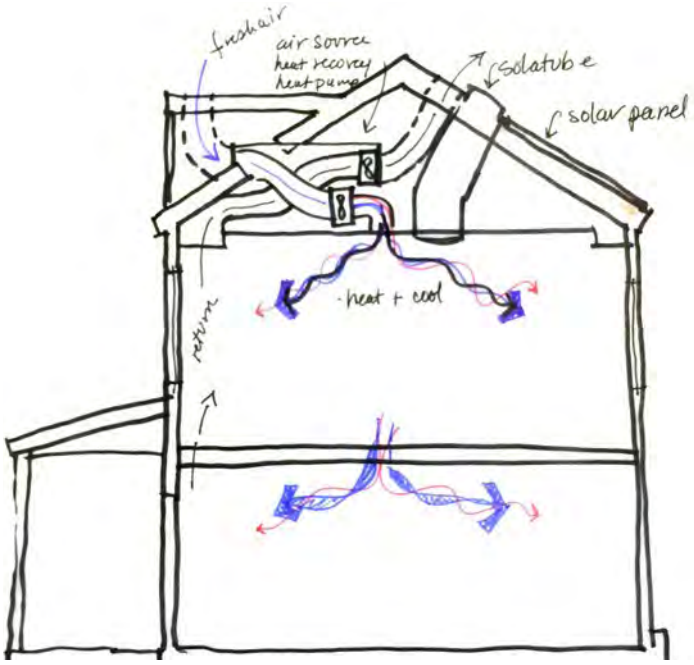
The housing development and charrette at Antioch College produced various housing, neighborhood, and block designs for single family, multi-family, co-housing, and dormitory spaces. To align with the various housing types being considered, this section gives energy recommendations by building type; small cottages, row housing, and multi-unit housing. The second section gives HVAC systems recommendations for each building type, providing two options for each.

Energy Use by Building Type

Tiny House or Small Cottage

A tiny house or small cottage is a building that is primarily single or two stories intended for one family. Tiny Houses are considered a construction type for people living in very small housing spaces compared with traditional home sizes. In both of these dwellings, the units tend to be free standing with their own standalone systems for plumbing, electricity and HVAC. The HVAC dedicated systems should be air-based smaller units described in the HVAC systems section.

For these homes, the annual energy usage is estimated to be between 8 kWh/sf and 13 kWh/sf. The relatively high energy usage is due to these small building's single standing structures with higher exposed wall-to-space volume ratios than other building types. For a standard house and family unit, the energy cost to the tenants would be between $300 and $800 a year.



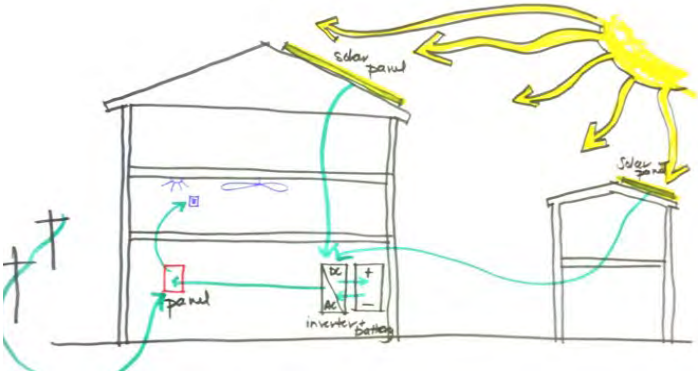
A cottage house that is typically one family unit, either one or two stories and an independent foundation and utilities.

Row Housing or Multi Row Housing

Row housing or mult-row housing are units which house several families in one standing structure. For energy use, the primary difference between a cottages is the amount of walls exposed to the outside conditions and the amount of shared walls.

These buildings could have their own individual HVAC dedicated systems or could share a larger HVAC system depending on the development. Centralized systems could improve the efficiency, as well as the cost for overall project installation and maintenance. However, a centralized system will be more constricting to define property lines and equipment ownership in the event of sale.

For these homes, the annual energy usage is estimated to be between 7 kWh/sf and 10 kWh/sf. The relatively high energy usage is due to these small building's single standing structures with higher exposed wall-to-space volume ratios than other building types. For a standard house tenants would be $500 and $700 a year.



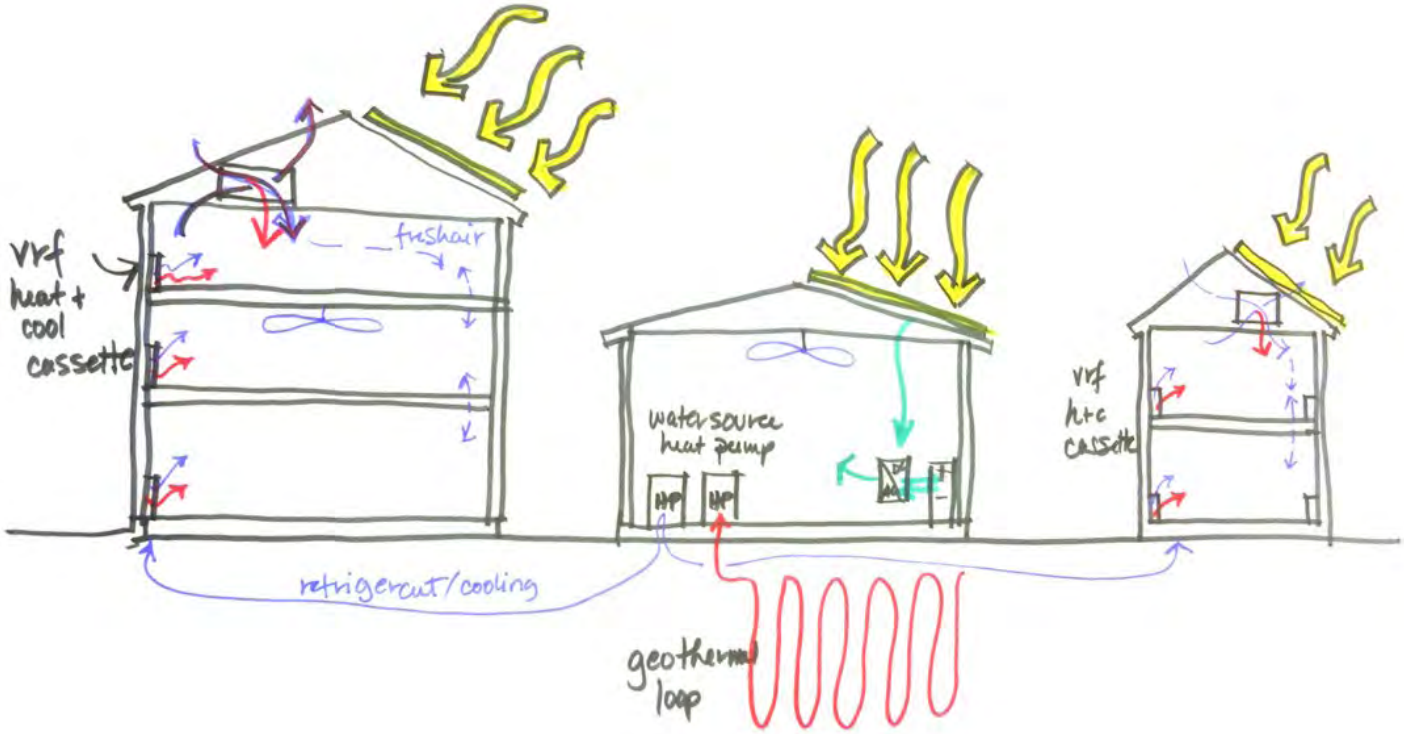
Multi-Unit or Co-Housing

Multi-Unit or co-housing buildings are set up to share common spaces and common functions, such as parking, access, yards, and storage. These buildings often share an architectural style and act more like home owners associations in how they are maintained.

These buildings will most likely have shared HVAC systems with individual heating and cooling elements, along with fresh air, connected back to a central plant or source. This will allow for the density in unit size and construction most likely desired as well as reduce the cost of HVAC costs for the overall project.

For these homes, the annual energy usage is estimated to be between 5 kWh/sf and 8 kWh/sf. The relatively high energy usage is due to these small building's single standing structures with higher exposed wall-to-space volume ratios than other building types. For a standard house the energy cost to the tenants would be between $250 and $350 a year.

Co-housing community.

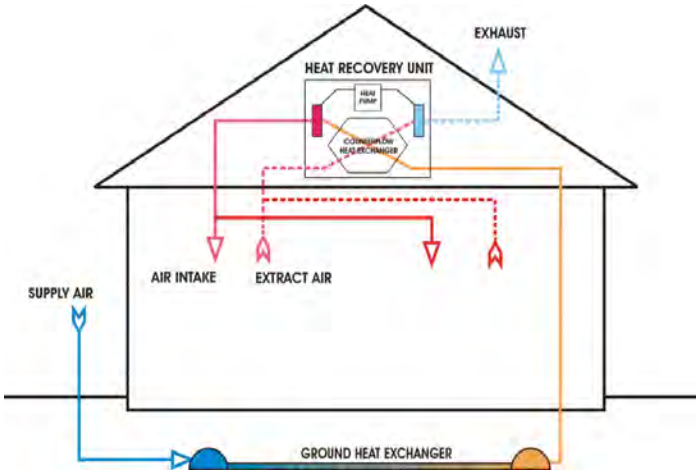


Co-housing conceptual elevation of HVAC and energy generation.

HVAC Systems

For each building type, there are two types of HVAC systems recommended, both highly efficient compared with a more traditional system. One type being a more economical option that is likely a lower cost option and uses more energy or more carbon. The other option is there a more efficient option or one that has a shared system for the larger buildings.

All information here can be used to estimate the size of systems if floor areas are known and the descriptions of each system type can be used to understand constructability. The information here would need a cost estimator to and or contractor to establish the implications of these recommendations in a life cycle or costing exercise.



This diagram represents a heat recovery heat pump. The device can be used with a ground-exchange pre-heating pipe or by itself.

Single Housing HVAC Systems

Good Option - Economic

The upper bounds of the energy usage estimates in the Energy Use by Building Type section were based upon a "Good Option" scenario, which would include an air-source heat pump for cooling and a furnace with heat recovery ventilator for heating. This unit consumes natural gas yet would be super-efficient compared with traditional units that do not include heat recovery ventilators nor a good envelope. This system is also economical, being high efficiency yet constructed from readily available products in regional markets.

The density for Heating is:

> 25 Btu/sf for heating (10 Btu/sf from ventilation air heating, 15 Btu/sf from envelope heat loss)

The density for Cooling is:

> 26 Btu/sf for cooling (6 Btu/sf from ventilation air conditioning, 20 Btu/sf from space loads)

As an example, for a house that is 800 sf, the heating capacity would be 18 kBtu/hr and the cooling capacity would be 21 kBtu/hr (1.75 tons). The heat recovery ventilator would be 30 cfm, sized for 15 cfm/person.

Best Option - Carbon Neutral

We recommend using the passive house heat recovery ventilator with groundloop preheater. As demonstrated in the following diagram, this combined unit has an earth-to-air exchanger that pre-conditions the outside air using an earth pipe. Then the tempered air gets further conditioned by the building exhaust air in the air-to-air counter-flow heat exchanger. Finally, the outside air is conditioned by the air-source heat pump and supplied into the space.

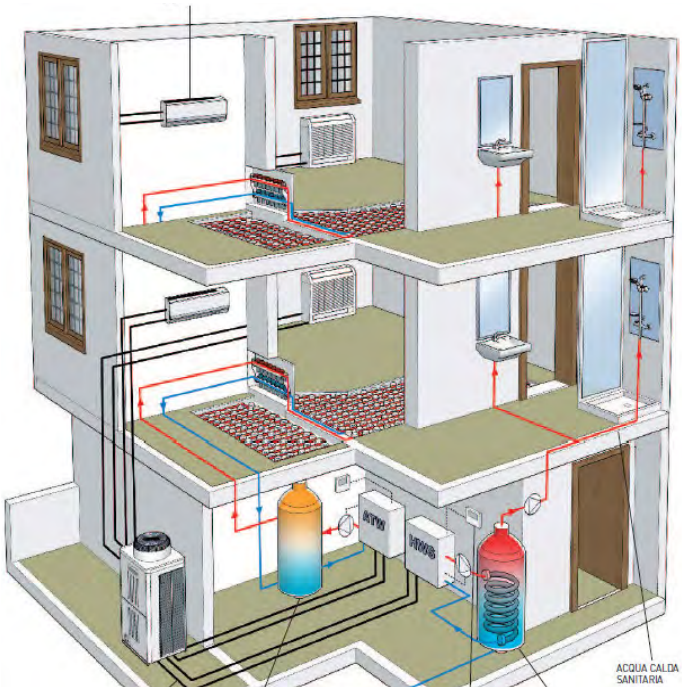
Large Housing HVAC Systems

Centralized Air-Cooled Heat Pumps

We recommend a centralized air-cooled and heated VRF unit with larger condensers located in a centralized location. Each unit would have its own set of room cassettes to provide heating and cooling. A separate centralized air system for only ventilation would be provided, possibly one per major building section serving a few apartments only.

Centralized Geo-Thermal Heat Pumps

We recommend a centralized ground source heat pump unit, most likely a VRF system again serving the buildings in the same manner as the air-based distribution. A similar arrangement of dedicated ventilation units with heat recovery ventilators would be provided.



Air-cooled heat pump example routing heating and cooling to each room through refrigerate piping.

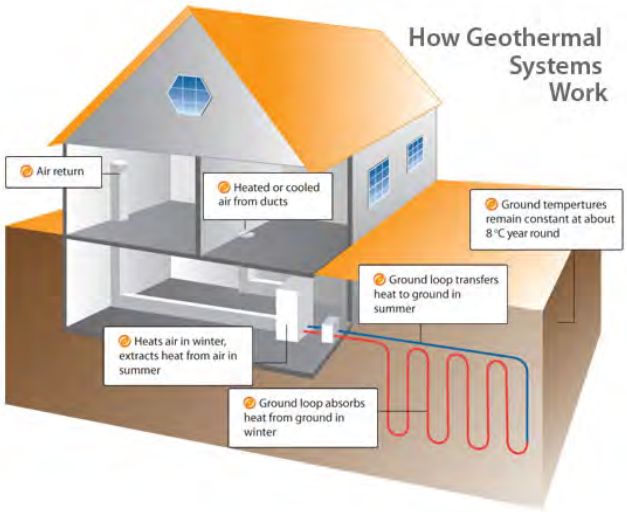
The density for Heating is:

> 18 Btu/sf for heating (10 Btu/sf from ventila tion air heating, 8 Btu/sf from envelope heat loss)

The density for Cooling is:

> 16 Btu/sf for cooling (6 Btu/sf from ventilation air conditioning, 10 Btu/sf from space loads)

Assume the capacity for the ground source heat pumps is 2 tons/bore, a co-housing development at 14,000 sf of space area would need a heat pump size of 252 kBtu/hr, which requires 11 bore holes.



Geothermal heat pump example routing heating and cooling to each room through refrigerate piping.

Whole Campus Buildings

The campus only has 2 total electric meters at the major sub stations. The Building Area, EUI, Number of Floors are inferred from the age and size of the buildings and other best available information. The goal of this table is to estimate the energy needed to power the whole campus and the relative renewable energy that would be required to reach a Living Community Challenge.

	Building Estimated Area	Current Usage %	Area IN USE	Current Energy Use Intensity	Energy Use with % of Usage	Number of Floors	Roof Area GSF	Roof for PV Area	On-Structure PV	Geothermal	Planned Potential
	gsf	%	gsf	kBtu/sf	kBtu	#	gsf	50%	sf		
Units Dorms & King Center	9152	50%	4,576	35	160,160	4	2,288	50%	1,144	No	Apartments
Science Building	64000	50%	32,000	80	2,560,000	3	21,333	50%	10,667	Yes	School
West Hall	12000	50%	6,000	35	210,000	3	4,000	50%	2,000		Dorm
Wellness Center / Curl Gym	44000	100%	44,000	70	3,080,000	3	14,667	50%	7,333	Yes	Gym
Birch Hall	30000	50%	15,000	35	525,000	2	15,000	50%	7,500		Dormatory
Rebecca Pennell House	3306	100%	3,306	35	115,710	1	3,306	50%	1,653	No	Offices
North Hall	23000	50%	11,500	43	494,500	4	5,750	50%	2,875	No	Dormatory
WYSO / Kettering Building	33400	30%	10,020	35	350,700	3	11,133	50%	5,567		Demo
McGregor Hall	33100	50%	16,550	35	579,250	3	11,033	50%	5,517	Soon	
South Hall	23000	50%	11,500	35	402,500	4	5,750	50%	2,875	Soon	Office Admin
Art Building	10850	100%	10,850	40	434,000	4	2,713	50%	1,356		Vacant
Olive Kettering-Library	44346	100%	44,346	35	1,552,110	2	22,173	50%	11,087		Long term plan is to demo this
New coHousing	160000	0%	-	14	-	2	80,000	50%	40,000		
New Dorm 1	23000		-	20	-	2	11,500	50%	5,750		
New Dorm 2	23000		-	20	-	2	11,500	50%	5,750		
New Dorm 3	23000		-	20	-	2	11,500	50%	5,750		
New Dorm 4	23000		-	20	-	2	11,500	50%	5,750		
Chapel	2280	100%	2,280	15	34,200	2	1,140	50%	570		Church
Scuplture Annex	10850	100%	10,850	5	54,250	1	10,850	50%	5,425	No	
Sontag Fels Building	58149	5%	2,907	5	14,537	3	19,383	50%	9,692		Demo
Theatre	15300	100%	15,300	5	76,500	1	15,300	50%	7,650	Yes	Needs renovation, windows
Antioch Hall	46800	0%	-		-						School
Antioch Inn/Student Union Bookstore	40000	0%	-		-						Demo
Evan R. Spalt	24300	0%	-		-						Demo
Evan Spalt NEW DORM	25000	0%	-		-						
Glen Helen Building	7138	0%	-		-						
Mills Hall	15400	0%	-		-						Already Demo'd
Trailside Museum	1460	0%	-		-						
Weston Hall	7200	0%	-		-						
Power Plant	20000	0%	-		-						
		Total	240,985		10,643,417				145,910		
				Total Consumption (kWh)	3,119,407						
				PV needed for Site Net Zero (kW)	2,836						

Table of estimated energy use of exsiting and new buildings for the whole campus. These are very high level estimates and not measured. Limited measured meters were available. Data here used to estimate the order of magnitude for any on-site pv generation.

Energy Use Matrix

For the project design, the following table of energy use by building type as well as a level of efficient design (from Good, Better Best) was developed. The table outlines the 7 types of housing discussed and gives an estimate of the energy use intensity anticipated (kBtu/sf-yr) as well as the anticipated energy cost per each person housed. This way, the types of housing can be quickly compared on a per person basis. A tiny house for instance may provide energy costs at $290/year while a co-housing project could achieve $$230/year per tenant.

			Tiny House	Cottage	Town House	Multi-Use & Apartments	Co-Housing	Micro-Apts	Student Housing
	Footprint	gsf	300	800	3200	11250	24000	20000	21000
	Number of Units	#	1	1	2	15	40	50	100
	Apartment Footprint + Shared	gsf	300	800	1600	750	510	340	210
	Energy Cost	$/kWh	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	Solar Panel Power	Watts	345	345	345	345	345	345	345
Standard	**Energy Use per Area**	**kBtu/sf**	**60**	**60**	**60**	**50**	**50**	**50**	**82**
	Energy Use per Area	kWh/sf	18	18	18	15	15	15	24
	Energy Generation	kW/sf	0.014	0.014	0.008	0.008	0.012	0.012	0.019
	Solar Array	kW	4	11	25	94	278	231	398
	Solar Panels	**# Panels**	**13**	**33**	**73**	**272**	**805**	**671**	**1155**
	Energy Cost per Unit	$/unit	$630 / yr	$1,690 / yr	$3,380 / yr	$1,320 / yr	$900 / yr	$600 / yr	$610 / yr
Good	**Energy Use per Area**	**kBtu/sf**	**44**	**44**	**34**	**27**	**19**	**19**	**19**
	Energy Use per Area	kWh/sf	13	13	10	8	6	6	6
	Energy Generation	kW/sf	0.010	0.010	0.004	0	0.004	0.004	0.004
	Solar Array	kW	3	8	14	50	107	89	93
	Solar Panels	**# Panels**	**9**	**24**	**42**	**145**	**309**	**258**	**271**
	Energy Cost per Unit	$/unit	$470 / yr	$1,250 / yr	$1,920 / yr	$700 / yr	$340 / yr	$230 / yr	$140 / yr
Better	**Energy Use per Area**	**kBtu/sf**	**39**	**39**	**30**	**23**	**17**	**17**	**17**
	Energy Use per Area	kWh/sf	12	12	9	7	5	5	5
	Energy Generation	kW/sf	0.009	0.009	0.004	0.004	0.004	0.004	0.004
	Solar Array	kW	3	7	12	47	107	89	93
	Solar Panels	**# Panels**	**8**	**22**	**37**	**136**	**309**	**258**	**271**
	Energy Cost per Unit	$/unit	$410 / yr	$1,100 / yr	$1,690 / yr	$620 / yr	$300 / yr	$200 / yr	$120 / yr
Best	**Energy Use per Area**	**kBtu/sf**	**27**	**27**	**23**	**18**	**13**	**13**	**13**
	Energy Use per Area	kWh/sf	8	8	7	5	4	4	4
	Energy Generation	kW/sf	0.006	0.006	0.003	0.003	0.003	0.003	0.003
	Solar Array	kW	2	5	9	33	71	59	62
	Solar Panels	**# Panels**	**6**	**15**	**28**	**97**	**206**	**172**	**181**
	Energy Cost per Unit	$/unit	$290 / yr	$770 / yr	$1,310 / yr	$470 / yr	$230 / yr	$150 / yr	$90 / yr

Power Generation Systems

To fully meet the Living Community Challenge (LCC) requirements for the community to be net-positive energy, incorporation of renewable power sources are critical to the success of the project. A comprehensive Photovoltaic (PV) system, distributed around different areas of the site, is the most optimal approach to generate power for the site. The passive nature of the panels, combined with the high efficiency compared to other renewable sources make PV a perfect candidate to provide energy to the site. The lack of moving parts will also mean low maintenance costs, leading to quicker payback of the system.

The first areas being considered for PV are the roofs of the classroom and campus buildings. Many of the existing buildings, such as the arts building, science building, South Hall, McGregor Hall, and even the central geo plant have open areas available for panels on their roofs. These areas would account for approximately 205 Kilo-watts (KW) of the new PV proposed for the site.

The next areas being considered are for shade structures in parking lots, and overhangs on existing buildings. These areas are ideal for PV placement because of the amount of open space available to install large, uninterrupted arrays. The parking lots adjacent to the Wellness Center, the Foundry Theater, and the parking lot on East South College St. all offer good opportunities to install PV parking structures. Additionally, some buildings, such as the arts building, are being considered for the installation of a south-facing overhang that will shade the building as well as provide area for PV installation. These areas would account for approximately 625KW of new PV for the site.

The final areas being considered are the roofs of the new residences. From an installation standpoint, these may be some of the easiest since the contractor will already be on-site and mobilized for construction of the houses. Additionally, the structure and electrical system can be designed to suit the requirements for the PV installation, versus the other locations where upgrades to structure and electrical components may be required. These areas would account for approximately 310KW of new PV for the site.