



6. BUILT SYSTEMS

CAMPUS SPATIAL STRUCTURE

The spatial, or civic, structure of a campus is its most important and memorable characteristic. There are two general campus spatial types in America: romantic, picturesque ones, like the University of California at Berkeley; and ones based on quadrangles, like the University of North Carolina at Chapel Hill. Picturesque campuses are characterized by rolling landscape, meandering paths, and lack of classically defined spaces. Quadrangular campuses are characterized by an organized hierarchy of streets, paths, courts, and quadrangles.

Middlebury College is “picturesque” in a postcard sense, but it is not, nor can it ever be, a picturesque campus in the Berkeley tradition. Rather, it is a unique version of a quadrangle campus. It is unique because it is less dense, and has larger spaces than most campuses. It also relates to the north-south Vermont landscape of ridges and valleys; and it has an openness to the surrounding landscape. Despite the rural setting of the College and the Town, however, neither is rural in character. Nor does either have a rural landscape; both College and Town have, or should have, urban landscapes.

Campuses, like towns, are not just random groups of buildings sprinkled in the landscape; they are spatial organizations that form communities, or neighborhoods. In order to achieve this, spaces need legible identities and relationships to each other, and there needs to be a sufficient variety of spaces. Middlebury College has a magnificent setting, but the campus spatial structure has several major problems. As the campus has expanded over two state roads, the original spatial structure of the central campus has gotten lost. The existing civic structure needs to be renovated, enhanced, extended, and connected.

Major problems of the campus spatial structure

1. *The three campus districts are incomplete and disconnected*
2. *The campus spaces are too big and ill-defined*
3. *There is an insufficient number and variety of spaces*
4. *The major streets are not civic streets*
5. *There is an insufficient number of pedestrian streets*
6. *The path system is irrational*
7. *Landscape elements do not support the spatial structure*

Districts

An urban or campus district may be described by three formal characteristics: a *clear center*, *consistent fabric*, and a *clear edge*. In practice, all three may not be present. A clear center is most important; a clear edge less so.

The town of Middlebury, like many Vermont and New England towns, is organized this way: it has a central green, surrounded by civic buildings, and streets radiating outwards organizing the private houses and buildings. It does not have a clear edge.

The historic core of Middlebury College is similar. It has a clear center, the Main Quad; a consistent, recognizable building fabric of heritage architecture; but no clear edge (or entry). Until the late 1940s this was sufficient; Middlebury could be a “one-quad campus.” There are many regional examples of one-quad campuses: e.g., Union College, Bowdoin College, and Dartmouth College.

The issue is how these campuses grow beyond their original quadrangle. Dartmouth College shares its green with the town, and as the College grew, it grew along a network of streets that add to that organization. Other colleges expanded by adding more quadrangles and courts to extend the public realm.

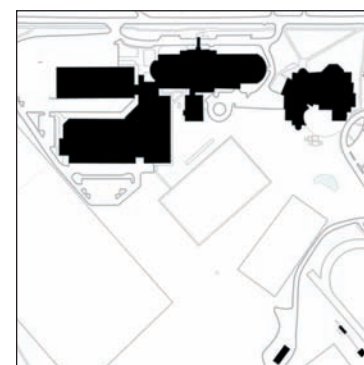
When the Middlebury College campus grew, however, it added neither streets nor quadrangles. Lack of an adequate plan facilitated suburban sprawl to the north and south. Now the campus is composed of three separate districts: the *South Campus* (arts and athletics), the *Central Campus*, and the *North Campus*.

Two of these districts (the North and South Campuses) lack sufficient identity and are suburban in character. They are not organized by streets, nor do they have legible spaces. In other words, they have no center, no consistent fabric, and no edge. (The random landscaping does not help establish a legible structure either.)

Further, the three districts are disconnected from each other, as they are separated by state highways. This contributes to the sense of greater distance than is actually the case, and blurs the already difficult issue of legible sense of arrival and campus entrance.



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FIGURE 1

Plan of the existing campus civic structure

FIGURE 2

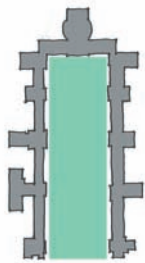
Existing plan of the Central Campus showing the defined Main Quad

FIGURE 3

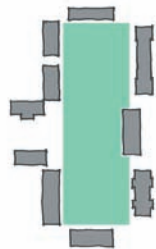
Existing plan of the South Campus showing no defined space

FIGURE 4

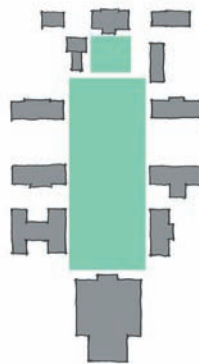
Existing plan of the North Campus showing no defined space



UVA Lawn
200' x 630'



Harvard Yard
240' x 650'



UNC Polk Place
270' x 780'

Quadrangles

Quadrangles are large public spaces defined by buildings and landscape. They are usually pastoral in nature, with no decisive function, and a seemingly inseparable relationship between the space and the buildings that define them. Most of America's memorable campuses are organized around the idea of the quadrangle. The Middlebury College campus has only one quadrangle, the Main Quad. For a campus its size, it should have three or four.

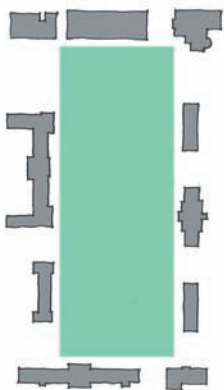
Size matters. Quadrangles that are too large lose their human dimension. Inappropriate landscaping can exacerbate this condition by blurring the spatial reading of the quad, or by lack of an idea about the space.

Normative quadrangles are about 200–300' wide by 600–800' long. The Lawn at UVA, the Yard at Harvard, and Polk Place at the University of North Carolina Chapel Hill are typical examples. These have many trees, but the buildings are visible between and under the trees. They have a reassuring human dimension that connects us to the environment.

Large quadrangles may be 400' wide by 1,000' long. The Arts Quad at Cornell University is a good example. Despite its large size relative to the height of its buildings, it is still a perceptible human-scaled space because it has fewer trees. Other large quadrangles, such as those at Ball State University, the University of Georgia, and McCorkle at UNC Chapel Hill, are filled with trees, and are more like parks than quadrangles. The Green at Dartmouth is a very large space, but it has few trees, and is bounded by a street, with buildings set back, so that the large space is articulated into smaller parts.

The Main Quad at Middlebury College is also a very large quadrangle, and its lack of articulation contributes to its vastness. But, although some of the buildings are small and widely spaced, the topography and very large buildings at the top of the hill make the space legible and human-scaled. On the other hand, the landscaping of the Main Quad is contradictory; it obscures the space and has a deleterious effect.

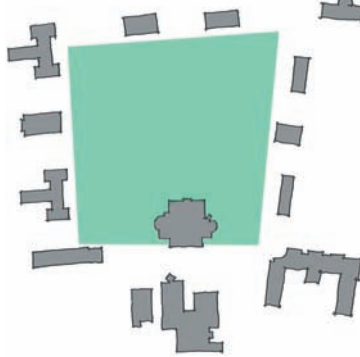
The North Campus at Middlebury has no legible space. Despite spectacular views out to the surrounding landscape, it is a vast undifferentiated no-man's land that becomes truly



Cornell Arts Quad
400' x 1,020'



Dartmouth College Green
ca. 400' x 600'



Middlebury College Main Quad
ca. 700' x 700'



Middlebury College North Campus

formidable in the winter. “Battell Beach” has a vague identity due primarily to the slope on the west, and its lack of trees and walks, but it is inadequate to organize the whole area.

Courts

A court is a relatively enclosed private or semi-private open space within a building, or a semi-private or public open space within a group of buildings. Courts may be purely private or purely public, but they are usually limited in size and legible in form. Their character and uses are directly related to the functional uses that surround them. Ross Commons has the only legible courtyard on campus. Forest potentially has another, as does the future Axinn Center at Starr Library. The CFA has a partially defined court. Courts are ideal elements for the Commons system, and should be the core of each Commons.

Parks

A park is a large tract of land that often includes lawn, grassland, and woodlands, and is used for ornament and recreation. Parks are usually larger, more naturalistic, and have fewer geometric boundaries than quadrangles. The recently redesigned Library Park is a beautiful example at Middlebury College. There could, and should, be more, however.

Streets

In our time this term has come to imply vehicles, movement, and asphalt or concrete paving. Traditionally, however, the term *street* has denoted a defined, linear urban space that is at once a connector and a place, and as such, one that is for both vehicles and pedestrians.

Generally, streets are small-scale, low-speed, local connectors. There are several different types of streets, but they are urban in character, with raised curbs, short building setbacks, wide sidewalks, and street trees along the edges.

There are no beautiful streets on the Middlebury College campus. Neither College Street nor South Main Street are urban streets that unite the campus. They are arteries that divide and separate the campus. The internal campus streets all need improvement.

Tree-lined Walks

These are sometimes former streets that have been converted to primarily pedestrian use. Locust Walk at the University of Pennsylvania and McCosh Walk at Princeton

University are beautiful examples of tree-lined walks. Tree-lined walks give structure and shade, and are important for the major pedestrian routes through the campus. There are no real campus walks at Middlebury College. In fact, the pedestrian experience seems not to have been considered at all in the design of the campus.

Paths

These are relatively narrow pedestrian connectors through campus spaces. Some may be reinforced by trees, others not. They may be of different widths based on traffic and service use. Generally speaking, paths should be orthogonal and diagonal within quadrangles and courts. Building entrances should connect to this system. Meandering curvilinear paths are appropriate for parks and other picturesque spaces, but not quadrangles.

The campus path system at Middlebury College is disjointed and ad hoc. It should be hierarchical and rationalized.

Landscape

Space and character are the essence of campus design. Buildings generally give the primary definition to campus open space. Trees generally give secondary, or complementary, definition to the spaces. When buildings are small and widely spaced, as they are at Middlebury College, however, trees must play a greater role in the form and character of the spaces. Plants and groundcover may also play a tertiary role.

Library Park is the only open space example at Middlebury College where there is a “fit” between the landscape form and the idea of the space. In some cases, such as the Main Quad, the landscape is at odds with the space. On the North Campus there seems to be no landscape idea whatsoever.

Summary

The campus does not have a sufficient variety of spaces—*quadrangles, courts, parks, streets, walks, and paths*. Nor does it have sufficiently defined, legible spaces, or an adequate circulation structure of streets and walks. There is also generally not an adequate relationship between the campus landscape and the campus spatial structure. Perhaps most important, Middlebury College’s relationship to the larger landscape is a defining characteristic of the campus, and this can be enhanced, rather than haphazard as it is now.

FIGURE 1

Comparative plans of campus quadrangles

FIGURE 1

Plan of existing campus spaces

FIGURE 2

Plan of proposed campus spaces

FIGURE 3

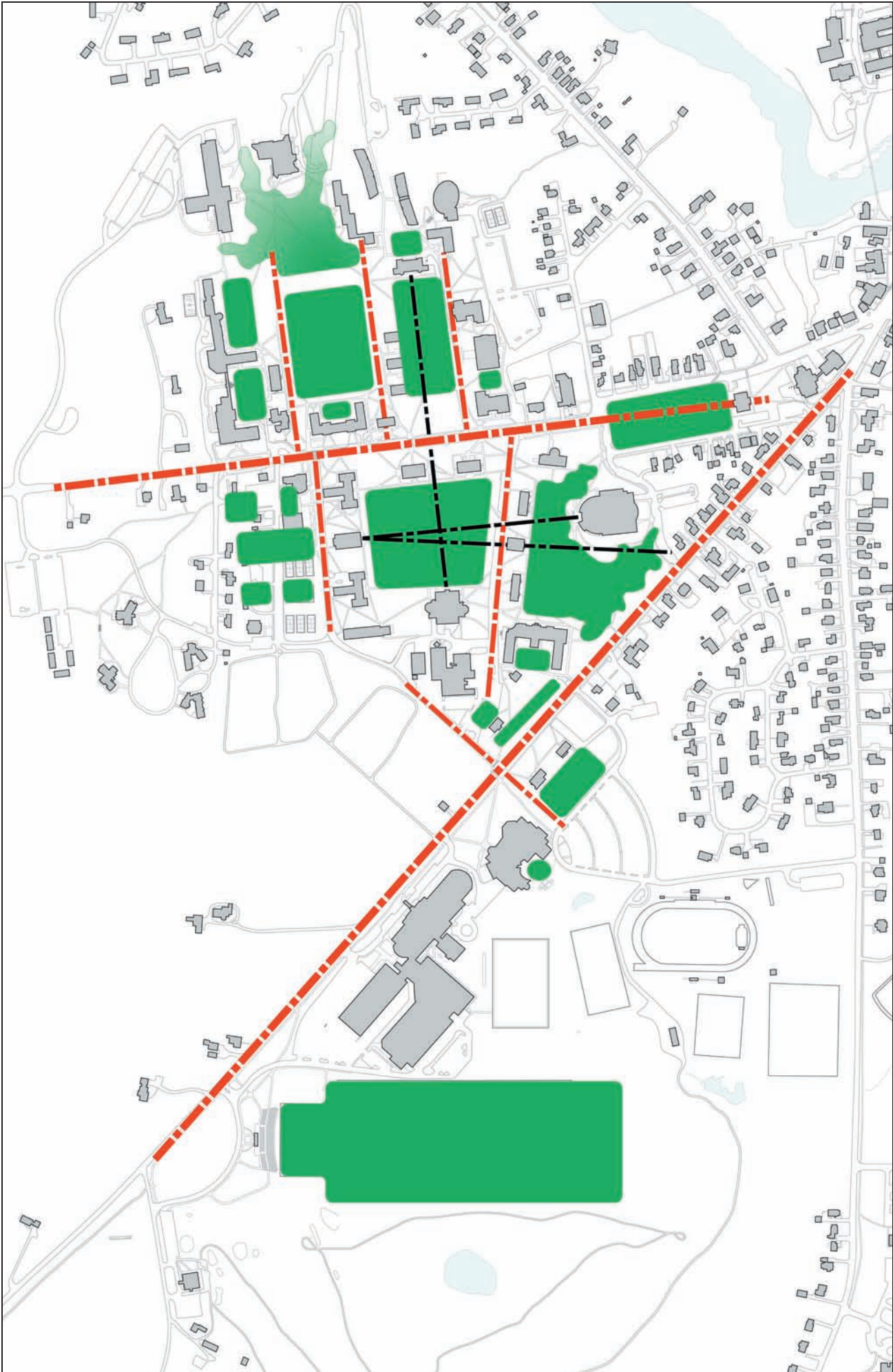
*Plan of proposed campus
civic structure*



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PROPOSED CAMPUS SPATIAL STRUCTURE

The proposed spatial structure of the campus is an extension of the existing spatial pattern in the historic core of the campus, which is quite beautiful, and needs only to be renovated, conserved, and enhanced. The extension—from the Central Campus into the North Campus and the South Campus—is not a new, arbitrary, or contradictory pattern, but merely one that emphasizes and articulates the existing one. The proposed structure aims to integrate the campus into a unified whole, and emphasize the distinct “personalities” of the three campus districts through variations of buildings, space, and landscape form.

In general, buildings are the primary means of defining the spaces that make up the campus civic structure, giving life, scale, and dimension to the spaces; and landscape form is a secondary, or complementary, means of definition. At Middlebury College, however, landscape form is at least as important as buildings, and perhaps more so. For this reason the proposed campus spatial structure is described in terms of landscape form—to be reinforced by future buildings as they are required. The spatial structure is therefore to be regarded as a “green reserve,” the spaces of which are free of buildings in perpetuity. Buildings should be inserted in the interstitial zones as required.

The spatial structure is composed of two sets of elements: the open spaces that form the outdoor rooms of the campus—*parks*, *quadrangles*, and *courtyards*—and the circulation network that links them—*streets*, *tree-lined walks*, and *paths*. Together, these elements frame the long-range development of the campus.

Major recommendations of the proposed campus spatial structure

1. *Complete and connect the three campus districts*
2. *Define and articulate the campus's spaces*
3. *Increase the number and variety of spaces*
4. *Make the major streets into civic streets*
5. *Increase the number of pedestrian streets*
6. *Rationalize the path system*
7. *Landscape elements should support the spatial structure*

Campus Districts

Each of the three campus districts should have at least one quadrangle to serve as its core.

The Central Campus has two major spaces: the Main Quad, and Library Park.

The North Campus has no legible spaces. The Campus Plan proposes that the vast open area be articulated into three major spaces: Bicentennial Park, Battell Quad, and Le Chateau Quad.

The South Campus consists of free-standing buildings and has no defined open space. The Campus Plan proposes a new Arts Quadrangle behind Munford and Meeker.

FIGURE 4

Plan of the Central Campus showing the Main Quad

FIGURE 5

Plan of the North Campus showing the proposed Battell Field and Le Chateau Quad

FIGURE 6

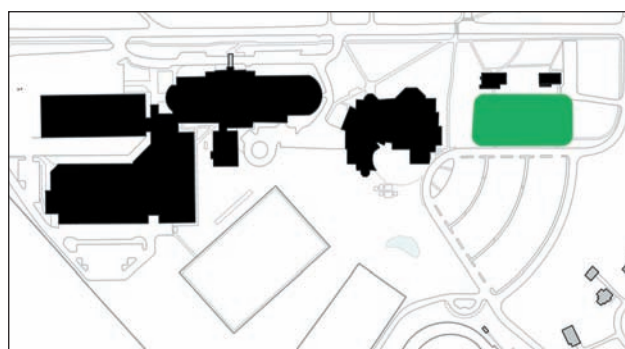
Plan of the South Campus showing the Proposed Arts Quad



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FIGURE 1

View of Library Park



FIGURE 2

Perspective view of proposed Main Quad



FIGURE 3

Perspective view of proposed Le Chateau Quad



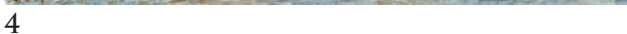
FIGURE 4

Perspective view of proposed Battell Field



FIGURE 5

Aerial perspective view of proposed Arts Quad



Parks

The College has one park: Library Park. The Plan proposes an additional one: Bicentennial Park, on the North Campus.

Quadrangles

The Plan proposes the renovation of the Main Quad, and the development of three new quadrangles. All are intended to be legible, human-scaled, and different in character.

The Main Quad is approximately 700' x 700'. It contains picturesque groupings of trees, and is crossed by a primarily orthogonal pattern of paths.

Battell Quad is approximately 350' x 500'. It is completely open, with no trees, and no paths through it in order to support a variety of activities.

Le Chateau Quad is approximately 300' x 600'. It is primarily an open space, but with a few central trees. It is crossed by important diagonal paths.

The Arts Quad is a three-sided space approximately 200' x 350'. It is thus more intimate than the other campus quads, but it opens to spectacular views of the mountains to the southeast.



Courts

The Plan proposes the development of a significant number of courtyards. Some are redevelopments of existing spaces, and many are associated with the Commons. Each Commons, or residential group, should have at least one associated courtyard.

1. Axinn Center at Starr Library Court is a welcome addition to the College's currently limited repertoire of courtyards. The winter garden is especially important as a transitional space that can be enjoyed all year.

2. Forest Court is potentially a wonderful space, but it cannot be accessed from the building. It should be redesigned, including direct linkage to the loggia and public interior spaces.

3. Ross Court is currently Middlebury's only real courtyard. It should be augmented by the development of a second Ross Court to the north.

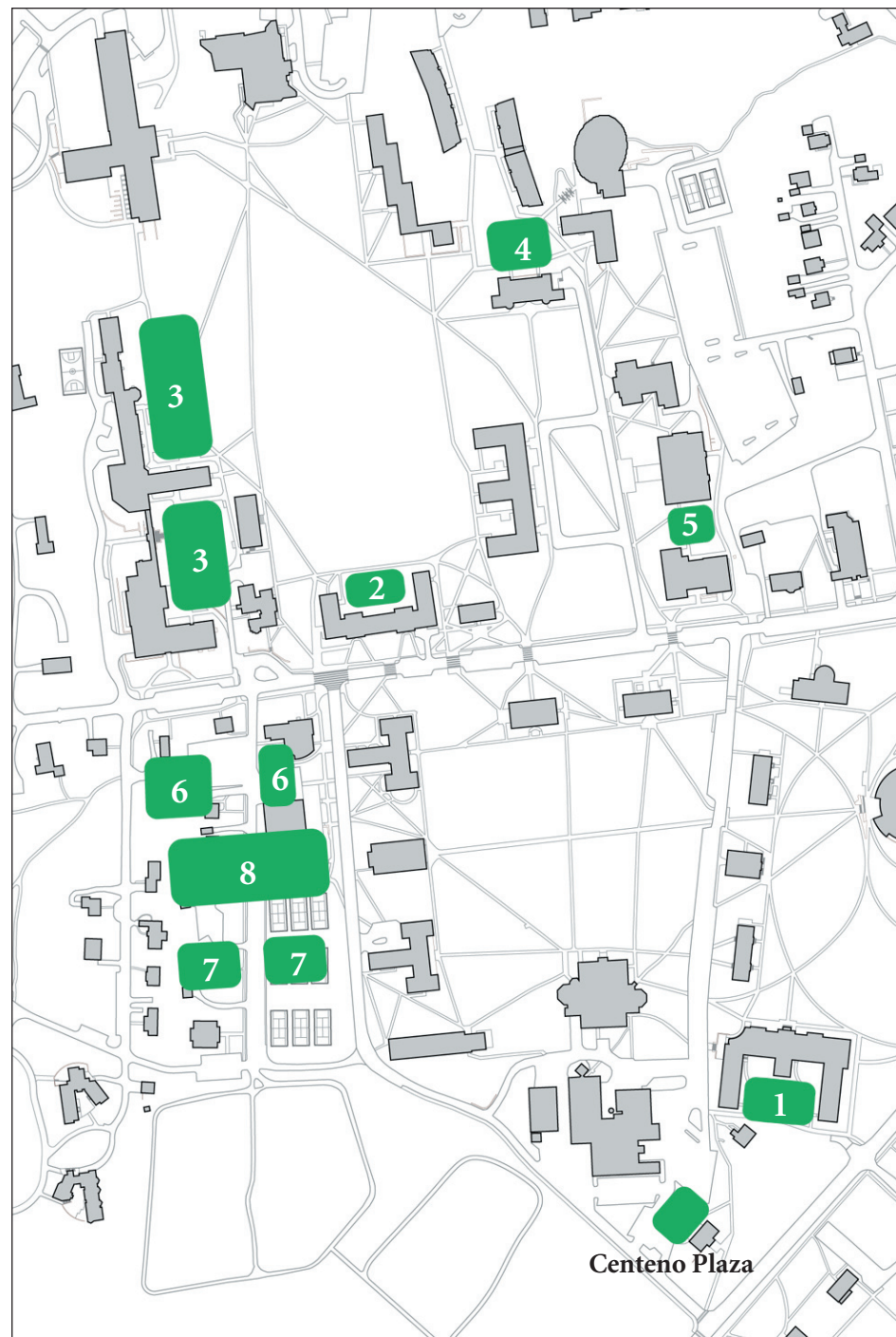
4. Atwater Court should be developed north of Le Chateau. Currently, Atwater Commons does not have a courtyard, and the provision of one is difficult. Nevertheless, one could be designed with strong landscape elements that incorporate the existing rock outcrop.

5. Johnson Court was among the first courtyards created by the College. It is currently underused, however, and separated by a service road from the existing Le Chateau Quad area. The enhancement of Le Chateau Quad is an opportunity to renovate this court as a more intimate garden off the new quadrangle.

6. Wonnacott Court could be developed in conjunction with new dormitory buildings south of LaForce. This court would form part of a larger pattern of open spaces west of Mead.

7. Brainerd Court, or courts, also could eventually be part of a larger fabric of dorms and open spaces that include those of Wonnacott Commons.

8. Hillcrest Court is the center of the larger fabric of dorms and open spaces that include those of Wonnacott and Brainerd Commons.



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FIGURE 6

Plan showing proposed courts

FIGURE 7

View of Forest Court

FIGURE 1

*Outdoor seating area at
Library*



FIGURE 2

Outdoor walls and seating



FIGURE 3

Gifford amphitheater



FIGURE 4

Proctor Terrace



Plazas and Seating Areas

The campus is especially short of small, paved gathering and meeting spaces. These are typically located at building entrances, but may also be found within larger spaces, such as courts, or along major path systems. Paving, benches, hedges, and trees are used to define them. Larger plazas may also accommodate vehicles.

Centeno Plaza is an entry plaza for Old Chapel Walk as well as the entrance to Centeno House. In contrast to the courtyards discussed above, it should be a paved space.

Smaller Plazas, or terraces, would be a welcome addition to the campus. The terraces outside Coffrin and Proctor are not well done, but they are very popular places because of their location and orientation. These spaces are especially important for the summer Language School programs.

Walk Seating is important, but is almost non-existent at Middlebury College. Benches and seating areas are appropriate along major walks at the edges of spaces, but usually not in the middle of the space.

Circulation Spaces

Streets, promenades, and walks form the circulation network that connects the pattern of campus open spaces. Enhancing the character and legibility of this network will at once provide a framework for the campus experience, and tie the spaces and their campus districts together.

The existing campus circulation network—the path system—is an inexplicable mélange of sizes, angles, and junctures. The proposed plan provides the opportunity and strategy to reorganize them. Basically, walks should be hierarchical and should not run door-to-door. Major walks should be orthogonal to the quadrangles, and should connect spaces. Buildings should be connected to this network. Diagonal walks are also appropriate within this orthogonal structure. In park areas, meandering, curved walks should prevail.

In most of the campus, pedestrians and bicycles share paths and will continue to do so. Heavily used paths should be wide enough to accommodate both types of traffic.



FIGURE 5
*Cross-section of proposed
College Street*



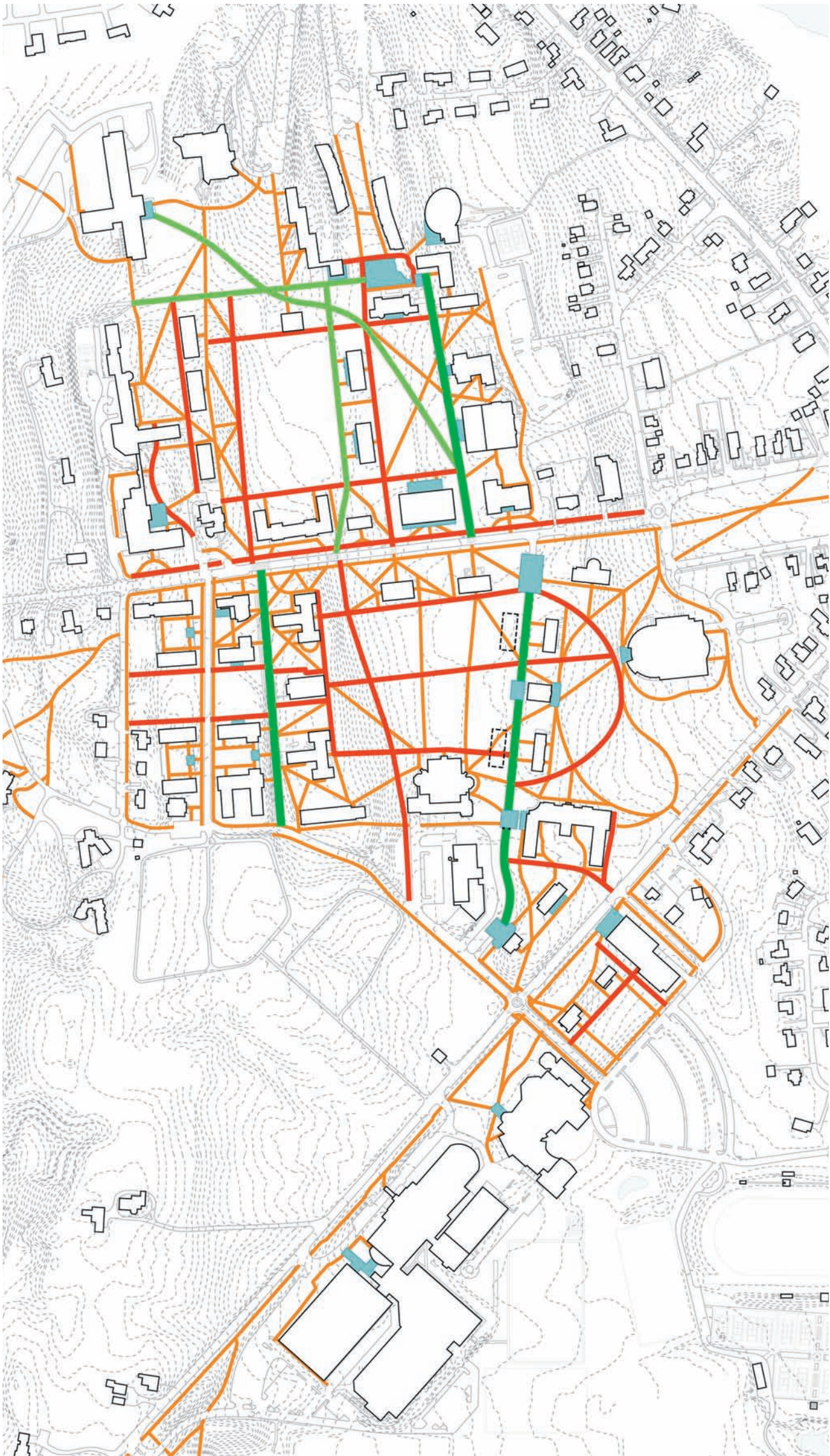
FIGURE 6
*Cross-section of proposed
Old Chapel Walk*

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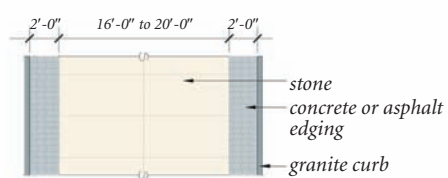
FIGURE 1
*Plan showing hierarchy and pattern
of proposed campus walks*

- LEGEND
- Tree-lined Walk
 - Secondary Walk
 - Major Walk
 - Path





Tree-lined Walk



Secondary Walk

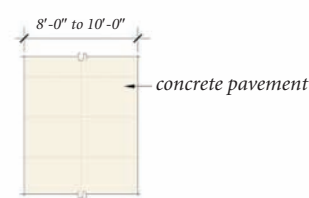


FIGURE 2

Plan and section of proposed tree-lined walk

FIGURE 3

Plan and section of proposed major walk

FIGURE 4

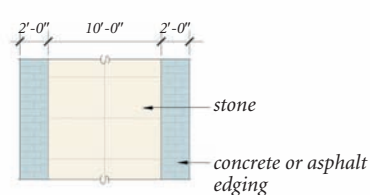
Plan and section of proposed secondary walk

FIGURE 5

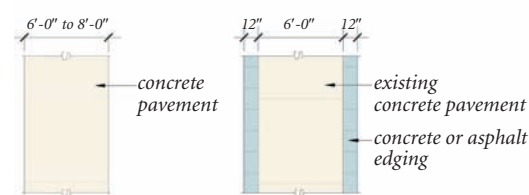
Plans and section of proposed paths



Major Walk



Path



Streets

College Street, South Main Street, and Stewart Hill Road are important elements of the circulation network. College Street is of central importance as it is the zipper that connects the central and north campuses, and it also connects the proposed north-south walks. The Plan proposes redesigning each of these streets as described in Chapter 4.

Tree-lined Walks

The Plan proposes redesigning three internal campus streets and service drives as pedestrian-oriented promenades: *Old Chapel Walk*, *Le Chateau Walk*, and *Hepburn Walk*. These promenades should be at least 16' wide, and be designed to carry vehicles as well as pedestrians. Seating and accommodation for special vehicles should also be considered.

Major Walks

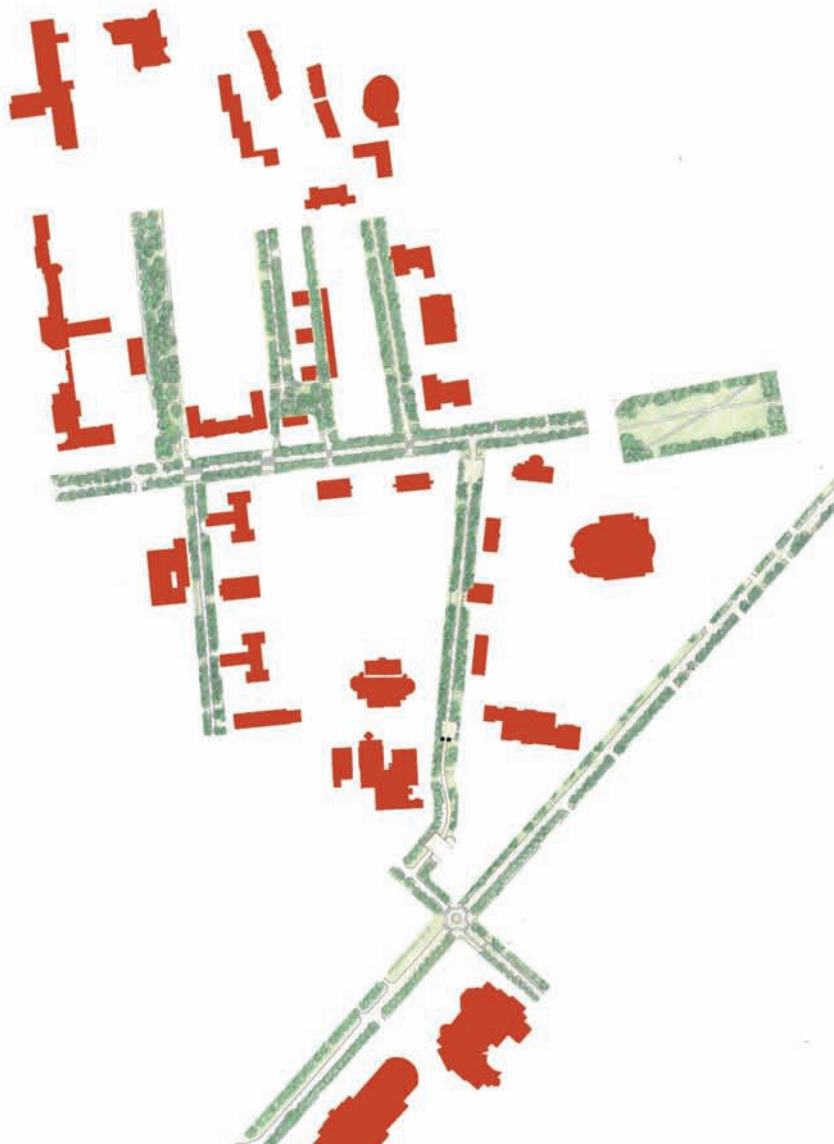
Major Walks are also pedestrian-oriented promenades, but are approximately 12' wide. They may, or may not, be tree-lined. Recommended walks of this type are indicated on the plan.

Secondary Walks

These walks are 8'–10' wide, and are designed as cartways to take pedestrians and vehicles. These will be typically limited to service vehicle use, but may be opened to public vehicles, for instance during move in and move out.

Paths

These walks are 6'–8' wide for pedestrians. The 8' walks may be existing 6' walks augmented by additional paving.



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FIGURE 1

*Plan showing proposed
circulation armature
of tree-lined streets and walks*



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FIGURE 2

*Plan showing proposed
open space plan without buildings*

FIGURE 3

*Plan showing proposed
open space plan with existing buildings*

Circulation Armature

The combination of tree-lined streets and tree-lined walks forms the armature that binds the campus spaces together. These streets and walks are the backbone of the campus open space structure—the landscape form of the campus. If the campus quadrangles and courts are like the organs of the human body, the circulation armature is like the skeleton.

The Open Space Plan

The proposed landscape form of the campus is designed to emphasize and highlight the best characteristics of the Middlebury campus. It complements the pattern of existing buildings, and provides the framework for future buildings. Indeed, it could be accomplished without any future buildings, and the campus would be improved. The plan on the right illustrates the existing campus buildings, with the proposed open space plan.

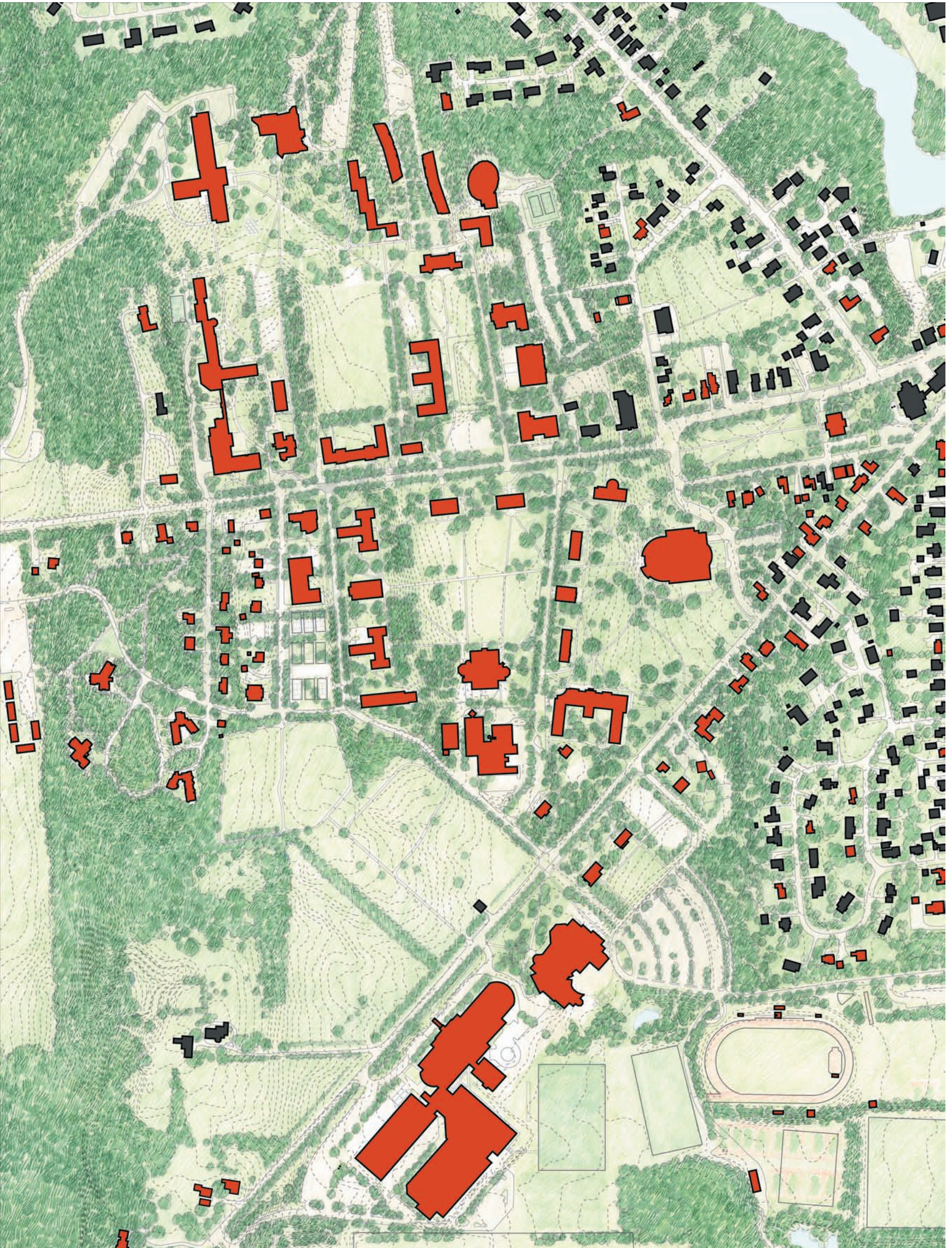


FIGURE 1

Plan showing architectural types

The blue buildings are individual, but they also define space and relate to each other

The orange buildings are also individual, and make some civic contribution

The red buildings are only individual buildings. They do not define space, and do not relate well to other buildings

FIGURE 2

Warner Hall

FIGURE 3

Munroe Hall

FIGURE 4

Le Chateau

FIGURE 5

Old Stone Row

FIGURE 6

Atwater Dining Hall

FIGURE 7

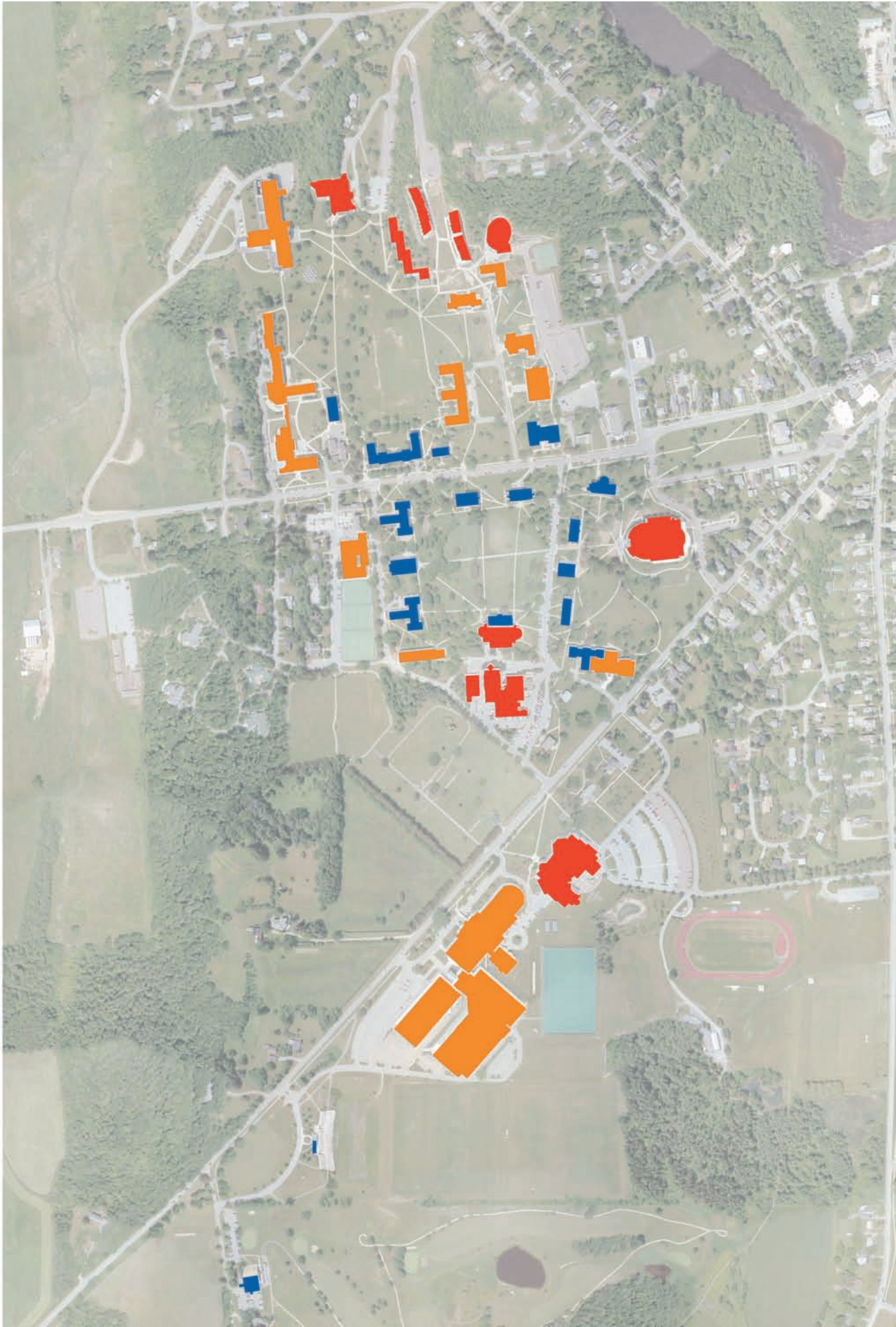
McCullough

FIGURE 8

Library

FIGURE 9

Mahaney CFA Terrace



THE ARCHITECTURAL PLAN

Three factors affect the architectural plan: *architectural type and character*; *growth necessity and capacity*; and *building placement*. The architectural plan addresses these issues, and makes recommendations for the future.

Architectural Type and Character

Middlebury College is blessed with a rich architectural heritage—one that still symbolizes the College today. In briefings with a broad spectrum of the campus community, the planning team learned there was unanimous appreciation for the campus's solid, dignified, heritage buildings, and with good reason.

For most of the campus's history, great care was taken with the size, architectural character, form, and placement of buildings. In the historic core of the campus, for example, the buildings tend to be small (or of small increments), made of stone or painted brick, with simple shapes, and they are placed to relate to other buildings and the landscape. These heritage buildings are often quirky and particular. Indeed, some—such as Old Chapel—have iconic qualities. But they also have a universal quality that transcends their idiosyncracies. More important, they form a “community” of buildings. For example, the buildings of Old Stone Row make a collective public face for the College, and together with Mead Chapel and other buildings, they help define the Main Quadrangle—one of America's quintessential collegiate spaces.

More recently, however, the attitude has changed regarding size, architectural character, form, and placement of buildings. As the campus has expanded farther and farther out, buildings have generally become larger, with unique (sometimes odd) architectural character, complex shapes, and little or no relationship to other buildings. Most of these buildings are primarily idiosyncratic rather than universal. They do not define space, or participate in the community of buildings, but stand alone as isolated individual statements. This is not an issue of chronology, however. LaForce is a contemporary building, but it performs as do the campus's heritage buildings.



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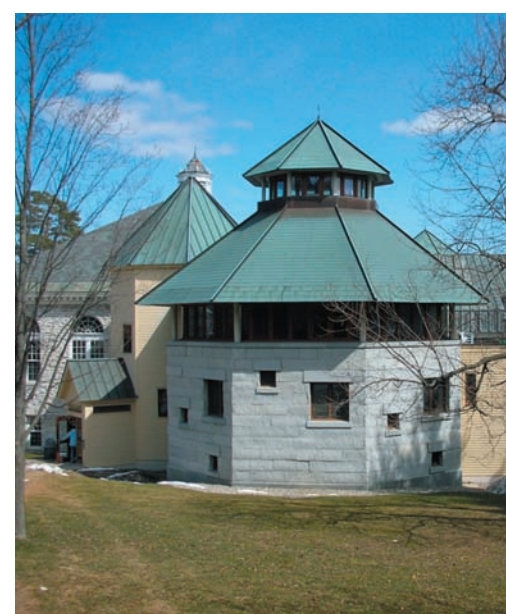
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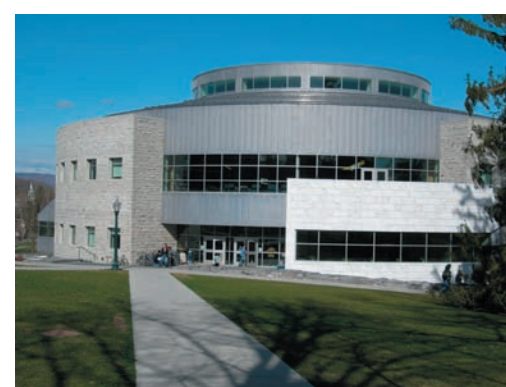
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8



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FIGURE 1

Proposed architectural plan
Existing buildings are in red,
proposed buildings are in orange

Building Form and Placement

There are two general kinds of master plans: one is generated from programmatic needs—known capital building projects; the other is generated from ideas—such as growth (or non-growth) management, and environmental quality. The first is short term, and is often obsolete within three to five years. The second is a long-term strategic plan that may, or may not, identify capital building projects. The most flexible plans provide a decision-making structure without specificity regarding building use. In that case the spatial structure plan is more important than the building use plan.

The Middlebury College Master Plan is primarily the latter of these two types, but some future capital projects are identified, or implied, within the plan. These are facilities for the arts, student activities, athletics, and housing. Other buildings shown within the plan are simply proposed, or possible, future buildings.

The Architectural Plan illustrates the proposed placement, size, and form of possible new buildings. The buildings are intended to define and reinforce the open space structure. Thus, the Architectural Plan has both a quantitative and qualitative aspect.

Growth and Capacity

The average rate of growth in built area for American universities over the last fifty years has been about 1% per year. The average rate of growth for Middlebury College during this period has been twice that: over 2%. Since the 1950s the built area of the campus has almost tripled, from 700,000 gross square feet to over 2,000,000 gross square feet. During the same period, student enrollment almost doubled, from about 1,200 to about 2,350.

An analysis of past growth patterns indicates that there was only one decade in the twentieth century (the 1920s) when less than 50,000 gross square feet was built. (See chart on page 18.) Thus, a minimum, median, and maximum calculation indicates a possible projected growth of 250,000–900,000 gross square feet over the next fifty years. No one can predict with certainty what will happen. The College is currently in a no-growth mode, and there are no plans to increase student enrollment.

Nevertheless, there are foreseeable, or likely, capital building projects that may approach a total of 250,000 gross square

feet within the next fifteen to twenty years. Those projects include: 1) field house replacement; 2) Fitness Center expansion; 3) music, dance, and theater expansion; 4) museum expansion; 5) one or more residence halls to accommodate the Commons; 6) an academic building for classrooms and offices; and 7) a Proctor renovation or replacement. The campus has the capacity to accommodate these facilities and improve the physical environment at the same time. The proposed Architectural Plan illustrates a capacity of about 550,000 gross square feet of possible future buildings.

The dashed outlines near Old Stone Row indicate other possible locations for future buildings. These sites are somewhat controversial, so they are shown as a future reserve—to be used if needed. The planning team believes that they could make a salutary contribution by more positively defining the Main Quad, and activating Old Chapel Walk—similar to Locust Walk at the University of Pennsylvania.

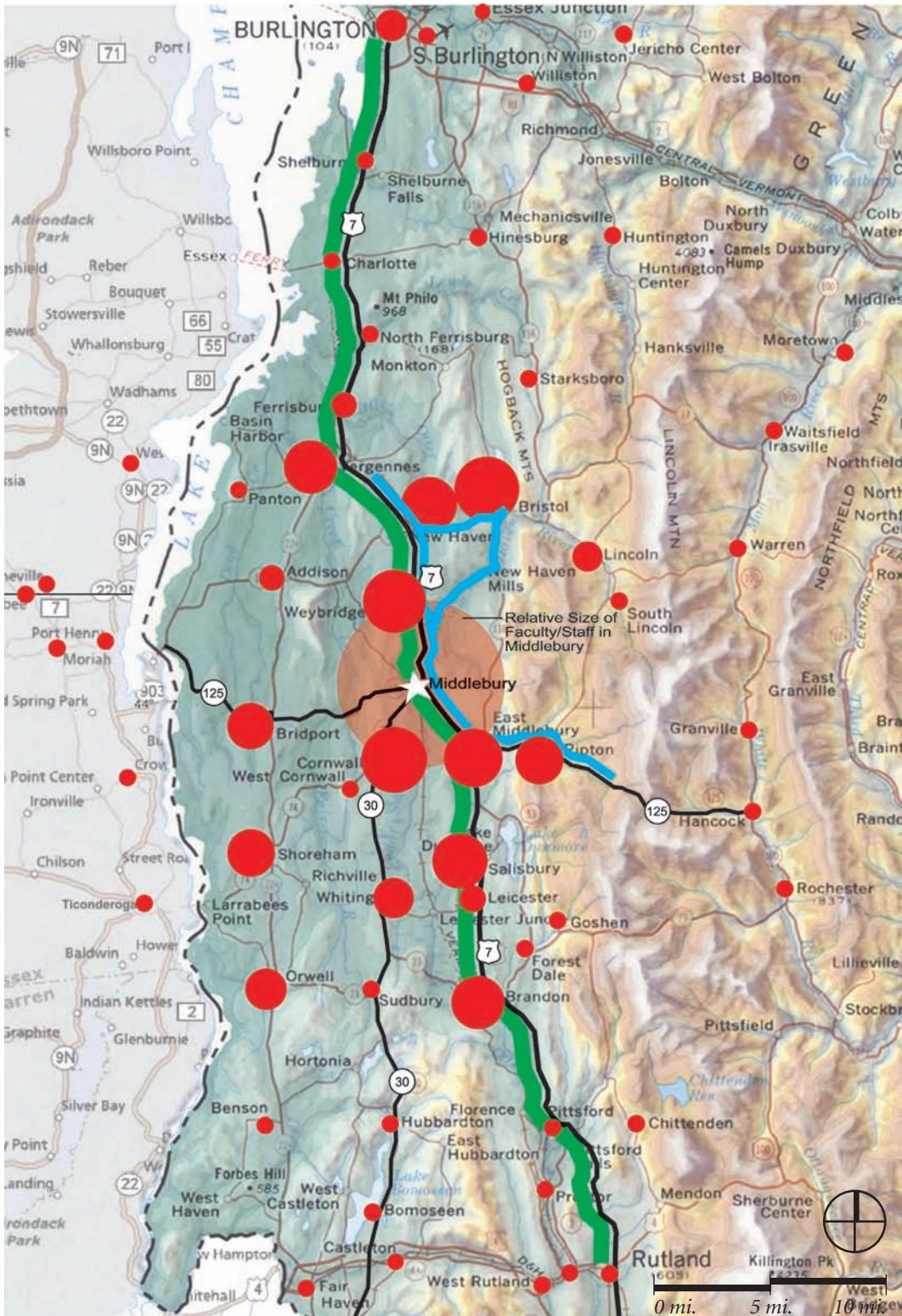
Only five buildings are proposed for removal and replacement: Proctor, the White Metal Building, the Service Building, Battell Hall, and the Bubble.

Architectural Principles

The following principles should guide the building development of the campus:

1. *Buildings should be carefully located internal to the campus, not on the periphery; i.e., acupuncture, not invasive surgery*
2. *Buildings should be small, or of small increments*
3. *Buildings should be widely spaced to preserve views*
4. *Buildings should define spaces; i.e., quadrangles and courts*
5. *Building form and language should be derived from heritage architecture*
6. *Buildings should be built of native materials*
7. *Buildings should be environmentally responsible*





1

FIGURE 1

Size of resident populations of faculty and staff in Vermont and New York State towns, relative to ACTR shuttle routes

LEGEND

Burlington & Rutland Bus Routes
Tri-Town Shuttle

100 People

50 People

Fewer than 10 People

FIGURE 2

Existing Town and Campus: names of streets and spaces

CIRCULATION

Regional Connections

The Town of Middlebury lies at the intersection of Vermont State Routes 7, 30, and 125, and is roughly equidistant from the state's two largest cities—Burlington to the north and Rutland to the south. Route 125 (College Street), which runs east/west, divides the North Campus from the Central Campus, and Route 30 (South Main Street), which runs northeast/southwest, divides the Central Campus from the South Campus.

Most College-bound traffic comes through the Town along Route 7, east of the College, and must cross Otter Creek to get to campus. Currently the Town has only one bridge across Otter Creek. Both the Town and the College are concerned that this causes too much congestion. A joint initiative has recently been undertaken by the Town and College to construct a new bridge in the center of Town.

Approximately 38% of College faculty and staff live in Middlebury, and another 15% within five miles of Town. Others, however, commute from much further away, from as far as New York State to the west and Burlington to the north. The reasons are varied but include the limited availability and relatively high cost of housing in Town. Based on an analysis of faculty and staff zip codes, it is estimated that the total faculty/staff daily commute for one year is in excess of 4,000,000 miles. The associated CO₂ emissions—1,900 metric tonnes—represents approximately 6% of the College's overall carbon footprint.

Much of the faculty/staff population lives within range of the region's bus and shuttle transit system, Addison County Transit Resources (ACTR). However, ridership among College personnel is extremely low; according to the 2007 report *Midd Shift: A Proposal for Carbon Neutrality at Middlebury College*, only 15 of the College's 800 faculty and staff regularly ride the bus or shuttle. Given the relatively high marginal cost of attracting new riders by adding service routes, the College and ACTR should first attempt to increase ridership in those areas already served. Incentive-based policies for reducing vehicular use, discussed in detail on page 80, combined with an emergency ride system, would both encourage and facilitate increased use of public transportation.



Intra-campus Circulation

The primary means of crossing campus for faculty, staff, and students is on foot. Although there is anecdotal evidence of private vehicular use to travel from one end of campus to another, statistically, this is probably not a major issue. However, it highlights the problems associated with recent campus sprawl.

Bicycling is the choice of transport for approximately 10% of the students in the non-winter months and 2% in the winter, as well as some faculty and staff. Inventories show a sufficient total number of bike racks on campus; however, racks are uncovered and impermanent, at certain locations there are too few of them, and not all are well designed, secure, well lit, or in good condition. Bike racks and their siting should be improved. There are no designated bike routes on campus—bicyclists share paths with pedestrians and service vehicles. Pathways should be widened and clarified to better accommodate these uses. See page 64 for the proposed path system.

The College has an internal shuttle system, MiddRides, with scheduled routes that also functions on a limited on-call basis. It serves the student population, operates only at night, and is generally deemed successful. Improvements such as bus shelters and a more consistent schedule would likely increase ridership, and several possible routes were developed during the planning process (see the Appendix). However, there is not much student demand for a continuously operating daytime shuttle system. A recent survey found that most students would rather walk than wait for a shuttle. In fact, MiddRides student ridership does not currently increase even in the winter months. A regular shuttle system would be most useful to students between classes, but to adequately serve the student population, the College would have to operate several vehicles simultaneously at these peak times. Given the low level of student interest in a shuttle, the necessary expense, and the associated vehicular carbon emissions, a regular shuttle system is inappropriate for the College. To provide for those individuals for whom long walking distances are difficult, particularly in winter, the best solution is probably an on-call shuttle or taxi system connecting outlying parking lots to the center of campus.

Major vehicular circulation through campus occurs along College Street and South Main Street, with lesser volumes

on a series of smaller internal campus roads. The two principal campus through-roads connecting from College Street to South Main are Old Chapel Road and Stewart Hill Road. Old Chapel Road runs parallel to Old Stone Row along the east side of the Main Quad. It has on-street parking that is in high demand by faculty and staff, and terminates in another parking lot adjacent to Stewart Hill Road.

Because Old Chapel Road is also a major pedestrian artery, significant conflict occurs between cars, pedestrians, and bicycles, exacerbated by the lack of continuous sidewalks. In response to the College's desire for a more pedestrian-friendly campus, the Master Plan proposes to reconfigure Old Chapel Road into Old Chapel Walk: a tree-lined promenade for pedestrians and bicyclists, with vehicular access limited to service, emergency, and handicapped vehicles and small pockets of parking at either end. This will both enhance historic Old Stone Row and the Main Quad and improve safety for bicyclists and pedestrians. It is not anticipated to impede vehicular circulation through campus; recent studies have found that most volume along Old Chapel Road is not through-campus traffic but cars in search of parking.

Stewart Hill Road, adjacent to the Town cemetery south of campus, is the main vehicular College entrance for those approaching from the southwest. It is currently a one-way road feeding downhill from Hillcrest and Hepburn Roads to the base of the hill. The Master Plan suggests that, if necessary, Stewart Hill Road could be widened into a continuous two-way street to facilitate vehicular circulation around campus and to compensate for the loss of Old Chapel Road as a campus through-road.

Most other intra-campus roads, such as Le Chateau Road, Hepburn Road, and the service drive west of Ross Commons, are typically chained off to all but service vehicles. This creates difficulties for staff that need to access these streets, complicates bicycle circulation, and generally contributes to a disjointed and underutilized circulation infrastructure.

The Master Plan recommends redesigning Le Chateau and Hepburn Roads into pedestrian-oriented promenades with limited vehicular access. Chains that have been used to restrict public access to these roads should be removed in favor of signage or, if necessary, bollards, which allow

for both pedestrians and bicyclists to more easily move through campus.

Traffic Calming

Because Middlebury College straddles two state highways, it has been difficult to clearly define points of entry to campus. This is problematic both for pedestrian safety and for establishing the basic identity and boundary of the campus. While formal, gateway-type entrances are not possible at Middlebury due to the campus's geography, it is possible to clearly signal to drivers that they have left the Town or the open countryside and have entered the precinct of the College.

To establish a sense of entry to the campus, and improve pedestrian safety by encouraging slower vehicular travel speeds, it is proposed that several roundabouts be constructed on roadways serving the campus. Roundabouts are, by design, smaller than traffic circles or rotaries and provide right-of-way to vehicles already in the circular travel way. A key feature of roundabouts is the raised, splitter island on each travel approach that forces drivers to slow down as they approach the roundabout. The raised islands can also provide refuge for pedestrians half-way into the crosswalk.

The center island of the roundabout is also raised but is designed to allow safe maneuver of larger vehicles such as fire trucks. The center can also provide a place for low landscaping or signage that alerts oncoming traffic to the roundabout and helps define the location as a campus gateway.

It is difficult to speed through a properly designed roundabout because of the raised islands that force drivers to slow down. These forced speed reductions help reinforce a significant change in the driving environment, such as the change in speed limit when traveling from the more rural sections of Route 125 and Route 30 to the more densely populated areas of the campus along College Street and South Main Street. Pedestrian safety is always improved when travel speeds are reduced.

Another beneficial aspect of roundabouts for the campus environment is the ease with which drivers can complete U-turn maneuvers. This is particularly useful for drivers who may have mistakenly passed their destination or are simply touring the campus.

The Master Plan proposes roundabouts in three locations as a traffic calming device and as a means of establishing entrances to campus. A roundabout is proposed west of campus on Route 125 (College Street), at the base of the hill near the Materials Recycling Facility; its primary purpose is to slow high-speed traffic approaching from the west. Another roundabout is proposed east of campus along Route 125, where it intersects Storrs Avenue; this creates a safer crossing for pedestrians at the intersection and provides a signage opportunity to announce entry to campus. A third roundabout is proposed at the intersection of Stewart Hill Road and Route 30 (South Main); this increases safety at this major pedestrian crossing, slows higher speed traffic from the southwest, and announces campus entry—in particular, parking access—for vehicles traveling either direction on Route 30. Also at the Route 30 location, a new road is proposed extending the Stewart Hill Road axis across the roundabout and down to the Mahaney Center for the Arts parking lot. This clarifies access to the lot for cars as well as pedestrians. Each of these roundabouts presents an opportunity for signage and other monuments to signal that the driver is within the limits of the College.

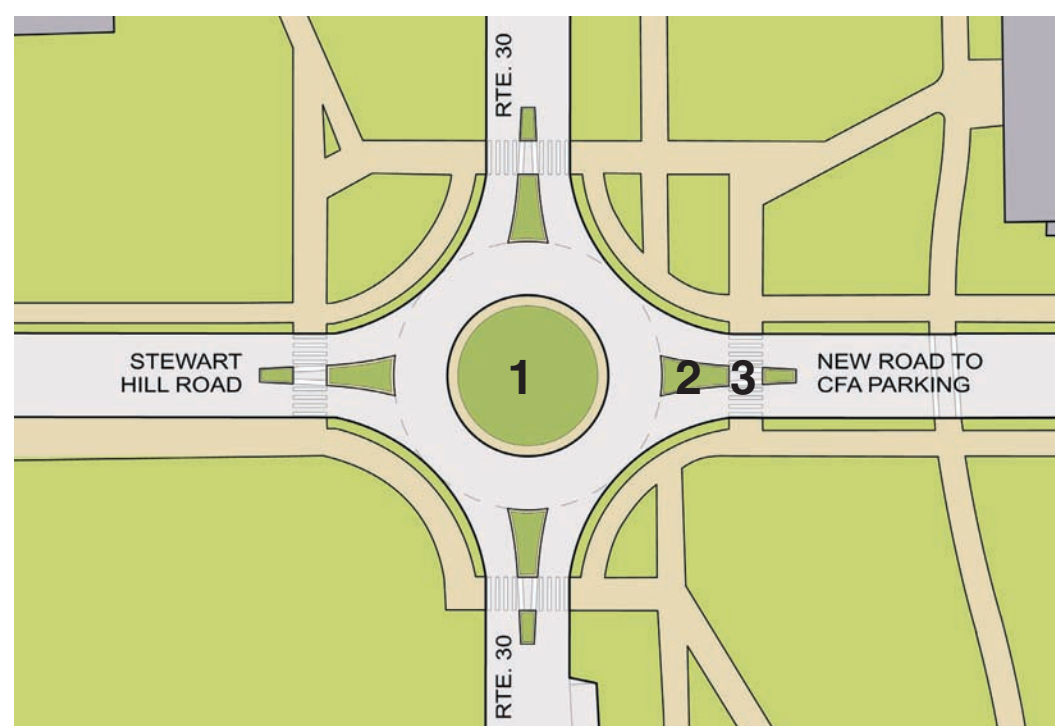
With frequent pedestrian crossings and high traffic volumes, College Street is a crucial location for traffic calming measures. Currently, parallel parking spaces on either side of the street serve to slow through-campus traffic, and a flashing yellow light alerts eastbound drivers that they are entering a pedestrian zone. Eight crosswalks occur at

FIGURE 1

Typical roundabout design

LEGEND

1. Central Island
2. Raised Splitter Island
3. Pedestrian Crossing



bump-outs between the parallel spaces. This strategy has been found to significantly improve safety.

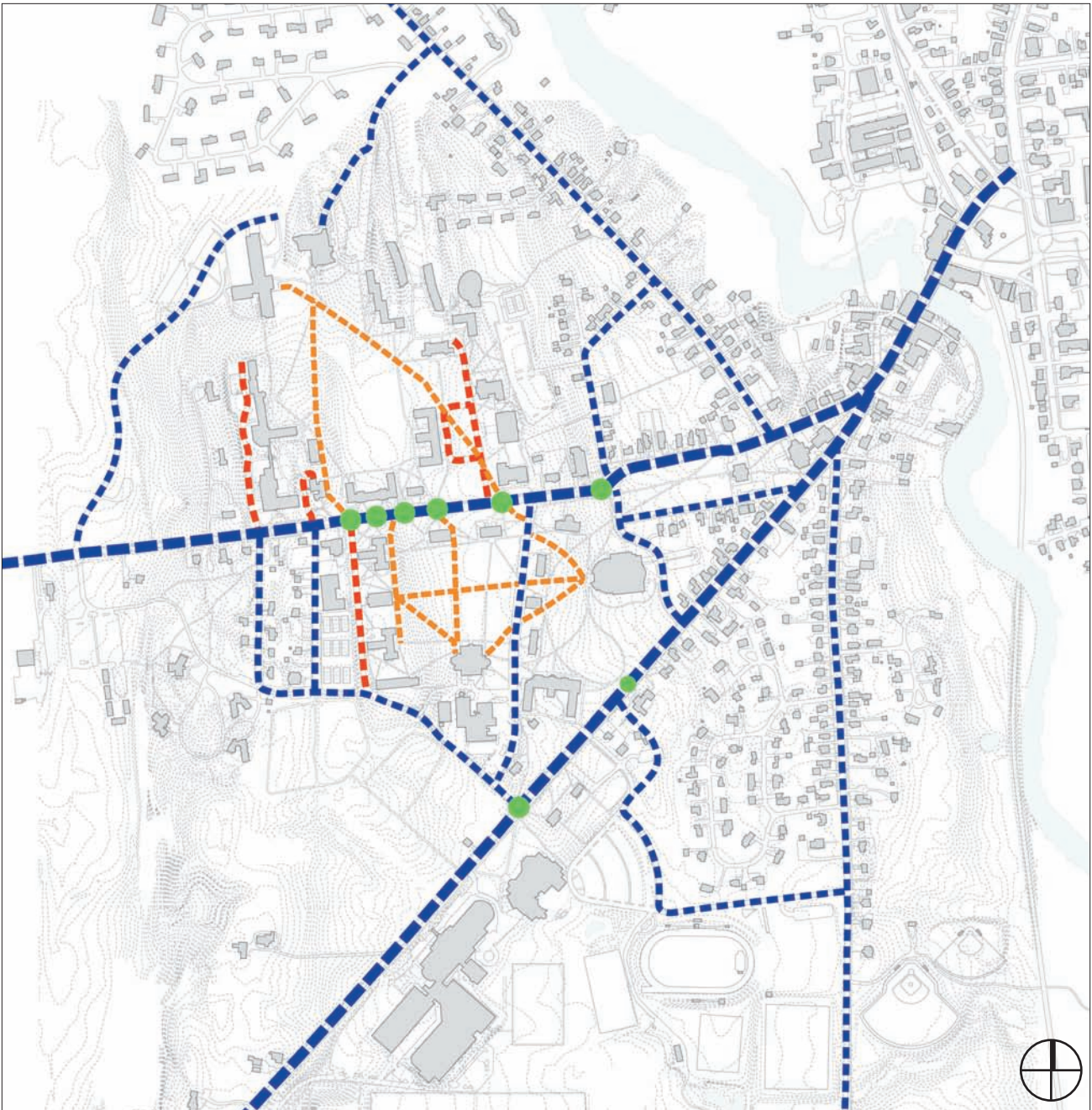
Parallel parking is an effective traffic calming measure, but for many reasons it is not the best strategy for this important campus location. Parked cars may block views to pedestrians, particularly those who don't cross at a bump-out, and cars pulling into and out of spaces may block pedestrians' views to oncoming traffic. Most significantly, the addition of parallel spaces on either side of College Street substantially widens the street and therefore the divide between the Central and North Campuses. The Master Plan proposes removing parallel spaces from the center of campus, maintaining approximately twenty spaces at either end. The central portion of the street will

be narrowed, to create a more intimate connection between North and Central Campus. Pedestrian crossing locations will be limited to five, placed at logical locations along the street, and highlighted by improved technology to alert drivers to pedestrians, particularly at night. A separate lane for bicycles will be added along the north side of College Street. Street lights will be replaced to eliminate glare and reduce light pollution. Finally, the street will be tree-lined, enhancing the intimate nature of the campus and clearly demarcating the College from the open farmland beyond. The combined effect of these improvements—roundabouts at either end of the street, tightened curblines, and street trees—together with the parallel parking spaces at either end, will change how College Street will be perceived. It will be no longer a highway, but a campus street.

FIGURE 1
*Existing Vehicular and Pedestrian
Circulation Plan*

LEGEND

- Major Street
- Secondary Street
- Service Road
- Major Pedestrian Path
- Major Pedestrian Crossing
- Minor Pedestrian Crossing



Movement of Materials

Campus deliveries occur on a daily basis. Most material arrives at the Service Building and is subsequently redistributed by campus vehicles. Other significant deliveries go directly to the three dining halls and the Grille, the Library, and to the College Store at Proctor Hall. Fuel is delivered directly to the Service Building, as often as twice daily in winter. Additionally, the Facilities Services staff makes frequent trips across campus to receive assignments and pick up materials.

Delivery of materials to the buildings along College Street is particularly difficult given the lack of loading areas and direct access to buildings. More storage space at the dining halls and at the Service Building to receive materials such

as paper and office supplies would reduce the frequency of trips to campus.

Recommendations

1. *Redesign Old Chapel Road into pedestrian-oriented Old Chapel Walk*
2. *Widen Stewart Hill Road if necessary for two-way traffic*
3. *Convert Hepburn and Le Chateau roads into pedestrian-oriented promenades with service access*
4. *Use roundabouts to slow traffic and announce entry into campus*
5. *Enhance and narrow College Street*
6. *Enhance South Main Street*
7. *Strengthen the Bicycle Program*

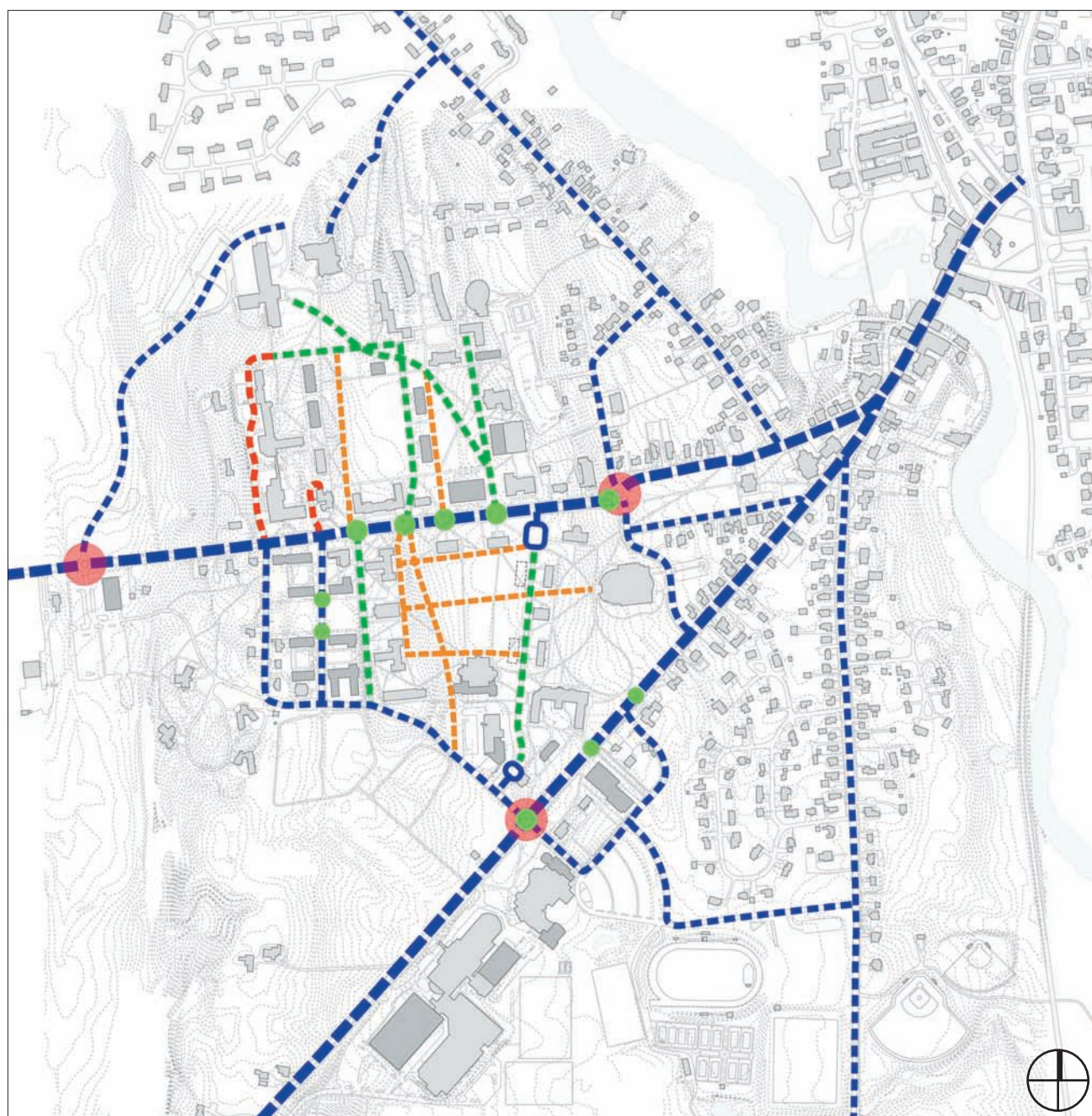


FIGURE 2

Proposed Vehicular and Pedestrian Circulation Plan

LEGEND

- Major Street
- Secondary Street
- Service Road
- Pedestrian Promenade limited vehicular access
- Major Pedestrian Path
- Roundabout
- Major Pedestrian Crossing
- Minor Pedestrian Crossing

PARKING

As with most colleges and universities, parking at Middlebury is a subject of great interest to the entire College community. Statistically, there are enough on-campus parking spaces for both faculty/staff and students to meet current and near-term estimated demand; however, the distribution, management, and location of these spaces can be improved.

At present, the College has a significant amount of parking throughout the center of campus—in particular along Old Chapel Road, College Street, Hepburn Road, and at the Service Building. However, these lots contribute to the fragmentation of the campus fabric and encumber pedestrian and bicycle circulation. In order to facilitate the pedestrian campus called for in the 2006 Strategic Plan, the Master Plan recommends that most of this parking be eliminated and these roads be converted into narrowed streets and pedestrian-oriented promenades. Of those spaces that remain, most are likely to be reserved for handicapped, service, and short-term or visitor parking. This will require changes in parking management and behavior, but need not inconvenience faculty and staff who drive to and park on campus daily. By reapportioning spaces within existing lots, improving pedestrian access to parking, providing additional parking in strategic areas, and limiting the total number of cars on campus, the Master Plan seeks to create a pedestrian campus without the loss of adequate, accessible parking.

Management and Operations

The College has designated lots for faculty/staff and student parking. All students—including first-year students—are allowed to bring a vehicle to campus. Student lots are designated by year; first-years park near the athletics complex, sophomores in the Mahaney CFA or athletics complex lots, juniors and seniors have open parking within student lots, and faculty/staff have open parking within their lots.

Middlebury charges no parking fees, either for faculty, staff, or students. Not charging a fee for students is in part a reflection of the College’s preference to aggregate individual costs and fees into the overall student comprehensive fee.

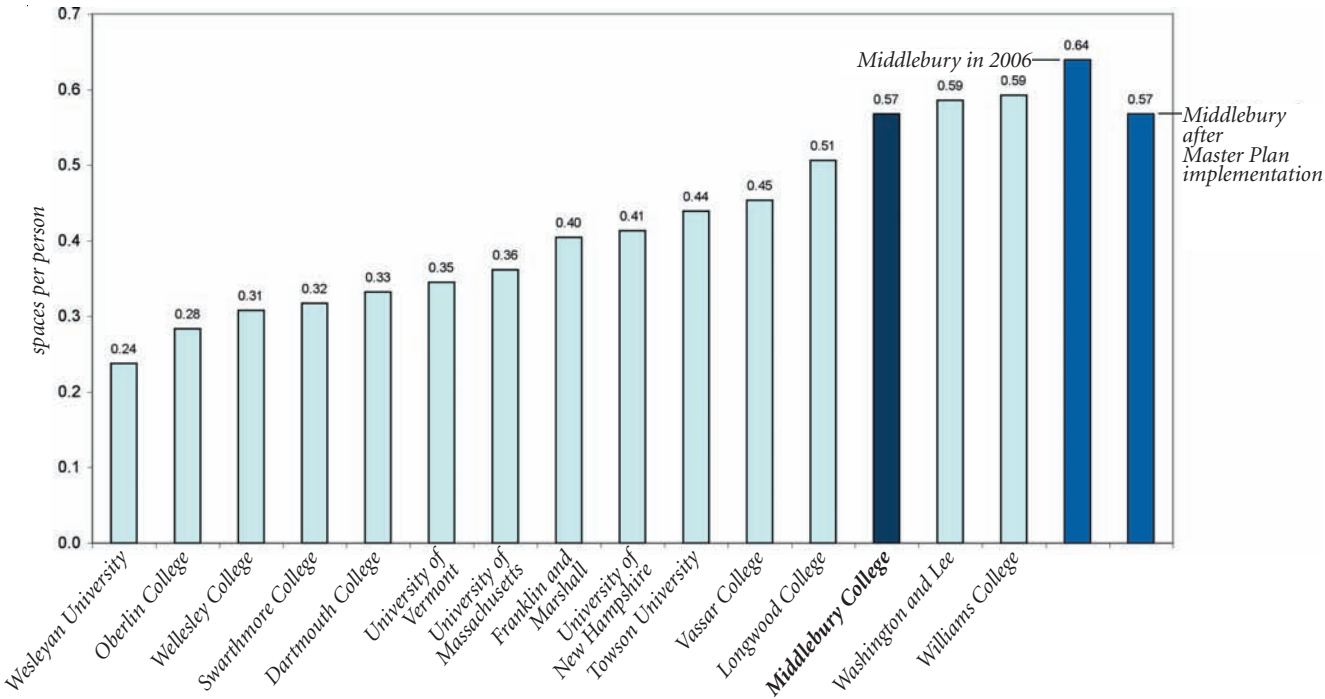
Quantity and Distribution

There are a total of 2,341 parking spaces on campus in 38 lots, ranging in size from 2 to 379 spaces. Nearly half (43%) of the total campus supply is on the south campus. The seven largest lots have over 100 spaces each, constituting 66% of the campus capacity. There are 1,135 student spaces, 875 faculty/staff spaces, and 331 visitor/handicapped parking/service spaces. This gives the College its current a ratio of 0.57 parking spaces per campus person (faculty, staff, or student)—a high number compared with similar institutions.

Of the approximately 2,350 students at Middlebury, 1,348 had parking permits issued for 1,135 student spaces in academic year 2005–2006. In spite of the greater nominal demand than supply, surveys have shown ample vacancies in student parking across most of the lots. A possible explanation is

FIGURE 1

Comparison of Parking Spaces per Campus Person with Peer Institutions 2001 data, courtesy Ayers Saint Gross



that students do not keep their cars on campus for the entire year. The percentage of cars on campus by academic year consistently increases from about 25% for first-year students to over 75% for seniors. This trend indicates that students take advantage of the more easily accessible parking spaces allotted to juniors and seniors, and they likely become used to the convenience of having a personal vehicle on campus.

There are roughly 800 faculty and staff present on campus on an average day, giving the College a 1:1 ratio of employee parking spaces to employees. This ratio is significantly higher than the 0.7 spaces per employee provided at similar institutions. In general, faculty/staff spaces are readily available at McCardell Bicentennial Hall, Wright Theatre, CFA, and the field house. Spaces in the lots closest to the Main Quad, including Old Chapel Road and College Street, have limited availability.

Spaces in the CFA lot are designated for students, faculty, and staff. Currently, the lot has an overall midday occupancy rate of 73% (99 spaces free), and a faculty/staff occupancy rate of 79% (11 spaces free). When the Axinn Center at Starr Library comes on-line in the fall 2008, faculty/staff use of this lot is likely to increase.

Prioritizing Faculty/Staff Parking

Proximate parking to one's office or workplace is universally desired, particularly in the winter months. It is both unsuitable and unfeasible to have parking adjacent to all campus buildings; however, providing parking within a reasonable walking distance of buildings is achievable. Assuming five minutes' walk—roughly 1,320 feet—as an acceptable travel distance, a quick study suggests parking availability within an acceptable distance of all campus buildings, with the large lots at CFA and Wright Theatre as the most likely source.

Because student parking spaces typically function as mid- to long-term car storage—most students using their vehicles once a week or less—the redistribution of student parking to peripheral lots is a key recommendation of the Master Plan. Keeping student spaces on the periphery allows the most proximate parking to be assigned to faculty/staff who drive to the College daily; moreover, making student parking more remote discourages many students from bringing cars to campus and limits the amount of student vehicular travel during the week. This ultimately reduces the total number of spaces needed on campus and reduces greenhouse gas emissions associated with student vehicular use.

In particular, it is recommended that student parking currently assigned to the CFA lot be redistributed to underused lots such as Lot U by the Track and Field facilities. Any student spaces remaining in the CFA lot should be relocated to the southern periphery. It is also recommended that students be redistributed from the Wright Theatre lot. Providing adequate numbers of parking for faculty and staff in these two key lots assures daily commuters a reasonably convenient space. Further, by reducing the total number of lots available to faculty and staff, it reduces time spent driving around to other lots in search of the most central space. Finally, assigning CFA spaces to daytime commuters leaves these spaces open for evening use. This provides additional guest parking for events at the Mahaney Center for the Arts and secondary parking for events at Kenyon Arena.

It is recognized that not all members of the Middlebury community find a five-minute walk manageable, particularly in inclement weather. The possibility of a campus shuttle or a taxi-type parking access service is discussed in the previous section on Circulation.

FIGURE 2

Five-minute walking-sheds overlaid on the Middlebury campus

The College's two largest lots—Wright Theatre and CFA—are both within a reasonable walking distance of most classroom and administrative buildings



FIGURE 1

Existing campus parking distribution

There are currently 2,341 parking spaces in the vicinity of campus. Parking shown in red is College owned and operated. Parking shown in blue is administered by the Town

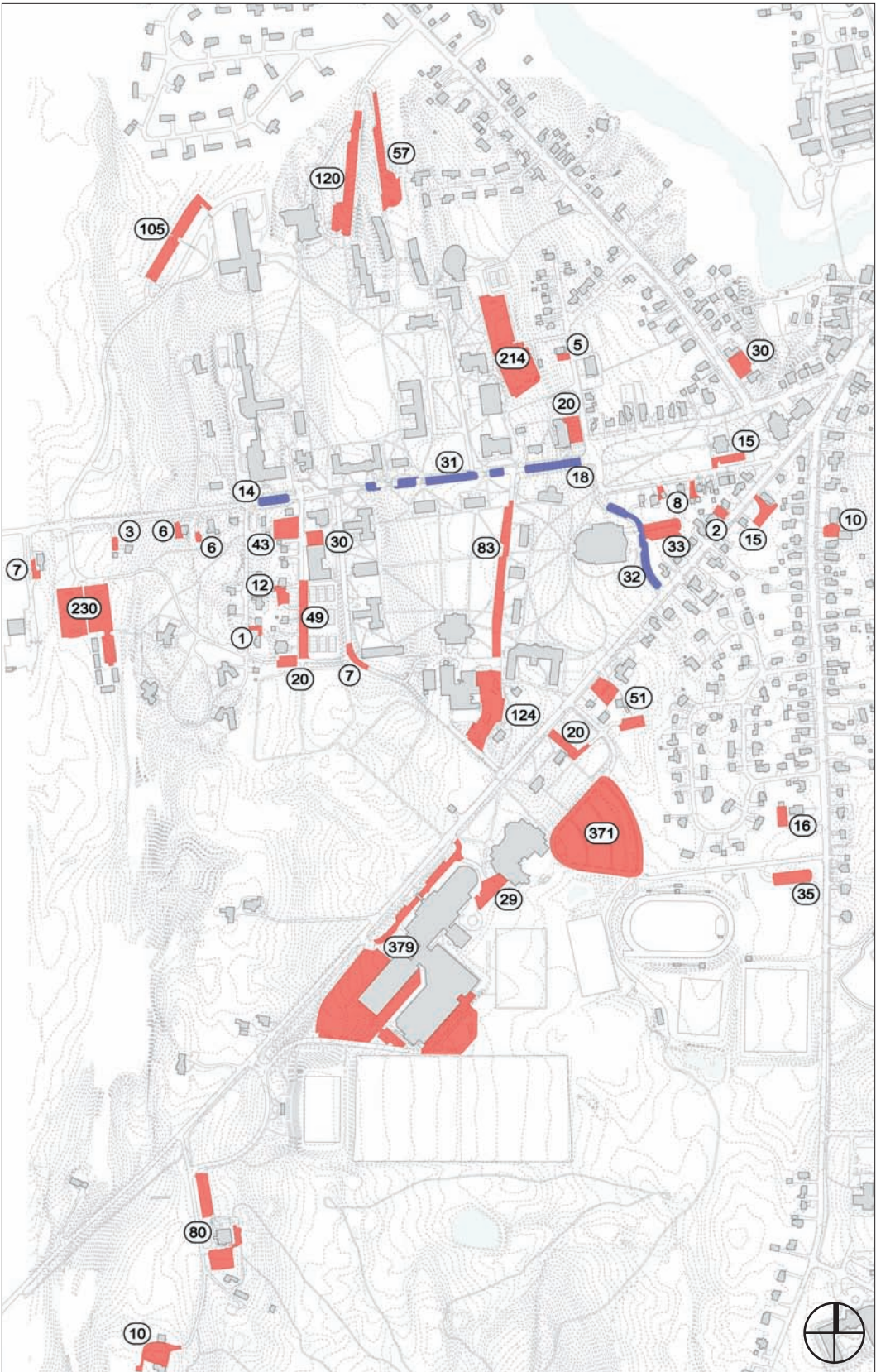
The proposed reconfiguration of Old Chapel Road and College Street will eliminate 62 faculty, staff, and visitor spaces from the center of campus. In anticipation of this loss, it was recommended that on-street parking spaces be added along South Main Street. This project was completed in the summer of 2007 and has resulted in approximately 40 additional spaces in the vicinity of the Axinn Center and Library Park.

Given the cost—financial, aesthetic, and environmental—of building and operating new surface parking, the College should strive to avoid adding new spaces. In the future, consideration should be given to including structured parking in new building projects, for instance at basement level. However, the College should strive to first reduce the use of private vehicles through alternatives and incentives, and promote a more pedestrian-friendly campus.

Transportation Demand Management Strategies

Middlebury College is interested in reducing vehicular travel to campus both to reduce emissions associated with vehicular use and to resolve parking needs without adding large areas of surface parking. Transportation Demand Management (TDM) is a series of strategies that promotes alternative transportation options to faculty, staff, commuters, and residents. The College should use TDM to manage existing transportation resources and promote transportation alternatives to the single-occupant vehicle. Student-focused TDM strategies include investigating car-sharing opportunities on-campus, establishing a car-free policy for first-year and possibly second-year students, and the continuation of shuttle services during college vacations to Burlington, New York, and Boston. TDM strategies targeted to faculty and staff include providing guaranteed rides home and daily pass options for those who choose to carpool or use public transit, promoting park-and-ride opportunities on Routes 30 and 125, and establishing a database of housing clusters to identify and target rideshare opportunities. (See Chapter 5: Sustainability, for a more comprehensive list of recommended TDM strategies.)

One of the most effective ways of discouraging private vehicular use is parking management. This can include reserving highly desired parking spaces for carpools and paying faculty/staff a nominal amount of money not to have a parking permit. The most effective management tool is instituting parking fees. Student fees are not currently charged for parking because of the College's comprehensive fee system; however, instituting a parking fee would not only lower the number of student cars on campus but could generate revenue for other transportation services. Additionally, zones of parking pricing, based on desirability or location, could be established for faculty and staff. However, alternative means of transport should be in place from the outset of any fee-based strategy.



Recommendations

1. Remove parking from center of campus
2. Designate parking closest to center of campus for faculty and staff
3. Relocate student parking to peripheral lots west of campus and athletics complex
4. Institute Transportation Demand Management strategies to reduce private vehicular use by faculty, staff, and students
5. Give consideration to integrating structured parking into new building projects

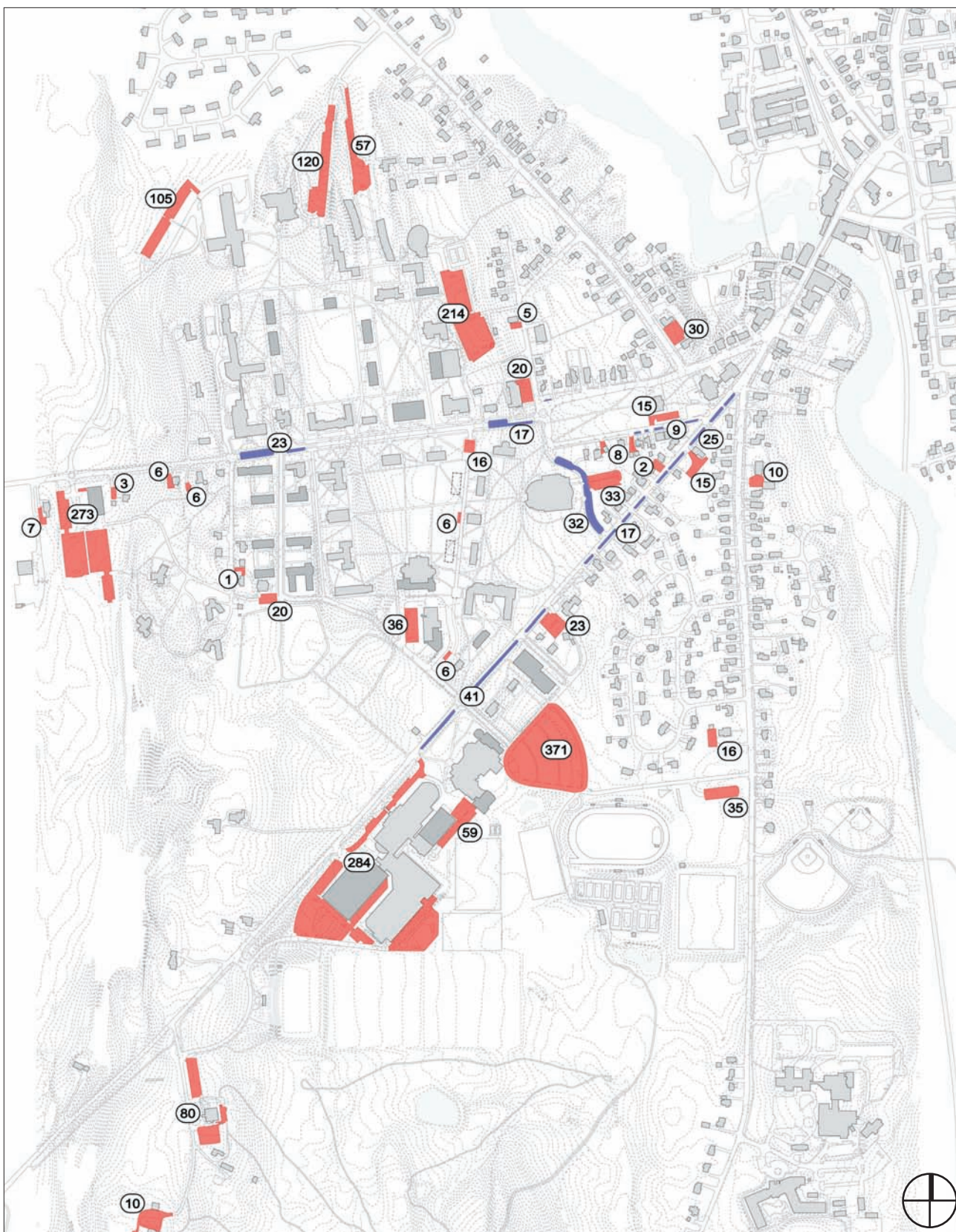
FIGURE 2

Campus parking distribution after Master Plan implementation—2,056 surface parking spaces in the vicinity of campus

These changes assume the College has incorporated Transportation Demand Management strategies to reduce the need for private vehicular travel to campus

LEGEND

- College-owned parking spaces
- Town-administered parking spaces



UNIVERSAL ACCESSIBILITY

As part of the master planning process, a universal accessibility audit was conducted of primary campus walkways and thirty representative campus buildings. The purpose was to identify existing barriers to accessibility and develop cost estimates for barrier removal.

In addition, interviews were held with representative faculty, staff, students, and alumni to help set priorities for barrier removal and universal design guidelines. These interviews revealed the number of barriers on campus, priorities for their removal, and their full impact on people with disabilities.

Existing barriers—regardless of the date of construction—are not all required to be removed immediately; however, federal law requires an ongoing architectural and communication barrier removal program. In advance of full barrier removal, it is permissible to provide assistance, make reasonable accommodations, and relocate certain meetings or classes; but the legal mandate is that some “architectural affirmative action” be combined with planned maintenance and construction to make the campus fully accessible over time.

Recommendations

Middlebury College should undertake a College-wide, universal access initiative that will:

- 1. Create a cohesive vision for a universally accessible campus for people of all ages and abilities;*
- 2. Create a prioritized barrier removal plan to ensure dignified access to all campus facilities, beginning with its most public and unique facilities and programs—Johnson Memorial Building, Wright Theatre, the Peterson Family Athletics Complex, Warner Hall, McCullough Hall, and the entrance to the Main Library;*
- 3. Institute an immediate and ongoing program to remove architectural barriers whose removal is “readily achievable,” and to provide automatic door openers, accessible parking near entrances, handrails on all stairs and ramps, lighting along pathways, and detectable warning and curb cuts at crosswalks;*
- 4. Propose design management protocols to ensure full compliance in all new construction and alterations;*

- 5. Devise accessible parking and transportation options coordinated with accessible building entrances to minimize distances to unlocked accessible entrances;*
- 6. Devise accessible dormitory and dining options that are centrally located on campus;*
- 7. Provide confidential and responsive employee accommodation policies and procedures, similar to those available for students;*
- 8. Create an accessible website for people with limited sight;*
- 9. Develop emergency evacuation and safety protocols for all known individuals with disabilities and for all facilities on campus.*

To be successful, this initiative must be:

- Sanctioned by the Board of Trustees and senior administration*
- Funded annually*
- Inclusive of people with and without disabilities*
- Integrated into existing practices campus-wide*
- Managed and monitored, with annual targets and reports*

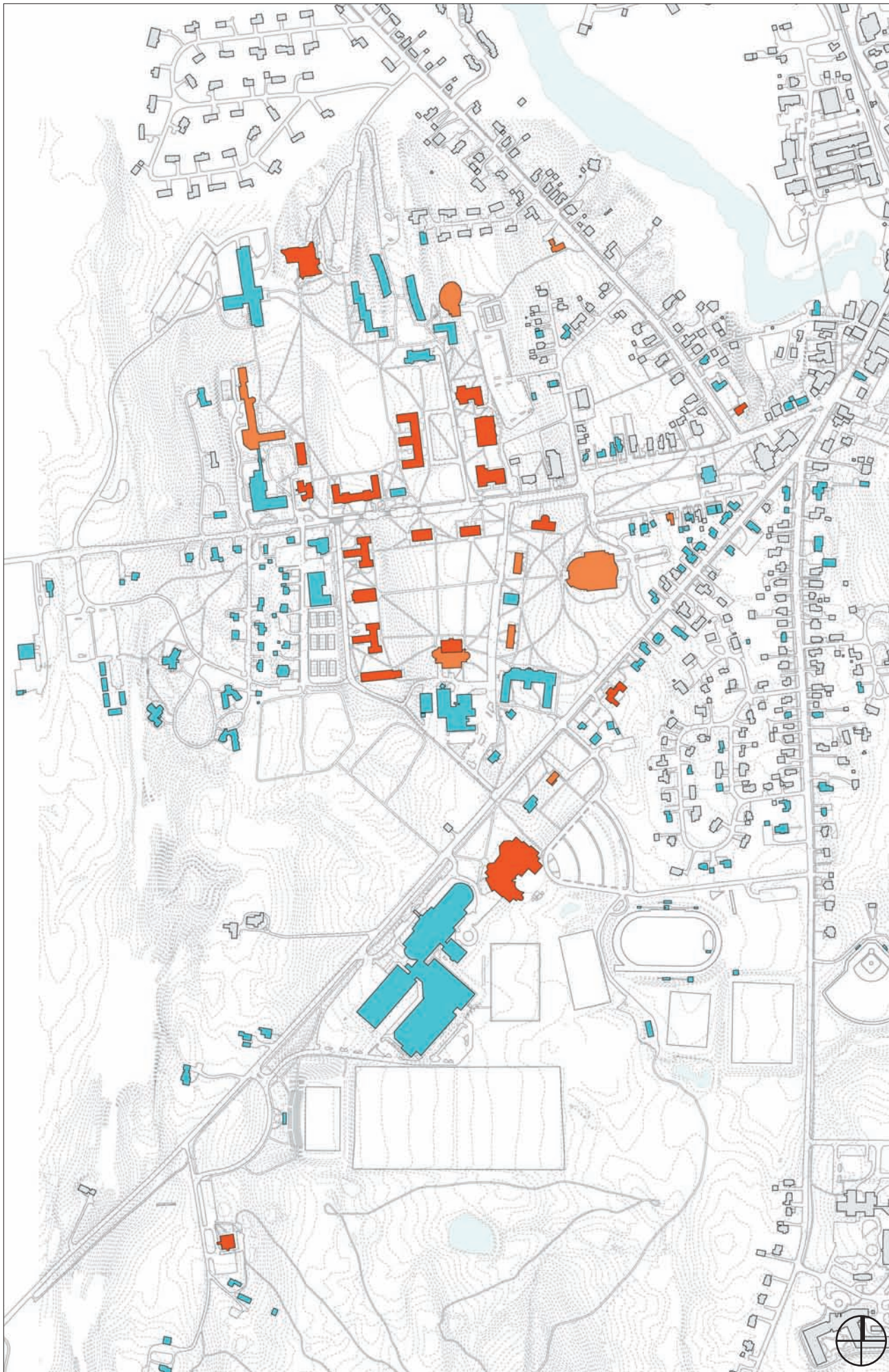


FIGURE 1

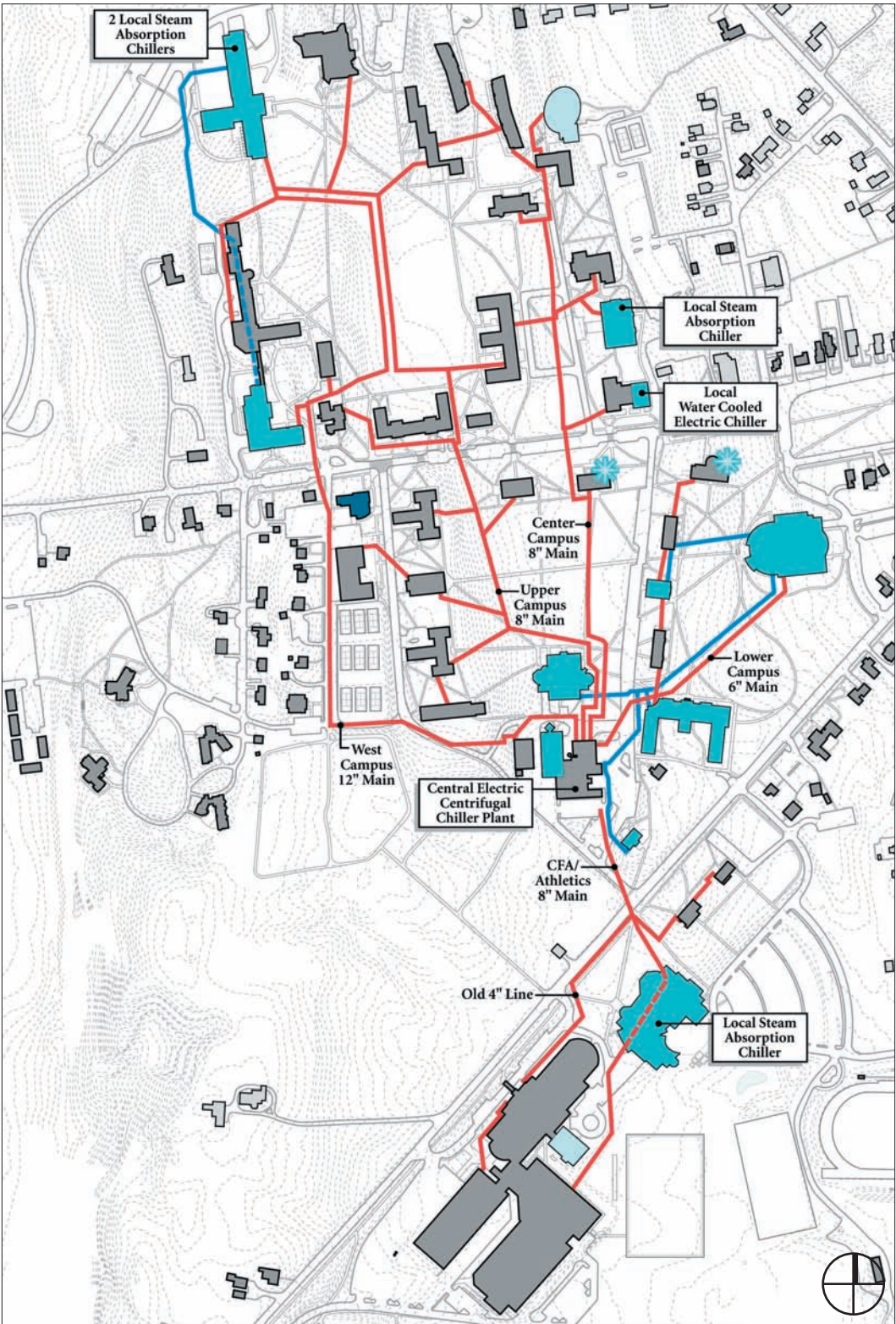
Access Audit Study Diagram

LEGEND

- Included in study; built before 1993*
- Included in study; built or significantly renovated after 1993*
- Not included in study*

FIGURE 1

Existing Heating and Cooling
Distribution



INFRASTRUCTURE SYSTEMS

Middlebury College has become a leader in the creative and aggressive pursuit of environmental responsibility. If the College were developing a campus on new land with no existing infrastructure, it is likely that an extensive study of alternative renewable fuel sources and distribution strategies would be undertaken. However, Middlebury has a 200-year history and must contend with the development that has taken place over that time. The College has an effective, well-maintained central plant and an extensive steam distribution network. Some alternative fuels, such as biomass, will be introduced into this existing network; however, it would be irrational and to some degree unsustainable to abandon the existing campus infrastructure. Rather, the Master Plan recommends planning within the campus's existing infrastructure for the foreseeable future, choosing energy sources with low carbon emissions and using alternative building systems to reduce energy consumption. As future buildings are brought on-line, investigation of alternative energy sources should be explored.

Heating—Steam Generation and Distribution

The main heating medium for the Middlebury campus is steam generated at its central heating plant. The central plant is in good condition and well maintained. It consists of four boilers burning #6 oil—two relatively new, operated as primary units, and two relatively old, serving as back-up units. A fifth biofuel boiler will come on-line with the completion of the Biomass Energy Plant in 2008. This will be fired by woodchips and is expected to displace approximately half of the campus's current oil consumption, reducing the College's carbon footprint by about 40%. The plant's two older boilers should be considered for replacement in the near future, although their situation is not critical since they are primarily used as back-up. Consideration should be given to coordinating their replacement with an expansion of the biofuel portion of the plant. With increased capacity brought about by the biomass project, no expansion of the central heating plant will be required to accommodate new construction.

Steam is utilized for space heating, domestic hot water heating, and in single effect steam absorption chillers. The existing steam and condensate distribution network consists of five main distribution spines—the West Main, Upper Campus Main, Center Campus Main, Lower Campus Main, and CFA/Athletics Main. Certain upgrades to this network will be necessary as part of the Master Plan implementation,

both to minimize energy losses and to provide adequate capacity to enable steam delivery to the existing and proposed new buildings.

Much of the Upper Campus Main is in need of replacement and is scheduled to be completely upgraded within the next ten years. The sizing of this main should be based on the steam demand of the buildings it currently feeds, including the full demand of McCardell Bicentennial Hall, now fed by both the West and Upper Campus Mains, as well as new buildings

in the northwest area of campus. As a part of the Master Plan implementation, the Center Campus Main will require replacement, both to upgrade older piping and to satisfy the steam demand of the new buildings proposed along Old Chapel Road and Le Chateau Road. The West Main, Lower Campus Main, and CFA/Athletics Main should not require any upgrades associated with the Master Plan; however, because the CFA/Athletics Main is already at capacity, proposed buildings along South Main Street will require a new main extending from the Central Plant east across South Main Street.

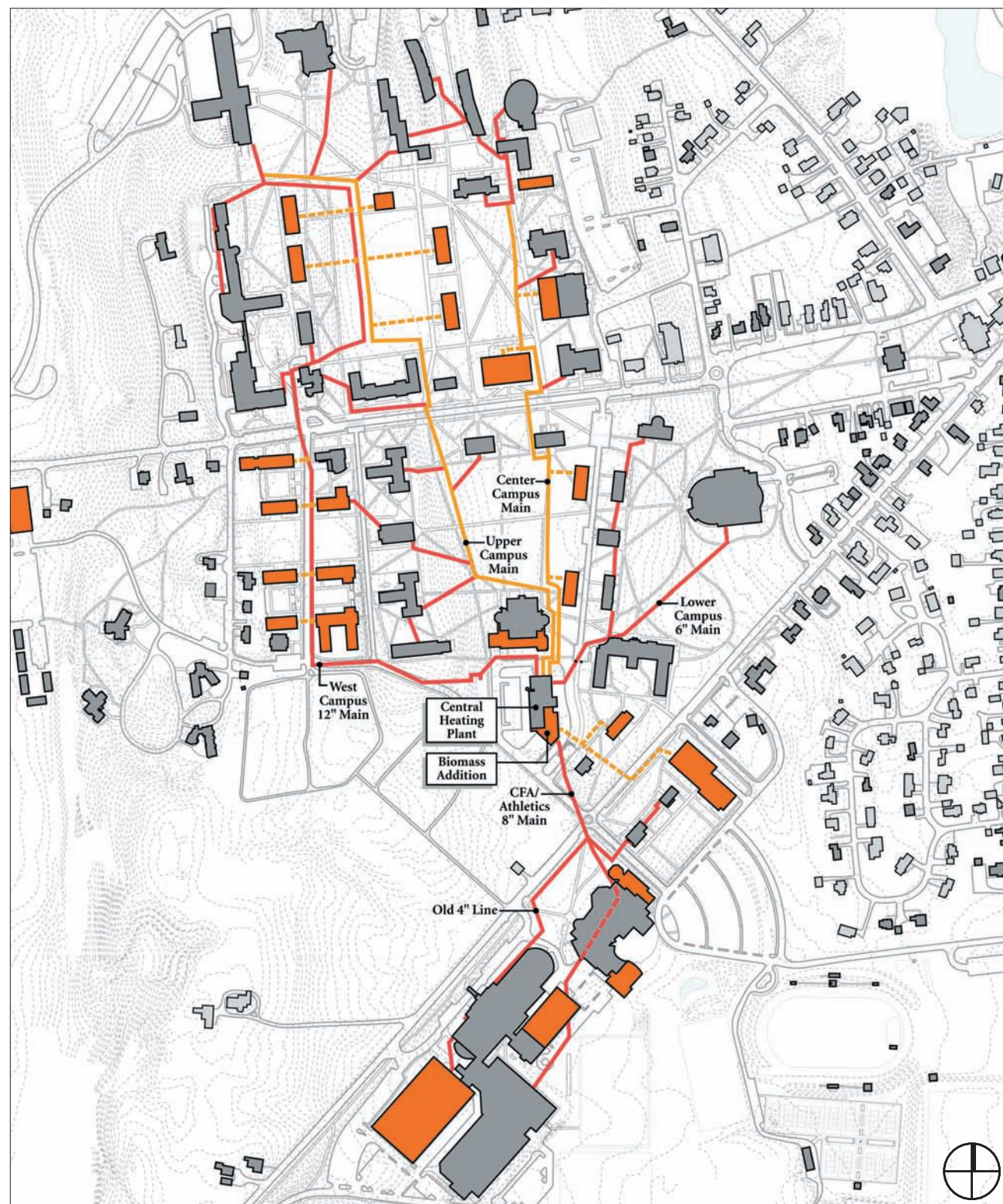


FIGURE 2

Proposed Heating Distribution

LEGEND

- Existing Steam Line
- Upgraded Existing Steam Line
- - - Additional Steam Line
- Existing Building
- Proposed New Building

Cooling

Middlebury College currently has a Thermal Comfort Plan which balances the need for mechanical cooling in periods of extreme heat with its impact on the College's operating costs and on the environment. This plan calls for providing mechanical cooling only after the incorporation of heat load reducing mechanisms such as ventilation and shading systems. The College should minimize the energy consumption of cooling systems by maximizing their efficiency and maximizing the thermal performance of building envelopes. (See the recommendations regarding building design and building systems in Chapter 5: Sustainability.) When such measures prove insufficient to provide comfort, mechanical cooling may be provided in laboratories, special equipment rooms, and most particularly classroom and dining facilities used by the summer Language Schools.

It is the aim of the Master Plan to develop a strategy for better configuring the campus's cooling plants so as to allow for a consistent and efficient approach to cooling media generation and distribution and to offer flexibility for varying degrees of campus air-conditioning. This will provide a framework within which the College can judiciously consider the addition of mechanical cooling to its buildings.

The desired extent of air-conditioning on campus is understood to include buildings or spaces categorized as primarily Classroom, Dining, Performance, Data Center, and Museum. Existing buildings in these categories that either are not air-conditioned or whose current systems require replacement are Wright Theatre, Sunderland Hall, Munroe Hall, Voter Hall, Warner Hall, Proctor Hall, and Mead Chapel. In general, residential facilities are currently not air-conditioned; however, numerous portable window units are used in the summer to cool particular rooms. Because most of the additional buildings proposed in this Master Plan do not have a prescribed function, the proposed cooling strategy allows for the potential cooling of all new buildings without making any recommendations as to which should be air-conditioned.

Cooling is currently provided to fifteen College buildings using stationary equipment, with an additional 230 window air-conditioners used in various buildings on an as-needed basis in the summer. The College's current

cooling strategy is highly decentralized. There is no central campus cooling plant; cooling media are generated by multiple chiller plants distributed throughout the campus. Three of these localized plants—the Mahaney Center for the Arts Plant, McCardell Bicentennial Hall Plant, and Johnson Memorial Building Plant—use steam absorption chillers. The Service Building Plant, serving the Main Library, Centeno House, Old Chapel, the Axinn Center at Starr Library, and McCullough Hall, uses a water-cooled electric chiller. Small air-cooled chillers are used to cool the Atwater Dining Hall, the fitness center, Warner Hall, and Dana Auditorium in Sunderland Hall. Although none of these plants is in need of immediate replacement, they are—with the exception of the plant at the CFA—maxed out and could not accommodate additional new campus buildings. It is further anticipated that the older plants at Johnson Memorial Building and Warner Hall will need replacement in the near future.

The College's current decentralized cooling approach reduces the required pumping energy to circulate chilled water and nearly eliminates the need for site distribution chilled water piping associated with a centralized plant system. However, the Master Plan recommends moving to a hybrid approach of semi-centralized district plants. The size and length of site distribution chilled water piping and the required pumping energy will be minimized as with a decentralized system. Further, this hybrid approach will provide some of the benefits of a more centralized system. For instance, each plant will consist of multiple water chillers; this not only provides equipment redundancy but also allows the plants to operate more efficiently by assuring that the number of chillers running and their respective loading do not exceed the cooling demand at any given time.

The Master Plan recommends creating three district cooling plants which should be expandable to match future additional cooling demands as the campus develops. The Central Cooling Plant (CCP) will be developed with the addition of a second chiller to the existing cooling plant in the Service Building. The CCP will continue to serve the existing buildings currently connected to it, with additional chilled water distribution to serve the proposed buildings on Old Chapel Road and along South Main Street. The West Cooling Plant (WCP) will be a new chiller facility on the west side of campus, either on the site of Proctor Hall

or adjacent to Ross Commons. The WCP will initially provide cooling to Proctor Hall and Mead Chapel, and should take over the cooling of Ross Commons from the current plant at McCardell Bicentennial Hall. Proposed new buildings along Hillcrest Road may also be served by this plant, depending on their function and the decision of the College. Finally, the East Cooling Plant (ECP) will replace the existing chiller in Johnson Memorial Building. This will be sized to accommodate air-conditioned spaces

within Johnson, Sunderland Hall, Munroe Hall, Voter Hall, and Warner Hall, as well as to potentially provide cooling to new buildings in the northeast area of campus.

The existing multiple chiller plants should continue to operate until the end of their equipment's useful life, at which point the buildings served by these plants may be connected to the new district chiller plants.

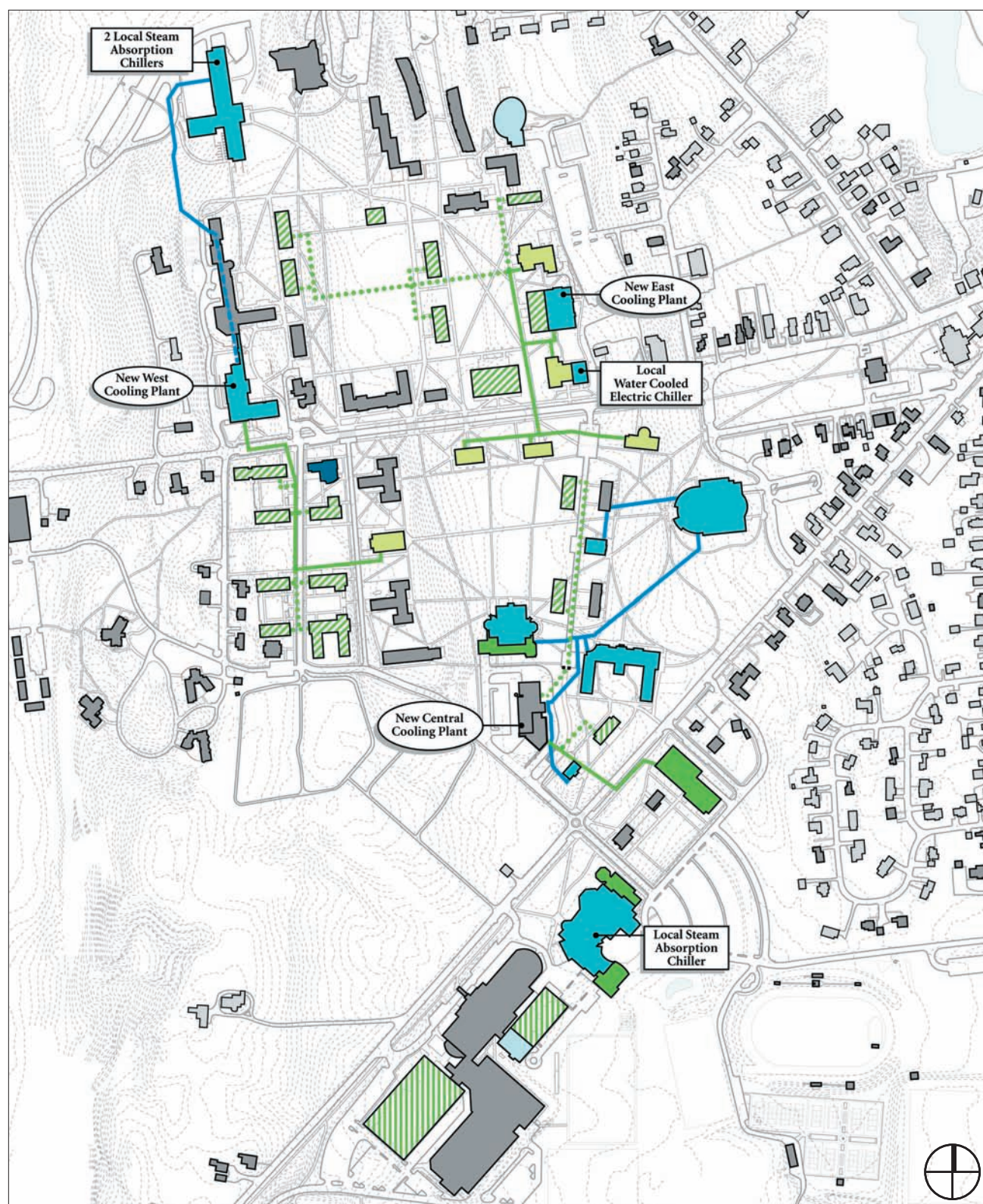


FIGURE 1

Proposed Cooling Strategy

LEGEND

- Existing Chilled Water Line
- Additional Chilled Water Line
- ... Optional Additional Chilled Water Line
- Existing Building without Air-Conditioning
- Existing Building with A.C. —Water Cooled
- Existing Building with A.C. —Air Cooled
- Existing Building with Geothermal Cooling
- Existing Building with Additional A.C.
- Proposed New Building with A.C.
- Proposed New Building with Optional A.C.

Electricity

Electricity at the College is distributed from its “point of sale” at the corner of College Street and Shannon Street through the College’s own network. This distribution network consists of two spines, the North Spine running overhead on poles along College Street, and the South Spine, which runs in an underground duct bank around the Library and continues overhead on poles along South Main Street. In addition, high-pressure steam generated by boilers at the central heating plant is passed through an electric co-generation plant, which is tied into the South Spine of the electric distribution network. This co-generation system produces 15% to 20% of the electricity that the College uses. Individual buildings are supplied by electric power from the campus network through a variety of indoor and outdoor mounted transformers.

The campus electric distribution network appears to be adequate to provide power for the future buildings included in the Master Plan, although the Central Vermont Public Service should be kept informed as to the addition of new buildings or additional power needs associated with air-conditioning.

Energy Source

Because of its existing Central Plant and distribution network, steam is the logical and anticipated primary heating medium

for the College. The Master Plan applauds Middlebury College’s recent move to reduce carbon emissions by replacing one of its #6 oil burners with a biomass wood-chip burner. While biomass steam production also releases carbon into the atmosphere, it is considered theoretically carbon-neutral because the natural regeneration or replanted biomass that replaces what is burned sequesters an equivalent amount of carbon. Provided the first biomass burner is successful, it is recommended that the College expand the biomass portion of the plant and ultimately replace all #6 oil with woodchips or other biofuel as the primary fuel source for campus heating.

In evaluating the most appropriate energy source to generate cooling, the most significant issues for consideration are operating cost and contribution to the campus’s carbon emissions. The College’s existing chillers utilize either electricity or steam from the central plant. The relative carbon emissions associated with either of these energy sources is hard to quantify in the long term. Steam from the central plant is likely to become less carbon intensive when the new biomass burner comes on-line. Meanwhile the College’s current electricity source, Central Vermont Public Service (CVPS), is understood to be relatively low in carbon emissions at this time—significantly lower than for steam generated with #6 oil. Because the Vermont Yankee Nuclear

FIGURE 1

Comparison of Carbon Emissions and Operating Cost for steam absorption and electrical centrifugal water-cooled chillers with various energy sources

“Full Biomass” indicates all Biomass steam production

“Biomass/Traditional” indicates half Biomass steam production—effective when Biomass Phase 1 comes on-line

Electricity associated with Biomass steam absorption is calculated based on current CVPS emissions; this value would increase slightly with the anticipated decommissioning of the Vermont Yankee Nuclear Power Plant in 2012

*Although the burning of Biomass also produces carbon emissions, this carbon is considered to be sequestered by new growth, thus theoretically resulting in zero net carbon emissions

** Costs are given using regular commercial electric rates. The utilization of 15% to 20% co-generated electricity (considered by Middlebury to be free of cost) would correspondingly reduce the electric costs

Cooling Method	Energy Source	Energy consumption per 1,000 SF air-conditioned space per year	CO ₂ Emissions per 1,000 SF air-conditioned space per year	Operating cost in 2006 \$ per 1,000 SF air-conditioned space per year **
Traditional Steam absorption	# 6 oil	590 gallons	7.670 MTCDE	\$ 825
Full Biomass Steam absorption	woodchips electricity	9.8 tons	0.000 MTCDE*	\$ 410
		420 KWH	0.068 MTCDE	\$ 40
			0.068 MTCDE*	\$ 450
Biomass/Traditional Steam absorption	# 6 oil woodchips electricity	295 gallons	3.835 MTCDE	\$ 413
		4.9 tons	0.000 MTCDE*	\$ 205
		210 KWH	0.034 MTCDE	\$ 20
			3.869 MTCDE*	\$ 638
Electric Centrifugal Water-Cooled Chiller	electricity (CVPS ca. 2000)	2730 KWH	0.443 MTCDE	\$ 260
	electricity (CVPS ca. 2012)	2730 KWH	1.502 MTCDE	\$ 260

Power Plant is scheduled to be decommissioned in 2012, however, the College's source of electricity going forward is uncertain and may become more carbon intensive (see *Carbon Neutrality at Middlebury College*, section III.4.2 in the Appendix). Nevertheless, until such time as the College replaces all of its burners with biomass burners, electric water-cooled chillers will produce significantly lower carbon emissions than steam absorption chillers.

The operating cost associated with energy source is another important consideration for the College. The annual energy consumption necessary to air condition a generic 1,000 SF space is 590 gallons of #6 oil for traditional steam absorption, 9.8 tons of woodchips plus 420 KWH of electricity for biomass steam absorption, and 2730 KWH of electricity for electric water-cooled chillers. Using 2006 average energy rates, these quantities carry an annual operating cost of \$825 for traditional (#6 oil) steam absorption, \$450 for biomass steam absorption, and \$260 for electric water-cooled chillers to air condition the same 1,000 SF of space. (See Figure 1 for a comparison of energy sources relative to carbon emissions and operating cost.)

Due to the lower operating cost and carbon emissions associated with electricity, it is the recommendation of the Master Plan to consider the use of electric water-cooled chillers in future chiller plants on campus. Electric chillers provide the further benefit of optional geothermal technology, which can increase the efficiency of water-cooled electric refrigeration by approximately 15%, for an operating cost of \$220/year per 1,000 SF of air-conditioned space.

Energy Efficiency

Regardless of the fuel source used to produce energy, it should be the College's goal to minimize the amount of energy necessary to achieve thermal comfort, whether for heating or cooling. The first step is to identify places where energy is currently lost. Portions of the steam distribution network, such as the Upper Campus Main, should be upgraded to reduce energy loss and thus reduce the amount of steam production. Existing building envelopes are also a significant point of energy loss, as discussed in the Sustainability chapter of this report. Envelope improvements such as window replacement, insulation upgrades, and weatherstripping should be considered an essential part of the College's sustainability efforts.

Additionally, the College should consider alternatives to conventional mechanical systems with each new building project to reduce energy use. These include but are not limited to passive solar heating and cooling, photovoltaics, geothermal technology, natural ventilation, and day-lighting. Properly implemented, these can minimize energy usage over the entire life of a building. However, they must be considered on a case-by-case basis, as some approaches are inappropriate for particular building functions or locations.

Energy Efficient Cooling Strategies

While central air handling and terminal type systems have been successfully used in buildings for decades, they do not necessarily provide the optimal and most energy efficient solutions. In order to reduce energy use and minimize the College's carbon footprint, several different strategies should be considered for use in future campus buildings to reduce or eliminate dependence on conventional mechanical cooling systems. No single strategy can be recommended for all new buildings; the effectiveness and appropriateness of alternative cooling strategies are highly dependent on building location, type, and use.

Passive Cooling and Heat Gain Reduction can be achieved with building envelopes designed to minimize the building's external heat gains—for instance, reducing U-values and increasing shading coefficients of the envelope elements, using external shading devices, using a “double skin,” increasing building thermal mass, and orienting the building so as to minimize solar gain—as well as implementing natural ventilation through operable windows and night ventilation. These techniques are applicable to almost all building types.

For large, tall spaces such as performance halls, classrooms, auditoriums, and dining facilities, consideration should be given to Displacement Ventilation. An alternative to conventional central “all air” mixing ventilation systems, Displacement Ventilation systems introduce supply air close to or at floor level at a relatively low velocity. This air floods the lower occupied zone, where convective air flows generated by heat-rejecting elements—occupants, equipment, and lights—draw used air up toward the ceiling where it is exhausted from the space. Displacement Ventilation provides higher indoor air quality, a quieter environment, and most particularly higher energy efficiency—the air is supplied at

a higher temperature, between 65 and 67 degrees Fahrenheit versus 55 degrees—than conventional mixing systems.

Chilled beams are a lower-maintenance, more energy efficient alternative to fan coil systems and are best suited to residential buildings. Radiant Cooling and Radiant Heating systems also may be used as supplemental systems in conjunction with other type HVAC systems or as primary building HVAC systems.

Finally, it is recommended that the College implement a campus-wide comprehensive Facility and Energy Management System (FEMS) of Direct Digital Control (DDC) type. Although the College has an extensive FEMS system in place, this system is not comprehensive. It should be further upgraded and developed over time, as outlined in the Utilities section of the Appendix. Such a system would allow the College to have continuous central control and monitoring and adjustment of the HVAC operating parameters and would ensure a comfortable environment while maintaining energy efficient operation of all systems.

Water Supply System

Middlebury College obtains its water supply from a Public Community Water System owned and operated by the Town of Middlebury. The sources of water are three drilled wells located east of Route 116. The natural water quality is excellent and the Town only treats the supply by the addition of chlorine and fluoride. The Vermont Water Supply Division permitted capacity of the wells is 2 million gallons per day (gpd); normal daily usage for the entire community—including the College—is slightly more than one million gpd; therefore, the system has ample reserve capacity.

An approximation of the total water supply needs for the main campus can be made by adding the typical student water demand of 70 gpd plus 15 gpd for faculty/staff. This results in a total demand of approximately 180,000 gpd, or about 18% of the community's usage. It is less than 10% of the Town's permitted capacity. The Town could provide another 100,000 gpd to the College in the future if needed, or approximately a 50% increase in current usage.

If the College wanted to drill its own well to serve the campus, it would require a reliable yield of approximately 300 gallons per minute—the likelihood of finding a source of well water nearby to achieve that yield is very small. Other

infrastructure such as a large storage tank, booster pumps, piping, and related items would be needed. Given the investment in the existing water supply infrastructure and the readily available supply of good Town water both today and in the future, a College-owned well that serves the entire campus is not the best use of resources; however, smaller wells to serve irrigation needs for athletics have been, and can be, drilled as needed.

The College owns the water mains within the campus—predominantly 8" diameter mains installed in a series of interconnected loops wherever possible—and has three main points of connection to the Town system. It is possible for water to flow into the campus at one connection then travel back out of campus at another location; therefore water is not metered on a master basis, but at each individual connection.

Approximately half of the system is less than 20 years old and in good condition in terms of both capacity and reliability; the remainder is of varying age and condition, with some up to 100 years old. Age alone should not be the sole criteria for planning replacement—repair incidence and history are better indicators. The College should consider nine projects to improve the system, a combination of replacement and new service (see Appendix), with an estimated total cost of \$500,000 in year 2006 dollars. Of these, a new 8" main from Atwater Dining to Weybridge Street (\$75,000 estimated cost) is the most important, as it would provide for better supply capacity and redundancy in the event the 10" water main near South Main Street is closed for any reason.

Wastewater System

As with the water supply, the Town of Middlebury Department of Public Works provides the conveyance and treatment of wastewater generated on the main campus. Ultimately, all wastewater discharged to the Town system on the west side of Otter Creek runs via a "sag pipe" under Otter Creek into the site of the former wastewater treatment plant; it is then pumped to the current treatment facility located in the Industrial Park in Town.

Most of the College wastewater system provides for gravity flow and connects to the Town system at several points. The components of the infrastructure owned and operated by the College include building service connections, sewer mains, pumping stations, pressure force mains, manholes,

and related items. The facilities are of varying materials, age, and condition. Some of the older sewers were constructed of clay tile. Those installed in the 1960s or 1970s were asbestos cement, and more recent sewer pipes are PVC. Many of the older sewers should be methodically inspected and tested, primarily using television equipment, to determine the structural integrity, segments of likely leakage, root penetrations, etc. See the Appendix for a list of sewer infrastructure to be tested and for those components already identified as needing improvement. Without this testing, it is difficult to accurately define the complete scope of needed improvements.

Future expansion of the system is most affected by the existing capacity of the sag pipe across Otter Creek. In recent years, the Town and the College have worked together to manage flows directed to the crossing, including the elimination of leaky sewer pipes and the phasing of pump stations. However, any significant additional flows proposed by the College or any other user to the west of Otter Creek would likely require the sag pipe to be replaced or upgraded. An increase of 10,000 gallons per day into the system (equivalent to an increase of 150 students on campus) will cause the sag pipe to approach its capacity unless other remedial actions to lessen the overall peak capacity throughout the system are taken. In the future, if the College were to reach the capacity of the water supply, the resultant wastewater flows would be approximately 200,000 gpd. The Town's capacity to pump and treat this additional volume is in place; again it is the sag pipe that is the limiting factor.

Storm Drainage System

The network of inlets, basins, and pipes collects a combination of surface runoff, roof drainage, and underground water so that these various forms of stormwater will not be a nuisance. Ultimately, all outlets drain to various tributaries of Otter Creek, and so into Lake Champlain, which is high in phosphorus pollution and siltation. (See the Natural Systems chapter of this report for recommendations to reduce the surface runoff on campus.) This network has developed and grown, mainly to allow specific projects to be suitably constructed and drained. While there are likely some old and/or undersized storm drains, the need for major improvements is not well known or documented at this time. A testing program similar to the one for the sewer system is recommended before any reasonable estimate of the capacity of the system can be made.

Exterior Lighting

Exterior lighting on the campus is generally discrete and appropriately unobtrusive. Lighting is provided on streets and paths, and on the football practice field. Building entrances are lit, but otherwise there is little illumination of building facades. A 2004 lighting study by Clanton & Associates, Inc. is included in the Appendix. It recommends that the College continue to minimize light pollution, and to utilize energy efficient systems. It further recommends that light levels be carefully controlled to reinforce the hierarchy of pedestrian paths, to provide even illumination, and to avoid glare and excessively bright spots. These recommendations will benefit public safety, help preserve dark night sky, and avoid unnecessary intrusion of light into surrounding residential neighborhoods.

Recommendations

1. *Upgrade steam distribution network to reduce energy loss and provide adequate heating capacity for new buildings*
2. *Create three decentralized cooling plants to serve existing and new buildings*
3. *Expand development of Biomass Gasification Plant by replacing old oil burners with Biomass burners to further reduce carbon emissions*
4. *Consider electric centrifugal water-cooled chillers for future cooling plants*
5. *Upgrade building envelopes to reduce energy loss*
6. *Implement alternative strategies to minimize the energy consumption of new buildings. These strategies will address building design and siting, landscape design, and building systems*
7. *Minimize the time and places where air-conditioning is used*
8. *Provide new 8" water main from Atwater Dining to Weybridge Street*
9. *Replace or upgrade several minor water main segments within campus limits*
10. *Initiate further study and testing of sewer lines with television equipment*
11. *Study the alternatives to improve flow capacity in the Town wastewater system at the Otter Creek crossing*
12. *Upgrade the sewer and grease trap for Proctor Hall*
13. *Establish a committee and a process to review issues pertaining to energy use and sustainability, and to make recommendations*