TOWARDS SUSTAINABLE CAMPUS PLANNING

Measuring Campus Development Scenarios

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TOWARDS SUSTAINABLE CAMPUS PLANNING: MEASURING CAMPUS DEVELOPMENT SCENARIOS

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A project submitted in partial fulfillment
of the requirements for the degrees of:

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Prepared for the
Society for College and
University Planning

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April 13, 2006

Dear Dr. Grummon:

We are pleased to present our model for assessing the sustainability of campus land use in the hope that it will be of value to members of the Society for College and University Planning. We believe that the model we developed fills an important gap in campus sustainability initiatives and will fit with SCUP's existing work, such as the Planning Institute.

Our model was developed through a literature review on sustainable development and higher education and an analysis of campus sustainability initiatives. To assess the strengths and weaknesses of the model we tested it on the University of Michigan's North Campus. In doing so, we also provided a methodology for other institutions wishing to apply our model to their campuses. Ultimately, it is our hope that, through SCUP, this model will help lead institutes of higher learning to a more comprehensive vision of campus sustainability—and also provide them with the tools to implement that vision.

Sincerely,

Andrew Brix
Trevor Brydon
Elijah Davidian
Keely Dinse
Sanjeev Vidyarthi

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EXECUTIVE SUMMARY

This study identifies and attempts to address three common shortcomings of today's campus sustainability initiatives: difficulties in measuring social and economic factors; a lack of consideration for integrative issues such as land use; and a generally reactive approach to proposed development. To engage these concerns, we develop a model for predicting the relative sustainability of different campus land use configurations. The model uses computer-based mapping software (a geographic information system or GIS) to measure a set of six sustainability indicators for each land use scenario. The indicators chosen represent all three competing interests of sustainable development: economic prosperity (one indicator), social equity (two indicators), and environmental integrity (four indicators).

We applied the model to the University of Michigan's North Campus as a case study to test its effectiveness—and also to test the claims of sustainability made by smart growth advocates. The North Campus land was purchased in the early 1950s and has yet to reach build-out. We designed three scenarios for how the North Campus might be built out. The first scenario is based on existing campus development practice at the University of Michigan, under which the University develops housing and commercial facilities only when such facilities are not adequately supplied by market forces in the surrounding Ann Arbor area.. This scenario maximizes the space on North Campus for the development of academic and research facilities while preserving the woodland belt that surrounds the present academic core. We derived the second scenario from principles of smart growth, creating an outcome that was more complex and urban in character, mixing in housing and commercial facilities with expanded academic and research facilities. For the third scenario, we employed surveys to characterize the preferences of current North Campus students and employees and then used the results to revise the smart growth scenario to include those preferences.

The results from the case study show that the two smart growth scenarios are more sustainable than the existing trends scenario. Between the two smart growth scenarios, the scenario that included public preferences produced slightly more sustainable results than the original smart growth scenario.

Looking more closely at the individual indicators, all three scenarios score similarly on the environmental indicators in absolute terms (e.g. area of impervious surface), but when measured in per capita terms (e.g. area of impervious surface/population) the two smart growth scenarios have significant advantages over the existing trends scenario. For the economic indicator, all three scenarios resulted in a similar amount of expanded academic research space on North Campus, suggesting that the ability for the university to attract research dollars from North Campus programs is roughly equivalent. The equity indicator results show that the development of affordable employee housing on North Campus (in the smart growth scenarios) can dramatically reduce the disproportionate commuting burden placed on lower-wage employees.

We believe our model can be very useful as a framework for assessing the sustainability of future development options at other colleges and universities, as well as at different scales of development. While our specific indicator package will not be appropriate for every situation, we hope that it gives potential users a base from which to adapt indicators for their particular situation. We also hope that our results lead to more consideration of both absolute and relative (per capita) measures in sustainability analyses. Most of all, we hope that we have made it easier for colleges and universities to move ahead with new and innovative approaches to achieving sustainable development on their own campuses and beyond.

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ORGANIZATION OF THE REPORT

The report is organized into three principal sections. The first section consists of three components: an introduction to sustainable development and higher education, discussion and development of sustainability indicators, and an introduction to scenarios as a decision support tool. To begin with, college and university sustainability initiatives are critiqued in light of their common theme of sustainability. Shortcomings in the way these institutions approach sustainability are identified, forming the basis for this project.

The section continues by identifying the role of indicators in college and university sustainability initiatives. Here, we look at gaps in current application and suggest an alternative approach. In doing so, we identify six sustainability indicators for expanding sustainable land use considerations. Each indicator is discussed at length, including detailed instructions for indicator application.

The first section concludes with a discussion of the use of scenarios as a decision support tool. In this section we highlight the potential for future build-out scenarios to inform campus land use decisions. Here, we also address the benefits and challenges of the scenario-based model, with emphasis on indicator-scenario compatibility.

To test the functionality of the tools described above, the second section constitutes a pilot study in which these tools are deployed. Focusing on the University of Michigan's North Campus, we identify two potential future build-out scenarios. To demonstrate the relative magnitude of change, baseline conditions are documented, followed by images and characteristics of either scenario. The results of campus community surveys are also unveiled in this section. These surveys speak directly to the potential build-out scenarios, as well as the existing campus character. A third scenario is presented, reflecting the campus community's preference among the original two, modified to incorporate public comments.

The final section concerns the relative sustainability of these scenarios. Here, we discuss how each scenario faired when measured by the sustainability indicators. Challenges encountered during indicator application are briefly discussed. The section concludes with recommendations for how the University might proceed with development of the North Campus given the outcome of the sustainability measurement, and recommendations for future directions our model might take.

In an effort to broaden consideration for sustainable land use practices in and around college and university campuses, we designed this project for academics, campus planning practitioners, as well as members of the broader campus community. As such, we attempt to provide a document that is innovative, operational, and transferable.

1. CAMPUS LAND USE SUSTAINABILITY: INDICATORS AND SCENARIOS

SUSTAINABLE DEVELOPMENT

Contemporary scholarship's comprehension of the term *sustainability* is shaped by a series of international meetings and their consequent reports that appeared during the 1970s and 1980s. These meetings were triggered by the recognition of human-imposed environmental degradation on quality of life and the long-term goal of maintaining economic prosperity in developed nations. *Our Common Future*, released in 1987 by the UN World Commission on Environment and Development, coined the term "sustainable development," capturing the increasing recognition of the cause/effect relationship between economic development and environmental degradation. The report argued that development decisions fail to consider social implications and ecological limits, and in doing so threaten the ability to sustain the present rates of human progress into the future. *Our Common Future* called for "a new era of economic growth – growth that is forceful and at the same time socially and environmentally responsible."[1] At the heart of this report was an effort to resolve the paradox between the desire for development and the need to make it sustainable over time.

The report also posited that future development should not be business as usual, as practiced since the eighteenth century, but should now began to evolve into a new paradigm called sustainable development, which it defined as "development that meets present needs without compromising the ability of future generations to meet their own needs."[2] Although varied definitions of sustainability have emerged since 1987, there is an increasing consensus that sustainable development seeks to balance three competing interests: economic prosperity, environmental quality and social equity.[3]

SUSTAINABILITY AND INSTITUTIONS OF HIGHER EDUCATION

We believe universities, like the societies in which they exist, have now begun to struggle in earnest to resolve the paradox between their desire for development, especially for higher-end research and student enrollment, and the need to become more sustainable. As early as 1990, the president of Tufts University convened the Talloires Conference, at which 22 international university leaders met to discuss sustainability. From this conference emerged the Talloires Declaration, in which university administrators officially acknowledged the importance of higher education in achieving sustainability goals through education, research, policy formation, and information exchange.[4] Two years later, the United Nations convened the Rio Earth Summit, a Conference on Environment and Development. The outcome of this conference was Agenda 21, an international agreement that further emphasized and clarified the vital role of both formal and non-formal education in promoting sustainable development and increasing knowledge of environment and development issues.[5]

The Talloires Declaration and Agenda 21 served as a call to action for higher education institutions. Since 1990, nearly 300 institutions worldwide have signed the Talloires Declaration. Many institutions have furthered this symbolic commitment by launching sustainability initiatives. According to University Leaders for a Sustainable Future, 83 colleges and universities in the United States have initiatives to improve campus sustainability.[6] Most of these initiatives began in the 1990s and took the form of task forces, projects or committees aimed at reforming university practices and policies.

CRITIQUE OF CURRENT SUSTAINABILITY INITIATIVES

A review of these initiatives reveals two problematic findings. The first is that although the term "sustainability" is used in the rhetoric of these programs, they tend to emphasize environmental aspects of sustainability, often to the exclusion of equity and economic concerns. The use of indicators to measure progress towards a desired end is common throughout these programs. While indicators are useful tools for understanding progress towards sustainability, their analytical power can vary in breadth and intensity. For example, many sustainability initiatives employ indicators that focus narrowly on environmental streams – e.g. waste production or water consumption. Such an approach is problematic because it fails to consider broader environmental considerations (i.e. transportation and land use). In essence, these initiatives implicitly equate sustainability with environmental performance. Ideally, policies and procedures meant to facilitate a movement towards a more sustainable state should integrate economic, environmental and social well-being, not just one or two of these three components.

A second critique of current sustainability initiatives in higher education is that they seem to overlook the larger framework in which campus development decisions are made. For larger institutions, this is the realm of campus land-use planning. Campus planning affects the entire campus in terms of environment, social equity and economy. For example the height and location of buildings, availability and affordability of housing, and integrity of a campus' natural features, are each affected by planning decisions. However, of the 36 public university and college sustainability websites identified by ULSF, 22 make no mention of land use-planning. Among these are some of the Nation's largest in terms of enrollment, such as the University of Texas at Austin, University of Minnesota-Twin Cities, University of Wisconsin-Madison, Indiana University-Bloomington and the University of Michigan-Ann Arbor. All of these universities have the infrastructure and the intellect to foster sustainable land use initiatives, yet land use planning remains largely absent from their campus sustainability initiatives.

While some of these institutions focus on making buildings more sustainable from an environmental perspective, few appear to consider how the connectedness and orientation of such buildings affect the communities in which they stand. By overlooking land use planning, these initiatives miss an opportunity to address broader questions of how land use and transportation patterns affect campus sustainability. In addition, very few of these initiatives include any assessment of the process by which decisions are made, thus limiting the usefulness of the sustainability data they compile. For those universities that do address land use, it is most frequently from an environmental perspective, with consideration of impervious surface area as the sole indicator of campus land use sustainability. Measuring total imperviousness sheds light on the localized impacts of development, while per-capita imperviousness is an indicator of land use efficiency. As discussed later, a strict focus on total imperviousness may contribute to overly consumptive land use patterns known as "sprawl." It is worth noting that a few universities consider additional land-use indicators, as evidenced below, but these are in the minority.

The relatively limited consideration for social equity, economic prosperity, and land-use in campus sustainability initiatives might be due to the fact that indicator projects are generally designed to be easy to conceptualize, easy to measure, and easy to repeat. Measuring environmental streams is easier and less contentious than measuring social equity and economic prosperity. This is because data on some environmental characteristics are more readily available than for others, and because social and economic issues are more politically contentious. Moreover, the relationship between land use and environmental phenomena is more distinct and easier to measure than the relationship between land use and equity or economic prosperity. For example, one can quickly calculate the increase in stormwater runoff resulting from greater building density on a campus, but deciphering the equity implications of such an increase requires a more time- and energy-intensive inquiry.

PROJECT OVERVIEW

This project responds to the challenges highlighted above by asking the following research question: How can college and university sustainability initiatives be broadened to include more consideration for sustainable land use practices? This project aims to complete the sustainability triangle, and increase the usefulness of indicators for measuring progress towards sustainable land-use. To accomplish this goal we craft a package of indicators for assessing the sustainability of campus land use. Using the University of Michigan - Ann Arbor as a case study, we create three build-out scenarios for the University's North Campus—one based on the current planning paradigm, one based on principles of the Smart Growth movement, and a third informed by Smart Growth and public input—and apply the land-use sustainability indicators to each one to determine which development scenario is more sustainable. In contemplating the outcome, we hypothesize that a campus developed according to smart growth principles is more sustainable than one reflecting current practice, and that a third scenario reflecting public comment can be rendered at least as sustainable as the preceding two.

INDICATOR DEVELOPMENT AND SELECTION

Indicators are measurement tools that convey information about the general functioning of a system. They also provide insight into how a system is changing, and can inform discussions regarding whether that change is toward a desired direction. Taken together, the right set of indicators can assist decision-makers in their attempts to accommodate competing interests through sustainable land use policies.

Indicators can serve as representatives or proxies of integrated system components. A classic example in economic analysis is gross domestic product (GDP). GDP represents the total dollar value of all goods and services produced in a country over a given period – typically one year. The individual components of the economy that influence GDP, such as the types, rates, and locations of individual transactions, are considered indicator linkages. That is, GDP serves as an umbrella metric for several, more detailed, processes. Understood this way, the indicator provides insight into the health of a system, without requiring an overwhelming number of measurements.

In isolation, however, the power of a single indicator is limited. No economist would base her analysis of a national economy solely on GDP. But when coupled with other indicators, the picture sharpens and more aspects of the economy become clear (i.e. resource depletion, employment, homelessness, trade deficit, etc.). As more indicators are added, the analysis' explanatory power increases, and observations about the health and trajectory of the economy can be made with more confidence. At the same time, too many indicators can overwhelm the user, potentially undermining the usefulness of the tool. The task then becomes selecting a manageable number of indicators that provide the greatest amount of information.

INDICATORS CURRENTLY IN USE

As noted earlier, several universities already use indicators to measure progress. While land-use is represented throughout some of these initiatives, few attempt to measure social or economic aspects, and none attempt to assess land use sustainability. Furthermore, all initiatives focus on a temporal method of measurement. That is, indicators are applied to existing practice over fixed time increments.

To contextualize this project, it is helpful to examine a few of the sustainability indicators currently used by some of the nation's larger universities. Table 1 lists indicators from four fairly comprehensive campus environmental initiatives, including programs at the University of California—Berkeley,[7] Penn State University,[8] the University of Florida,[9] and University of Michigan—Ann Arbor.[10] While multiple universities use some of the indicators, no single university uses all of them.

TABLE 1. INDICATORS BEING USED BY UNIVERSITY SUSTAINABILITY INITIATIVES

CATEGORY	INDICATOR	CATEGORY	INDICATOR
Land	➢ Land accumulation and policies ➢ Impervious surfaces ➢ Native vs. exotic plants on campus ➢ Pesticide use in land care ➢ Landscape & habitat	**Energy**	➢ Energy Sources ➢ Energy Consumption ➢ Greenhouse gas emissions ➢ Renewable Energy Contribution
Built Environment	➢ Building decision process ➢ Building priorities ➢ Ecological design in buildings ➢ Building Utilization ➢ Long range planning	**Water**	➢ Total and per capita water consumption ➢ Ground water quality ➢ Waste water disposal ➢ Water Tracking, Feedback, and Education
Material Resources and Waste Disposal	➢ Total waste production ➢ Recycled solid waste ➢ Paper purchasing, use, and disposal ➢ Hazardous chemical waste	**Research**	➢ Ethical treatment of research subjects ➢ Disposal of laboratory wastes ➢ Research on sustainability ➢ Research priorities
Food	➢ Dining hall diet ➢ Dining hall waste ➢ Food purchasing policies ➢ Food tracking and education	**Decision Making**	➢ Core values guiding decisions ➢ Openness
Transportation	➢ Car dependence ➢ Green space converted to parking space ➢ Transport-related safety ➢ Modal split ➢ Fuel Consumption ➢ Presence of transportation demand management programs (TDM) ➢ Housing availability and affordability near campus	**Community**	➢ Sustainability-related courses ➢ Sustainability-related organizations ➢ Town and gown relations ➢ Ecological literacy of graduating seniors ➢ Student crime ➢ Student alcohol consumption ➢ Student depression ➢ Green custodial chemical use ➢ Indoor air quality ➢ Workplace injuries

It is important to consider these indicators for three reasons. First, the indicators listed in Table 1 provide a good starting point for thinking about the diversity of indicators currently in use. While not representative of all sustainability initiatives, Table 1 provides insight into the types of factors that indicators can measure. This is a good starting point, but there remains much room for improvement, especially where equity and economy are concerned. Second, the table provides examples of measures that might be used to complement our model. As noted earlier, this effort is not intended to serve as a stand-alone model for measuring sustainable development. Rather, it is intended to complement existing college and university efforts to track progress towards more sustainable land use practice. Finally, a number of the indicators listed in Table 1 could not be used in this model because of spatial and temporal limitations, which are discussed below.

PRINCIPLES OF INDICATOR SELECTION

The choice of indicators is inherently subjective. Inclusion or omission of an indicator largely depends upon the value one places on the piece of the system that is represented by that indicator. Therefore, the challenge is to minimize subjectivity by identifying key system components, such that when the indicators are taken together they represent the complete system. For instance, we rely on the Three E's model of economy, environment, and equity as a general framework for indicator selection. Nonetheless, the reasoning behind selecting each indicator should be outlined. Such a discussion might include the indicator's relationship to sustainability, identification of phenomena for which the indicator serves as proxy, whether the indicator has previously been applied, and how it is to be measured. At the same time, the collection of indicators must not be so numerous as to overwhelm the user. Equally important, the indicators must be sufficiently general, so as to appeal to the understanding of decision-makers and the general campus community.

In selecting indicators for this project, we first looked for indicators that were currently in use. In doing so, we reviewed the sustainability literature, examining dozens of sustainability indicators. The vast constellation of existing indicators[11] and the multitude of considerations that emerge can make indicator selection a daunting endeavor. To assist in this process, Economist Victor Anderson developed general criteria for evaluating the usefulness of an indicator (See Table 2).[12]

TABLE 2. INDICATOR SELECTION CRITERIA

1.	The indicator, or the information from which it is calculated, should be readily available.
2.	The indicator should be relatively easy to understand.
3.	The indicator must be about something which can be measured.
4.	An indicator should measure something believed to be important or significant.
5.	There should only be a short time lag between the state of affairs referred to and the indicator becoming available.
6.	The indicator should be based on information which can be used to compare different geographical regions.
7.	International Comparability is desirable.

Anderson's framework attempts to balance the breadth, depth, and timeliness of assessment while maximizing its realm of application. Of course, a number of other considerations will influence indicator choice, but several components are essential. For example, if applying the indicator is extremely labor-intensive or the data are largely unavailable, its usefulness as an informational tool will be limited. Similarly, if the concept being measured is incomprehensible to decision-makers or the campus community, the power of the indicator to inform may also be limited.

Anderson's framework also suggests that indicators should be transferable and comparable across regions and nations. Indeed this is possible with many indicators, such as those for income and energy consumption. However, the nature of land use is such that indicator selection is often context-dependent. For example, a forested riparian buffer indicator would not be an optimal indicator for ecological health in a desert campus setting or one through which no streams pass. Similarly, location, size, and layout of colleges and universities might also complicate transferability. For instance, commute time may carry a different meaning for suburban and urban regions. In a suburban region, where more people drive, commute time may correlate strongly with distance, therefore shedding light on housing equity and air pollution. In a more densely developed urban area, where several transportation modes exist, the distance-time correlation could be skewed by traffic congestion or mode of transportation.

While useful for thinking about indicator selection more generally, not all of Anderson's criteria apply neatly to this project. Nonetheless, we attempted to follow Anderson's guidelines in developing indicators for this study. The indicators selected are outlined in Table 3, which lists the primary features that each indicator measures. Each indicator is also accompanied by linkages, or connections to various other environmental, social, or economic factors that the indicator addresses.

Table 3 lists four environment indicators, one indicator for economic prosperity and two for social equity. This is due in part to the spatial nature of environmental features. At the same time, social and economic forces lend themselves less to spatial analysis than to other methods of inquiry, such as surveys. This is an area in need of further study, as it constitutes a gap in existing sustainability literature. Were more social and economic indicators spatially oriented and amenable to application to hypothetical scenarios, they would enjoy greater representation in this study.

With that said, it is important to note that the disproportionate number of environmental indicators does not suggest that environmental indicators deserve greater consideration. Nor does this suggest that social and economic systems are less complex than those of the environment. Movement towards sustainability does not necessitate a perfect balance of the three Es. It becomes clearer in later sections that there will be tradeoffs between the three; for this reason, sustainable land-use is inherently political.

TABLE 3. SUSTAINABILITY INDICATORS AND LINKAGES

CATEGORY	INDICATOR	PRIMARY MEASURE	OTHER LINKAGES
Economy	**Ratio of Academic Building Gross Floor Area (GFA) to Total Building GFA**	➢ Institutional recognition ➢ Knowledge advancement ➢ Public investment	➢ Job creation ➢ Innovation ➢ Philanthropy
Equity	**Commute Time**	➢ Transportation equity	➢ Air quality ➢ Energy consumption ➢ Terrestrial ecosystem health
	Affordable Housing	➢ Housing Equity	
Environment	**Percent Forested Riparian Buffer**	➢ Bank stabilization ➢ Water quality ➢ Stormwater filtration ➢ Food and habitat for wildlife	➢ Aesthetic and recreational quality of waterways ➢ Community health and well being
	Total Area, Per-capita, and Ratio of Artificial Green to Total Green Space	➢ Surface water runoff ➢ Water quality ➢ Biodiversity	➢ Economic costs of landscape maintenance
	Total Area and Percent of Forest that is Interior	➢ Invasive species ➢ Wildlife habitat ➢ Forest fragmentation ➢ Ecosystem integrity	➢ Air quality ➢ Water quality
	Total Area and Per-Capita Area of Imperviousness	➢ Water quality ➢ Aquatic habitat ➢ Altered drainage patterns ➢ Erosion ➢ Air quality	➢ Aesthetic quality and recreational capacity of waterways ➢ Economic loss due to flooding ➢ Vehicle miles traveled

SUSTAINABLE LAND-USE INDICATORS

Specific indicators are presented in the following sections. Each indicator includes a brief definition, discussion of significance, implications for other system components (linkages), whether and where it is currently in use, and how the measurement was derived. Each section concludes with a step-by-step guide to indicator application. The indicators selected for use in this model are intended to serve as representations of broader processes. Some of the indicators that were not directly applicable to this project, for reasons discussed above, are represented through linkages to those that are included.

Indicator selection was both model- and context-specific; the development of hypothetical scenarios and the use of a GIS platform necessitated indicators that are time independent and spatial in nature. As a result, despite the number of indicators listed in Table 1, most are not compatible with this alternative scenarios approach to measuring land-use sustainability. Indicator selection was further influenced by the character of the University of Michigan's Ann Arbor Campus and surrounding development patterns. As noted earlier, the North Campus is a suburban-style campus, with large tracts of open space, surrounded by urban development. Such a setting raises questions about the appropriate development density of the North Campus and the ecological value of its open spaces and woodlots. More specifically, as development pressures continue, campus planners are faced with decisions about where to direct that development. A critical factor in any such decision is the extent to which developing urban spaces relieves development pressures on more sensitive rural places.

Despite the limitations on indicator selection, the model remains a potentially powerful tool. When combined with ongoing initiatives this exercise can help broaden efforts to operationalize sustainable development. The indicators broaden the range of land-use variables ripe for consideration by decision makers. And, as it is intended to complement existing indicator-based sustainability initiatives, shortcomings in the model may be compensated for by the host of indicators to which it will become party (i.e. those included in Table 1).

ENVIRONMENT INDICATOR: RIPARIAN BUFFER

Definition

Riparian buffers are forested zones along rivers and streams.

Significance

Riparian buffers help maintain the physical, biological, and chemical integrity of adjacent waterways.[13] They do so by providing a buffer between the aquatic ecosystem and terrestrial development pressures. Vegetated buffers protect the physical integrity of the system through bank stabilization and the prevention of erosion and siltation. These zones also provide food and habitat for aquatic and terrestrial organisms.

People also benefit from nature trails, or greenways, through these vegetated zones. As recreational amenities, greenways can improve community health by providing a place for walking, running, skating, and biking.[14] Because of their natural character and proximity to the water, greenways also provide for a number of passive recreational opportunities such as bird watching, fishing, and serendipitous encounters with friends or wildlife. In academic settings, these can be places to study, relax, reflect, and research.

Linkages

Riparian buffers are a robust indicator because of their significance for both natural and social systems. As such, buffer integrity serves as a proxy for a multitude of system components to which buffers are directly connected. A few such linkages are outlined below.

- Bank stabilization
- Water quality
- Stormwater filtration
- Food and habitat for wildlife
- Aesthetic and recreational quality of waterways
- Community health and well being

Application

The riparian buffer indicator is currently used by the Maryland Department of Natural Resources as part of their Surf Your Watershed Project. The Project is part of a cooperative statewide effort to catalog environmental, socioeconomic, and programmatic information on a watershed basis.[15]

Measurement

While there is no generally agreed upon minimum buffer width for maximum effectiveness, the literature points to buffers of 100 feet wide as sufficient for providing a host of services.[16] Mature forest stands are considered optimal, but transition forests and grasses greater than six inches in height also provide beneficial services.

Technique

1) The indicator is calculated by first creating a 100-foot buffer on either side of all free-flowing water bodies on-site. This is the *ideal* buffer.

2) Bring forest inventory and land use data into the GIS.

3) Calculate the total area for the ideal buffer.

4) Next, calculate the total area of unforested buffer for the entire site.

5) Subtract the area of unforested buffer from the area of forested buffer. This is the *actual* buffer area.

6) Finally, to determine what proportion of the ideal buffer remains intact, divide the actual buffer area by the ideal buffer area.

Sites with a ratio of actual to ideal forested buffer area closer to 1.00 are considered more sustainable. Multiplying by 100 will provide the percentage of riparian buffer that is forested.

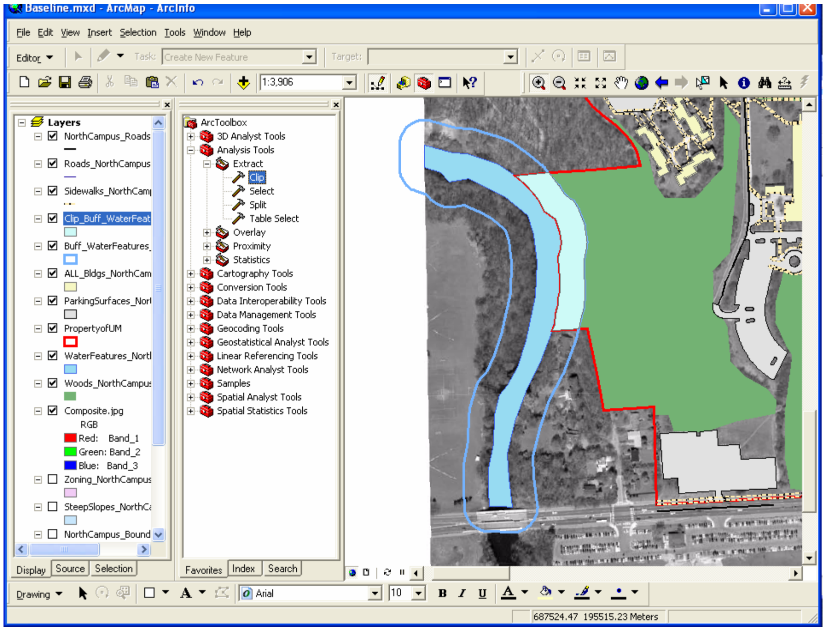

Figure 1. Delineating a Riparian Buffer area (light blue) in the GIS.

ENVIRONMENT INDICATORS: MANAGED GREEENSPACE

Definition

"Artificial Green" describes a greenspace that requires significant amounts of resource-intensive maintenance to remain healthy and aesthetically pleasing, while "Natural Green" refers to a greenspace that requires minimal human intervention. Combined, they constitute the total vegetated area of a site, or "Total Green." The Artificial Green : Total Green indicator defines artificial green as acres of intensively managed greenspace (e.g.turfgrass) and all other greenspaces as natural green.

Significance

The environmental and economic implications of maintaining artificial green landscapes, instead of natural greenspaces such as woodlands or prairie, are numerous and predictable. Therefore, artificial green serves as a robust indicator for sustainability of the campus landscape. Although manicured lawns are more permeable than a paved surface, they have limited ability to absorb water compared to other naturally green landscapes due to shallow root systems and the compacted soils on which turf grasses are usually planted.[17]

In addition to increasing the quantity of surface water runoff, lawns degrade water quality because the chemicals used for lawn maintenance can contaminate surface and groundwater supplies when they leach into the ground or are carried away by runoff.[18] Turfgrass lawns are generally composed of non-native grass species that require continued human intervention if they are to thrive.[19] Landscaping departments use pesticides and fertilizers to keep lawns lush and aesthetically pleasing. Pesticides are known to produce cancers, reproductive effects and neurological effects in humans.[20] Fertilizers are often over-applied and the unused compounds are transported by surface runoff to waterways where they create an overabundance of nutrients that can lead to algal blooms, which smother desirable aquatic life by depleting the water's oxygen content.[21]

Due to their monocultural nature and the habitat fragmentation they create, turfgrass lawns also lead to decreased biodiversity.[i][22] The lack of plant diversity constrains wildlife diversity because few animal species thrive in turfgrass habitat. In addition, a lawn may decrease the biodiversity in adjacent naturally green landscapes. This is because the transition from natural green to artificial green is often a distinct edge and because the lawn often fragments a larger, more naturally green parcel. Edges and fragmentation reduce biodiversity.[23]

Finally, lawns require frequent cutting using mowers and other machines that require fossil fuels. This practice costs money and creates more air pollution than would be emitted in maintaining woodlands or prairie.

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[i] Marzluff and Ewing (2001) highlight three characteristics of lawns that are particularly problematic for biodiversity: lack of foliage height diversity, lack of native vegetation and deadwood, and lack of water sources and nesting sites.

Linkages

The amount of artificial green on a college campus serves as a proxy for:

- Surface water runoff
- Water quality
- Biodiversity
- Economic costs of landscape maintenance

Application

To our knowledge, neither the Artificial Green: Total Green, nor total area of artificial green indicator has been used as a sustainability indicator. The concept of artificial green was drawn from Robbins and Birkenholtz, who studied the expansion of lawn monocultures and their chemical management regimes in America.[24] Their study highlights the connections between green lawns and high-input chemical use and their effects on ecosystem dynamics. The study also provides evidence that the presence of lawns indicates lower environmental quality. Thus, we also measure total area of artificial green.

Measurement

Measuring the ratio of artificial green to total green, as opposed to total land area, allows for consideration of managed and natural green spaces. This approach sheds light on the tradeoffs between artificial green and natural green within a campus, while clearly demonstrating the potential for improving the score by allowing managed areas to revert back to more natural conditions. In contrast, a ratio of artificial green to total land area may produce misleading results if, for example, a campus with a very low ratio of artificial green to total land area (ideal) consists of all pavement and buildings, with only a small patch of lawn and no natural areas. As the imperviousness indicator demonstrates below, lawn is preferred to pavement. To avoid misleading results in either case, it is also useful to couple the first approach with a measurement of total area of artificial green space. A ratio measurement reveals nothing about total acreage. When evaluating alternative futures, total acreage of artificial green is a simple and useful comparative measure.

Despite the environmental implications of managed greenspace, it is worth noting that such spaces are an important part of human environments; people like their lawns. Recognizing that turf grass is unlikely to be phased out in the near future we can at least begin to think about how to utilize managed green spaces more efficiently. That is, if artificial green space is managed primarily for humans, then how many people have the opportunity to use these spaces? A per-capita measure of artificial green space will reveal how efficiently that space is being used.

Technique

1) In the GIS, calculate total vegetated land area requiring intensive management, including turf grass. This will be the total area of artificial green. If detailed land use data are not available, artificial green can be calculated by subtracting the

areas of all features that are not artificial green from the total site area. For example, by subtracting the acres of roads, sidewalks, woodlands, prairies, wetlands, parking lots, and buildings from the total site area, what area remains may be considered artificial green.

2) For a per-capita measure of artificial green, divide the total area of artificial green by the total number of site users. The number of users will likely vary based on time of year. Thus, a weighted average may be appropriate.

3) Next, calculate total land area covered by vegetation that does not require intensive management (i.e. pesticides, fertilizers, soil amendments, etc.). This may include woodlots, unmanaged prairie, vegetated wetlands, etc. This will be the area of natural green.

4) Sum the areas of artificial green and natural green to yield the total vegetated land area, or total green.

5) Finally, calculate the ratio of artificial green to total green by dividing the area of artificial green by the area of total greenspace.

Scenarios are considered less sustainable as the total area of artificial greenspace increases. However, as per-capita use increases, so does the site's sustainability. Finally, campuses are considered less sustainable as the ratio of artificial green : total green increases (moves closer to 1.00). Multiplying by 100 will provide the percentage of all vegetated areas comprised of artificial green.

ENVIRONMENT INDICATOR: INTERIOR FOREST

Definition

Interior forest is forest that lies at least 330 feet (100 meters) from adjacent non-forested areas, e.g. agricultural fields or urban development.

Significance

Forest fragmentation occurs when contiguous forests are divided into smaller patches by residential and commercial development, roads, agriculture and other disturbances. The habitat provided by the new fragments will differ, often dramatically, from that of the original forested area. The change is largely due to the increase in the amount of the forest edge relative to forest interior that results from forest fragmentation. Forest edge is a term used by landscape ecologists to describe the area where the forest ends and an adjacent landscape begins. Numerous species benefit from the addition of edge habitat, such as rabbits, deer, crows, and jays. Other species, however, are forest-interior specialists whose occurrence and reproductive success requires large forest patches. For these area-sensitive species, fragmentation is detrimental because it subjects more of the forest to the stressors associated with forest edge. The types of stressors will vary depending on the adjacent land use, but often include noise, pollution, disease, colonization by invasive species, and predation and nest parasitism by those species that thrive at the forest edge. [25] Forest interior is defined as forest that is far enough from the edge to be protected from the stressors associated with the edge.

In the urban and suburban areas where forest fragmentation occurs most dramatically, edge-loving species tend to thrive and provide the human residents with a connection to nature that is aesthetically pleasing and psychologically restorative. Forest interior, however, is becoming increasingly rare as development fragments the landscape, and therefore large forest patches and the flora and fauna that they support are of conservation concern.

Habitat fragmentation reduces the capacity of a landscape to support healthy wildlife populations by diminishing original habitat, reducing patch size, increasing edge, increasing isolation of patches, and modifying natural changes or disturbances (e.g. fire suppression).[26]

Inherent in using this indicator is a question about the value of preserving interior forest habitat within urban areas. Would developing would-be interior areas in urban areas reduce suburban and rural development pressure, thereby reducing habitat fragmentation outside the urban area? We do not attempt to answer this question, but merely note it to put this indicator into its proper context.

Linkages

As patterns of forest fragmentation associated with urban development continue to spread, the importance of forest interior increases as an indicator. Forest interior has far-reaching implications, such as:

- Invasive species
- Wildlife habitat
- Forest fragmentation
- Ecosystem integrity

Application

The interior forest indicator is used by the Government of Ontario as part of a campaign to educate landowners about forest management. A joint effort between the Ontario Ministry of Natural Resources (OMNR) and the Land Owner Resource Center resulted in a public education pamphlet entitled *Conserving the Forest Interior*.[27]

Measurement

There is no single agreed upon distance from the forest perimeter that constitutes interior. Instead, ecologists generally think of forest interior in terms of the needs of a particular species. For example, many avian species, such as the scarlet tanager, require an interior patch at least 330 feet from the forest edge to ensure successful breeding.[28] Bird populations are commonly used as indicators of ecological health, and the avian buffer appears regularly in forest management literature.[29] As a result, this study defines interior forest as that which lies at least 330 feet (100 meters) from the forest periphery.

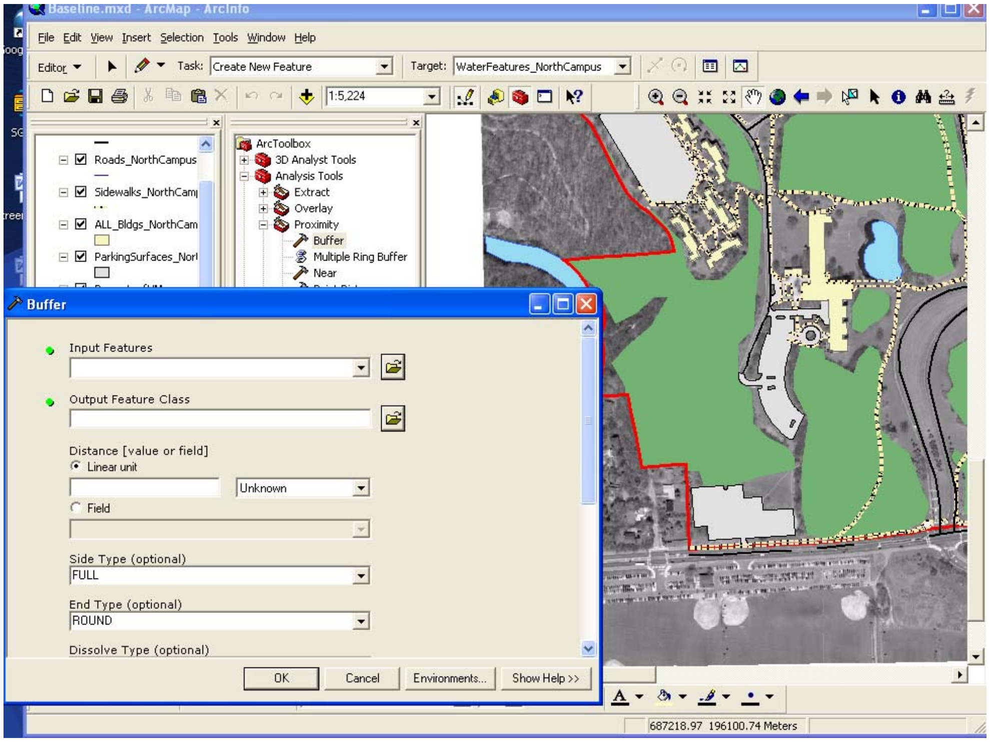

Figure 2. Using the Buffer Tool to delineate Interior Forest Area

The services provided by forest interior will vary based on the forest's successional stage, nearby land uses, patch shape, and proximity to other interior patches. That is, the biological diversity of core areas and their resilience to stressors will vary depending on age, type of stressor, and the ease of species movement between core areas. The shape of the interior patch can also affect habitat quality; circular patches are preferred to slender rectangular or irregularly shaped patches. This is because circular and square patches have the greatest amount of interior proportionate to their total size.[30]

Many college campuses exist in areas that are already significantly fragmented. This does not diminish the importance of the forest interior indicator. Calculation of the indicator will allow campus planners to better understand the ecological role of their wooded properties. Forests with a significant amount of interior should be managed for its ecological services while areas without any interior, or with very little, can be managed for different purposes. It is important to note, however, that a forest patch with no interior is not necessarily devoid of benefits or ecological services. The patch may create a restorative natural setting for the human users or it may serve as a critical habitat corridor linking to areas where contiguous habitat is present. These roles should be taken into consideration when evaluating a forest patch.

Technique

1) The indicator is calculated by first bringing forest inventory data into the GIS.
2) Sum the total forest area for the site.
3) Next, using the buffer tool, delineate the area of forest that lies 330 feet (100 meters) from forest edge.
4) Sum the total area of forest interior.
5) Finally, divide total forest interior area by total forest area to find proportion of forested areas that are interior forest.

Scenarios are considered more sustainable as the total area of interior forest increases. Sustainability also improves as the ratio of interior forest to total forest area increases (moves closer to 1.0).

Environment Indicator: Impervious Surfaces

Definition

Impervious surfaces are those that prevent the percolation of rainwater into the soil. Examples of impervious surfaces include streets, parking lots, sidewalks, houses, sheds, and rooftops. In contrast, examples of pervious surfaces include forests, meadows, and wetlands.

Significance

By inhibiting stormwater retention, impervious surfaces can have detrimental impacts on watersheds and the organisms that rely on them for habitat and sustenance.[ii] Impervious surfaces such as roads and parking lots are reservoirs for trash, automobile-related chemicals, pesticides and fertilizers from urban landscaping, and other pollutants such as bacteria and atmospheric deposition.[31] Rain events flush these surfaces clean of debris. Under natural conditions, these pollutants might be retained by soils or wetlands, where they would be metabolized. However, most impervious surfaces drain directly into natural waterways. The resulting degradation of water quality can detrimentally affect aquatic ecosystem health, including the wildlife and humans that rely on them for food and hydration.[32]

Water that percolates into the soil allows for a greater lag-time between surface impact, peak stream flow, and groundwater recharge. Paving or development of these surfaces can increase the number and severity of flood events as the surface fails to retain water, and can result in property damage and the erosion of stream and river banks and beds. Conversely, during dry periods aquatic ecosystems rely on groundwater sources for maintaining healthy water levels. By inhibiting groundwater recharge, impervious surfaces reduce groundwater source contributions to aquatic ecosystems between rain events.[33]

Linkages

Impervious surfaces act as a medium upon which a multitude of development-related stressors converge. As such, they are a detriment to social, natural, and physical systems. For these reasons, measurement of impervious surface area serves as a proxy for several other stressors. A few such linkages are:[34]

- Water quality
- Aquatic habitat
- Altered drainage patterns
- Erosion
- Aesthetic quality and recreational capacity of waterways

[ii] For a comprehensive account of the impacts of impervious surface, see Kent B. Barnes, John M. Morgan III, and Martin C. Roberge. 2000. “Impervious Surfaces and the Quality of Natural and Built Environments.” Department of Geography and Environmental Planning Towson University.

- Economic loss due to flooding
- Air quality
- Vehicle miles traveled

Application

The impervious surface indicator is a commonly used metric of stormwater runoff potential. The indicator is used in all levels of government and a host of non-profit organizations. As noted earlier in Table 3, the impervious surface indicator is also used by several campus environmental initiatives. Universities that currently use the impervious surface indicator include the University of Michigan, the University of California, the University of Florida, and Penn State University.

Table 4. Imperviousness of Various Land Uses[35]

Land Category	Imperviousness Coefficient
Forest	.01
Urban/Suburban Open Land	.03
Low Density Residential (0.5 units/acre)	.12
Low Density Residential (1 units/acre)	.20
Medium Density Residential (2 units/acre)	.25
Medium Density Residential (3 units/acre)	.30
Medium Density Residential (4 units/acre)	.38
High Density Residential (5-7 units/acre)	.40
Multifamily Townhouse (>7 units per acre)	.65
Commercial	.85
Parking – Unpaved	.90
Parking – Paved	1.00

Source: NOAA Coastal Services Center. (2004). Alternatives for Coastal Development: One Site, Three Scenarios. The National Oceanic and Atmospheric Administration. Accessed via Internet on October 29, 2005 at: http://www.csc.noaa.gov/alternatives/

Measurement

Conventional approaches to measuring impervious surfaces focus on total imperviousness. That is, they measure the total area of impervious surfaces within the site boundaries. As the Victoria Transportation Policy Institute notes, considered alone, this method can encourage sprawling development patterns in areas that are trying to combat water quality problems.[36] For example, if regulators are faced with two development proposals, one for 25 houses and the other for 15, they may choose the one for 15, arguing that the latter reduces site-level imperviousness. However, that reasoning fails to consider the possibility that the 10 remaining houses may be built on an undeveloped plot of greenspace. As a result, the combined impervious area of the two developments could well exceed the initial plan to develop 25 houses on the original site.[37] Total area of impervious surfaces remains an important indicator for site-level impacts on the local watershed. However, consideration for the regional implications of local development decisions is equally important. Impervious area per capita refers to the efficiency with which the land is used locally, while also paying attention to the regional impacts of development. As a result, it is also an ideal sustainable land use indicator.

Technique

1) Imperviousness is calculated by first characterizing land use into a select number of categories, based on percent imperviousness. Table 4 lists imperviousness for various land use categories. Calculating imperviousness will be easiest when GIS data layers exist for all land use categories across campus, although imperviousness can also be calculated from aerial photographs of the campus.

2) If GIS data layers exist, add all land use layers. If GIS data layers do not exist, land use areas will have to be digitized from an aerial photograph.

3) As some layers may contain multiple types of land cover, a categorical identifier may be necessary. If this is the case, assign a unique identifier to all campus land cover that pertains its relative category, i.e. Lawn = 1, Institutional Buildings = 2, Roads = 3, Dorms = 4, etc. Do this by adding a new field to the layer attribute

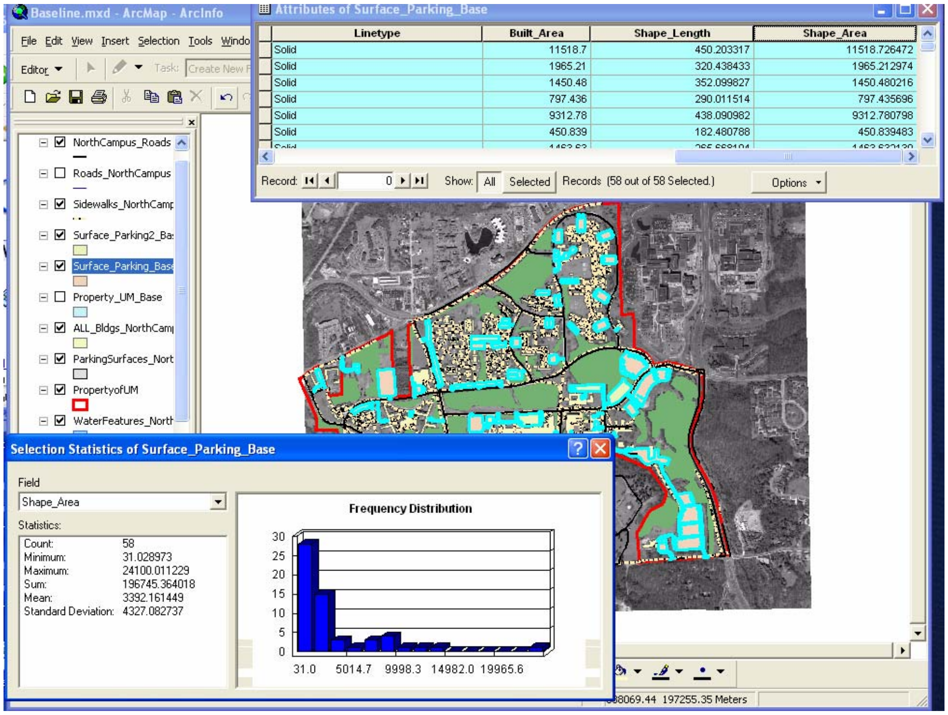

Figure 3. Calculating the total area of surface parking lots as part of the Impervious Surface Per Capita indicator.

table.

4) Next, calculate the total area for each of the land use categories.

5) Determine the imperviousness for each category by multiplying the category area by its relative imperviousness factor from Table 4.

6) Sum the results of the percent imperviousness calculations to determine total campus imperviousness.

7) To determine per capita imperviousness, divide total campus impervious surface area by the total campus population.[iii]

Scenarios with less impervious surface area are considered more sustainable. However, as impervious surface area per capita decreases, campus sustainability also decreases.

[iii] Formula modified from *Summary of the Method Used to Develop an Algorithm to Predict the % Imperviousness of Watersheds* that developed by Jeff Dennis and Allison Piper 2002. State Government of Maine. http://mainegov-images.informe.org/dep/blwq/docstand/stormwater/method.pdf

Economy Indicator: Academic Building Area

Definition

Gross floor area of academic buildings refers to those buildings that are predominantly used for research and teaching, including office spaces for research staff, faculty, and administration. Recreation centers, commercial facilities, and residence halls are not considered academic buildings for purposes of this indicator, but still contribute to the total building gross floor area. This indicator assumes that an institution best fulfills its mission by maximizing the proportion of floor area dedicated to academic uses.

Significance

As demand for higher education increases across the country, colleges and universities are experiencing a growing divergence between costs and projected revenues. The resulting increase in demand for amenities provided by large institutions, such as scientific research equipment, books, periodicals, physical amenities, and financial aid are driving up per-student costs faster than the current rate of inflation. This, in turn, is driving up cost of tuition. However, tuition will likely hit a ceiling, as student and taxpayer resistance mounts. As a result, colleges and universities must search for alternative mechanisms to sustain themselves economically.[38]

While student tuition constitutes a major source of college and university revenue, institutions of higher education also engage in other activities that generate revenue. Research, contracts, and additional services provided to private enterprise are substantial revenue generators. Academic institutions also rely on large-scale projects, such as the erection of new buildings and establishment of research institutes. These types of initiatives increase the public visibility of the institution, elevate prestige, and ultimately attract donors and fund raising organizations.[39]

To better understand the relationship between revenues and land use, we compared trends in research revenues with those of building areas for the University of Michigan's North Campus. The method is detailed in Appendix D. The analysis reveals a strong positive correlation between research revenues and academic building floor area. The data suggest that academic building floor area is a limiting factor for research revenues: research cannot grow indefinitely without a corresponding increase in its allotment of floor area. Because research revenues promise to narrow the gap between the University's costs and revenues, research constitutes an indicator of economic sustainability for the institution. However, research cannot be measured spatially, as our model requires. Because academic building floor area correlates with research revenues, we have chosen academic building floor area as a proxy for institutional economic sustainability.

Linkages

Revenues generated through academic research are linked to several institutional and community factors necessary for economic sustainability:

- Job creation
- Innovation
- Advancement of knowledge
- Philanthropy
- Public investment
- Institutional recognition

Application

To our knowledge, this indicator has never been used before. This is likely due to the difficulty of measuring spatial dimensions of institutional economic prosperity under hypothetical scenarios.

Discussion

Built into this indicator are assumptions about the relationship between building expansion and research revenues. A direct relationship is obscured by the ancillary effects of building expansion, such as increased enrollment capacity and greater demand for human and technological resources. It appears that an important reason for adding facilities is to remove bottlenecks. This can be the case with student housing, performance venues, and commercial space, as well as academic buildings.

It is true that the amount of space in academic buildings dedicated to other uses, such as classrooms, administrative offices, and computer labs, may blur the relationship between building area and research revenue generation, but facility expansion opens up greater potential to capture revenues through the intellectual capital of graduate student enrollment, more contracts with state and federal labs, a broader alumni donor base, and ultimately the ability to attract and accommodate a greater number of leading researchers. For our purposes, however, it is enough to state that adding academic space removes a bottleneck to expanding research revenues—a point supported by our data—such that limited academic space constrains growth in research revenues.

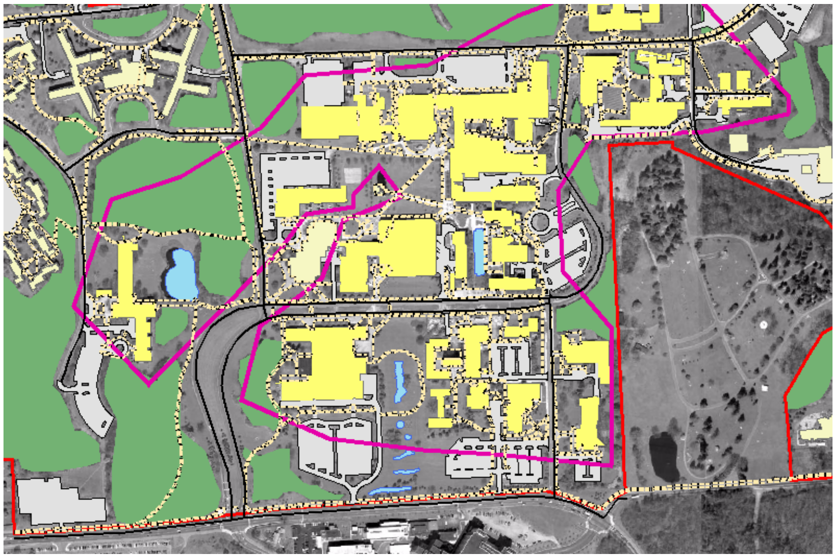

Figure 4. Identifying academic buildings (in yellow).

The relationship between building area and research revenues will likely vary across institutions. For example, the relationship is likely to be much stronger among leading public research institutions than private liberal arts colleges. In applying this indicator it is important to recognize the assumptions that it carries, and to evaluate its suitability with the type of institution to which it will be applied. Furthermore, we recommend conducting a preliminary analysis to determine the appropriateness of this indicator. For this, we recommend the method outlined in Appendix D.

Technique

1) First, calculate the total gross floor area for all buildings on campus. For ease of measurement, we recommend first contacting the planner's office for exact figures before attempting to do this in the GIS.

2) Next, calculate the total building area dedicated to academic uses, not including recreation centers, commercial facilities such as cafeterias and coffee shops, or residence halls.

3) Finally, divide the total floor area of academic buildings by the total floor area of all buildings to determine the ratio.

Institutional economic sustainability improves as the ratio increases (moves closer to 1.0).

EQUITY INDICATORS: COMMUTE TIME AND AFFORDABLE HOUSING

Definition

Commute time refers to the time staff and faculty must spend in transit between home and work. Affordable housing refers to the availability of housing that costs less than 30 percent of a lower-income employee's income. These two indicators are used as a composite indicator in this study to explore the relationship between them.

Significance

Affordability of housing is determined by income; those who earn more can afford to spend more on housing. Commute times are influenced by housing affordability to the extent that housing closer to employment centers is more desirable therefore more expensive. The availability of affordable housing is important to equity in a community because it allows households at different income levels more equal access to the community's amenities—in part by reducing the length of commutes.

In the university setting, faculty members typically earn more than staff. In many college and university towns, where the school is a major regional employer, the cost of buying a home tends to rise with proximity to the school. These conditions can have the effect of forcing lower income college and university employees (generally staff) to search for housing farther away from work than that of their colleagues.

Where such conditions exist, staff will not have an equal opportunity to purchase housing near their work. While locating on the periphery may provide lower housing costs, a greater proportion of staff time and income will be dedicated to commuting than that of their faculty colleagues. Increasing congestion and volatile fuel prices make the time and money cost of commuting highly variable. These fluctuations disproportionately affect employees with the lowest incomes since even small increases in fuel prices can translate into a sizable increase in the proportion of income dedicated to transportation.

Beyond economic effects, longer commuting times may have the effect of widening the social divide between these groups. High travel costs may limit staff members' ability to attend functions on campus, such as lectures, picnics, and other social events. Finally, longer commutes also affect regional water and air quality as a result of higher fuel consumption and vehicle emissions. When considering the equity relationships to commuting, commute time is preferable to commute distance because road improvements are not evenly distributed throughout regions (i.e. two employees may live equidistant from campus but have their commute times vary because one lives near the highway while the other uses local roads.)

Linkages

While commute time and affordable housing directly address important housing and equity concerns, commute time also speaks to environmental issues as a proxy for the following ecological impacts of automobile travel:

- Air quality
- Water quality
- Energy consumption
- Aquatic ecosystem health
- Terrestrial ecosystem health

Application

The USGS Western Regional Council recently conducted an analysis of commute conditions for employees in their office in Menlo Park, CA, a rapidly developing part of the San Francisco Bay area. The commute analysis was part of a broader assessment of the Office's future under changing Bay Area conditions.[iv]

Discussion

A multitude of factors affect where people choose to live. Many choose to live close to their place of employment. Those with children may base their decision on the quality of the school district. Others may place a greater weight on community character. Still others may choose to live where housing costs are low. Household income and housing cost are two sides of the affordability coin. In this indicator, we use the supply side technique of providing affordable housing in order to impact commute times.

Using this indicator assumes that affordability plays a role in the decision to live farther from campus. A detailed analysis is required to explain this relationship with adequate confidence. However, the availability of data, the complexity of the analysis, and the time required to run the analysis would likely render this approach difficult to translate to other campuses. Therefore, this indicator focuses only on correlations between commute time and employee status.

Survey data collected as part of this study show that housing cost is one of several important factors in housing choice and that UM staff live further from campus than faculty. In larger cities, the relationship between distance from campus and cost of living might not be as strong. Therefore, to ensure transferability, the relationship between income and commute should be explored through the use of Census Block Group data. In places where property values decrease as one moves away from the institution, and where commute time is unequal between faculty and staff—as is the case in Ann Arbor—we deem the situation inequitable.

Technique

This indicator can be calculated several ways. The most robust method would include using Census Feature Class Codes (CFCC), which are included as fields in state road data layers, to calculate a speed and time cost for each road segment in a region. The work and home address for each employee can be translated into geographic coordinates along the road network using a process called geocoding. The commute

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[iv] For a more detailed account of the Western Regional Council's assessment technique, see http://gis.esri.com/library/userconf/proc99/proceed/papers/pap151/p151.htm.

time for each employee can then be calculated using the Network Analyst extension in ArcGIS to find the shortest ("least-cost") path for each employee origin to destination. The tool will add together the time cost of each road segment along the least cost path to output a commute time for each address. The advantage of this method is that it will include almost all employees in the analysis and individual home addresses can be assigned to their Census Block Group to obtain additional demographic data.

If linking employees to Census data is not necessary, the geocoding process can be avoided by assigning each home address to a zip code area and then using Network Analyst to calculate the least-cost path and commute time from the centroid of each zip code.

We chose a hybrid approach that uses each home address as the origin, but also avoids the need to create a geocoding processs through ArcGIS. We obtained a spreadsheet from the University of Michigan with the employee data and used a macro (see Appendix C) to automate a process of looking up commute times using the Mapquest web service and adding them to the spreadsheet. The Mapquest software handles the geocoding of the addresses and calculates both commute distances and times, significantly reducing the time and effort required.

While commute times can be measured relatively easily using existing data, we need to make a few assumptions in order to make comparisons between future scenarios. First, we assume that if there is no significant change in the number and location of units of available housing within the region, the existing patterns of residence and commuting will remain unchanged within the scenario. In other words, if affordable housing options stay on the periphery of a region, employees with lower incomes will continue to live further away and have greater commute times and distances than higher income employees.

Second, if affordable housing units become available closer to the place of employment, we must make assumptions about how this will affect employees' housing choices. Will new residences be filled first by those who currently live furthest away or by a group that is random distributed spatially? Who will be able to afford units? A range of possibilities must be considered in order to understand the potential outcomes of adding housing on campus.

Below, we describe the steps for analyzing the commute/housing relationship in our case study, recognizing that the technique will change and require different assumptions in every application.

1) Calculate existing commute times for a representative sample of campus faculty and staff, using one of the methods outlined above. This sample is used in later steps to explore changes in commute times.

2) Divide the sample into two groups: one that is eligible for affordable housing and one that is not.[v]

3) Calculate the number of housing units available and the percent that will be affordable (or a range of percents to explore).

4) Select a representative sub-sample from the eligible and ineligible groups that are forecast to move in to the hypothetical housing units, using one of the following two methods (or use both and average the results, as we do):

    a. Random Sample: Select the sub-sample such that it is random with respect to current commute time.

    b. Furthest Away: Select a sub-sample that consists of those with the longest current commute times.

5) Change the commute times of those sub-samples who have moved in to reflect the commute time from the hypothetical housing units.

6) Finally, compute the mean commute times for faculty and staff with the updated commutes.

7) Repeat steps 4-6 for each percentage of affordability that is being explored.

Equity increases as the ratio of mean commute times between faculty and staff approaches 1.0. Social and environmental costs decrease as the mean commute time for all employees approaches zero because no commute means no tailpipe emissions and less transportation infrastructure.

[v] In the case study, we use the median mortgage payment for Ann Arbor; if the annual mortgage cost was greater than thirty percent of the employee's income, we consider them eligible for an affordable unit.

SCENARIOS AS A DECISION-SUPPORT TOOL

Scenarios have been employed by business, military and public institutions since the 1950s to manage the uncertainty of the future by defining several sets of assumptions and comparing the potential consequences of decisions based on these assumptions. While the creation and use of scenarios in a decision-making framework allows for wide variation, Shearer points to four principles that all scenario development efforts should consider.[40] These principles are outlined in Table 5.

TABLE 5. PRINCIPLES OF SCENARIO DEVELOPMENT

1.	Scenarios are fictional (where fictional is understood to mean unverifiable but plausible, not fanciful) accounts which represent a process of change over some duration
2.	Scenarios describe situations, actions, and consequences that are contingently related
3.	Scenarios are understood to be predictive judgments that describe what could happen, not predictions that describe what will happen, or even what is likely to happen
4.	Scenarios organize information within explicitly defined frameworks

Source: Shearer, Allan W. 2005. Approaching scenario-based studies: three perceptions about the future and considerations for landscape planning. Environment and Planning B: Planning and Design. Vol 32. Pg. 67-87

When considering university land-use sustainability, scenario-based analysis is beneficial for a variety of reasons. First, in addition to the physical result, scenarios account for the decision-making processes that lay behind physical development. Also, since we are concerned with how different development patterns affect land-use sustainability, scenario-based analysis provides a structure to compare land-use measures across possible futures. Finally, the construction of future land-use scenarios in GIS allows for demonstration of the results of possible development processes in maps and images that are immediately accessible, allowing for more informed discussion and participation in current land-use decisions across a broader population of stakeholders.

CREATING FUTURE DEVELOPMENT SCENARIOS

Meadows emphasizes the temporal aspect of a sustainability indicators.[41] In her view, standard indicators provide but a snapshot of a system at any given point. Only with the addition of time, limit, or target, does an indicator become a sustainability indicator. That is, sustainability indicators should measure progress towards a more sustainable condition.

The temporal measurement approach proposed by Meadows and used in practice in sustainability initiatives presents a post-hoc method for measuring sustainability. According to this view, indicators serve to measure the sustainability of current practice in fixed intervals over time. While such an approach reveals something about the state of the existing system, it does little to inform how best to plan for the future. This results in a somewhat retroactive approach to sustainable development.

We propose an alternative system of ex-ante evaluation that allows for more informed decision-making on the front end. This is accomplished through the creation of build-out scenarios. These scenarios consist of two-dimensional land-use plans to which sustainability indicators can be applied. This approach is not wholly inconsistent with that of Meadows, as the indicators can also be applied to current practice. The three scenarios we develop for our case study are guided by existing university land-use trends and principles of Smart Growth, respectively. Each of these concepts is discussed at length in later sections.

Applying sustainable land-use indicators to existing campus land-use plans would be useful for comparison between institutions; however, such an approach would not reflect the impact of future development decisions on the institutions' efforts to make their campuses more sustainable. Future campus development is contingent upon a dynamic process of institutional culture, laws and the decisions of individual actors, all of which create uncertainty in predictions of future conditions. Because these processes are not static, opportunities remain for injecting sustainability into the land use planning dialogue. A more forward-looking approach to measuring sustainability, such as the one that is the subject of this document, has the potential to guide future development decisions, rather than serve as a recovery framework.

EXISTING-TRENDS SCENARIO

When developing scenarios for the purpose of strategic decision making or exploring possibilities outside of present constraints, it is useful to also develop a surprise-free or existing-trends scenario, against which other scenarios can be compared. Shearer defines this type of scenario as one that anticipates "no significant changes in the social, political, economic, technical, or environmental aspects of the world."[42] The existing trends scenario assumes stability among influences external to the organization (national economic and political stability, automobile-based transportation systems, absence of cataclysmic natural disaster), and internal factors (administrative culture, development processes and interpretation of institutional mission). Since the existing-trends scenario assumes stability in all facets of the organization it attempts to be a descriptive representation of the most feasible of all possible futures.

The construction of an existing-trends scenario can serve both constructive and critical purposes. A constructive approach recognizes that each organization is composed of a unique set of people, goals, ideas and history, and that each organization will respond to identical situations in different ways. The creation of an existing-trends scenario identifies the underlying assumptions of conventional thinking within an organization, which allows the organization to explicitly examine and discuss the value of these assumptions. A more critical application could use an existing-trends scenario as a baseline to compare against a more attractive alternate outcome, allowing the creator to emphasize the benefits of pursuing organizational change toward an alternate vision of the future.

SMART GROWTH SCENARIO

The smart growth scenario is based upon a collection of development principles designed with the intention of providing an alternative to the conventional low-density land use pattern. The US Environmental Protection Agency (EPA), one advocate for Smart Growth, defines it as "development that serves the economy, the community, and the environment."[43] It changes the terms of the development debate away from the traditional growth/no growth question to "how and where should new development be accommodated."[44] The EPA asserts that communities pursuing development according to principles of Smart Growth will benefit from a healthier environment, and enjoy greater economic development and job creation, while producing stronger neighborhoods with more transportation choices such as walking, biking and transit.[45]

TABLE 6. SMART GROWTH PRINCIPLES

1. Mix Land Uses	2. Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas
3. Take Advantage of Compact Building Design	4. Strengthen and Direct Development Towards Existing Communities
5. Create Range of Housing Opportunities and Choices	6. Provide a Variety of Transportation Choices
7. Create Walkable Neighborhoods	8. Make Development Decisions Predictable, Fair and Cost Effective
9. Foster Distinctive, Attractive Communities with a Strong Sense of Place	10. Encourage Community and Stakeholder Collaboration

Source: Smart Growth Network (SGN). 2005. "About Smart Growth," Accessed online, http://www.smartgrowth.org/about/issues/issues.asp?iss=4, 27 November 2005.

Similarly, the Urban Land Institute defines smart growth as development that is environmentally sensitive, economically viable, community-oriented, and sustainable. The Institute suggests that every geographical area (i.e., village, city or region) should define what Smart Growth means to them.[46] We, however, use the definition and the principles from the Smart Growth Network as a starting point because they represent a widely accepted formulation of smart growth ideas, similar to those advocated, for example, by the Michigan Land Use Leadership Council and the Urban Land Institute.[47]

The Smart Growth Network (SGN), partially funded through the EPA's Smart and Sustainable Communities Program, is comprised of environmental groups, historic preservation organizations, professional organizations, developers, real estate interests, and local and state government entities.[48] The organization advocates for smart growth through a variety of media, including an extensive online information clearinghouse. SGN published the ten principles of smart growth reprinted in Table 6.

The Network contends that by adopting these principles, future growth and development can be accommodated more sustainably by consuming less land and fewer nonrenewable resources.[49] It is this very assertion that we attempt to test through scenario development and application of sustainability indicators. Despite the prevalence of the term *sustainability* throughout the smart growth literature, we are careful to avoid the tautological trap of conflating smart growth and sustainability. Therefore, the sustainable land-use metrics were designed so as to avoid conflating our measures with generic smart growth principles. Similarly, a concerted effort was made to develop the smart growth scenario according to principles of smart growth on their face, as opposed to focusing on smart growth principles that speak directly to principles of sustainability, or—more precisely—the sustainability indicators developed for this analysis.

LIMITATIONS OF USING INDICATORS IN SCENARIO-BASED ANALYSIS

Although scenarios offer a promising approach to measuring progress towards more sustainable land use, their hypothetical nature limits scope of indicator application. With Meadows' traditional temporal approach, indicators are applied in real time. That is, measurements of existing features are taken as they occur in the real world. With the temporal model, any indicator is potentially viable because all of the data are technically available; indicator choice is limited only by time and impracticality. This is not the case with scenarios. Campus land-use scenarios present three principal limiting factors.

First, the hypothetical nature of scenarios precludes the measurement of variables that might otherwise be readily available under existing conditions. A prime example is the affordability of campus housing. Applying the temporal model in a city, one could access Census data for median rent and median income. Based on these figures, one could determine the proportion of income paid for rent, and therefore discover relative affordability of housing in that community. However, rent and income are based on a tremendous number of time- and context-dependent variables. Deriving these figures for hypothetical conditions, where land and building configuration has been altered, would be speculative at best. Strict affordability of housing is one of a host of potential indicators that could not be directly measured. Where possible, we developed methods for indirectly measuring such variables. Affordable housing is one such example.

The second hurdle stems from the nature of land use and the platform upon which the scenarios are developed. Measurement of land use is inherently spatial: the height of a building, the area of forest cover, the distance between home and work, etc. The spatial nature of land use makes GIS an excellent platform for scenario development. Changes in land use can be graphically displayed and discretely measured in the GIS. However, the spatial nature of the platform complicates efforts to measure social variables such as population growth and wealth distribution, both of which are critical to the concept of sustainability. As a result, selection of the equity and economy indicators presented a particularly challenging task, as one does not generally consider these factors in a spatial context. This conceptual hurdle is exacerbated by hypothetical nature of scenarios.

Finally, the institutional nature of colleges and universities complicates spatial measurements of economic prosperity through hypothetical scenarios. Whereas unemployment or manufacturing base might be suitable indicators of economic prosperity in a typical community, they are a poor fit for campuses. This is due to the quasi-public nature of the campus and the demographic to which it caters. For example, in a traditional community, the number of restaurants per square mile may be an appropriate indicator of market supply, and therefore, of economic prosperity in that area. While campuses are small communities, they sometimes consist of large tracts of state- or privately- owned land, sheltered from the whims of markets and local zoning laws. In such cases, commercial and residential development patterns may be more reflective of college or university policy, rather than simple demand. As a result, we consider economic prosperity through the eyes of the institution. In doing so, we focus on that which demonstrates sustainable economic prosperity for the college or university, rather than a city or village.

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2. Testing the Model:

University of Michigan North Campus

This pilot study is an effort to demonstrate the usefulness of the methods developed in the previous sections. Here, we focus on the University of Michigan's North Campus as a test case. Using the existing North Campus layout as a baseline, we develop three potential build-out scenarios. The first scenario represents a feasible future for North Campus, should principles guiding current land-use decisions continue into the future. The second scenario illustrates a possible land-use outcome if the University of Michigan were to build-out according to an expert-driven interpretation of principles of Smart Growth. Finally, the third scenario builds upon the second, while also incorporating the perspectives of the broader campus community into the physical plan.

To assist with the creation of campus build-out scenarios for our case study we utilized Geographic Information Systems (GIS) software and collected data layers that are publicly available from federal, state and local governments as well as the University. In doing so, we follow a tradition of GIS-based scenario creation that began in the 1970s.[1] With the operating platform in place, we applied the sustainability indicators to each of the three scenarios. The methods were combined in an effort to determine which development principles would guide development more towards sustainable land use. In contemplating potential development futures, two hypotheses emerge:

1) A build-out scenario for the North Campus that follows Smart Growth tenets regarding urban form will yield more sustainable outcomes in terms of the consumption of land, energy, and resources, particularly with regard to transportation requirements, than the likely build-out scenario for North Campus based on current campus conditions and plans.

2) The stated preferences of students, staff and faculty can be integrated with the tenets of Smart Growth to yield a more sustainable community than either of the previous two build-out scenarios.

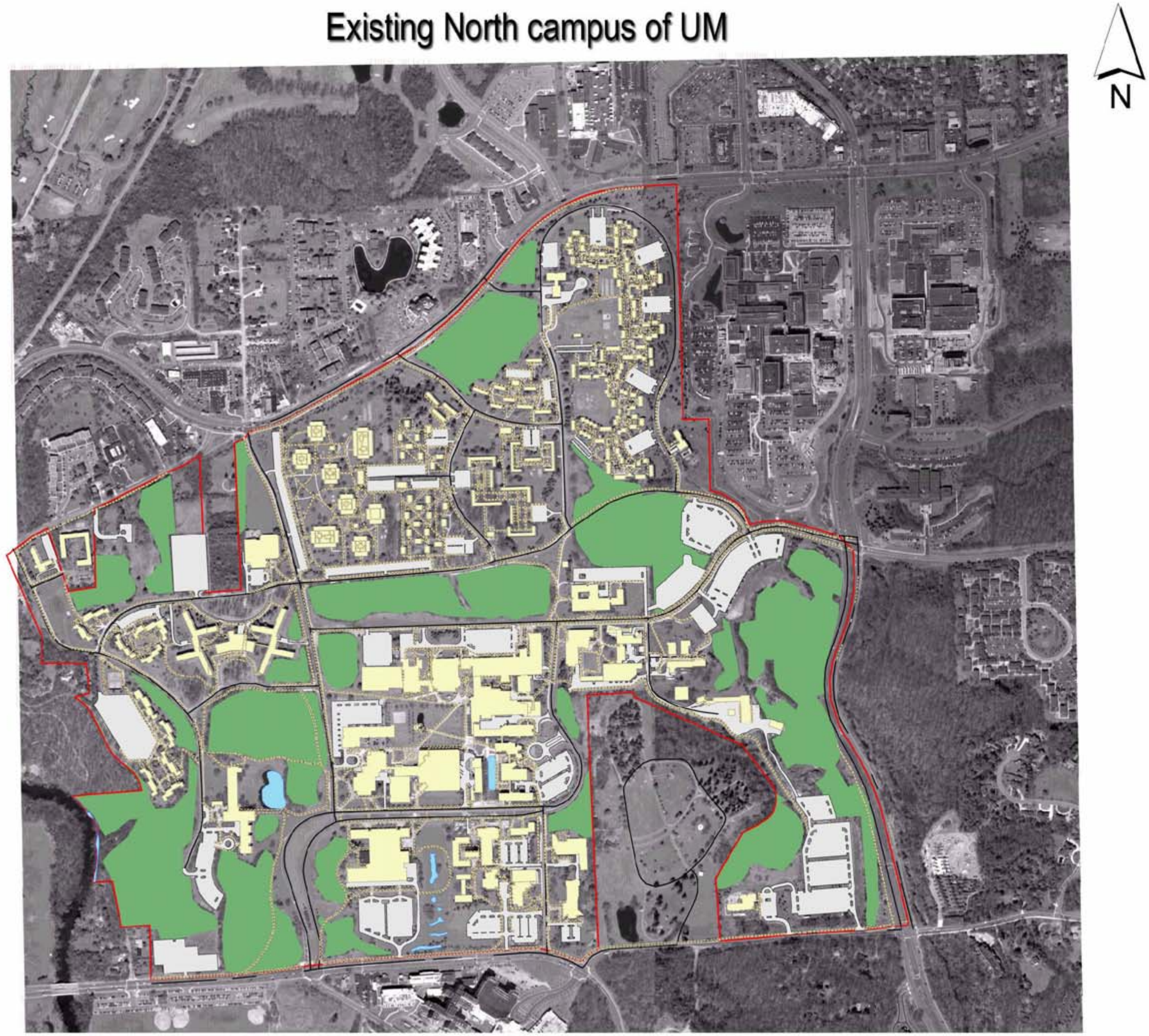
It is important to note that these scenarios are principle-driven. That is, they do not reflect the authors' preferred state, nor do they reflect explicit desires of the University. Instead, they reflect our interpretation of how various development principles might play out on the ground. Also noteworthy is the fact that these principles could be interpreted in a diversity of ways, resulting in an infinite number of build-out scenarios based on the same principles. The following represent but one illustrative interpretation of these principles.

BACKGROUND

The University of Michigan (UM), established in 1817 and moved to Ann Arbor from Detroit in 1837, has evolved into a leading public research institution with an international presence. While Ann Arbor boasts five UM campuses, two campuses- Central Campus and North Campus- constitute the major academic centers. Total land area spans 3,177 acres and hosts 355 buildings covering 23,157,417 square feet. As of 2004, the Ann Arbor campuses employed 3,700 regular faculty and enrolled approximately 38,000 students. The UM budget for fiscal year 2002 was $3.5 billion. While Ann Arbor's population is just over 100,000, the University of Michigan's academic, economic, and environmental presence has implications beyond the local community, extending to state, nation, and planet.

The 800-acre North Campus lies approximately 1.5 miles north of its Central Campus counterpart. Originally designed as a commuter research campus for greater Southeast Michigan, North Campus is markedly different from that of Central Campus. Aside from the distance, the two campuses are also separated by the Huron River Valley, which presents a physical and psychological barrier to further integrating the two campuses. Improved linkages between the North and Central Campus have long been a topic of great interest to the University. Whereas the Central Campus is older and more integrated into the densely urbanized City of Ann Arbor, North Campus retains a more suburban, automobile-oriented feel.

Existing North campus of UM



Vital statistics

Building footprint

Existing: 2.02 million Sqfts.

Residential units

Undergrads & Grads: 2675 units

Parking spaces

6,235 cars

Woodlots

100.9 Acres

# of Commercial facilities

10 facilities

Mode of travel: Bus

- Walkways
- Roads
- Existing Buildings
- Water Bodies
- Surface Parking Lots
- University Owned Land
- Woodlots

Taubman College of Architecture and Urban Planning

Master of Urban Planning - Professional Project

0 250 500 1,000 Feet

The focus of this study is the "core" of North Campus, a 464-acre section just north of the Huron River where the majority of North Campus buildings are located. Bounded by Plymouth Road to the north, Fuller Road to the south, Huron River Drive to the east and the Huron River to the west, the North Campus core (hereafter referred to as the North Campus) comprises mainly academic, research, and housing structures. The existing layout of the North Campus study site is illustrated in Figure 5. This figure serves as the baseline for future scenario development.

Figure 6. This student dormitory (Baits II) is representative of North Campus's suburban character.

During the fall and winter terms, over 7,500 students, faculty and staff use North Campus. Presently, building floor area totals 2,634,500 square feet of academic, research, and service buildings, not including housing.[2] Regarding housing, North Campus provides approximately 2,675 units for both graduate and undergraduate students. Serving the daily needs of North Campus users are ten commercial facilities, including coffee shops, a general store, a dining hall, and a cafeteria. In addition, the Campus hosts a bank and a travel agency.

North Campus housing and academic spaces are separated by woodlots. Housing is concentrated in the north and northeastern portions of the campus, while the primary academic and research centers extend to the south and southeast. Large tracts of woodlands bound the core, casting a 'natural' feel about the campus. Vast expanses of lawns and large modernist building structures with large setbacks give the campus a feel similar to that of a corporate office park.[3] The primary modes of travel to and from North Campus are bus and private automobile. Existing surface parking lots can accommodate approximately 6,235 vehicles, and buses serving both Central and North Campus run on a five to ten minute headway.

SCENARIO DEVELOPMENT

Several factors make the North Campus an optimal location for testing our measurement technique. First, it is home to the program from which this study emerged. Our presence within the campus provides not only the opportunity to physically interact with the campus, but also enables direct access to data and knowledge about the campus history and planning process. This approach is significant because those for whom this model is being developed will likely be applying it at their respective home campuses. A second characteristic that makes North Campus ripe for this study is that it has yet to realize its maximum "build-out" potential. That is, because the campus is relatively young, a considerable amount of developable land remains within its borders. This provides some flexibility in thinking about campus build-out. Remaining build-out potential is, in part, due to the third characteristic—its relative isolation from the surrounding community.

While the North Campus is ultimately connected to the City of Ann Arbor and other UM-Ann Arbor campuses, its geographical separation from these communities creates a more controlled state. While we recognize that North Campus is unique in this respect, and that many campuses are more integrated into the communities in which they are situated, North Campus serves as a proving ground for this technique. Future studies, if conducted within more integrated campuses, may indeed discover challenges unforeseen by this study.

To fully understand the significance of the site and how it might be developed, it is useful to understand North Campus in light of its planning history. A brief history of North Campus planning efforts can be found in Appendix A. The following sections outline the principles underlying development of both the existing trends and Smart Growth scenarios, including maps and vital statistics of each.

SCENARIO A: DEVELOPMENT BASED ON EXISTING TRENDS

The existing-trends scenario (hereafter referred to as Scenario A) represents a possible future North Campus layout, assuming the principles guiding University land-use decisions remain unchanged. To better understand the drivers of such decisions and their implications for Campus form, we tracked 50 years of North Campus development trends, consulted historic planning documents, and engaged people familiar with planning process—inside and outside the University. From these efforts we distilled a set of principles that have guided North Campus planning. We used these planning principles, outlined in Table 7 and further explained below, to guide the creation of Scenario A.

ASSUMPTIONS OF SCENARIO A

While the principles underlying the current layout will remain the same in Scenario A, build-out necessitates certain assumptions about what will and will not change on the ground. Assumptions provide insight into the reasoning behind the selection of principles. In the section that follows, principles and their implications for campus development are outlined.

TABLE 7. SCENARIO A: PRINCIPLES AND IMPLICATIONS FOR SCENARIO DEVELOPMENT

Existing Trends Principle	Implications for Campus Development
Future Plans Should Build Upon Previous Planning Studies; the Past Should Inform the Future. (See Appendix A for a more detailed historic account of North Campus Planning.)	➢ The Campus will continue to grow, absent a comprehensive land-use plan. ➢ Natural features are an important component of the North Campus character and will continue to be protected. ➢ Academic units will continue to relocate to North Campus. ➢ The North Campus academic core will continue to densify, eventually necessitating the creation of a second North Campus academic core. ➢ With densification, new buildings will be taller, averaging 3.5 floors. ➢ Parking surfaces around the academic core will give way to buildings. ➢ Multi-level parking decks will accommodate future parking demand
Ensure Planning Decisions are Consistent with the Mission of the Planner's Office and the University.	➢ Future land-use decisions will continue to be mission-driven (and therefore somewhat unpredictable).
Maintain Maximum Flexibility with Regard to Land Use Decisions	➢ Future land-use decisions will continue to be incremental and outside the confines of a comprehensive future land-use plan.
The University Should Not Compete with the Community for Housing and Commercial Market Share	➢ Future development on North Campus will consist largely of academic or research facilities, located in close proximity to comparable units.

In considering build-out that follows current trends, we assumed that major roads, undergraduate dorms, the general layout of the academic core, and North Campus woodlots would remain intact as build-out ensues. As a result, the integrity of these features is largely maintained between the baseline and Scenario A.

A second key assumption underlying Scenario A is that the University will continue to pursue a rate of growth equal or greater to that of its past. That is, we expect that the North Campus will continue to add buildings at its historic rate. Fifty years of development trends reveal a strong positive correlation between building area and time. Figure 7 reveals the relationship between the completion of building projects (in gross square feet) and research dollars.[i] Given this trend, we assume that construction of academic and research structures will continue and with that, the addition of parking structures. We also expect a greater proportion of campus housing to be allocated for undergraduate students, with a greater reliance on large dormitories, as aging family housing is replaced.

While this study is primarily concerned with development of the North Campus, it is important to note that it is but one of five campuses that comprise UM-Ann Arbor, including a largely undeveloped East Campus. The North Campus continues to grow, but in an inefficient manner, while the University also pursues development of its other properties. The University seems reluctant to further densify the North Campus for fear that it might detract from the natural character of the property. To the extent that the University pursues this rationale, we assume that development that does not happen on North Campus will be forced out onto more remote, more natural, campuses such as the East Campus. The following section provides further insight into how principles of existing practice will affect future development patterns.

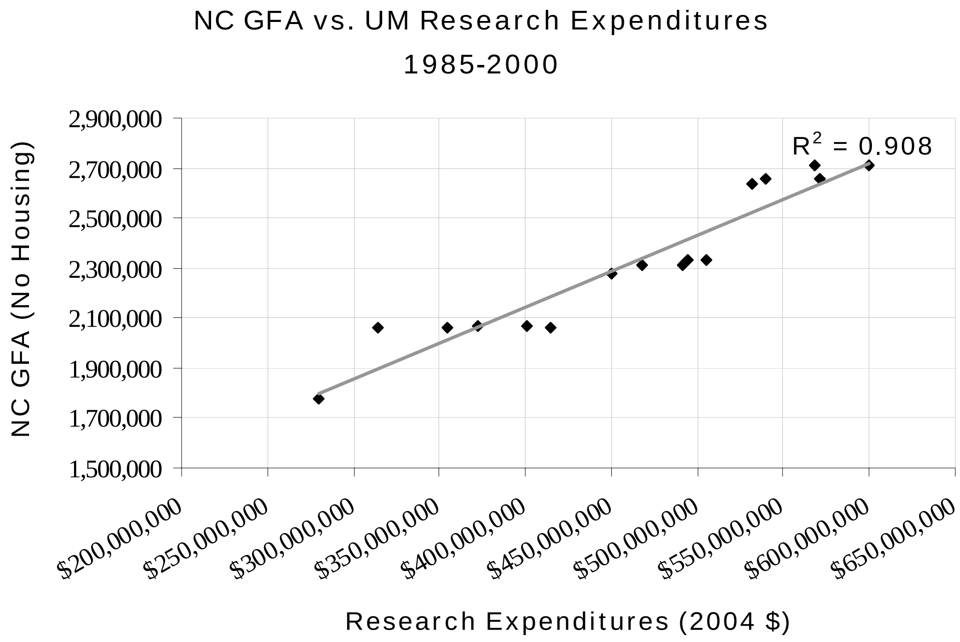


Figure 7. Plotting research expenditures against North Campus's Gross Floor Area.

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[i] See Appendix D for more on the relationship between the growth in research expenditures and North Campus building area.

EXISTING TRENDS: PRINCIPLES AND IMPLICATIONS

Future Plans Should Build Upon Previous Planning Studies (The Past Should Inform the Future).

Historic North Campus planning documents show that the purpose, function, and future of North Campus have long been debated. The most recent master planning effort, conducted by consultants Venturi, Scott, Brown and Associates (VSBA), suggests this debate is very much alive. All the while, the University has continued to develop the Campus. The VSBA studies present six potential University development scenarios for how the North Campus might fit into the larger campus system.[4] The absence of an updated land use plan for the North Campus is further evidence of this debate. While past planning studies do not paint a clear picture of anticipated future development, they reveal some general themes that are likely to continue to influence future development decisions. A few such themes are bulleted below. Please see Appendix A for a detailed historical account.

- The Campus will continue to grow, absent a comprehensive land-use plan.
- Natural features are an important component of the North Campus character and will continue to be protected.
- Academic units will continue to relocate to North Campus.
- The North Campus academic core will continue to densify, eventually necessitating the creation of a second North Campus academic core.
- With densification, new buildings will be taller, averaging 3.5 floors.
- Parking surfaces around the academic core will give way to buildings.
- Multi-level parking decks will accommodate future parking demand.

Ensure Planning Decisions are Consistent with the University Mission

The University of Michigan campus planning process is largely mission-driven. That is, land use decisions are justified based on their compatibility with the mission of the University, as well as the Planning & Development Department (housed in Architecture, Construction, and Engineering (AEC)). Both statements are presented below.

Mission of the University of Michigan:

> *The mission of the University of Michigan is to serve the people of Michigan and the world through preeminence in creating, communicating, preserving and applying knowledge, art, and academic values, and in developing leaders and citizens who will challenge the present and enrich the future.*[5]

Mission of Architecture, Engineering, and Construction:

> *To deliver efficient, productive and responsive professional services to create the most functional and enriching environment for the University community.*[6]

These mission statements are quite abstract. As land-use is not addressed in most mission statements, their implications for campus planning are not immediately clear. AEC's mission is to serve the academic mission of the University (not to make the University part of the Ann Arbor community). But questions regarding the extent to which land use patterns affect research, teaching, and learning, remain. Consequently, the relationship of campus land-use decisions to the University's mission remains open to interpretation. Thus suppositions about future building placement or type, based on the mission, remain rather tenuous.

- Future land-use decisions will continue to be mission-driven (and therefore somewhat unpredictable).

Maintain Maximum Flexibility with Regard to Land Use Decisions

Another principle underlying University land-use decisions is flexibility. Not unlike a city that has no idea what the next big economic trend will be, to remain competitive, the University must be ready and able to house the next big academic breakthrough. Because the University has no way of knowing where such innovation will occur, it is hard pressed to plan ahead. The difference here is that unlike a city, the university is one entity that arguably has more control in making decisions. At the same time, the opportunistic nature of Campus building projects, often requiring a large donation, necessitates a negotiable site selection process. What results is a seemingly incremental development process incompatible with a comprehensive vision for the future.

- Future land-use decisions will continue to be incremental and outside the confines of a comprehensive future land-use plan.

The University Should Not Compete with the Community for Market Share

As in any forum where land use decisions are being made, politics and money play a significant role. At a time when universities are struggling, and in a state with a depressed economy, the University of Michigan seems to be particularly cautious when considering future building investments. For reasons mentioned above, developable property is an extremely valuable University asset. Based on this valuation, it seems that the University views the addition of facilities for non-academic or non-research uses to be a liability. The construction of additional on-campus housing, for example, may be viewed by the University as having too high of an opportunity cost; housing neither generates profits nor enhances flexibility. Similarly, the University views the addition of housing and commercial facilities on North Campus as competing with the Ann Arbor Community, where a functioning market exists for these goods. Competing with the Community may not be consistent with the University's mission. Based on these observations, we assume that:

- Future development on North Campus will consist largely of academic or research facilities, located in close proximity to comparable units.

Alternative "A" - Future build-out scenario for North campus of UM

Vital statistics

Building footprint

Existing: 1.77 million Sqfts

New: 1.49 million Sqfts

Total: 3.26 million Sqfts

Residential units

Undergrads: 2883

Parking spaces

6,174 cars

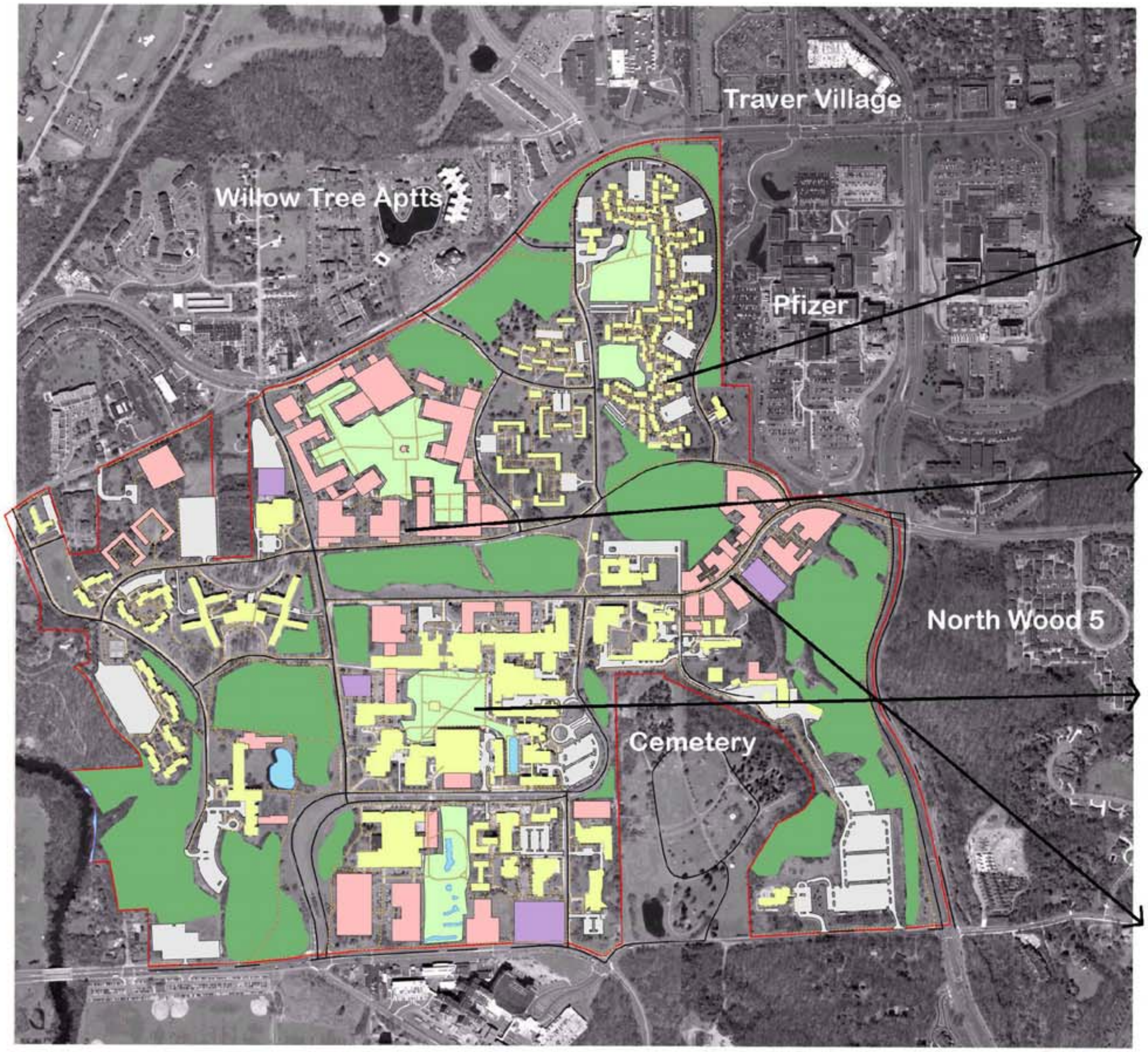
Woodlots

99.73 Acres

# of Commercial facilities

20 facilities

Mode of travel: Bus



- Walkways
- Roads
- Parking Decks
- Proposed Buildings
- Existing Buildings
- Water Bodies
- Surface Parking Lots
- Parks
- University Owned Land
- Woodlots

N

0 250 500 1,000 Feet

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SCENARIO B: DEVELOPMENT BASED ON SMART GROWTH

The Smart Growth Scenario (hereafter referred to as Scenario B) was developed to test our hypothesis that a campus organized according to Smart Growth principles would be more sustainable than one designed according to the conventional land-use planning paradigm, such as that underlying Scenario A. Smart Growth principles were originally designed to inform land use regulations at the local government level. As such, they are not directly transferable to campus land use planning. Two important factors distinguish campus planning from traditional city planning: colleges and universities differ from municipal governments in their spheres of influence and in their primary missions.

To begin with, colleges and universities usually control only a fraction of the land within the larger community. At the same time, such institutions generally rely on local governments for services such as transportation infrastructure, housing, commercial facilities, open space, and utilities. As such, these institutions have a large stake in the way their surrounding communities develop. While campus activities certainly influence community decisions, and campus planners often work closely with local planners, institutional land-use decisions are confined to college and university property. That being said, the adoption of Smart Growth principles by institutions of higher education would influence campus build-out but may not be reflected in development outside of the institution's jurisdiction. Therefore, campus land-use planners must consider how their campus fits into the larger community, recognizing that they are only one piece in the puzzle—albeit sometimes a large piece.

Additionally, institutions of higher education typically view their primary purpose as educating students and conducting research. Certain development options may be constrained to the extent they conflict with these primary goals, i.e. if providing space for housing or commercial uses reduces the space available for academic or research uses. Each institution's mission will be different and most tend to be somewhat open to interpretation. This is distinctly different from a municipal government, which is vested with the power and responsibility to protect the public health, safety, morals and general welfare of its citizens. Municipal land-use regulations are often an obstacle to Smart Growth. Smart Growth advocates might contend that universities are well positioned to take the lead on developing smart growth campuses because they are free from the types of local government development restrictions that might otherwise prevent smart growth development patterns.

In order to accommodate these deviations from the conventional model, Smart Growth principles are oriented towards municipalities; we translate Smart Growth principles into analogous principles specifically tailored for campus development. The following discussion describes this translation process and the implications for what we call "smart campus" principles.

ASSUMPTIONS OF SCENARIO B

Whereas Scenario A employs one set of norms characteristic of conventional development patterns, Scenario B draws from a less prevalent, but equally normative set of principles.[7] Smart campus principles describe a vision for how campus planning ought to be done, according to proponents of Smart Growth. This does not mean, however, that this scenario presents an entirely new North Campus layout. Instead it attempts to retrofit the existing campus to bring it in line with Smart Growth principles. As such, certain assumptions need to be made to keep the scenario in the realm of the possible. Table 10 lists these assumptions.

As noted above, Scenario B is designed according to our smart campus principles. These principles drive several of the changing features listed in Table 8. Examples include moving parking to structures and pushing surface lots to the campus periphery. Among the remaining assumptions are that academic and research space will be added at the current rate, graduate apartments (Northwood I, II, III) will be torn down when they become too costly to repair, and that demand for undergraduate housing on campus will increase.[8]

TABLE 8. SMART GROWTH ASSUMPTIONS

Stable Aspects	Changing Features
Major roads/utility corridors (Bonisteel, Murfin, Beal, Hayward, Duffield)	Academic/research buildings added at historic rate of growth
All academic buildings remain	Aging graduate student housing structures torn down
Existing undergraduate dorms remain	More parking in structures, surface lots continue to move to periphery
	Greater diversity of housing options
	New commercial added on University property
	Woodlots, natural features may be developed
	Ownership – some land may be sold
	Automobile orientation diminishes

The Stable Aspects listed in Table 8 are necessary to make Scenario B a possibility. Rerouting major utility corridors or roads, replacing existing academic space, or replacing/reducing available undergraduate housing would be prohibitively expensive for the University, as would tearing down still-valuable buildings.

SMART CAMPUS: PRINCIPLES AND IMPLICATIONS

Ensure a mix of land uses within the larger community

The aim of this Smart Growth principle is to encourage different, yet compatible, land uses to develop in close proximity. As a result, Smart Growth advocates contend that a variety of goods and services can be accessed at a reduced travel cost when compared to conventional development, which tends to separate uses into distinct districts such as residential, commercial and institutional.

College campuses often fall into one of two patterns, each having different implications for the application of this principle. Some campuses are interlaced with the surrounding community, whereas others exist as more isolated islands of land, clearly disconnected from surrounding properties. On campuses that are woven tightly into neighborhoods that already boast a mix of uses, it may only be necessary for the college to provide academic uses. In this case, the institution adds to the existing mix of uses to produce an overall diversity of uses.

However, on campuses that function more independently of surrounding neighborhoods—either because they are somehow buffered or because the neighborhoods in which they lie lack a functioning mix of uses—it may be necessary to develop non-academic uses on campus to ensure a diversity of land uses. Otherwise, these "institutional islands" are prone to increasing automobile dependence when students, faculty, and staff must drive to and from the campus and commercial and retail establishments.

- ➢ Adding commercial directly to the north of the existing academic core, as well as the residential colleges and faculty/staff housing create a finer-grained mix of uses on and around North Campus.

Take advantage of compact building design

Compact building design can reduce impervious surface area, thereby improving water quality. Similarly, dense development also reduces land consumption, thereby reducing transportation demand (and generally decreasing carbon emissions and other air pollution). This principle transfers directly to college and university development.

No changes to the principle are necessary, partly because compact building is part of the traditional college campus aesthetic; older campuses, developed before elevators and cheap transportation are characterized by three or four story buildings, which made efficient use of the land. Some universities have moved away from these traditional designs in constructing research buildings or when—in the case of private universities—land-use regulations mandate conventional development patterns. The result is a land-consumptive, automobile-oriented design that follows conventional low-density land use patterns.

- ➢ New buildings added in the scenario are around four stories, a height that uses space efficiently without sacrificing the collegiality of the building.

Ensure a range of housing opportunities and choices for students, faculty and staff

The goal of this principle is to provide quality housing in appropriate price ranges for community members at all income levels.[9] In a college setting, this includes students, faculty, and staff. Advocates contend that this is an integral component of Smart Growth, as it produces neighborhoods that have greater diversity of architecture and incomes. If this housing is provided close to or on campus (following the principle of mixing land uses), it may also have the effect of reducing travel demand.

Colleges and universities are also in a unique situation when it comes to housing provision because, while they often have the resources to provide significant quantities of housing, they are likely to find the private market also willing to provide a great deal of housing. Among housing options, however, the private market is least capable of providing a sufficient quantity at an affordable price. This is often because municipal land-use regulations impede the development of denser housing forms. Where such circumstances exist, universities may experience difficulty attracting top faculty due to the cost or accessibility of near-campus housing.

- Residential colleges and on-campus faculty and staff housing provide opportunities that have so far not been offered by either the University or the local private market.

Figure 9. The Walgreen Drama Center is being built on what was a surface parking lot.

Create walkable campuses

Creating walkable spaces is an important component of one of Smart Growth's main goals: reducing reliance on the private automobile for travel. Walkable spaces feature a dense, fine-grained network of sidewalks, trails, and other paths and typically exclude the wide streets and surface parking lots associated with easy automotive access. While a walkable campus does not guarantee reduced automobile travel, it supports such an outcome; creating opportunities to walk between campus destinations may not cause more people to walk, but to not create such opportunities virtually ensures walking will not increase.

- Eliminating surface parking in the core of the campus and not adding "superblock" buildings makes walking on campus easier.

Foster distinctive, attractive campuses with a strong sense of place

For many universities, this principle is redundant and therefore unnecessary, but we include it here nonetheless. An important aspect of creating a desirable, livable place—as Smart Growth tries to do—is the aesthetics of the place. While aesthetics remain subjective, a number of institutions owe part of their reputation to the distinctiveness and attractiveness of their campuses. For example, every tour of the University Michigan stops to take in the 'M' (distinct) on its central campus diag (attractive). Such a memorable space ties the academic institution to a specific place. A similar effect is not likely to be created by institutional structures floating on a sea of grass; it requires attention and care to architectural and landscaping details. These details are what can make each campus distinct from other campuses and from non-campus environments.

- A complete North Campus diag with adjacent commercial space helps here, as does the potential for a Winter Art Fair, but much of the sense of place will be determined by architectural detail that is beyond the scope of this study.

Figure 10. Creating a sense of place: The 'M' on the University of Michigan's Central Campus diag.

Preserve open space, natural beauty, and critical environmental areas where appropriate within the larger context

Open space is critical to the great number of college campuses that are built around a central diag or quad. Public open space is often used as a primary means of creating a sense of place on a campus. Less consideration was given to ecological function in early planning efforts to create open space. For example, development on the University of Michigan's North Campus began in the mid 1950s, but the first environmental survey of the campus was not commissioned until 1978, following the increase in public environmental awareness in the 1960s and 1970s.[10] Greater knowledge of the role that open space can play in protecting wildlife habitat, biodiversity, surface water quality, and groundwater recharge areas gives today's campus planners an opportunity to provide open space that is both ecologically and socially functional.

One challenge in applying this principle lies in determining how much open space to preserve. Compact development often comes into conflict with open space preservation, especially in areas subject to high growth pressure. Developing compactly on a sensitive site may discourage the development of larger and more sensitive sites on the urban periphery, but there is often no means of directly assessing such a tradeoff. For example, how much "sprawling" development is avoided when a university builds an 800-bed dormitory? We interpret this principle to mean greater localized development, provided that open space is easily accessible to campus users. At the same time, care should be taken to minimize development impacts to existing critical environmental features.

- Riparian buffers are respected, and core woodlands are created in the Southwest while the stand of second-growth forest between Hayward and Hubbard is developed to serve the larger goal of decreased private automobile travel.

Strengthen and direct campus development towards existing infrastructure

One of the ways in which Smart Growth aims to conserve resources is by using infrastructure more efficiently, and one means of doing so is to direct new development to areas where necessary infrastructure already exists. For example, rather than leapfrogging new development into the countryside and having to build new utility lines, new development should go where it can tap into existing utilities. This may be city sewer and water or a district heating system. The result is a cost savings in addition to reduced energy and resource consumption.[11]

- This scenario attempts to maximize the development potential of the North Campus property in order to reduce the pressure for development—academic and research, as well as commercial and residential—at the city's edge or on additional satellite campuses.

Provide a variety of transportation choices

In trying to reduce automobile dependence, there is no single alternative mode of transportation that will work for everyone at all times. Smart Growth therefore encourages a variety of modes in order to increase the likelihood that someone making a given trip will choose a mode other than the private automobile.

This goal has several implications for campus planning. One is the need to design for walkability, as outlined in a previous principle. Another is the need to plan for bicycles, including bike lanes and separate bike paths on campuses that own large, contiguous blocks of land, and at the least to provide bike parking at destinations. Indoor bicycle parking and showers for longer-distance bike commuters also help promote bicycling. Finally, bus and rail are considered to be the third piece of the non-personal auto transportation puzzle. While many institutions do not operate their own bus service (and very few, if any, will operate any kind of rail), most will want to work with local municipal providers to ensure their campus is conveniently accessible by transit.

- North Campus already provides effective bus service and automobile access, and the above-mentioned walkability improvements and additional housing should benefit both pedestrians and bicyclists.

Find ways to make development decisions predictable, fair, and cost effective

This Smart Growth principle is aimed at helping private developers embrace Smart Growth regulations. For public institutions that are largely exempt from local development regulations, this principle generally does not directly apply. An institution that is not subject to local regulations is not likely to be concerned with the ease of complying with those regulations. However, a university that embraces Smart Growth principles will want to ensure that development regulations are predictable, fair, and cost-effective for those that will be developing land adjacent to the campus. This principle suggests that such institutions will benefit from greater transparency in local planning decisions as private developers respond with similar types of development about the campus periphery.

- While not addressed in the scenario itself, which is a physical plan, this issue is important for local governments to consider.

Encourage community and stakeholder collaboration in development decisions

Collaborating with campus users, surrounding community members, and municipal staff can lead to campus development that better meets the needs of all these groups. Although the logic is straightforward, the means for achieving this principle are not always so. In general, increased collaboration adds complexity to a process and requires more time and resources. In the campus context, getting student participation in project planning may be difficult if students do not perceive an interest in development that (often) will not be completed before they graduate. Collaborating with the community is likely to require incorporating viewpoints that do not coincide with institutional goals of education and research. This principle contends that the end result of increased collaboration, however, can likely be better development and better relations between students, administrators, and the surrounding community.

- In order to test our second hypothesis it was necessary to design this scenario without formal input from campus users. See the following section for further explanation.

TABLE 9. SCENARIO B: PRINCIPLES AND IMPLICATIONS FOR SCENARIO DEVELOPMENT

Smart Campus Principles	Implications for Campus Development
Ensure a mix of land uses within the larger community	➢ Adding commercial facilities, residential colleges and faculty/staff housing directly north of the existing academic core creates a finer-grained mix of uses on and around North Campus.
Take advantage of compact building design	➢ New buildings added in the scenario are around four stories, a height that uses space efficiently without sacrificing the collegiate character of the building.
Ensure a range of housing opportunities and choices for students, faculty and staff	➢ Residential colleges and on-campus faculty and staff housing provide opportunities that have so far not been offered by either the University or the local private market.
Create walkable campuses	➢ Eliminating surface parking in the core of the campus and not adding "superblock" buildings makes walking on campus easier.
Foster distinctive, attractive campuses with a strong sense of place	➢ A complete North Campus diag with adjacent commercial space helps here, but much of the "sense of place" will be determined by architectural detail that is beyond the scope of this study.
Preserve open space, natural beauty, and critical environmental areas where appropriate within the larger campus context	➢ Riparian buffers are respected, core woodlands are created in the Southwest and the stand of second-growth forest between Hayward and Hubbard is sacrificed to serve the larger goal of decreased private automobile travel.
Strengthen and direct campus development towards existing infrastructure	➢ This scenario attempts to maximize the development potential of North Campus property in order to reduce the pressure for development—academic and research, as well as commercial and residential—at the city's edge or on additional satellite campuses.
Provide a variety of transportation choices	➢ North Campus already provides effective bus service and automobile access, and the above-mentioned walkability improvements and additional housing should benefit both pedestrians and bicyclists.
Find ways to make development decisions predictable, fair, and cost effective	➢ While not addressed in the scenario itself, which is a physical plan, this issue is important for local governments to consider.
Encourage community and stakeholder collaboration in development decisions	➢ In order to test our second hypothesis it was necessary to design this scenario without formal input from campus users.

Alternative "B" - Future build-out scenario for North campus of UM

Vital statistics

Building footprint
- Existing: 1.71 million Sqfts
- New: 2.10 million Sqfts
- Total: 3.82 million Sqfts

Residential units
- Undergrad, grad, staff & faculty:
- 4,240 units

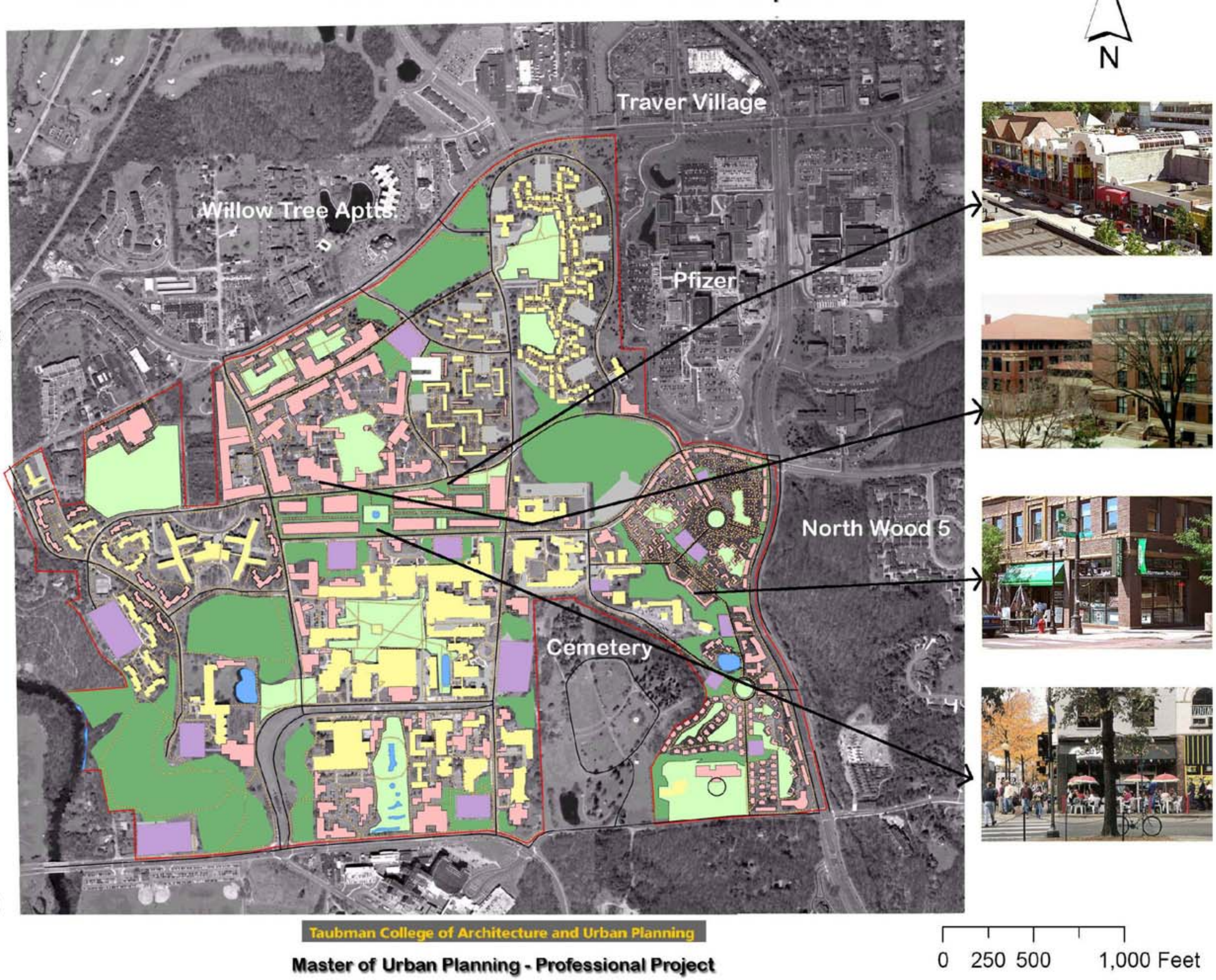
Parking spaces
- 7,232 cars

Woodlots
- 79.84 Acres

# of Commercial facilities
- 35 facilities

Mode of travel: Rail or people-mover

Walkways
Roads
Parking Decks
Proposed Buildings
Existing Buildings
Water Bodies
Surface Parking Lots
Parks
University Owned Land
Woodlots



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Scenario C: Smart Growth + Public Input

As stated in the previous section, public input was not formally incorporated into the development of Scenario B. Although incorporation of public input is a Smart Growth principle, it was necessary to violate this principle in order to test our second hypothesis. The hypothesis posits that the stated preferences of students, staff and faculty can be integrated with the tenets of Smart Growth to yield a more sustainable community than either of the previous two build-out scenarios. To successfully test this hypothesis we needed two scenarios that were identical (based on the same principles) except for the public input variable. The creation of a third scenario, Smart Growth + Public Input (Scenario C), would be developed using a formal public input process and would be compared against Scenario B to assess the extent to which public input can be incorporated to create a more sustainable North Campus.

Despite the titles of the scenarios, Scenario B could be considered an expert-driven Smart Growth scenario because it adheres to only the substantive principles of Smart Growth, while Scenario C could be considered a true Smart Growth scenario because it adheres to *all* of the principles of Smart Growth including those related to process, namely public input in the plan-making process.

Public Input

We used two instruments to obtain the public input that would be used in designing Scenario C: an online survey and a poster session. The online survey asked campus community members about their travel patterns, housing preferences, and interest in faculty and staff housing on North Campus, in addition to asking what they most like and dislike about the "built and natural environment of North Campus." An analysis of these responses provides a sense of what the community's ideal North Campus would look like because the respondents were not asked to rank their preferences or consider tradeoffs between them. For example, a respondent could express a simultaneous desire for two actions that are nearly mutually exclusive in the North Campus setting, such as infill development and preservation of woodlots. For detailed methods and results of both public input instruments, see Appendices E through H.

The poster session involved presenting North Campus users with 24 x 36 inch images of the baseline conditions, Scenario A and Scenario B. Interested passersby were asked to fill out a comment card on which they would indicate the scenario they prefer, why they chose that scenario and what could be done to improve the scenario they selected. The poster sessions forced respondents to consider their likes and dislikes about North Campus in the context of two future scenarios. Asking them to choose which scenario they preferred forced them to prioritize their preferences and consider the tradeoffs between them.

Combining the results from the online survey and the poster sessions provided us with the public input needed to inform the creation of Scenario C. The surveys provided a sense of users' "ideal" North Campus, while the posters gave us a sense of how these ideals could be translated into realistic, on-the-ground development.

Online Survey

Two online surveys, one for faculty and staff and one for students, were sent to random samples of each target population. The Faculty and Staff Survey differed from the Student Survey in that it contained more questions about housing preferences and interest in on-campus faculty and staff housing. A total of 382 North Campus employees completed the Faculty and Staff Survey, with a response rate of 13.5%. The response rate for the Student Survey was slightly higher at 14.8%, although only 178 students completed it.

When asked which campus layout they preferred, that of Central Campus or that of North Campus, a majority of faculty preferred Central Campus (63% of responses) while a majority of staff preferred North Campus (65%). A small majority of students preferred the layout of Central Campus (52%).

TABLE 10. FACULTY AND STAFF - LIKE MOST ABOUT NORTH CAMPUS

	n (%)
Natural Features	378 (67)
Quiet/Suburban	68 (12)
Buildings/Architecture	55 (10)
Diag	18 (3)
Convenient Parking	15 (3)
Like Nothing	6 (1)
Other	25 (4)
Total	**565 (100)**

TABLE 11. FACULTY AND STAFF - DISLIKE MOST ABOUT NORTH CAMPUS

	n (%)
Too Suburban	100 (24)
Buildings/Architecture	64 (16)
Lack of Retail Options	51 (12)
Inconvenient Parking	48 (12)
Too Urban	44 (11)
Not Enough Nature	27 (7)
Construction	24 (6)
Lack of Community	19 (5)
Dislike Nothing	9 (2)
Other	23 (6)
Total	**409 (100)**

As shown in Table 10, faculty and staff most enjoy the natural features, the quiet/suburban character, and the buildings/architecture of North Campus. Table 11 displays what faculty and staff most dislike about North Campus. Interestingly, two of the most well-liked characteristics were also the most disliked. Faculty and staff were not in favor of the suburban character, the buildings/architecture and the lack of retail options on campus.

Tables 12 and 13 list what students like and dislike about North campus. The most well-liked characteristics were the natural features, followed by the buildings/architecture, and the quiet/suburban nature of campus. As with the faculty and staff survey results, two of the students' most well-liked characteristics were also their most disliked. The students were not in favor of the suburban nature and the buildings/architecture. Students also disliked the construction on North Campus.

TABLE 12. STUDENTS - LIKE MOST ABOUT NORTH CAMPUS

	n (%)
Natural Features	120 (49)
Buildings/Architecture	54 (22)
Quiet/Suburban	32 (13)
Compact	12 (5)
Like Nothing	6 (2)
Other	21 (9)
Total	**245 (100)**

TABLE 13. STUDENTS - DISLIKE MOST ABOUT NORTH CAMPUS

	n (%)
Too Suburban	52 (28)
Buildings/Architecture	24 (13)
Construction	24 (13)
Inconvenient Parking	16 (9)
Lack of Retail Options	11 (6)
Lack of Community	8 (4)
Not Enough Nature	7 (4)
Dislike Nothing	9 (5)
Other	32 (17)
Total	**183 (100)**

When asked what specific facilities they thought should be added to North Campus, the top three responses from faculty and staff were food (37% of cited facilities), retail (17%) and parking (9%). The students also suggested food (36%) and retail (12%), but cited recreation facilities (10%) as the third.

In the Faculty and Staff Survey, employees were asked to indicate their interest in on-campus housing. Overall, 51% of all faculty and staff were interested in more housing options for them on North Campus. Specifically,

- 35.9% of faculty and staff (48% of faculty and 33% of staff) were at least somewhat interested in purchasing a single-family lot on North Campus
- 32.2% of faculty and staff (47% of faculty and 28% of staff) were at least somewhat interested in purchasing a condo on North Campus
- 30.1% of faculty and staff (33% of faculty and 23% of staff) were at least somewhat interested in long-term rental units on North Campus

Poster Sessions

The results from the poster sessions were consistent with the results of the online survey. As shown in Table 14, the public display boards elicited 310 responses. Scenario B (Smart Growth) was the clear favorite, receiving twice as many votes as Scenario A (Existing Trends).

TABLE 14. SCENARIO PREFERENCE.

Scenario	n (%)
A	103 (33)
B	207 (67)
Total	**310 (100)**

Table 15 highlights the reasons why those respondents who preferred Scenario A did so. For the 103 respondents who chose Scenario A, the three most popular reasons were because it has more natural spaces and more suburban character than Scenario B and because it does not mimic Central Campus.

TABLE 15. MOST COMMONLY CITED REASONS FOR CHOOSING SCENARIO A

Reason	Frequency	% of Votes	% of Reasons
Natural spaces	45	44%	35%
Suburban	30	29%	23%
Not Central Campus	13	13%	10%
Less commercial	10	10%	8%
Likes North Campus	6	6%	5%
Other	25	24%	19%
Total	**129**	**125%**	**100%**

Table 16 lists the most common suggestions for improving Scenario A, as provided by those who preferred it. The most frequent suggestions included more parking, more natural spaces, and more food.

TABLE 16. MOST COMMONLY CITED SUGGESTIONS FOR IMPROVING SCENARIO A (FROM THOSE WHO PREFERRED SCENARIO A)

Improvement	Frequency	% of Votes	% of Suggestions
More parking	18	18%	23%
More natural spaces	15	15%	19%
More food	6	6%	8%
Less commercial	2	2%	3%
More academic space	1	1%	1%
Other	31	30%	39%
Total	**79**	**77%**	**100%**

Table 17 highlights the reasons why those respondents who preferred Scenario B did so. For the 207 respondents who chose Scenario B, the top three reasons were because it is more urban, has more activity, and more commercial uses than Scenario A.

TABLE 17. MOST COMMONLY CITED REASONS FOR CHOOSING SCENARIO B

Reason	Frequency	% of Reasons	% of Votes
Urban	51	17%	25%
Activity	33	11%	16%
Commercial	29	10%	14%
Main street	24	8%	12%
Parking	23	8%	11%
Quality of life	21	7%	10 %
Like Central Campus	17	6%	8%
Other	95	32%	46%
Total	**293**	**100%**	**142%**

Table 18 lists the most common suggestions for improving Scenario B, as provided by those who preferred it. The most frequent suggestions included more natural spaces, more parking, and less development.

TABLE 18. MOST COMMONLY CITED SUGGESTIONS FOR IMPROVING SCENARIO B, FROM THOSE WHO PREFERRED SCENARIO B

Improvement	Frequency	% of Votes	% of Suggestions
More natural spaces	27	13%	25%
More parking	14	7%	13%
Less development	8	4%	7%
More housing	6	3%	6%
More food	4	2%	4%
More entertainment	4	2%	4%
Other	45	22%	42%
Total	**108**	**52.2%**	**100.0%**

DESIGN OF SCENARIO C

The survey showed that users like the natural character of North Campus but would like more retail services, food options and parking. The poster session provided specific feedback on Scenario B, with respondents suggesting that it could be improved by adding more natural spaces, more parking and reducing the amount of development.

Although less weight was given to the comments of those who preferred Scenario A in the poster session, we considered their suggestions for more parking, natural spaces and food.

In response to these concerns, we made changes to Scenario B to create Scenario C. The changes were not dramatic because Scenario B actually addresses many of the concerns of faculty, staff and students. Scenario C increases the amount of retail space, parking per capita and activity on campus by adding more nighttime uses such as a commercial district and more housing.

To incorporate the widespread desire to keep natural spaces on North Campus, we restricted development in a few areas of Scenario C to preserve larger sections of woods and also restored lawns and open spaces to more natural prairies and woodlots. To reflect the desire for more parking we added floors to the proposed parking decks.

Notes:

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[4] VSBA. 1998. The University of Michigan Campus Plan: Phase I Overview. Venturi, Scott Brown, and Associates, Inc. April 22, 1998.

[5] UMOP. 2005. "Mission Statement." University of Michigan Office of the President. Accessed via internet on November 18, 2005 at: http://www.umich.edu/pres/mission.html

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[7] Shearer, Allan W. 2005. "Approaching scenario-based studies: three perceptions about the future and considerations for landscape planning," Environment and Planning B: Planning and Design 32, 67-87.

[8] Jean, Amyar. 2004. New Dorm Will Replace Frieze (Part I). Michigan Daily. October , 1.A.

[9] SGN. 2005. Smart Growth Network. Accessed via Internet on October 28, 2005 at: http://www.smartgrowth.org

[10] JJR. 1984. North Campus Planning Study. Johnson Johnson & Roy, Inc

[11] Burchell, R. W., and S. Mukherji. 2003. Conventional Development Versus Managed Growth: The Costs of Sprawl. American Journal of Public Health 93, 1534-1540.

Alternative "C" - Future build-out scenario for North campus of UM

(Based on smart growth tenets + user input)

N

Vital statistics

Building footprint

Existing: 1.71 million Sqfts

New: 2.22 million Sqfts

Total: 3.93 million Sqfts

Residential units

Undergrad, grad, staff & faculty:

4,409 units

Parking spaces

9,025 cars

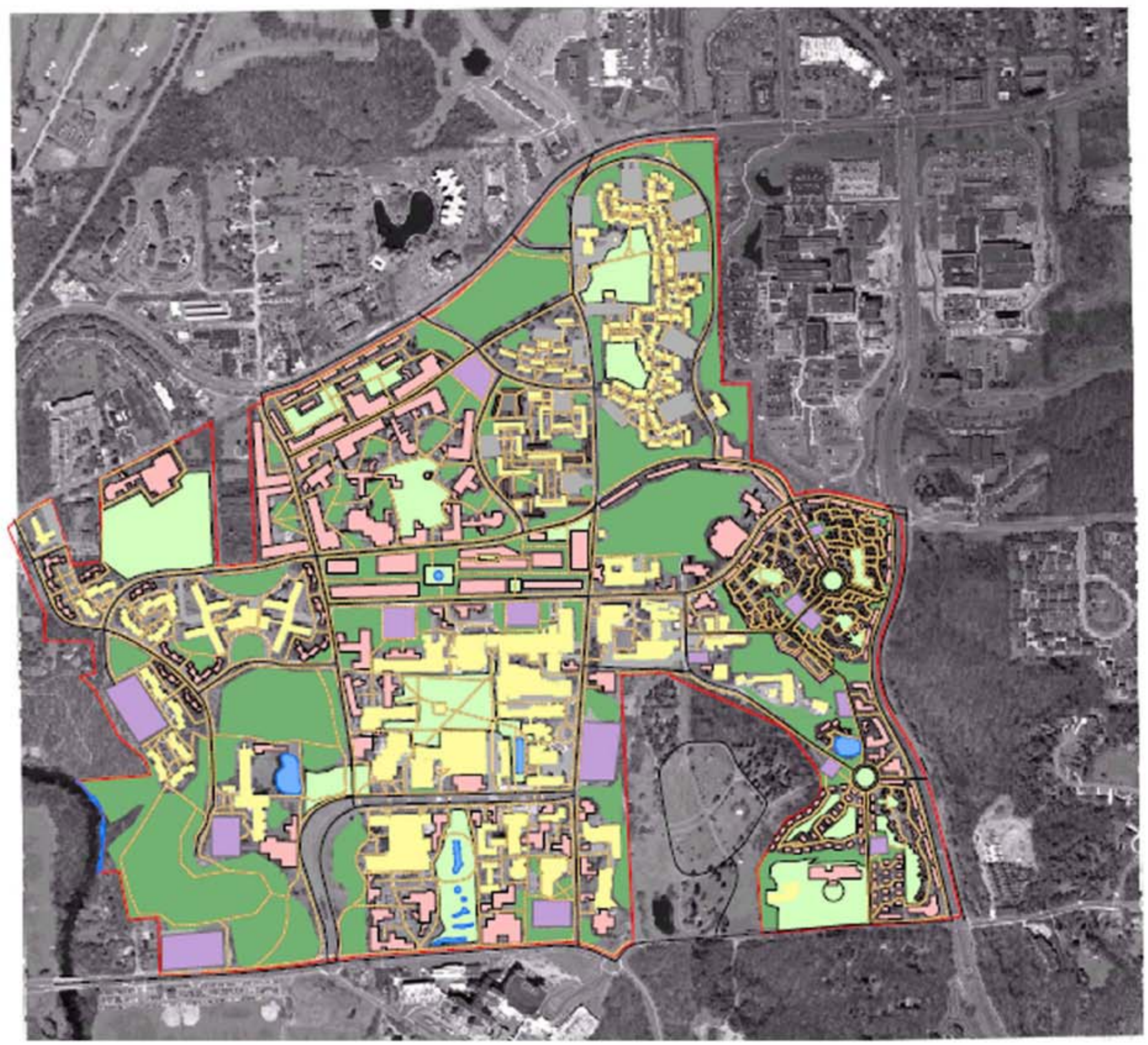
Woodlots

100.76 Acres

# of Commercial facilities

35 facilities

Mode of travel: Rail or people-mover



- Walkways
- Roads
- Parking Decks
- Proposed Buildings
- Existing Buildings
- Water Bodies
- Surface Parking Lots
- Parks
- University Owned Land
- Woodlots

Taubman College of Architecture and Urban Planning

Master of Urban Planning - Professional Project

0 250 500 1,000 Feet

3. RESULTS AND CONCLUSIONS

This results section is divided into two parts. The first discusses specific results from the case study and the degree to which they supported our hypotheses, followed by further discussion about what this might mean for the University of Michigan as it moves forward with developing North Campus. The second section discusses results relating to our model: Does indicator measurement of scenarios work and which parts of the model are more likely to be transferable to other universities.

CASE STUDY RESULTS

The process of measuring each indicator generated a wealth of data about the North Campus population and environment. These data allowed for analysis beyond the scope of the indicators described at the beginning of this study. Where additional analyses could assist in communicating the results of the study, we included them below.

Several indicators include a per capita measure, where the feature being measured is consumed primarily by humans. This necessitated the derivation of population figures for the North Campus, which is both an employment center and a residential community. To do this, we obtained population data from the Office of the Registrar and the University Housing Department. These data revealed the current number of students enrolled in colleges on North Campus, the number of employees (staff and faculty) with work addresses on North Campus and the number of undergraduate and graduate students living in university housing on North Campus.

We also adjusted the calculation to avoid double counting students and employees who both reside and study or work on North Campus. Future scenario student/employee populations were based on current ratio of students and employees to the gross floor area of academic and research buildings on North Campus. The resident population for future scenarios was derived from an average number of residents assigned to each unit type. A double-counting adjustment was also applied to the future scenario population projections.

Since the North Campus student and undergraduate resident populations dramatically reduce in the summer months, population calculations were run separately for the peak months of September to April and the off peak months of May to August. These separate totals were combined to create a weighted average population for each scenario.

Environment: Percent Forested Riparian Buffer

The only riparian feature present on North Campus is the Huron River, which abuts University owned property on the Southwestern corner of our study area. Presently, the area within 100 feet of the river is completely forested. The buffer is situated several hundred feet from the nearest current development -- the Moore Building, which houses the School of Music, and the curved roadbed of Bonisteel Boulevard.

According to the assumptions that guided scenario creation, this buffer area remained completely forested in each of our scenarios. This indicates that future North Campus development of any type is unlikely to encroach upon this ecologically sensitive area. The University-owned property adjacent to the east bank of the Huron River is protected by one of the largest forest patches in our study area and is set back from the present Campus road network.

Figure 13 below displays the present situation of the University owned buffer area. Due to the buffer's remote location on North Campus and the relatively small tolerance of 100 ft., this area remained undisturbed by development in all three scenarios. Other university campuses that have rivers and streams that run through university property or have a longer stretch of property that borders a riparian body would face greater challenges in preserving a riparian buffer area.

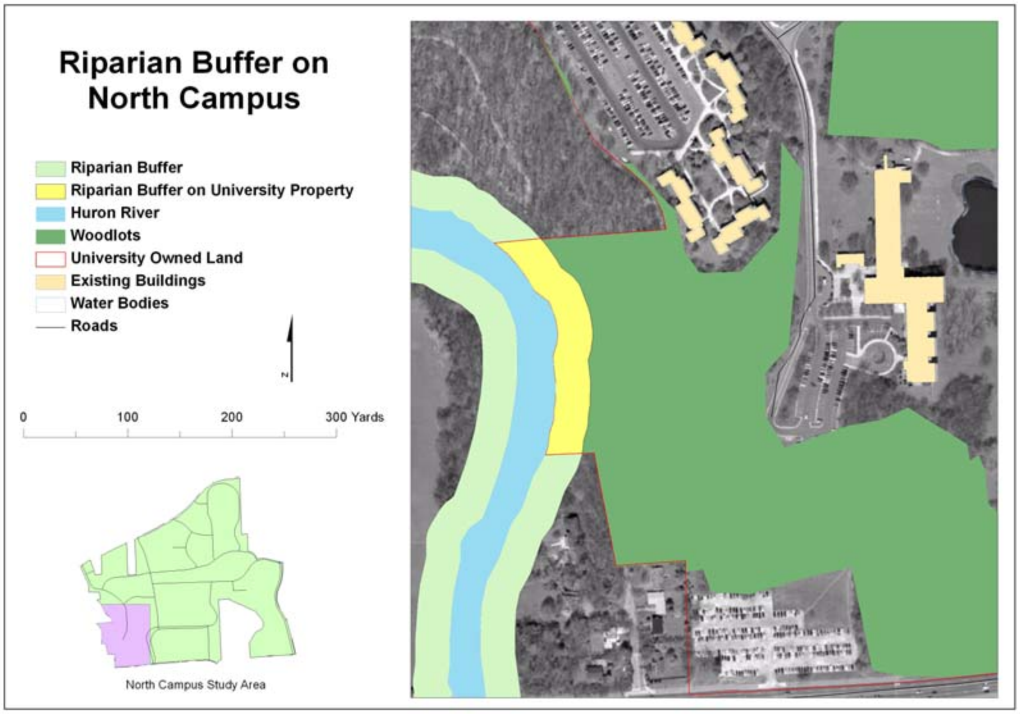


Figure 13. The yellow area represents riparian buffer that intersects the study area.

Environment: Interior Forest

Interior forest measures the amount of forest area that is at least 100 meters from the forest edge, which would provide habitat for some native bird species that avoid proximity to human settlement. Applying this indicator to present-day North Campus revealed that there is currently no interior forest within our study area. According to this measure, the current woodlots provide habitat only for animals that adapt to human proximity and therefore thrive in forest edge (such as deer and raccoons). This indicator does not measure the quantity or quality of this forest edge habitat, but does reveal that the diversity of species on North Campus is limited by the absence of an entire category of habitat.

When applying this indicator, none of the scenarios resulted in the creation of a patch of forest that was of a sufficient size or shape to constitute a core forest habitat area. A close examination of the forested areas of North Campus reveals no areas that could potentially develop significant interior forest area. An insignificantly small core forest patch could be created in the Southeastern corner of the study area if two surface parking lots were removed and converted to forest. Such a small core area is of questionable ecological value, however, and would not change the results of the indicator significantly.

Environment: Managed Greenspace

This indicator tries to balance the genuine human need for the presence of visible and accessible green space with the negative environmental impact associated with the maintenance of managed green areas like turf grass. To this end, green areas were divided into categories of artificial green (green spaces maintained with fertilizers, pesticides, mowing) and natural green (forested spaces that do not receive regular maintenance). Eliminating artificial green with its associated pollutants and high energy requirements is neither feasible nor desirable, but minimizing the amount of artificial green in total amount, in proportion to total green area, and per campus user would represent a more sustainable situation.

The portion of North Campus within our study area currently has 190 acres of artificial or high-maintenance green space that requires the application of fertilizer, pesticides and mowing with gas powered machines. It also currently has 121 acres of natural or low-maintenance green space, which requires fewer soil amendments and pesticides. This means that under current conditions, according to the artificial green indicator, 61 percent of all vegetated areas on North Campus are intensively managed.

Regarding Scenario A, the total number of acres of artificial green increased to more than 200, while acres of natural green slipped to 99 acres. This resulted in an artificial to total green ratio of 0.68 for Scenario A. Due to increased development in Scenario B, the amount of artificial green increased slightly to 198 acres while the number of natural green acres decreased sharply to 79, resulting in an artificial to total green ratio of 0.71. Finally, with small patch reforestation efforts in Scenario C, the artificial green

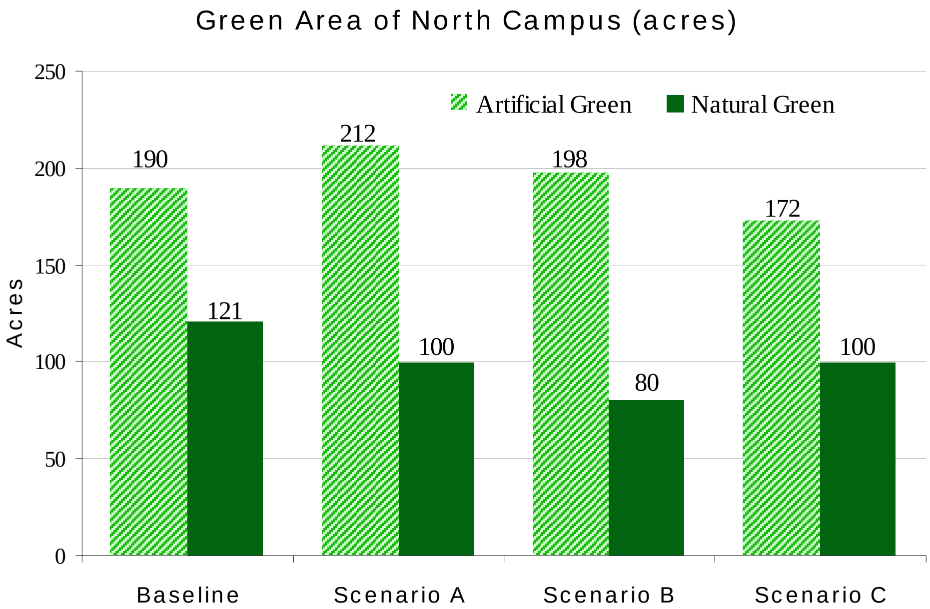


Figure 14. Comparing the acreage of Artificial and Natural Green across scenarios.

decreased to 172 acres, 12 acres less than present conditions. At the same time, the amount of natural green was very similar to Scenario A with 100 acres. This resulted in an artificial to total green ration of 0.63, the most desirable of the three build out scenarios.

Table 19. Results of the Managed Greenspace Indicator

Scenario	Artificial Green	Natural Green	Total Green	Ratio of Artificial to Total Green
Baseline	190	120	310	0.61
Scenario A	212	99	311	0.68
Scenario B	198	79	277	0.71
Scenario C	172	100	272	**0.63**

Table 20. Results of Campus Population Model

Scenario	Peak Population	Off-Peak Population	Ratio of Off-Peak to Peak
Baseline	11,331	3,760	0.33
Scenario A	19,315	3,551	0.18
Scenario B	24,056	9,747	0.41
Scenario C	29,562	10,958	0.36

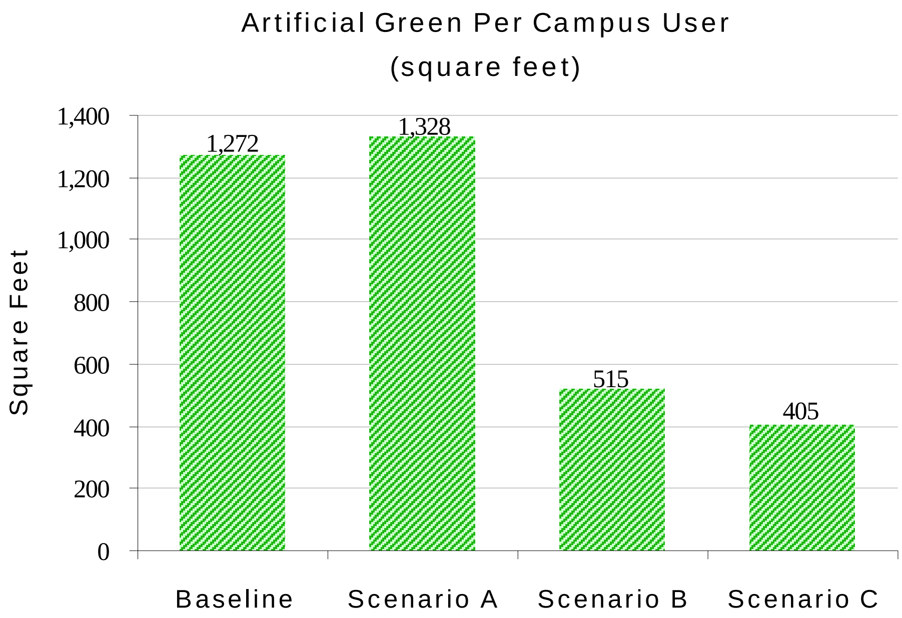


Figure 15. Artificial Green space (in square feet per campus user) across scenarios.

Population estimates were also used to calculate artificial green per capita, which reveals the amount of high-maintenance green space provided for each student, employee and resident. The results show that Scenario A will provide over 1,300 square feet of artificial green space for each campus user, the size of spacious apartment. This is a slight increase over the present amount of artificial green space per person. With an overall increase in campus users as well as a more stable residential population, Scenarios B and C reduce this number to around one-third the per capita area of Scenario A. This is a significant decline, and to the extent that campus users would otherwise have worked at locations with more artificial green per capita, Scenarios B and C may reduce the total area of artificial green in the watershed.

Environment: Impervious Surface Area and Impervious Surface Per Capita

Per capita measures of impervious surface in the build-out scenarios yielded results similar to those of artificial green per capita, with more than 1,300 square feet provided for each student, employee and resident in Scenario A. Per capita imperviousness drops in both Scenario B (500 ft^2) and Scenario C (400 ft^2). This suggests that, according to the

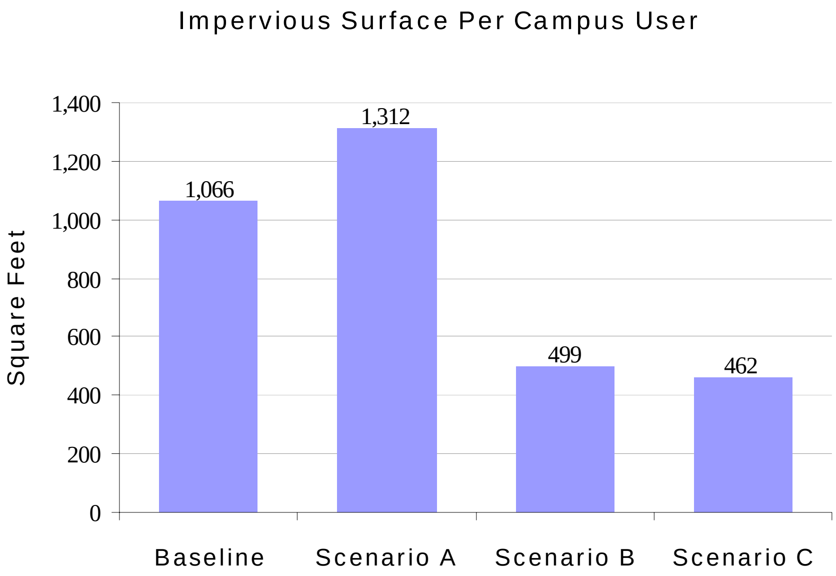


Figure 16. Comparing Impervious Surface Area across scenarios on a per capita basis.

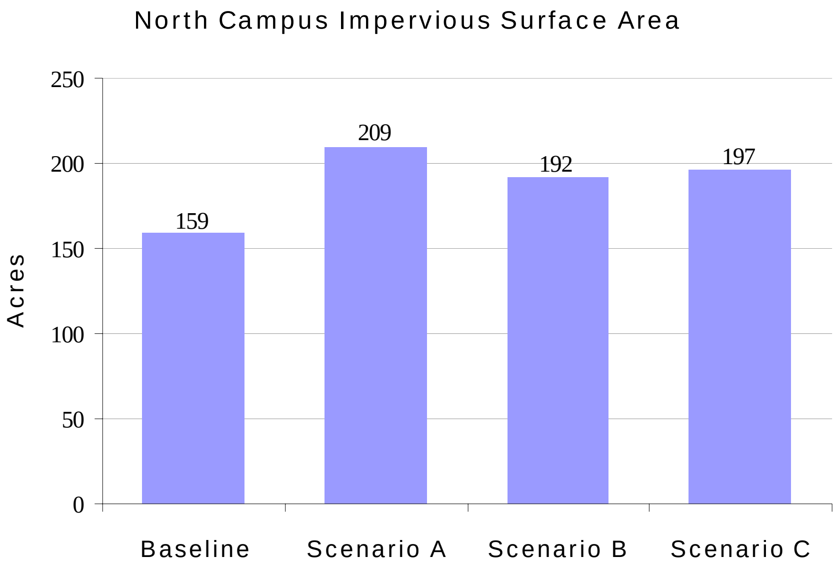


Figure 17. Comparing total Impervious Surface Area across scenarios.

Impervious Surface Per Capita indicator, Scenario A is far less sustainable than Scenarios B or C.

When considering total imperviousness, all three future scenarios have a similar amount, with Scenario A just above 200 acres and Scenarios B and C just below 200 acres. This suggests that the significant increases in population density and use of University facilities present in Scenarios B and C does not necessarily entail an increase in area of impervious surface. In fact, our model showed a slight decline in total impervious area in Scenarios B and C when compared with Scenario A.

Since all conventional human settlements require construction with impervious materials, population growth means an expansion of impervious surface areas. Without changing population growth rates, impervious surface areas can be adjusted by 1) using currently unconventional construction materials that are less impervious, or 2) build a campus that increases the efficiency that impervious surfaces are used (less impervious surface per capita). Since Scenario A does not provide for employee housing or expanded student housing, the total of impervious surface for the Ann Arbor region would likely increase to an amount much greater than the 200 acres estimated for Scenario A.

Economy: Ratio of Academic GFA to Total Building GFA

The University of Michigan focuses on providing facilities for academic instruction and research. In general, the institution relies upon the private market in the greater Ann Arbor area to supply facilities for housing, food and other non-academic services. The university does supply residence halls with dining facilities for first and second year undergraduate students, graduate housing units, and space for a cafeteria, restaurant, office supply store and coffee shops on North Campus. The commercial facilities present on North Campus are not viewed as income producers for the University. In some cases, the University even subsidizes the operation of these facilities.

Under this current approach, the University maintains flexibility in expanding academic and research facilities in order to respond to funding trends and remain competitive with other research universities. Remaining competitive also requires providing facilities and services that will attract top researchers who will increase the prestige of the institution. However, if the University provides space for a restaurant at the expense of space for a potential research lab, the University has limited its future capacity to bring in research funding.

According to people familiar with North Campus planning, commercial facilities tend to suffer in evenings, weekends, and during the summer and winter breaks, when the number of people using the North Campus facilities drops precipitously. Larger, more permanent, populations may generate greater around-the-clock demand for commercial facilities during present off-peak periods. The increased variety of commercial services on or near North Campus is directly linked to reducing the disparity between peak and off peak populations. This can be accomplished either by adjusting academic programming so that classes are offered and attended at similar intensities year-round, or creating more residential opportunities on North Campus, or both.

The measurement of academic and research space across our future scenarios shows, first, that total Gross Floor Area (GFA) will expand in all scenarios, but also that development will be significantly greater in Scenarios B and C. Second, the amount of GFA dedicated to academic and research facilities is basically equal across all scenarios. This indicates that the choice between academic research space and other types of development is in fact not an either/or choice. Third, the Existing Trends Scenario (Scenario A), in which the University channels its resources almost entirely into expanding academic and research space, has the highest proportion of building space dedicated to academics and research. In other words more than half of the floor space of North Campus will be dedicated to the University's core function, a significant increase over the baseline ratio of 0.36. It is also interesting that the smart growth scenarios have very similar ratios to the present day situation.

TABLE 21. RESULTS OF THE ECONOMIC INDICATOR

	RATIO OF ACADEMIC AND RESEARCH GFA TO TOTAL GFA
Baseline	0.36
Scenario A	0.53
Scenario B	0.37
Scenario C	0.38

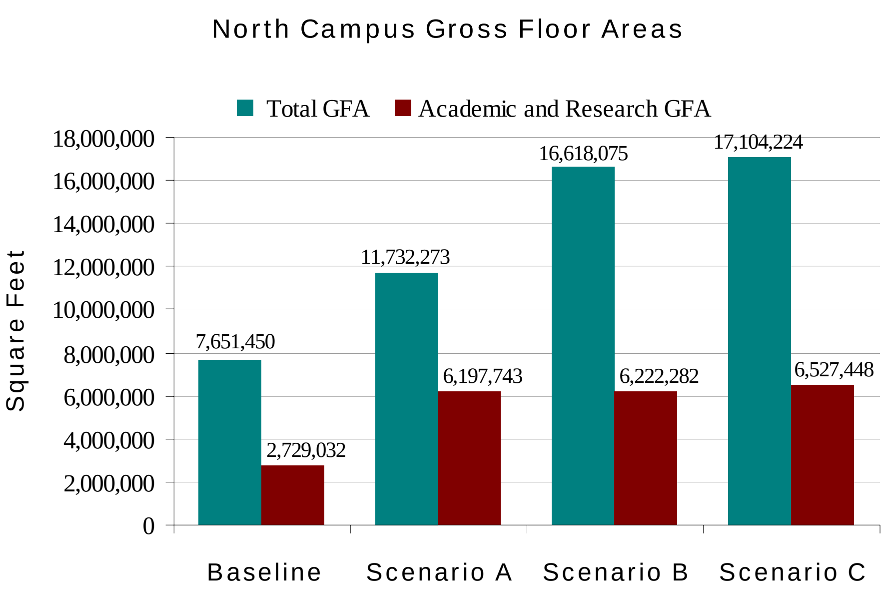


Figure 18. Comparing Gross Floor Areas (GFAs) across scenarios.

The ratio in Table 21 measures economic health based on conventional understandings of university's mission, organization and development. However, since the maximum number of research dollars the University receives is determined in part by the total GFA of its academic research facilities, this ceiling of Academic and Research GFA is virtually the same across all three scenarios. This suggests that Scenarios B and C would not restrict the potential for academic and research building expansion on North

Campus. In spatial terms, all three scenarios would provide equivalent economic capacity in regards to conventional university development. Depending on the administration and financial structure of the commercial and residential facilities, the additional development could potentially be revenue producers for the University.

Equity: Commute Time and Affordable Housing

The commute and affordable housing indicators for social equity turned out to be the most conceptually challenging and computationally difficult of the six. Despite our best attempts to streamline the process by using macros for automation, this composite indicator took considerably more time to compute than the others. Further, this indicator as it is presently structured works in the Ann Arbor, MI context, where housing in the city in general is more expensive than in the areas outside the city. A university that is located near the center of a major metropolitan city may have the opposite pattern with the most affordable houses located in a low-income area near the campus and more expensive homes located in the surrounding suburbs. The choice to measure commute time rather than commute distance seeks to resolve some transferability issues by recognizing that housing values tend to increase near transportation improvements and transportation improvements tend to disproportionately serve wealthier areas. Therefore, two employees living equal distances from campus but with significant differences in income should have similar differences in commute time.

This relationship between commute time and income is also linked to housing prices in the Ann Arbor area. Housing values and rents in Ann Arbor are higher than the surrounding cities and townships, allowing at least higher income university employees residential location options near their place of employment. Meanwhile, lower income university employees tend to reside farther away from the University, where housing values and rents are more affordable. Reducing commute times for lower income employees would require policy decisions that increased the number of affordable units near University facilities, either by increasing the supply of such units to meet demand or providing subsidies to the qualifying employees.

In analyzing the residential location data for North Campus employees, we found a pattern in which higher paid university employees had significantly shorter commute times than lower paid employees. Employees designated as faculty have higher incomes in general and have a mean commute time of 12 minutes, while the lower income staff have a mean commute time of 20 minutes. This means that, on average, for every minute a faculty member travels to work, a staff member travels 1.7 minutes. This constitutes a heavy burden for employees who cannot afford housing in Ann Arbor. Even though these employees earn less, they have higher transportation costs both in terms of time and money. Any rise in fuel price will disproportionately affect the University’s lowest paid employees since they tend to live farther away.

In environmental terms, any policy that reduces vehicle miles traveled to campus by any group of university employees translates into less environmental impact, resulting from reduced fuel consumption and emissions. In equity terms, any university policy that reduces vehicle miles traveled in employee work commutes must also aim to reduce the disparity between faculty and staff commute times until they are at least roughly equivalent. In the case of North Campus employees, the current 1.7 ratio between faculty commute time and staff commute time would reduce to 1 in a situation of strict equity.

To apply this indicator to the Existing Trends Scenario (Scenario A), we assumed that the University would continue its current practice of relying on the private housing market in the Ann Arbor region to provide residences for all its employees. Although population growth and infrastructure expansion on the urban edge will likely lead to and an upward push on the current 1.7 ratio (i.e. yielding a greater disparity in equity), for simplicity the current ratio was preserved as the outcome for future employees in the Existing Trends Scenario. The Smart Growth Scenario (Scenario B) and the Smart Growth with Public Input Scenario (Scenario C) both include the provision of employee housing on North Campus. To apply the equity indicator, we posited a university policy that would assist employees who could not afford a mortgage in Ann Arbor. We then looked at how employee housing on North Campus with varying levels of affordability affected the ratio of faculty commute time to staff commute time.

For the purposes of this indicator, we defined those employees who would occupy the affordable units as those who would need to devote more than 30 percent of their income to the average mortgage payment for Ann Arbor, according to the 2000 U.S. Census. This definition is different than a typical affordable housing standard, in which a household would qualify if its income is below a percentage of the area's median income.

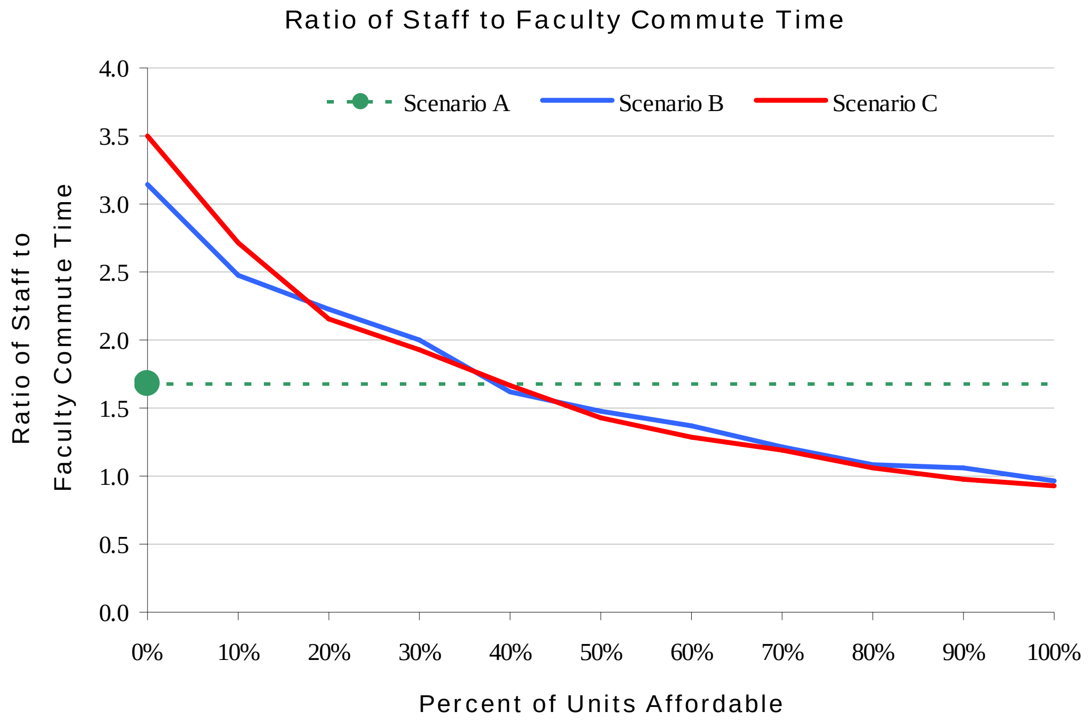


Figure 19. Comparing Staff and Faculty Commute Times Across Scenarios.

Figure 19 indicates that an equitable situation for North Campus employees, given the number of employee housing units in each scenario, would be attained as the ratio approaches 1. With Scenario A, which has no employee housing on campus, the ratio is held constant to the baseline ratio of 1.7 and so never approaches or moves away from 1. The other two scenarios both have around 800 units of staff and faculty housing and the commute time ratio approaches 1 when about 80 percent of the units are designated affordable. It is also important to note that Scenarios B and C have ratios greater than 1.7 until around 40 percent of the employee units are designated as affordable. This means that inequity in commute time actually increases if on-campus employee housing is made available at market rates, since the employees who could afford the units already live closer on average than those who cannot afford an Ann Arbor mortgage payment.

In environmental terms, Scenarios B and C eliminate automobile commutes to North Campus for around 800 employees, provides immediate access to a high frequency transit system, and locates them within walking distance of an urban commercial center. For employees that locate on North Campus, these smart growth scenarios allow at least the opportunity for a substantial reduction in vehicle miles traveled and a similar reduction in the pollutants associated with car travel. These environmental benefits could be realized without any consideration for affordable housing in the policy. However, the maximum reduction in vehicle miles traveled would require the relocation of the employees that live the furthest distances from North Campus, which on average are lower income employees.

In equity terms, these results also suggest that the University could exercise broad discretion in instituting an affordable housing policy that creates a situation that is more sustainable than the present conditions. Concerning Scenarios B and C, as long as the University designates at least 40 percent of the employee units as affordable, the result is more sustainable than Scenario A, which relies on local zoning laws and market values to determine the location of affordable housing.

SCENARIO DISCUSSION

In considering which scenario performs the best across this set of indicators, it is instructive to consider our hypotheses:

- A build out scenario that follows smart growth tenets (Scenario B) will yield more sustainable outcomes than the likely build-out scenario based on existing development trends (Scenario A).
- The stated preferences of students, staff and faculty can be integrated with the tenets of smart growth to yield a result (Scenario C) that is at least as sustainable as the previous two scenarios.

To answer these hypotheses the individual indicator results will be compared separately, rather than combining all of the indicators into one final indexed ranking. The individual indicators will evaluate absolute results, as well as per capita and ratio measures where applicable. Our final analysis of the overall sustainability of scenarios will consider the performance of each scenario across the six indicators chosen for this case study.

This model is not intended to provide a comprehensive measure of total sustainability at a university. Rather, these indicators were selected to be appropriate to this particular university context and guide development to create a more sustainable situation at the University of Michigan.

Environment: Riparian Buffer

TABLE 22. RESULTS OF THE RIPARIAN BUFFER INDICATOR

INDICATOR	METRIC	EXISTING TRENDS SCENARIO A	SMART GROWTH SCENARIO B	SMART GROWTH WITH PUBLIC INPUT SCENARIO C
Riparian Buffer	Forested Buffer Area	67,023 ft²	67,023 ft²	67,023 ft²
	Ratio: Forested Buffer Area to Total Riparian Buffer Area	100%	100%	100%

- Scenarios A, B and C all leave the entire Riparian Buffer on university property undeveloped, achieving the best possible score for this indicator.

Environment: Interior Forest

TABLE 23. RESULTS OF THE INTERIOR FOREST INDICATOR

INDICATOR	METRIC	EXISTING TRENDS SCENARIO A	SMART GROWTH SCENARIO B	SMART GROWTH WITH PUBLIC INPUT SCENARIO C
Interior Forest	Interior Forest Area	0 ft²	0 ft²	0 ft²

- Presently on North Campus there is no forested land that has any interior forest area, given a 100 meter buffer zone. After examining the three scenarios, none of them assembled a future forest patch that had sufficient size and bulk to contain an interior forest area.

Environment: Managed Greenspace

- Scenario B resulted in 14 fewer acres of Artificial Green area than Scenario A.
  - This is a relatively small difference compared with the size of the total study area, but still would constitute a significant long term reduction in fertilizer, pesticides and energy outputs on North Campus.
- Scenario A scored a lower, more favorable, ratio of Artificial Green to Total Green area by 3 percent.
  - This difference would not significantly change the relationship between Artificial and Natural Green space on North Campus.

TABLE 24. RESULTS OF THE MANAGED GREENSPACE INDICATOR

INDICATOR	METRIC	EXISTING TRENDS SCENARIO A	SMART GROWTH SCENARIO B	SMART GROWTH WITH PUBLIC INPUT SCENARIO C
Artificial Green	Artificial Green Area	212 acres	198 acres	172 acres
	Ratio: Artificial Green to Total Green	0.68	0.71	0.63
	Artificial Green Area Per Capita	1,328 ft^2/pop	515 ft^2/pop	405 ft^2/pop

- The largest difference between the two scenarios occurred in the comparison of Artificial Green area per capita, with Scenario B generating 813 ft^2 less per user than Scenario A.
    - This result has potential regional implications, since more people would make use of the Artificial Green space on North Campus and perhaps reduce the pressure to convert unmanaged land cover to turf grass.
- Scenario C compares favorably with to the first two scenarios for this indicator in area, ratio and per capita measures.
    - Its total Artificial Green area is a sizable 40 acres fewer than Scenario A and 26 Acres fewer than Scenario B.
    - In per capita terms, Scenario C improves upon Scenario B's large reduction in the Artificial Green area provided for every employee, student and resident.
    - Unlike Scenario B, Scenario C scored more favorably in the ratio measure than Scenario A.

Environment: Impervious Surface

TABLE 25. RESULTS OF THE IMPERVIOUS SURFACE INDICATOR

INDICATOR	METRIC	EXISTING TRENDS SCENARIO A	SMART GROWTH SCENARIO B	SMART GROWTH WITH PUBLIC INPUT SCENARIO C
Impervious Surface	Impervious Surface Area	209 acres	192 acres	197 acres
	Impervious Surface Area Per Capita	1,312 ft^2/pop	499 ft^2/pop	462 ft^2/pop

- The Impervious Surface results echo the Artificial Green results, both in total area and area per capita, for Scenarios A and B.
    - There is a modest, 17 acre, difference in impervious surface area in favor of Scenario B.

- There is a large improvement in Impervious Surface per capita for Scenario B, totaling 813 fewer square feet per campus user than Scenario A.

➢ Scenario C has similar results to Scenario B, scoring favorably compared with Scenario A in area and per capita measures.

- Scenario C results in 12 fewer total acres of Impervious Surface and 850 fewer square feet per campus user than Scenario A.
- Although Scenario C's results are very similar to Scenario B, its performance is mixed in a direct comparison. Scenario C results in 5 more acres of Impervious Surface, but 37 ft^2 fewer per captia than Scenario B.

Economy: Academic and Research Facilities

TABLE 26. RESULTS OF ECONOMIC INDICATOR

INDICATOR	METRIC	EXISTING TRENDS SCENARIO A	SMART GROWTH SCENARIO B	SMART GROWTH WITH PUBLIC INPUT SCENARIO C
Academic and Research Facilities	Academic and Research Gross Floor Area	6,197,743 ft^2	6,222,282 ft^2	6,527,448 ft^2
	Ratio: Academic and Research to Total GFA	0.53	0.37	0.38

➢ There is a very small difference between the total Academic and Research GFA of Scenario A and Scenario B.

- Scenario B has a total of 24,539 ft^2 more Academic and Research GFA than Scenario A. This difference expressed as a percentage of the Academic and Research GFA of either scenario is less than one half of one percent.

➢ These roughly equivalent area figures indicate that the University would have the same capacity to attract research dollars in either Scenario A or B.

➢ The ratio measurement shows a significant difference between Scenario A and Scenarios B and C.

- This ratio measurement basically measures conventional campus development practice. This ratio improves as more building space is dedicated to academic and research functions and more accessory uses, such as housing, food, and recreation are located off-campus. Scenario A scores better in this ratio since one of its design goals was to maximize the amount of academic and research space in new development.
- Since all three scenarios have similar Academic and Research GFA totals, the difference in ratio is due to the construction of facilities for residential and commercial uses in Scenario B and C. This places doubt on the usefulness of this ratio measure to point to economic health, since

Scenario B and C actually increase the total academic and research space on the campus.

- The results also suggest that it is possible for the University to become much more sustainable in terms of equity and the environment without sacrificing its economic development potential. In other words, it is not an either/or choice.

➢ Scenario C results in significantly more total Academic and Research GFA than Scenarios A and B.

- Scenario C has 329,705 ft² more Academic and Research GFA than Scenario A. This is over a 5 percent increase when expressed as a percentage of the total Academic and Research GFA of Scenario A.

- This additional Academic and Research GFA in Scenario C translates into a slightly higher capacity for North Campus colleges to attract research dollars.

Equity: Commute Time and Affordable Housing

TABLE 27. RESULTS OF COMMUTE TIME AND AFFORDABLE HOUSING INDICATOR: RATIO OF STAFF TO FACULTY COMMUTE TIME

	PERCENT OF UNITS AFFORDABLE										
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Existing Trends: Scenario A	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Smart Growth: Scenario B	3.1	2.5	2.2	2.0	1.6	1.5	1.4	1.2	1.1	1.1	1.0
Smart Growth with Public Input: Scenario C	3.5	2.7	2.2	1.9	1.7	1.4	1.3	1.2	1.1	1.0	0.9

➢ Consistent with present practices, Scenario A relies completely on the private housing market to supply residences to University employees. The commute time ratio will fluctuate according to regional housing market conditions. However, absent longitudinal data, it was assumed that the existing ratio of 1.7 would remain representative for North Campus employees.

➢ If Ann Arbor housing values and rents continue to increase and the Ann Arbor urban area continues to expand into surrounding rural lands, this 1.7 ratio will likely increase for Scenario A since the lower cost residential options will be located further from North Campus than present conditions.

➢ Scenarios B and C, which both include the development of employee housing, provide a variety of policy options that will improve the equity of transportation costs among university employees.

- Enacting a policy that supplements the housing payments for at least 40 percent of the units would improve equity among university employees.

- Enacting a policy that supplements the housing payments of all the units would create a situation in which faculty and staff have equivalent commute times.

- Developing employee housing on North Campus without any policy to address affordable housing would still reduce the average commute distance of university employees and so produce an environmental benefit, but also create a significantly less equitable situation.

Results Summary

In general, these indicators demonstrate that Scenario B (Smart Growth) results in a higher level of sustainability than Scenario A (Existing Trends). In absolute terms, the Scenario B performed as well as or modestly better than Scenario A in all indicators, suggesting that there would be modest local environmental benefits to developing in a North Campus more urban fashion while preserving the University's capacity to attract research funding. The ratio measures are similar between the two scenarios except for the economic ratio, which is of dubious value when placed in the context of the absolute totals.

The most significant difference between Scenario A and Scenario B is shown in the per capita measures, which strongly favor Scenario B. This suggests that in addition to the small local environmental benefits and equivalent economic potential to developing a more urban North Campus, there is the potential for large regional environmental and social benefits as well. New employees of an expanding university system will need to dwell somewhere in the Ann Arbor region. With low density development currently surrounding North Campus and city planning efforts reinforcing this pattern (see Northeast Area Plan), poorer employees will seek to locate on an ever expanding suburban periphery around Ann Arbor. For every family that chooses to live on North Campus, there is that much less pressure to widen roads, pave fields and convert large natural areas and farmland into lawns. The degree to which regional environmental and social benefits will be realized in Scenario B will be largely determined by how attractive and affordable the employee housing units are on North Campus. Since the lowest paid employees tend to live the furthest distance from North Campus, enticing this population to live on North Campus will cause the greatest reduction in automobile pollution and the largest gain in equalizing the transportation costs of university employees.

Combining North Campus employee and student preferences with smart growth principles (Scenario C) produced results that were generally similar to Scenario B in absolute, ratio and per capita measures. Although similar, Scenario C's results were also consistently more sustainable than Scenario B, suggesting that it is possible to incorporate public preference into development design, without compromising environmental, economic or social benefits.

Future Directions for the University of Michigan

In general, the case study revealed much about the preferences of the North Campus community and what alternative futures for the campus might look like. There is clearly a strong desire for a denser, more lively, North Campus. Furthermore, the model suggests that the North Campus should urbanize. Despite these factors, it seems the future of North Campus development lies with the University President, executive officers, and ultimately, the UM Regents. At issue is how these leaders view the University's Mission.

With regard to land use, it seems that the University leaders currently approach the Mission quite narrowly, focusing mainly on building UM's international reputation as an academic leader, and less on the social and environmental consequences of its land development decisions on the campus and surrounding communities. This leads to questions about whether students, faculty, and staff should have a greater voice in campus planning decisions. Similarly, urbanization of the North Campus would undoubtedly have an impact on the character of the communities surrounding the campus. Stakeholders outside the University institution who are the potential beneficiaries of a university smart growth policy should be proactively engaged. Such efforts will also require a balancing of time and money costs with the benefit of dialogues with City of Ann Arbor and other local community stakeholders.

This speaks to the broader power of this model. While it allows for a discrete comparative analysis, it also provides a mechanism for drawing attention to broader issues of environment, equity, and equality in Campus planning. While some of the issues addressed in this report may not have occurred to decision makers, the report, or at lease the exercise of putting it together may have the effect of heightening awareness on these issues. The relevance of planning to the Campus community is evident through the more than 800 survey responses we received in just over one week. It seems that the level of interest in this project as demonstrated by the number of responses, and the conversations that will result, can only serve to heighten awareness for sustainable campus planning throughout the North Campus community and among university leaders.

MODEL RESULTS: INDICATORS AND THE CASE STUDY

As discussed above, the case study was undertaken to test the practicality and transferability of this model. Indicator selection and scenario development allowed for conceptual exploration of the model, but only through a pilot study could we begin to understand how the model performed in practice. This study highlights some additional considerations that the case study helped reveal, in addition to a few ideas that might be useful for future applications of this method. The section begins with specific indicators, and concludes with a discussion of the scenarios and some additional thoughts on the future of the University of Michigan's North Campus.

Environment: Percent Forested Riparian Buffer

While the riparian buffer indicator did not reveal any discrepancies across the scenarios it remains a powerful indicator. Functionally, no consensus exists on the minimum necessary riparian buffer width. The width of the buffer will likely vary based on slope, soil composition, land cover, and depth of water table. Nonetheless, the width we use in this model is widely used throughout the literature, and was applied consistently across all scenarios. More generally, the indicator serves its purpose as a comparative tool and awareness generator. It is easily understandable – conceptually and visually – and is one of the easier indicators to measure. Finally, it is broadly applicable at any institution whose campus abuts a stream or river.

Environment: Interior Forest

The percent forest interior indicator is useful for representing the habitat needs of area-sensitive species. From a broader ecological perspective, the power of this indicator could be enhanced if coupled with indicators for patch shape and proximity to other patches. It is important to note that the absence of interior forest does not necessarily mean that existing woodlots are without any ecological value; services such as shade, water retention, and habitat for non-area-sensitive species may remain. Thinking more broadly, the indicator is particularly useful for choosing among potential development sites where the tradeoffs can be known.

In applying this indicator to other university campuses, things to consider would include:

- What area-sensitive species are native to the region? Are there non-native area-sensitive species that play a critical role in maintaining current ecological balance?
- Of these species, which are compatible with a nearby human institution? For example, songbirds are more compatible to a university campus than predatory cats.

- Is there sufficient undeveloped campus land to dedicate for the habitat of these species both in the existence of forest core area and area characteristics such as size, shape and proximity to other patches?
- Could habitat for these desired species be better preserved in quantity and quality on non-university land? If so, what university policies could contribute to its preservation?

Environment: Managed Greenspace

This indicator is useful because it allows for a quick determination of the percentage of total vegetated land cover that requires intensive management. However, interpreting these results in light of sustainability is less straight forward. This speaks to the tension between environmental integrity and equity. Artificial green has negative implications for forest contiguity, habitat, and air and water quality. At the same time, access to open space is an integral component of human quality of life. This indicator does not resolve this tension. While the indicator may reveal a low ratio of artificial green to natural green (more sustainable), it may mean that local populations have to travel farther to access open spaces (less sustainable). Finally, the indicator reveals nothing about the how much green space exists within the study area. As a result, a site that has a low ratio of artificial green to natural green (more sustainable) may also have very little total vegetation (less sustainable). The inclusion of total areas of green space and artificial green space as well as artificial green per capita measures gives context to this ratio and allows for analysis of the overall sustainability in any given study area.

Environment: Impervious Surface Per Capita

Most sustainability initiatives that consider land use measure total imperviousness, as opposed to impervious surface per capita. Impervious surface per capita refers to the localized efficiency of land use, but does not represent the cumulative impacts of imperviousness within a watershed. The indicator assumes that the benefits of densifying locally will be felt within the watershed by reducing more land consumptive developments, which tend to have higher per-capita imperviousness, in other parts of the watershed. However, if this does not happen, and the entire watershed becomes densely developed, the watershed will likely become degraded even though the land is being used efficiently. The power of the impervious surface per capita indicator could be enhanced if coupled with an indicator of total imperviousness for the watershed in which the campus lies.

Economy: Ratio of Academic GSF to Total Building GSF

To begin with, public institutions of higher education are mission driven, rather than profit driven. The economic prosperity of the institution will be influenced by many external factors such as the health of the state economy and decisions of the state legislature. As in the case of the University of Michigan, declining direct state and federal funds places greater importance on the money an institution brings in through tuition or research grants. Regardless of a particular institution's revenue balance, the economic prosperity of the public institution is more difficult to measure than that of a for-profit corporation since its reason for being is to serve a public purpose rather than maximize private profit. Nonetheless, it is still possible to measure economic development at these institutions. The usefulness of this particular indicator will be more appropriate for institutions where research dollars are strongly correlated with growth of academic and research floor area. Despite this correlation, it is not clear that research dollars will actually drive building growth, or whether the relationship will change over time (i.e. Can these institutions grow without increasing research dollars? Conversely, would growth hit some threshold and then plateau, and how would that affect the flow of research dollars?).

Also, the indicator assumes that campus development is a zero-sum-game. That is, it assumes that any use of campus land not for academic or research buildings will have a negative economic impact on the institution. In retrospect, it seems that this interpretation may be overly simplistic. College or university provision of housing and commercial facilities may ultimately prove remunerative, or at least be accomplished without inhibiting the academic growth of the institution. However, the provision of housing and commercial facilities may run counter to the way the University currently interprets its mission. As long as the University views the provision of such facilities as competing with the "free market," housing will not significantly increase on North Campus, and as a result, commercial facilities located on the campus will continue to struggle during the long off-peak periods.

Equity: Commute Time and Affordable Housing

These indicators for social equity were the most conceptually challenging and computationally difficult of the six. Despite our best attempts to streamline the process by using macros for automation, this indicator took considerably more time to compute than the others. Further, it is only a useful indicator in situations where employee incomes are inversely correlated with travel times, and where near-campus housing tends to be unaffordable among lower ranking employees. Also, this indicator assumes that people with lower incomes actually want to live closer to the campus, and that they view longer commute times as a cost burden. Since land with easy access to transportation improvements increases in value (decreases affordability), measuring employee commute times rather than employee commute distances is an attempt to make these indicators more applicable to a variety of contexts. Application of these indicators to other university campuses will require the verification that lower paid employees do bear higher transportation costs than higher paid employees.

Scenario Discussion

The architect of a scenario has a great deal of control over the selection of principles and how those principles are translated into design. The same is true in attempting to reconcile conflicting public preferences, distill public priorities, and then translate them into a design. We entered into this project with an awareness of our own subjectivity, and made an honest effort to interpret principles and public input. We realize that an infinite number of outcomes are possible, even with the most earnest efforts to accurately represent these principles through design.

Scenario development necessitated assumptions about time horizon, building heights, population growth, commute times, commercial facilities, and a host of others. Three assumptions had a particularly significant impact on the way the scenarios were developed. First, by selecting the North Campus as a case study, we largely assumed away much of its integration within the larger University. In fact, the North Campus is but one of five UM campuses in Ann Arbor. In reality, university decisions regarding transportation, housing, and land use on other campuses will also affect the sustainability of North Campus. But the same case can also be made for the University in a regional context, and the region in a national context. As a result, we assumed that the localized focus was appropriate for this pilot study.

Second, we assumed that the University would continue to grow, and much of that growth would be directed towards the North Campus. Again, a multitude of external factors will shape the University of Michigan's growth rate, many of which are out of the hands of the Regents. Nonetheless, this assumption influenced our concept of build-out, including how much parking to provide, how many buildings to add, and the number of levels each might require.

The third assumption, having mainly to do with the smart growth Scenarios, was that on-campus development would relieve off-campus development pressures, especially those that might occur on ecologically valuable green space. This approach assumes much about how the City of Ann Arbor will respond and how the larger region will develop. Nonetheless, it seems that to not develop the campus densely would preclude any efforts to stave off university-induced encroachment on the region's remaining ecologically valuable green space.

MODEL RESULTS: TRANSFERABILITY AND MORE

In an effort to augment existing campus sustainability initiatives, we set out to develop a model that was easily transferable. With this goal in mind, we attempted to select indicators that were easily measurable, not overly context dependent, and whose results could be easily interpreted. Similarly, we sought a platform for developing these scenarios that would allow for easy indicator application and one that was widely accessible to college and university students and campus planners.

Geographic Information Systems (GIS) were an integral component of this model. This technology allowed for timely creation, modification, and calculation of various scenarios. Without the benefit of GIS this technique could quite possibly have been time prohibitive. As information technologies continue to become more widely available, GIS becomes a more feasible platform for scenario development. However, it may be that some smaller colleges do not have the resources to purchase GIS, or the knowledge to operate the software. At the same time, the availability of data layers varies across locations. At the University of Michigan we were fortunate to have access to a cutting-edge spatial analysis laboratory and a wealth of federal, state, local, and University data resources. For institutions without these resources, the model may not be useful.

Because indicators had to be conducive to the GIS platform (i.e. spatial in nature), and applicable in hypothetical scenarios (i.e. independent of time), the pool of useable indicators was fairly limited. During the process of indicator selection we quickly realized that environmental indicators tended to fit the criteria more easily than those of equity or economy. This is because environmental indicators tended to be more easily quantifiable and spatial in nature, thus rendering them highly compatible with the GIS platform. In contrast, social factors such as population growth and affordability of housing tended to be more abstract, more difficult to measure, and more context-dependent. Each of the two social indicators – economy and equity – required several assumptions and intensive calculation. As a result, we expect that the social indicators, especially the commute times, would be difficult to reproduce at other campuses.

For these reasons, the indicators chosen for this model are reasonably comprehensive for our purposes but not exhaustive. Some of the indicators used in this model, such as the riparian buffer indicator, may not be relevant at other institutions. At the same time, other institutions may wish to measure features other than those represented by our indicators (i.e. acres of agricultural land in production). Also, the commute time and economic prosperity indicators were unavoidably context dependent; they may not transfer as easily to other institutions. In stepping back, it seems that generalizability is an elusive concept. The model is intended to provide general representations of system components, and consistently measure them across scenarios. In order to address unforeseen transferability issues, we thoroughly documented the processes of indicator selection and scenario development, so as to provide the reader with sufficient information to make an informed decision on how to proceed.

Future Directions: New Applications

Corporate campuses represent one area where this model might be applied without much modification, as they are typically developed on a single large tract of land. We imagine this would be a relatively straightforward process.

Campuses that are less self-contained (whether corporate or college) represent a more complex potential future application of the model. One way in which this might be done is to model an area that contains the campus, but also includes the spaces in between that are owned by others. Scenarios could then be drawn that make changes only to those areas under the institution's control and, optionally, make assumptions about how independently-owned land might change.

Another step up in the complexity that the model might be capable of addressing is at the level of an entire community or municipality. For example, the City of Ann Arbor recently held a downtown visioning workshop in which participants prepared scenarios for the downtown. These scenarios could potentially be compared via a model similar to the one developed in this study. There are several challenges in ratcheting this model up to the city level: GIS data may be less complete and unpredictable market forces play a larger role in determining actual outcomes. The process of analyzing scenarios may still be very valuable, especially for its educational benefit to both the community and local planners.

Future Directions: New Issues to Address

Within the college campus realm, there are other issues that the model might address. While the equity indicator in the case study focused on employee commute discrepancies, there is another important issue with regard to equity within the student population. For instance, it is likely that graduate students—who are less likely than undergraduates to be receiving financial assistance from family—are forced to commute further than their undergraduate counterparts. Similar inequities can be expected within the undergraduate population at state universities between students from in-state and those from out-of-state (who are more likely to come from higher-income families). Ultimately, addressing these kinds of issues, and testing our method in different places will prove the mettle of our approach for transforming a university campus into a sustainable community.

APPENDICES

APPENDIX A: LITERATURE REVIEW OF SUSTAINABLE DEVELOPMENT

The qualifier "sustainable" was first used in conjunction with the word development in the early 1980s.[1] The marriage of these two words was not solely figurative but encapsulated a major perceptual shift towards the phenomenon of development. A linear and limitless view of development was posited as untenable and a new type of development which can be sustained by the future generations was called for by think-tanks such as the Club of Rome. Since then the notions of sustainability and what is sustainable has been conceptualized from various disciplinary and inter-disciplinary perspectives.

Among these various conceptualizations of sustainability, such as from the perspective of consumerism, environmentalism, growth management, progress and development, economics, and user participation, the later three or lack thereof, in our understanding, apparently have a greater impact on the sustainability of existing campuses of the universities than the former. This is so because, firstly, the progress and developmental vision of the universities as manifested in the desire to be on the cutting-edge of research and technological paradigm requires them to be flexible. To remain flexible, universities do not want to make long-range commitments of resources like land and money. Second, economic worries because of reduction in both state and research funding have emerged as the leading problem for the university leadership. Third, institutions of higher education and the lack of student participation in long-term goals of these institutions, in our view, pose major challenges to the sustainability of the university campuses. In this section, we present a concise overview of relevant sustainable development literature that has critiqued the notions of progress and development, economy and the participation of the users.

Critiques of progress, development and economic growth

The most acerbic critique, from the sustainable development literature, of the traditional views of progress and development is that three centuries of 'progress' in the name of 'modernism' has failed to provide the promises that fueled its unwavering pursuit. The promises of modernism included: subduing nature through use of western science, greater material well being, and more equitable sociopolitical organization. Not only has this experiment failed, but it has in many respects had the opposite effect. The 'modernity' that we have achieved consists of environmental degradation, global inequality, aggression, and political gridlock.[2]

More mainstream sustainable development literature, on the other hand, not only challenges the traditional economic-gain-dominated view of progress and development that has aimed at continually increasing the size of the pie but also calls for a fresh conceptualization of these terms. For instance, Roseland posited that natural and social capital are equally important outcomes of progress[3]. Natural capital suggests that in order to be sustainable, we must live off the income, or the new stock that is being produced by a forest or a fishery, without touching the capital or principal. Natural capital is made up of not just more obvious components like as renewable and non-renewable resources, but also more abstract services such as pollution absorption and natural systems' own ability to regenerate. Social capital exists in the bonds between people — not those created by contracts or convenience, but rather genuine relationships maintained through mutual trust. Social capital differs somewhat from other forms of capital in that instead of diminishing with use, it actually grows.[4]

Herman Daly has called for replacing the continuous progress and development paradigm with a "steady-state economy." In his view, faith in technological salvation—belief that we can find scientific solutions to all problems; fallacy of exponentially increasing natural resources productivity; and discounting the future value of natural resources have placed the future of humanity in peril. Thus, he asserts that "very notion of growth includes some concept of maturity or sufficiency, beyond which point physical accumulation gives way to physical maintenance; that is, growth gives way to a steady state. [5]"

We believe that the above literature provides two key insights for a project like ours. First, the natural and social capital balance sheets of a university community are as important as its fiscal capital. Instead of exclusively focusing on being a continuously growing and fiscally healthy academic and research facility, for instance by deferring functions such as housing to the private market, the universities may do better by aiming to be socially healthy communities as well. Second, the mature universities, such as the University of Michigan, have arguably reached a point where growth should give way to a steady state. Sustainability of the present state, in our view, assumes more importance than the usually desired aim of continuous growth.

Public participation

The sustainable literature places a major emphasis on the involvement of stakeholders in the decision-making processes. Prugh, Costanza, and Daly have pointed to three elements of modern society that necessitate broader stakeholder engagement: uncertainty, adaptation, and preference orientation.[6] They have argued that "uncertainty and ignorance can no longer be expected to be conquered: instead, they must be managed for the common good.[7]" While this may be overly cynical, it speaks to the importance of complementing science with community dialogue in the decision-making process. This provides for greater consideration of how the communities, who will bear the burden of the decision, value the risks associated with uncertainty. [8]

In popular practice, however, tools such as cost-benefit analysis are a popular mechanism for weighing the merits of policy decisions. This is understandably attractive to policy makers because it provides a deterministic framework for decision making, based on observed human behavior in the market.[9] However, scholars such as Mark Sagoff argue that consumers and citizens approach decisions with different rationales. Whereas the consumer may be primarily interested in satisfying an immediate want, she may also be perturbed by the overall implications of that action on society.[10] This is further illustrated by the earlier discussion of externalities. The problem then is a lack of complete information about how individual choice affects the collective environment. Prugh, Costanza, and Daly, therefore, suggest that conventional decision making processes fail to achieve sustainability because they lack an informed and engaged citizenry.[11] In their view, public participation is fundamental to determining true preference orientation.

Stephen Wheeler captures the importance of public involvement in the planning and policy making process in his work on regional sustainability. Wheeler writes, "Public involvement in regional sustainability planning is important for many reasons: to fulfill democratic ideals, to put the knowledge and experience of citizens to use in planning the urban environment, to help promote learning and public education, and to build political support for the resulting policies. [12]" Moving towards a more sustainable society will require more localized collective decision making. Such a process will likely be evolutionary, require a strong consideration of the implications of uncertainty, and be informed by civic, not market, idealism. Therefore, we believe that universities ought to make extra efforts to involve campus users (i.e. students, faculty, and staff) in matters such as the designing of campuses and facilities that are predominantly used by the campus community.

Sustainable Development and Higher Education

The role that education could play in the shift to more sustainable development patterns has been recognized since the publication of *Our Common Future*. As early as 1990, the president of Tufts University convened the Talloires Conference, at which 22 international university leaders met to discuss sustainability. From this conference emerged the Talloires Declaration, in which university administrators officially acknowledged the importance of higher education in achieving sustainability goals through education, research, policy formation, and information exchange.[13] Since 1990, nearly 300 institutions worldwide have signed the Talloires Declaration. Many institutions have furthered this symbolic commitment by starting sustainability initiatives. According to University Leaders for a Sustainable Future, 83 colleges and universities in the United States presently have initiatives to improve campus sustainability.[14] Most of these initiatives began in the 1990s and took the form of task forces, projects or committees aimed at reforming university practices and policies. For instance, in 1994, the Campus Earth Summit brought together university delegates from 22 countries, 6 continents, and all 50 states at Yale University to craft the *Blueprint for a Green Campus,* a set of recommendations for higher education institutions across the globe to work toward an environmentally sustainable future.

Though the numbers of Universities that have signed declarations and initiated efforts to improve campus sustainability keeps increasing, most universities find it difficult to operationalize the principles of sustainability. T. E. Graedel has criticized the colleges and universities that adopt the attractive goal of sustainability but are unable to take it further. He asserts that universities and colleges “are intellectually honest only if they go on to devise operational approaches to meet that goal. [15]” Michael Shriberg, studying the University of Michigan, found that the university is not an “environmental laggard,” but the “recent media attention exaggerates the campus' progress by ignoring the fact that sustainability efforts are scattered and have not deeply permeated the culture, leadership, policies and practices of the institution. [16]” Julian Keniry has asserted that an Environmental Management System should be adapted by the universities and colleges to achieve tangible outcomes. The Environmental Management System, according to her, is a framework for “greening all facets of the campus, from the classroom to the power plant and from the budget to the student body, while continuing to improve performance over time.[17]”

Interestingly, the few sustainable measures that have been successfully operationalized by the universities focus narrowly on the consumption and waste streams of the campuses, and the need for more green buildings. For instance, Walter Simpson has called for further reinforcing, reinvigorating, and expanding the energy conservation programs on campuses.[18] And Jon Shimm asserts that incorporating energy-efficient features into residence halls saves money and makes students' campus experience more enjoyable.[19] The Environmental Task Force at the University of Michigan (2004), on similar lines, has taken a rather narrow view and has not looked at the interrelationship between the buildings and the relationship between sustainability and the land use of campuses.

The need to incorporate sustainable practices into campus land-use decisions is increasingly being recognized in the campus planning field. For instance, Franklin, Durkin & Schuh[20] posit that the universities need to look at the landscape of their campuses to advance their mission and Bernheim asserts that "Greening the campus … is the precursor to 'greening' the curriculum.[21]" Thus, the roles of land use and sustainability measures that can be operationalized appear as crucial missing links in the present efforts of universities and colleges to become more sustainable over time.

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APPENDIX B: A BRIEF HISTORY OF NORTH CAMPUS PLANNING

A multitude of external forces have influenced the trajectory of North Campus development over the last fifty years including: changing tides of state and federal economies; philanthropy; technological advances and changes in research trends; the demand for education and population growth; University politics; and land-use patterns in the City of Ann Arbor and the surrounding region. In an effort to remain competitive in the face of these pressures, the University has been repeatedly confronted with the question of how best to use its land, including that of North Campus. To aid in this process, the University has commissioned over the last fifty years a number of land-use and planning studies for the North Campus. These reports provide a window into the past, shedding light on perceived needs of the day, and some of the land-use concepts considered at the time. As such, this section profiles a collection of these studies in an effort to provide an historical context for understanding how the North Campus came to be as it is today. Summaries of these documents highlight their various treatments of housing, transportation, environment, and physical layout.

1950-1959:

NORTH CAMPUS ACQUISITION AND EARLY DEVELOPMENT:

The University of Michigan began purchasing land north of the Huron River in 1950, upon which an extension of its downtown Central Campus—one and a half miles to the south—was to be built. The expansion was viewed as necessary to accommodate a growing demand for education, particularly among married students, following World War II. Increased federal expenditures for engineering research provided further justification for the expansion[1].

The University retained the services of Architect Eero Saarinen between the years of 1951 and 1958 to assist with development of conceptual plans for the newly acquired land. Unfortunately, there is little record of the work that Saarinen and Associates produced during the formative years of North Campus. While a few glass slides are archived, Saarinen submitted no report to complement these slides. However, these slides are not without relevance. Figure B-1 depicts the North Campus as Saarinen envisioned it in 1953, when only one research facility had been completed. This vision laid a conceptual foundation into which future developments would be woven.

With a few exceptions, e.g., the leveling of the North Campus core, the *Saarinen Plan* respected the natural character of the site. Notable features are the forested corridors and abundance of open space; the east-west grid of the Campus' academic core; and vast tracts of lawn separating grand modernist architecture from boulevard-like roadways. All of these features are strongly represented in the current layout of the North Campus.[2] The scale of architecture and road widths presented in the *Saarinen Master Plan* anticipated a strong automobile presence and connection to the region, as evidenced by the proposed US Highway 23 access ramps to the southeast. Although the highway was ultimately built farther to the east, the automobile orientation and scale has remained until today.

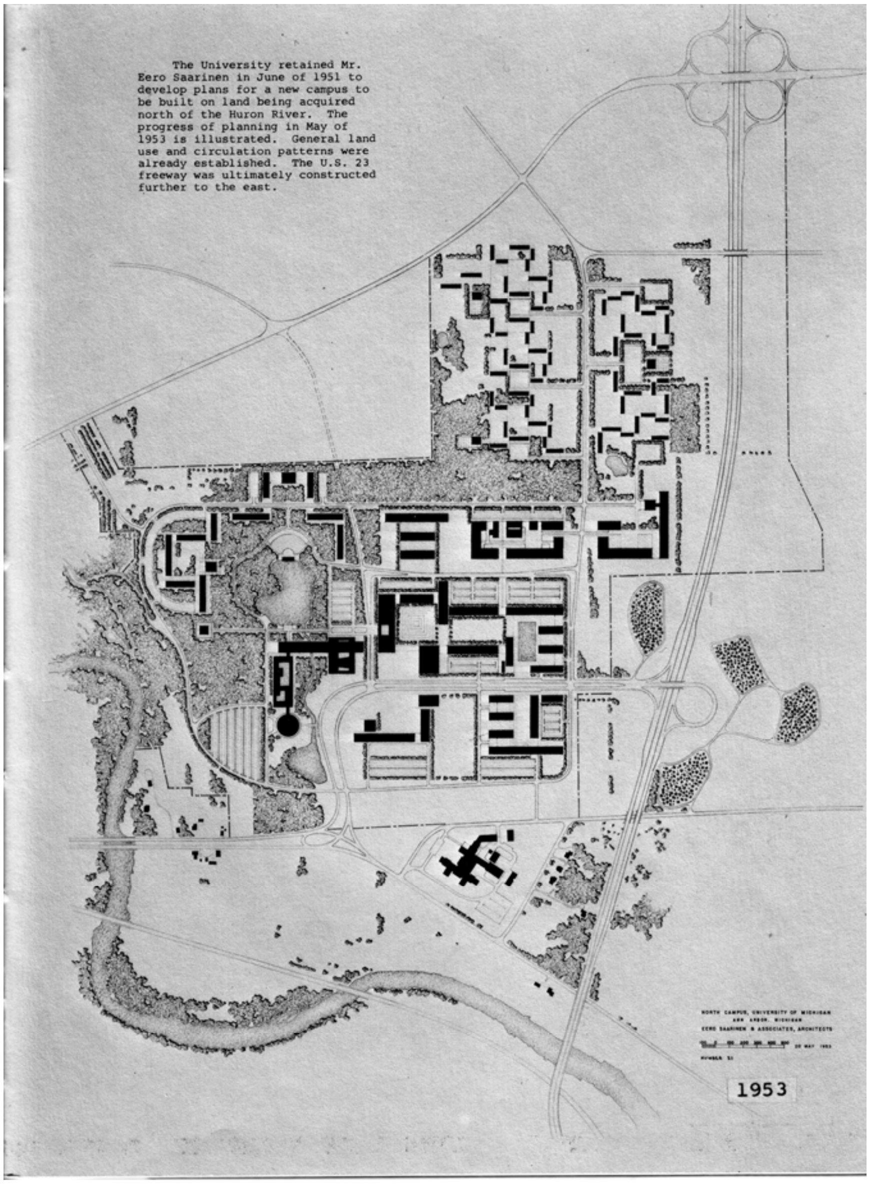

Figure B-1. Eero Saarinen's 1953 North Campus Plan, showing the anticipated US-23 immediately East of the campus.

By the mid-1950s, North Campus development was gaining momentum. One University magazine, *Michigan Tradesman* , in 1955, wrote, "Today [North Campus] is the scene of rapid, yet meticulously planned, development… where the University of Michigan is preparing to meet the rigorous demands of the future with the same high degree of competence it has answered those of the past.[3]" By the end of the decade, the University had completed some 313,000 gross square feet (GSF) of research laboratories, and just over 34,000 GSF of married and family student housing on the North Campus. The site was taking form; a concentration of institutional structures and roads would form the core, with an interspersion of open space, housing, and institutional buildings about the periphery.

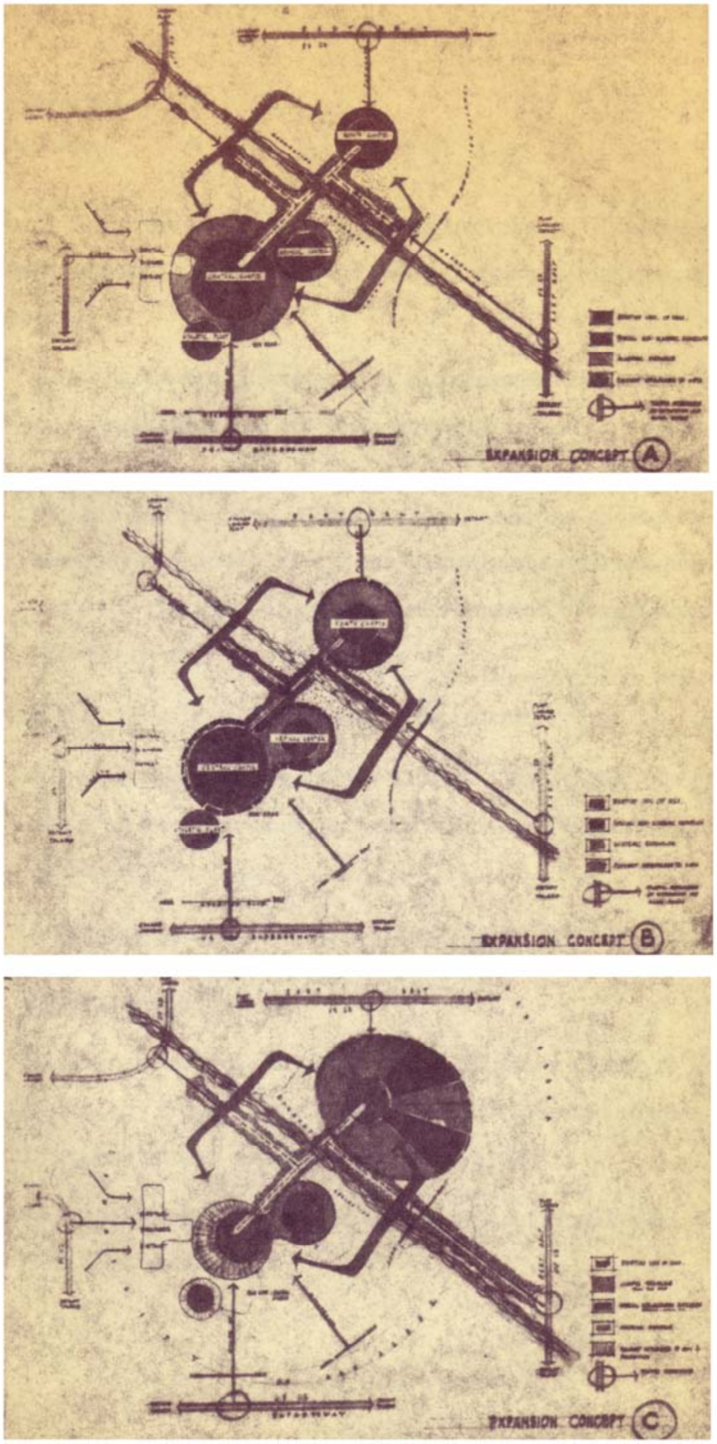

Figure B-2. Central Campus Expansion Concepts under consideration in 1960.

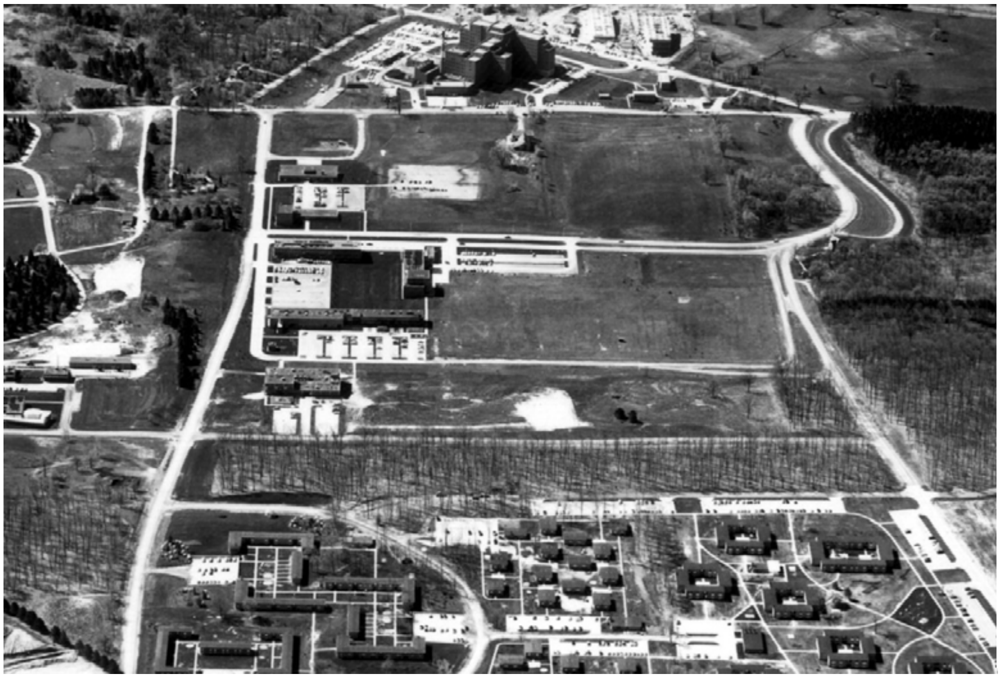

Figure B-3. Looking South over North Campus in 1960. (Northwood Apartments in foreground).

Photo courtesy of University Planner's Office – U-M Plant Extension.

1960-1969:
GROWING THE CAMPUS AND ITS CHARACTER

North campus planning did not stop with the resignation of Saarinen in 1958; indeed quite the opposite was the case. In Saarinen's absence, a Planning Advisory Committee was formed to address pressing issues of University growth and North Campus land use. Capturing the concerns of the Committee, in 1960, William J. Johnson and Associates published *The University of Michigan North Campus Planning Report,* which consisted of three conceptual expansion scenarios (Figure B-2, above). Whereas the North Campus had previously been considered an applied research campus, the *Planning Report* was commissioned to help the University think about the future relationship between North and Central Campus.

After more than a century of development, the Central Campus could no longer accommodate the University's explosive growth rate. As the University had already invested heavily in land north of the Huron River, and because continued growth was expected, the North Campus became a candidate for intensive development of academic facilities. In evaluating the potential for expansion of academic facilities onto North Campus, two formidable barriers emerged. First, the 1.5 miles separating the campuses presented a 30 minute walk, or 10 minute automobile trip, for those with ties to both. Second, the two campuses were divided by the Huron River Valley, presenting a distinct conceptual and physical barrier to uniting the Campuses. [4]

With a strong pro-growth emphasis, the *Report's* Summary Plan and Action Program recommended the acquisition of twelve parcels on the south and east edges of North Campus, and one on the northwest edge. Automobiles were seen as the answer to overcoming the remoteness of the Campus and the barrier Huron River Valley gap.

Referring to the development potential of a newly acquired 400-acre parcel north of the Huron the report stated, “This suggests that a common automobile approach to both the North Campus and the Central Campus through the Huron River Valley is possible.[5]” The intersection of the proposed north-south Highway 23 route and nearby US 12, connecting Detroit to Chicago, furthered the automobile orientation of the Campus. The *Report* continued, “Due to the crossing of two major expressways…there is statewide ease of automobile access to the University of Michigan.[6]”

The *Report* acknowledged the significance of natural features to the character and development potential of the site and the Valley. In contemplating build-out, Johnson and Assoc. referred to “natural land units”, as defined by the topography and vegetation of the North Campus landscape. Here, the *Report* envisioned development “as the land dictates.[7]” The importance of the Huron River Valley as a geographical center of the University was emphasized, and it was presented as a unifying characteristic of the North and Central Campuses. The *Report* suggested orienting growth toward the Valley so as to further unite the Campuses through shared facilities and recreation areas. At the same time, the *Report* encouraged early designation and preservation of open space.

However, the 1960 *Report* provided little direction for on-the-ground development. And interestingly, between 1960 and 1965, North Campus experienced more development than in the previous decade. A notable milestone was the 1964 completion of the Earl V. Moore Building, a 125,000 GSF structure developed to house the School of Music—North Campus’ first academic college. With some 3,500,000 GSF of buildings under study, the University was hard pressed to solidify a plan for the future of North Campus

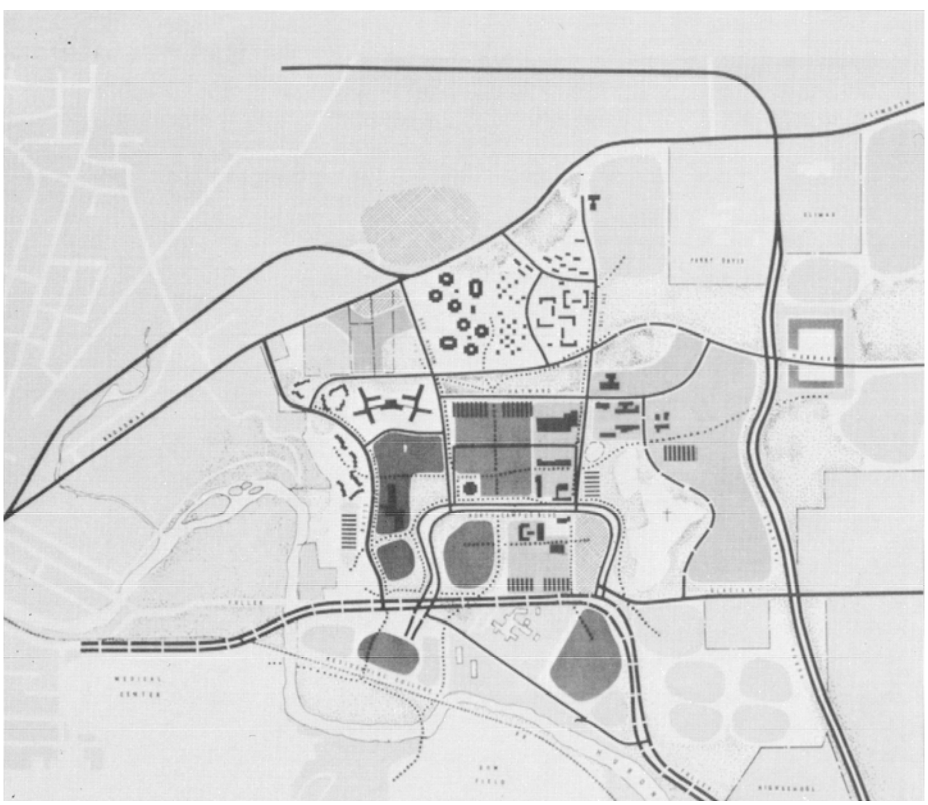

Figure B-4. Summary Plan that came out of the 1965 North Campus Planning Conference.

land use.[8] In the path of imminent development, the University retained the services of Johnson, Johnson & Roy (JJR), to hold a planning conference to update the 1960 *North Campus Planning Report*.

A central goal of the Conference was to establish a planning framework for North Campus development, in light of its emerging role as an academic campus. The conference addressed a broad range of issues including general land uses, pedestrian, bicycle, and automobile entrances and circulation, parking, and identified several areas for permanent open space consideration. Capturing the essence of previous plans, and the thinking of various units, JJR produced the *North Campus Summary Plan* (Figure B-4).

The *Summary Plan* reflected the University's interest in maintaining a denser core of primarily academic buildings, surrounded by "academic sub-centers" consisting of up to four residential colleges. The walkable scale of the core area was emphasized, and bus routes between Central and North Campus were proposed. The Plan also identified some 130 acres—between the academic core and Huron Parkway, and on either side of Hubbard—as a potential future academic nucleus. Two central dining facilities were proposed for North Campus, one for existing academic core and one for the potential future academic core.

The Planning Conference Report also identified ten potential housing sites, concentrations, and types on the general periphery of the central academic core. These included housing for single graduate students, underclassmen, married students and staff, and five potential sites for residential colleges. Several tracts of open space existed throughout these housing complexes and residential colleges, many of which were recommended for permanent protection. Five areas were recommended for protection based on their campus-enhancing character, beautification of thoroughfares, and opportunities for active and passive recreation. Two additional non-university owned parcels were mentioned. The report recommended acquisition of these parcels and further study to determine their open space and housing potential.

The Conference Report emphasized greater walkability and bikeability about the Campus; several potential routes for bicycles and pedestrians were proposed. Modification and addition of Campus roadways was also recommended to improve circulation. The document noted, "Parking about the Academic Core will be in multi-floor parking structures and in locations peripheral to the central core (as on the Central Campus).[9]" At the time of the conference, no parking on Campus roadways was allowed. The Plan encouraged continuation of this policy. In anticipation of future growth and density, parking lots were expected to give way to buildings. The report assumed that as parking became increasingly scarce around the central cores, "student parking would be forced further and further out probably requiring the institution of some scheme of loop transit to move from these peripheral parking lots to the built-up areas of the Campus.[10]"

North Campus planning pressures spiked during the 1960s. The decade began with a conceptual exercise concerning the future role of the land north of the Huron River. By mid-decade, Campus planners and consultants were preoccupied not only with converting the North Campus into an academic center, but also an unprecedented housing boom. By decade's end, more than 1,350,000 GSF of building space had been completed, including hundreds of student housing units. The 1960s represented an unprecedented period of growth on the North Campus, one that has yet to be repeated.

1970-1979:
THINKING ABOUT LAND USE AND ENVIRONMENT

While the 1960s proved to be the most active development period in North Campus history, development pressures continued into the 1970s. Land-use planning until 1970 was informed by two then-outdated planning documents: the *Saarinen Plan*, which provided a conceptual building layout for a research campus; and the 1960 *University of Michigan North Campus Planning Report,* which provided no concrete direction for North Campus land use. By 1970, the main challenge facing North Campus planners was how to reconcile problems between competing land uses; how to think in detail about the interrelationships between land uses, the pedestrian network, and support facilities. While the 1965 *North Campus Summary Plan* touched on these issues, "it did so in a very superficial way.[11]" To fill this gap, the University Planner's Office commissioned the 1971 *North Campus Land Analysis*.

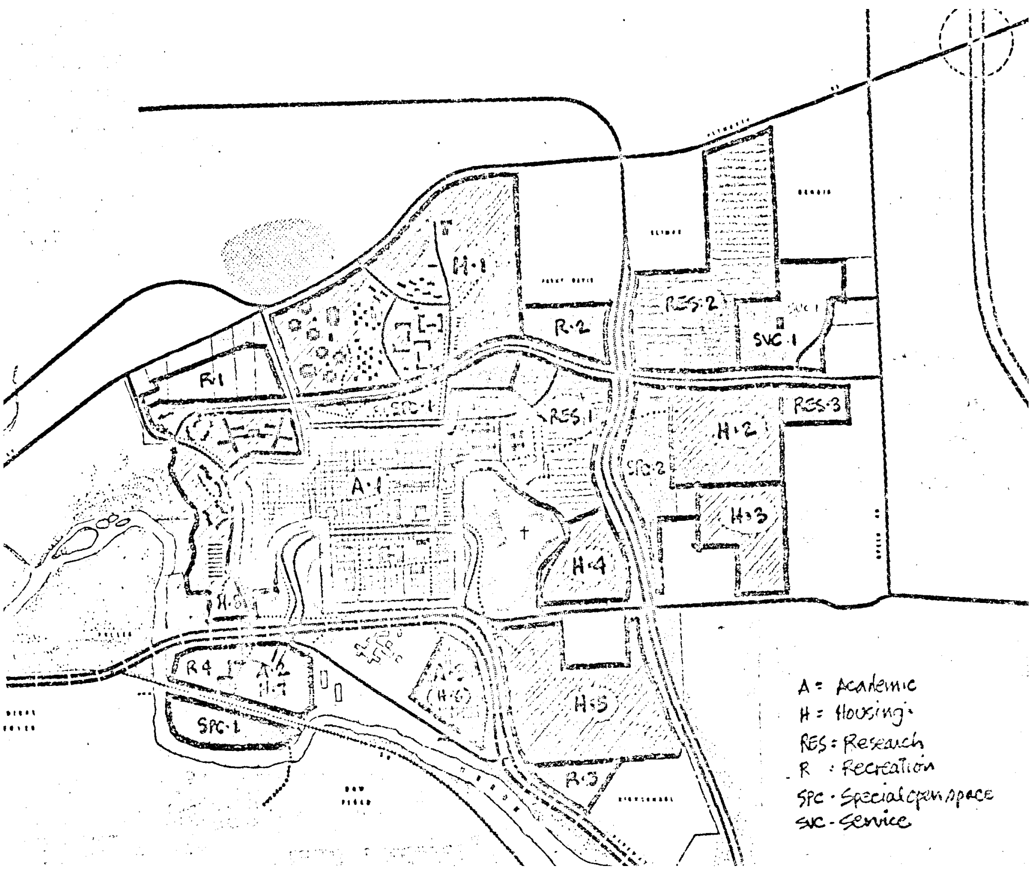

Figure B-5. Land Use Zones as laid out in the 1971 North Campus Land Analysis.

Anticipating continued growth, the *North Campus Land Analysis* was concerned with capacity. Using the 1965 *Summary Plan* as a baseline, the *Land Analysis* tracked development trends through the late 1960s. Based on these trends, and considering factors such as circulation and parking, community relations, natural features, and open space preservation, the report analyzed the development capacity of the North Campus land holdings.[12] The document focused on five principal land uses: academic, research, housing, recreation, special areas, and services. As Figure B-5 illustrates, North Campus was separated into land use zones, not unlike a municipal zoning map. Zones were then evaluated based on use, acreage, and land character.

At the time of the *Analysis,* the building height for all North Campus structures was two levels and, with the exception of housing, Campus development was relatively low density. In order to achieve the expansion proposals and capacity projections, taller buildings and higher densities across all developable land categories would be required. To meet projected build-out, average heights of buildings in the academic core would exceed 3 floors (with some as tall as six floors), research zones would increase to an average of between two and two and a half, and some housing densities were to increase to as much as 13.5 units per acre. As building density increased so too would demand for parking. At the time of the study, North Campus parking capacity exceeded 2,000 spaces. The report assumed future parking would be accommodated in multi-level structures on the periphery of the academic core area. [13] To accommodate future drivers, demand for an estimated 4,000 to 5,000 new spaces was projected, with half of the existing spaces being retained as surface parking. Thus by the time of build-out, the *Analysis* assumed a demand for some 6,000 parking spaces.

As evidenced by Figure B-6, below, the *North Campus Land Analysis* was only the second plan to propose actual building placement, the first being the *Saarinen Plan*. In keeping with the University's policy goal of maintaining flexibility in land use decisions, it would prove to be one of the last plans to propose building placement.

By 1971, with a newly completed build-out analysis and some 18 years of development history, the North Campus had yet to undergo a single environmental assessment. Another eight years would pass before the first would appear. In 1978, JJR released the *North Campus Environmental Survey*. By that time, more than 2 million square feet of building area had been constructed on North Campus, including the 226,000 square foot architecture and design building, and the 66,000 square foot recreation building, in 1974 and 1976 respectively.

The *Environmental Survey* provided a general characterization of the Campus' natural features. Rather than serving as a detailed environmental assessment, the *Survey's* level of detail was sufficient to: "develop general concepts such as open space and developable zones for North Campus; provide information on environment in response to impact and assessment issues; and identify problems and concerns regarding management of North Campus as a whole. [14]" More specifically, the *Survey* highlighted landscape patterns and features that could complicate development, and sensitive areas in need of protection. Issues addressed included archaeology, climate, topography, drainage, soils, vegetation, fauna, air quality, and visual resources. The *Survey* noted that more detailed site-specific analyses would be required for specific land uses, such as buildings or parking lots.

In the wake of the 1960s development boom, the 1970s were a period of reflection and regrouping for North Campus planning. With a considerable amount of infrastructure already on the ground, and more in the pipeline, planners focused their energy more on the character of the whole Campus, rather than on specific details of site planning. In doing so, planners attempted to accommodate competing uses and improve accessibility, while preserving the natural amenities that contributed to the overall Campus character. Although the rate of development was markedly slower in the 1970s than in the previous decade, it was not insignificant. Between 1971 and 1978 nearly 500,000 GSF of building space was added to the North Campus. While a detailed building study preceded each of these developments, they were carried out in the absence of an updated comprehensive plan.

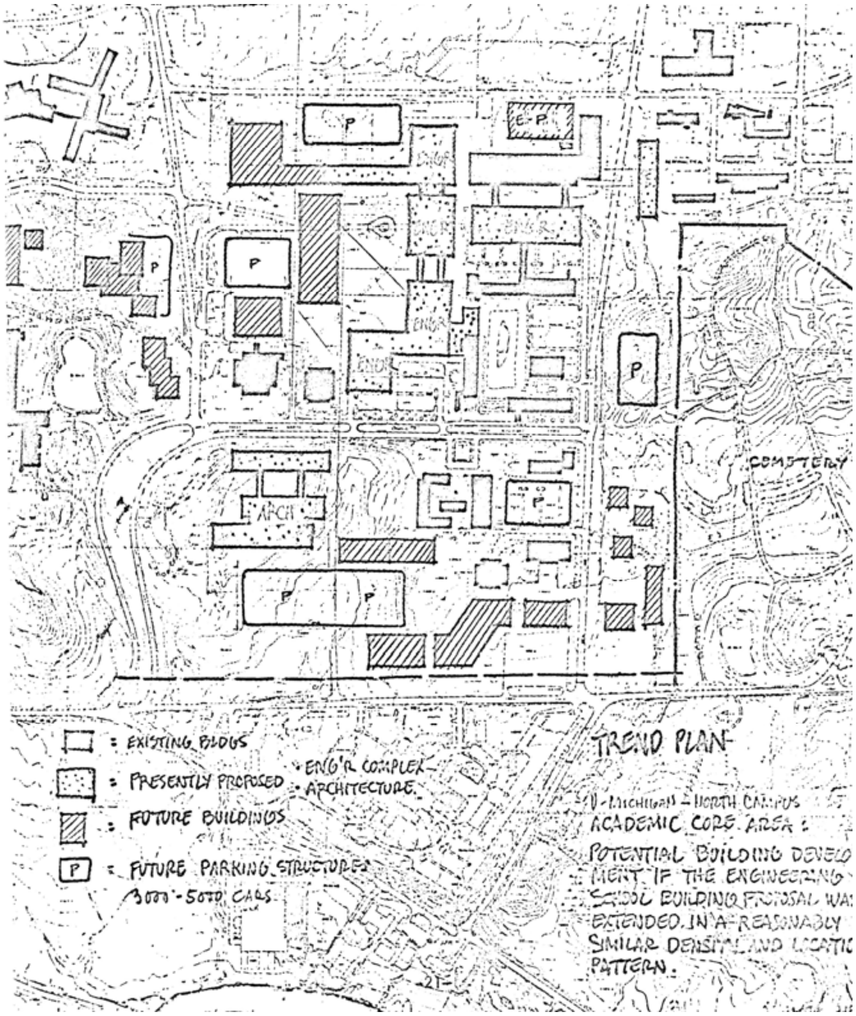

Figure B-6. Building Plan from the 1971 North Campus Land Analysis

1980-1989:
A CLOSER LOOK AT THE LAND

North Campus development leading up to the 1980s was relatively free of land-use constraints. While a number of topographical hurdles persisted throughout Campus, an abundance of developable land area in the academic core allowed for relative ease of site selection. The decision to move the College of Engineering (COE) to North Campus in the early 1980s brought to the fore issues of land scarcity in the academic core; the COE promised massive land consumption and continuous growth. As outlined above, by the 1980s, the character of North Campus was well documented in a variety of studies. However, these studies lacked the finer grained analysis necessary for flexible and

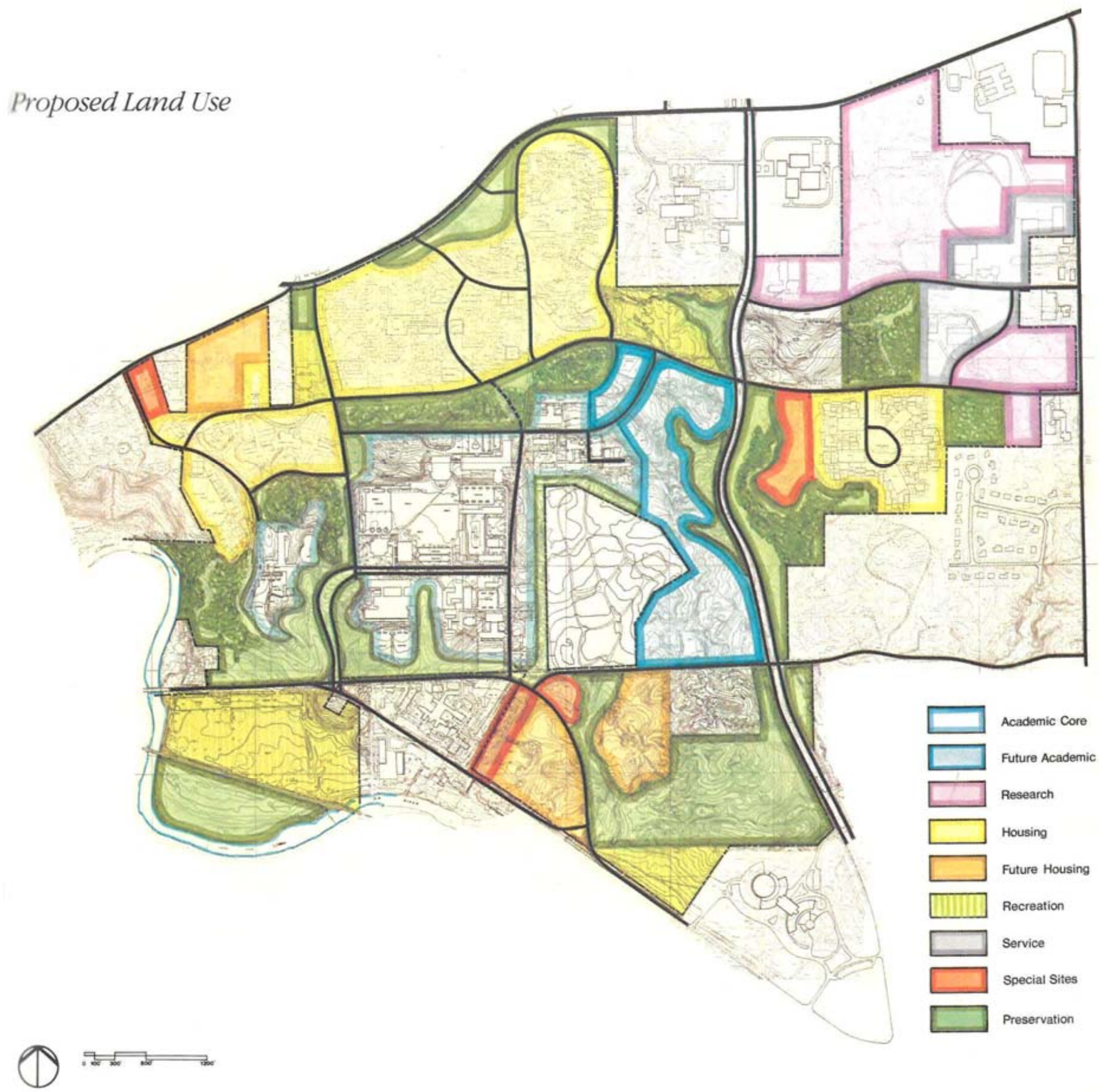

Figure B-7. 1984 North Campus Planning Study's Proposed Land Uses.

efficient growth within the academic core. More importantly, the only North Campus master plan existing in 1980 was the *Saarinen Plan*—a product of the 1950s—consisting of little more than a physical plan. A new master plan was in order.

The *University of Michigan North Campus Planning Study*, published by JJR in 1984, was the most comprehensive plan ever prepared for North Campus. The *Study* utilized insights from prior planning documents and the existing building and road network to develop a framework for analyzing future development potential. Perhaps its greatest contribution to North Campus planning was the identification of developable parcels within the academic core. This is significant because prior planning studies positioned buildings without detailed consideration for site feasibility, or limited land use considerations to broad development zones. The detailed approach of the 1984 *Study* is evident in Figure B-7. The *Study* also laid out potential building footprints, but refrained from presupposing what units might be housed in these structures.

While the *North Campus Planning Study* focused mainly on the academic core, it acknowledged the importance of other significant Campus features. The authors note, "The landscape is one of the most visible and important assets of the North Campus…This asset should be protected; it should set the theme of the developed campus.[15]" Through its discussion of physiography, the *Study* described Campus topography, vegetation, drainage, and soils. In doing so, it outlined a host of ecological services provided by Campus woodlands and wetlands. The *Study* encouraged protection of these areas through text and identification of potential future building sites.

One approach to satisfying development pressures, while preserving the environmental character of the Campus, was through the use of surface parking lots in the academic core as potential future building sites. The parking analysis stated, "…as the core expands, key "close-in" lots are vulnerable as building sites… As in the case of Central Campus, decks will have to be constructed to satisfy the need for convenient "close-in" parking.[16]" At the same time, the *Study* anticipated a 100% increase in demand for parking. To accommodate such an increase, the document proposed a lower ratio of parking to building area, from 1/550 sq. ft. to 1/750 sq. ft. The remaining demand was to be handled through a combination of surface lots and parking decks. Sixteen sites were identified, eleven for surface parking, and five for decks. The lots were to accommodate 1743 and 3050 vehicles respectively. As suggested in previous planning studies, the five sites identified for potential parking decks were each located on the periphery of the academic core.

With the exception of a few detail concerns, the vehicular circulation of the North Campus was characterized by the *Study* as "well organized, safe, and efficient.[17]" Major weaknesses identified included aesthetics of entryways and entrance accessibility from north and south arterials. The *Study* also identified the need to reduce potential pedestrian/auto conflicts by making the Campus a "humanly scaled environment.[18]" While most of the Campus interior was isolated from traffic, the *Study* suggested that several opportunities remained for creating elevated walkways or skyways, and climate controlled arcades along the Campus exterior. These would become part of the proposed exterior walkway system outlined in the document. Less attention was given to the bicycle network. It was generally assumed that cyclists would utilize the road network, but that principle campus bicycle routes should be connected to the greater Ann Arbor bicycle network. The *Study* identified several possible bicycle routes, and suggested that bicycle storage facilities be provided at various nodes throughout the Campus. While it was suggested that bicycles be allowed in the Campus interior, the study cautioned that their speed should be controlled.

The 1984 *North Campus Planning Study* would prove to be an influential guidance document for the next twenty years of land-use decisions; so much so that most future buildings closely followed the physical plan.[19] Despite its fine-grained analysis, the *North Campus Planning Study* made only brief mention of housing. While the *Study's* Proposed Land Use Plan recommended an increase of 42.9-acres for housing, there is no mention of this in the text. [20] This is a sharp deviation from previous plans that proposed several fairly detailed housing projects. Coincidently, of the 570,000 GSF completed during the 1980s, none consisted of housing.

1990-1999:
TAKING STOCK

As best we could discern through archival searches and discussions with persons familiar with the Campus planning history, no significant North Campus planning documents were produced during the late 1980s or early 1990s. As previously mentioned, land-use decisions during this period seem to have been guided largely by the 1984 *North Campus Planning Study*, with the input of the Campus planner, faculty, deans, and executive officers. With a few exceptions, most of the development that occurred during the 1990s involved research facilities, building additions, and service facilities. One such exception was the 1991 completion of the 105,011 GSF Francois-Xavier Bagnoud Building, designed to house Aerospace Engineering. Another significant development was that of the 239,811 GSF North Campus Media Union, accommodating several classrooms and lecture halls, computing labs, and the Art, Architecture, and Engineering Library.

A landscape design study, entitled the Northwoods Plan, was completed in 1995. The Plan focused mainly on defining a character for the aging apartment complex, and how to better connect it with the academic core. The Plan was never formally adopted, but is said to have influenced subsequent planning decisions about North Campus.[21] While services and renovations to existing housing stock continued throughout the 1990s, no housing units were added.

Between 1998 and 2000, the firm of Venturi, Scott, Brown, & Associates (VSBA) prepared several planning studies for the University's Ann Arbor Campuses, including the North Campus. These studies were commissioned to address land-use planning decisions which then-President Bollinger felt were headed in the wrong direction. President Bollinger is quoted in the report: [22]

> The last ten years have witnessed an unprecedented period of construction on [all U-M] campuses. We are, however, at risk of centrifugal sprawl, of diluting our essential coherence and sense of community. Much good work has been done on planning for the University campus but it no longer suffices to plan campus by campus. We need to conceive of our Campus as a whole and consider its place in the larger Ann Arbor community. We need to take a long view, to consider what our University Campus might be like, what its character should be, one hundred years from now.

Titled *The University of Michigan Campus Plan,* the VSBA studies appear to be the preliminary phases of a comprehensive planning document that would never materialize. The first phase laid a general framework for future studies, including a mission statement, goals, opportunities, problems, issues, and options (MGOPIO). The document appears to be more of a general overview of existing conditions, rather than a comprehensive planning effort; or what the firm called a "once-round-lightly. [23]" Nonetheless, VSBA's efforts shed light on several issues of relevance to the North Campus. The MGOPIO section detailed issues and options related to the environment, facilities/amenities, and transportation, among others. A few North Campus-specific findings are briefly examined below.

While President Bollinger has since left the University, many students, faculty, and staff still share his concerns. Through our research and interviews, we learned that consultants such as VSBA historically played a significant role in campus planning. Today, the University's planning and development department is considerably larger than during Bollinger's tenure, although consulting firms are still used. While the department is surely aware of these concerns, it may be too early to tell whether their efforts are effectively reversing these trends.

Environment and Natural Features

VSBA's *Campus Plan* highlights two environmental stewardship philosophies emerging from the firm's discussions with the University. The first was an internally focused approach, suggesting that University land-use decisions, where environment was concerned, needed only be concerned with University landholdings. The second took a more regional approach, considering the University as part of a larger community and environmental network. The *Campus Plan* does not advocate for either of these positions, but explores planning options in light of each.[24]

Discussion of North Campus environmental problems center mainly on degradation of near-campus waterways, resulting from impervious surfaces (i.e. roads and rooftops), and the pesticides and fertilizers used to maintain the greens.[25] To curb stormwater runoff, VSBA looked to the natural filtration capabilities of woodlots. Recognizing both aesthetic and ecological services resulting from existing forest cover, the *Campus Plan* suggests expansion of these woodlands. However, the authors advocate for a shift away from conifers, which were not a predominant component of historic Campus vegetation. Noting the extensive soil amendments required for North Campus conifers, the plan encourages a return to the upland hardwoods, such as oaks, maples, and beech trees, which historically colonized the property. These views are consistent with the *Plan's* emphasis on developing within the ecological parameters of the site.

Andropogon Associates and Turner Environmental were contracted in 1998 to conduct an environmental review and planning study to augment the efforts of VSBA. The report, entitled, *University of Michigan Campus Plan: Environmental Planning Study-North Campus and Surrounding Area,* was developed with the intention of guiding the modification or prioritization of planning options. In doing so, the document provides another general overview of existing conditions and discussion regarding potential planning options.

Environmental features examined in the *Study* include geology, surface water, and vegetation. Recommendations fall into three general categories and seem to build upon one another. The first set focuses on planning with nature so as to enhance campus character and sense of place. The second set focuses more on the need to incorporate environmental management principles into future planning and development considerations. Finally, the last set call for better coordination of knowledge and data, such that the first two sets of recommendations might be realized through the planning process.[26] The *Environmental Planning Study* concludes with a discussion of potentially developable sites and respective environmental considerations. While careful consideration was given to each of these sites, the authors maintain that detailed site-specific environmental analyses precede any development decisions.[27]

Facilities and Amenities

In characterizing the North Campus, the VSBA *Plan* highlights perceptions of isolation, decreased personal security, and increased vehicular use, resulting from a lack of diversity in Campus land uses. For example, the document cites a then-recent survey revealing general dissatisfaction with the number and quality of dining facilities on North Campus. In addition, the report points to an unmet demand for Campus housing.[28] Contemplating the vastness of North Campus' developable land area, the *Campus Plan* pointed to several opportunities for improving activities, functional relationships, and use of space.

While the VSBA *Plan* acknowledged that the ultimate role of the North Campus had yet to be determined by the University, it proposed a number of options with the intention of addressing the concerns outlined above. Many suggestions seem to orbit around two themes: 1) Getting more people to use North Campus, 2) Get more people to stay on North Campus. To accomplish these, the *Plan* suggested, among other things, locating administrative units on North Campus to increase its regular non-student base. Increasing dining and entertainment options was viewed as a way to promote conviviality, while locating food and a general store in the Media Union was seen as a way to support the Union's 24-hour activity. The VSBA *Plan* also pointed to the need for more casual outdoor space as having the potential to encourage informal interaction. Despite the said demand for campus housing, the *Plan* did not present the addition of housing on North Campus as an option.[29]

Transportation and Parking

Regarding transportation and circulation, the *Campus Plan* poses more rhetorical questions than guidance or alternatives. Such questions pertain to the future modes of transportation between campuses, relationship between campus- and Ann Arbor transit, the role of cars on campus, and policy approaches to addressing parking demand. Several of the proposed options require extensive study before their feasibilities could be compared. The options generally break down into three components, transit, parking, and non-motorized access. The transit options include discussions of a joint UM-AATA transit system; a mass transit line, such as that of London's Oxford Underground Line; or a high speed people mover, such as that of downtown Detroit. To encourage greater use of such a mass transit system, the *Campus Plan* suggests creation of transit-oriented parking structures, organized by pay and allocation systems. As with previous studies, the *Campus Plan* also suggests a move towards remote commuter parking facilities, coupled with a fleet of smaller, more direct, shuttles throughout Campus.

Consistent with President Bollinger's view that the campus needs to be denser, parking lots near the academic core would likely be preferred sites for future development. While the *Plan* did not project future demand, it assumed that demand would increase. To offset this increase in demand, the *Campus Plan* outlined several non-motorized options, including recreational corridors linking Campuses to destinations within Ann Arbor, and by encouraging more bicycle commuting through improved surfaces, bike lanes, and bicycle parking and storage facilities. Other options included the narrowing of Bonisteel Boulevard and greater integration of residential and social spaces on Campus.

2000-2005

Despite conversations with persons familiar with university planning, were able to ascertain little about why, after more than five years, the VSBA *Plan* remains incomplete. Nor could we locate any document explaining the abrupt end to a seemingly enormous planning effort. It may be too soon to understand the significance of these plans in shaping North Campus land use decisions. The lack of fine-grained site-specific analysis in the VSBA *Plan* further complicates such efforts. Despite its incomplete status, the VSBA *Plan* is said to influence Campus planning decisions to date.[30] We are told that the University periodically consults VSBA for feedback on project ideas. The depth or content of these meetings remains unknown to us.

Two other noteworthy efforts have emerged over the last five years. The first is a project developed by students of the Taubman College, under the supervision of Dean Douglas Kelbaugh. The study, entitled *North Campus Redux,* emerged in response to a seeming dissatisfaction with the North Campus among its users. As catalysts for the study, its authors cited "an undeveloped sense of place, a sense of incompleteness, a perceived lack of new investment,… the lack of a published comprehensive plan, and a general restlessness among North Campus stakeholders about the pace and scope of development.[31]" The study outlines a brief history of campus planning, juxtaposes the North and Central Campuses, and contemplates the appropriate organization and feel of a university campus. Concluding that the North Campus is "too far removed from daily life," the authors present two development proposals for the North Campus' academic core.[32]

The first proposal embraces a more traditional development approach, with axes, symmetry, and clearly defined boundaries of open space. The second, a more modernist approach, is less formal than its counterpart, having less defined boundaries, open axes, and is asymmetrical. The study concludes with a series of guidelines that both informed designs of each scenario, while also comprising the study's recommendations. These guidelines include; 1) maintaining woodlands; 2) retaining and enhancing greenspace; 3) ensuring walkability; 4) reducing surface parking; 5) increasing consideration for the role of landscape architecture in contextualizing structures; 6) improving linkages to the Medical Campus and Central Campus; and 7) the provision of greenspace on the North Campus periphery for commercial and residential facilities, including housing for faculty, staff, graduate students, and visiting faculty. [33]

The University's Planning Advisory Committee produced a second noteworthy guidance document in May of 2005. The document, entitled, *The University of Michigan: North Campus Vision – 2005-2025*, reflected the *North Campus Redux*, in its critique of the North Campus. The document outlined four main challenges facing the North Campus[34]:

1) The barrier of physical distance that leads to a feeling of isolation from the other campuses:
2) An inequity in social, retail, and service amenities;
3) A lack of destinations that voluntarily attract people to North Campus; and
4) A lack of the density, small-scale outdoor spaces, and architectural detail necessary to make an enjoyable and walkable campus environment.

In attempting to overcome these challenges, the Committee emphasized the need for improvement across four core planning areas: land use mix; development patterns and expansion; open space and environment; and transportation, circulation and parking. Principles of sound practice were outlined under each core planning area. The Committee pulled the various themes and principles together to create a Vision Statement. The Statement is more explicit than that of the University or the Planner's Office, with regard to land use, but retains a great deal of flexibility for interpretation. The statement emphasized mixing land uses and improving transportation linkages between the North and Central Campuses. The report's authors also called for more convenient multi-deck parking, taller buildings, and smaller building footprints. The need for environmental stewardship, including natural resource preservation, was also emphasized. Finally, the Committee recommended the establishment of an advisory group, consisting of students, staff, and faculty, to assist with implementation of the vision[35]

The influence of these documents in shaping the North Campus land use decision-making process remains unknown to us. Nevertheless, the 1984 *North Campus Planning Study* remains the most recent comprehensive plan, and therefore seems to be the principal planning document used today. At mid-decade, the trend in North Campus development appears consistent with years past. Two major projects are nearing completion, the 97,500 GSF Walgreen Center, and the 104,000 GSF Computer Science and Engineering building.

Originally conceived of as a remote research campus for a handful of engineers, the North Campus has grown into a place where more than seven thousand people spend the majority of their time. While the evolution of North Campus has been an iterative process, the original automobile orientation of the campus bears strong influence on development decisions today. It is clear from the historical account above that consideration for the natural and social environments has increased over the years, but much remains if the University desires to become more sustainable. In reflecting on North Campus evolution, it seems that three sticking points are inhibiting movement towards a more sustainable North Campus land-use.

First, chronic indecision—as reflected throughout historic planning documents—regarding the role of the North Campus in the larger university may be a stumbling block. With a clearer understanding of how the Regents want to use the property, planners might feel more comfortable pursuing a more rigorous sustainability development pattern. This indecision ties in with the second sticking point, how the University's mission is currently interpreted. Based on the existing layout of the University, it is not clear that university decision-makers appreciate the connection between land-use and enrichment of the academic community. The divide between North and Central Campuses already retards efforts to engage in inter-campus activities such as attending seminars, workshops, and collaborative efforts.
Continuing this trend of decentralization, i.e. by locating a Great Lakes Research building on Green Road, might further prevent widespread engagement and the serendipitous interactions that can result in a more concentrated campus environment.

Finally, the University's justification for preserving the "green" character of North Campus ought to be examined more closely. If by not building more densely the University is trying to protect the ecological integrity of the North Campus, the ecological impacts of building elsewhere must also be considered. Existing North Campus environmental assessments do not support the notion expressed by a number of those interviewed that the North Campus woodlots are ecologically valuable and in need of protection. At the same time, it is clear that all of Southeast Michigan is experiencing sprawling development that is consuming land at a rate far in excess of population growth. Over the last three decades, for example, the Detroit metropolitan area developed land at 13 times the rate of its population growth.[36] Concentrating development on North Campus will alleviate development pressures on the exurban fringe, in places like East Campus and elsewhere. While it may be difficult, if not impossible, to know exactly which areas experience that relief, it is clear that to not build more densely in already urbanized areas, is to preclude any efforts to offset development pressures in undeveloped areas that are likely to have a higher ecological value.

Due to the convoluted nature of land use decisions at the University of Michigan, it is unlikely that a single individual will be able to bring about the types of changes called for in the previous section. Rather, it will likely require the work of hundreds of committed community members, including faculty, staff, students, and the university planner's office. We expect that educating decision makers about the broader implications of individual development decisions will continue to be an important component of these efforts. Thus, we hope that this historical account, and the study to which it is party, will help university decision-makers think more broadly when making future land-use decisions.

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[1] PAC. 2005 *North Campus Vision 2005-2025*: Preliminary & Advisory- Final Draft for Review. University of Michigan Planning Advisory Committee.

[2] JJR. 1984 University of Michigan North Campus Planning Study. Johnson, Johnson & Roy, Inc.

[3] U-M. 1955. Michigan Tradesman: North Campus Issue. University of Michigan.

[4] Johnson, William J, and Associates. 1960. University of Michigan North Campus Planning Report. p. 7.

[5] Ibid, p.7.

[6] Ibid, p.5.

[7] Ibid, p.8.

[8] JJR. 1965 The University of Michigan North Campus Planning Conference Study. Johnson, Johnson & Roy, Inc. p. 1.

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[10] Ibid, p.11.

[11] Johnson, W.J. and F.W. Mayer. 1971 *North Campus Land Analysis*. p.3.

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[13] Johnson, W.J. and F.W. Mayer. 1971 *North Campus Land Analysis*. p.34.

[14] JJR. 1978. Environmental Survey: University of Michigan/ North Campus. Johnson, Johnson & Roy/ Inc. p.1.

[15] JJR. 1984 University of Michigan North Campus Planning Study. Johnson, Johnson & Roy, Inc. p.67.

[16] Ibid, p. 23.

[17] Ibid, p. 38.

[18] Ibid, 42.

[19] PAC. 2005 *North Campus Vision 2005-2025*: Preliminary & Advisory- Final Draft for Review. University of Michigan Planning Advisory Committee. p.12.

[20] JJR. 1984 University of Michigan North Campus Planning Study. Johnson, Johnson & Roy, Inc. p.36.

[21] PAC. 2005 *North Campus Vision 2005-2025*: Preliminary & Advisory- Final Draft for Review. University of Michigan Planning Advisory Committee. p. 12.

[22] VSBA. 1998. The University of Michigan Campus Plan: Phase I Overview "Learning form Michigan and MGOPIO I.. Venturi, Scott, Brown, and Associates, Inc. February 22, 1998. p.1

[23] Ibid, p.1

[24] Ibid, p.77

[25] VSBA. 1998. *The University of Michigan Campus Plan: Phase I Overview.* Venturi, Scott, Brown, and Associates, Inc. April 22, 1998. A-16

[26] Andropogon Associates, Ltd. 1999. *University of Michigan Environmental Planning Study – North Campus and Surrounding Area.* Andropogon Associates, Ltd & Turner Environmental, Inc. p.2.

[27] Ibid, p.1.

[28] VSBA. 1998. *The University of Michigan Campus Plan: Phase I Overview.* Venturi, Scott, Brown, and Associates, Inc. April 22, 1998. p.20.

[29] VSBA. 1998. The University of Michigan Campus Plan: Phase I Overview "Learning form Michigan and MGOPIO I.. Venturi, Scott, Brown, and Associates, Inc. February 22, 1998. p.81.

[30] PAC. 2005 *North Campus Vision 2005-2025*: Preliminary & Advisory- Final Draft for Review. University of Michigan Planning Advisory Committee. p.12.

[31] Kelbaugh, Douglas. 2002. The North Campus Redux. University of Michigan, Taubman College or Architecture + Urban Planning. p.2.

[32] Ibid, p.17.

[33] Ibid, p.22.

[34] PAC. 2005 *North Campus Vision 2005-2025*: Preliminary & Advisory- Final Draft for Review. University of Michigan Planning Advisory Committee.

[35] Ibid.

[36] Benfield, Kaid, Matthew Raimi, and Donald Chen. 1999. "Once There Were Greenfields." Natural Resources Defense Council/ Surface Transportation Policy Project, Washington D. C. p.8.

APPENDIX C: MACRO FOR COMMUTE TIMES

The Commute Time indicator is potentially the most time-intensive to calculate of our indicator package. One reason for this is that mapping home and work addresses (geocoding) can be a very time consuming process. This difficulty can be lessened somewhat by grouping residences by zip code and calculating commute times and distances from the geographical center of the zip code area. Unfortunately, this simplification results in a considerable loss of detail in the data.

To solve this dilemma, we developed a means of getting detailed data without taking the time to geocode every address in the sample or population. The following macro takes a spreadsheet with home and work addresses (see Figure C-1) and looks up commute times and distances using the online mapping service, Mapquest.

	B	F	G	H	M	N	O	P	Q
1	Address 1	City	St	Postal	Work Street	Work City	Work State	Commute Distance	Commute Time
2	1234 Sesame St	Ypsilanti	MI	48197	1150 W Medical Center Dr	Ann Arbor	MI	13.66	24
3	100 Barrow St #10	Ann Arbor	MI	48104	1101 N University Ave	Ann Arbor	MI	1.11	4
4	1250 Elm Ave	Ypsilanti	MI	48197	1150 W Medical Center Dr	Ann Arbor	MI	5.91	13
5	1111 McIntyre Dr	Ann Arbor	MI	48105	1150 W Medical Center Dr	Ann Arbor	MI	2.44	5
6	1600 Penn Ave	Ann Arbor	MI	48105	1101 N University Ave	Ann Arbor	MI	4.08	12
7	787 K St	Ann Arbor	MI	48103	1150 W Medical Center Dr	Ann Arbor	MI	1.26	3
8	1633 Highland Ave.	Ann Arbor	MI	48105	1085 S University Ave	Ann Arbor	MI	4.03	11
9	651 Green Bay Rd.	Williamston	MI	48895	1205 Beal Ave	Ann Arbor	MI	56.28	58
10	3000 Ringside Dr	Ann Arbor	MI	48104	930 N University Ave	Ann Arbor	MI	0.78	2
11	1500 Natalie Ln #25	Parma	MI	49269	1500 E Medical Center Dr	Ann Arbor	MI	46.94	49

Figure C-1: Excel Spreadsheet with Home and Work Addresses

USING THE MACRO

The macro is written in Visual Basic and tested with Microsoft Excel 2003 for Windows. It has not been tested with Macintosh versions of Excel. Before running the macro, some setting up is required:

1) Prepare the data in a spreadsheet as shown in Figure C-1.

2) Bring the macro into the Excel spreadsheet you wish to use it with, either by:

   a. Obtain the `mapquest.bas` file from one of the authors and import it by selecting '`Tools->Macro->Visual Basic Editor`' in Excel and then '`File->Import File...`' in Microsoft Visual Basic

   b. Open the Visual Basic editor ('`Tools->Macro->Visual Basic Editor`' in Excel) and type the macro in by hand

3) Activate two "References" files in Visual Basic:

   a. Open the Visual Basic editor (From Excel: '`Tools->Macro->Visual Basic Editor`')

b. In Visual Basic Editor, select '`Tools->References`' and make sure the boxed are checked next to "`Microsoft VBScript Regular Expressions`" and "`Microsoft Internet Controls`"

4) Enter 'Settings and Preferences' in the macro

5) Find the portion of the macro labeled "`Settings and Preferences`"

6) For each column of data, (work street, home state, commute distance, etc.) enter the number of the corresponding column of the spreadsheet you will be working from. Excel uses letters for columns, so if your "work city" column is Column B, the line in the preferences should read: "`WorkCityColNum = 2`"

7) Enter the row that your data starts and ends at (or that you would like the macro to start and end at if you do not want to calculate it all at once)

8) Finally, run the macro by selecting '`Tools->Macro->Macros`' in Excel, selecting '`GetCommuteDistances`' and clicking the '`Run`' button. The Internet Explorer and Excel windows can be minimized, allowing the macro to run in the background.

```
' Requires the following Visual Basic libraries to be active:
'       (In Excel, Select Tools->Macros->Visual Basic Editor; In VBE, select
Tools->References)
' (1) "Microsoft VBScript Regular Expressions" (or similar, sometimes "1.0" or
"5.5")
' (2) "Microsoft Internet Controls"

Public Sub GetCommuteDistances()
    Dim IEObject As New InternetExplorer
    Dim i As Long
    Dim theHtml As String
    Dim theUrl As String

    Dim homeStreet As String
    Dim homeCity As String
    Dim homeState As String
    Dim workStreet As String
    Dim workCity As String
    Dim workState As String

    Dim HomeStreetColNum As Integer
    Dim HomeCityColNum As Integer
    Dim HomeStateColNum As Integer
    Dim WorkStreetColNum As Integer
    Dim WorkCityColNum As Integer
    Dim WorkStateColNum As Integer
    Dim CommuteTimeColNum As Integer
    Dim CommuteDistanceColNum As Integer

    Dim mainRE As New RegExp
    Dim mainMatch As Match
    Dim colMatch As MatchCollection
    Dim commuteDistance As String
    Dim commuteTime As String

    Dim StartRow As Long
    Dim EndRow As Long
    Dim SkipExisting As Boolean

    Dim tempVar As Variant


    ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
    ' *** Settings and Preferences ***
    '
    ' Replace '#' below with appropriate number
    '
    ' Work Street Address Column Number
    WorkStreetColNum = #
    '
    ' Work City Column Number
    WorkCityColNum = #
    '
    ' Work State Column Number
    WorkStateColNum = #
    '
    ' Home Street Address Column Number
    HomeStreetColNum = #
    '
    ' Home City Column Number
    HomeCityColNum = #
    '
    ' Home State Column Number
    HomeStateColNum = #
    '
    ' Commute Time Column Number
    CommuteTimeColNum = #
    '
    ' Commute Distance Column Number
    CommuteDistanceColNum = #
```

```
    '
    'Skip Existing Entries (If True, will only calculate entries with no commute
time listed)
    ' (This also acts as "write protection", such that True = Do Not Overwrite)
    SkipExisting = True
    '
    ' Start with which row?
    StartRow = #
    '
    ' End at which row?
    EndRow = #
    '
    '  (End of Settings and Preferences)
    ''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''


    ' Get started by creating an Internet Explorer window
    Set IEObject = CreateObject("Internetexplorer.application")
    IEObject.Visible = True

    For i = StartRow To EndRow
        'Skip entries that don't have either a work address or home address
        If (Cells(i, WorkStreetColNum).Value = "") Or (Cells(i,
HomeStreetColNum).Value = "") _
            Then GoTo SkipThisOne
        If (SkipExisting = True) And (Not Cells(i, 17).Value = "") Then GoTo
SkipThisOne

        'Get Home Address formatted (with '+' in place of spaces)
        homeStreet = Replace(Cells(i, HomeStreetColNum).Value, " ", "+", , ,
vbTextCompare)
        mainRE.Pattern = "\+\#[\s\+\-0-9A-Za-z]{1,5}"
        homeStreet = mainRE.Replace(homeStreet, "")
        homeCity = Replace(Cells(i, HomeCityColNum).Value, " ", "+", , ,
vbTextCompare)
        homeState = Replace(Cells(i, HomeStateColNum).Value, " ", "+", , ,
vbTextCompare)

        'Get Work Address ready (with '+' in place of spaces)
        workStreet = Replace(Cells(i, WorkStreetColNum).Value, " ", "+", , ,
vbTextCompare)
        workCity = Replace(Cells(i, WorkCityColNum).Value, " ", "+", , ,
vbTextCompare)
        workState = Replace(Cells(i, WorkStateColNum).Value, " ", "+", , ,
vbTextCompare)

        theUrl =
"http://www.mapquest.com/directions/main.adp?go=1&do=nw&rmm=1&un=m&cl=EN&ct=NA&r
sres=1&1a=" _
            & homeStreet & "&1c=" & homeCity & "&1s=" & homeState & "&1z=&2a=" &
workStreet _
            & "&2c=" & workCity & "&2s=" & workState & "&2z="

        'Load URL
        IEObject.Navigate (theUrl)
        ' Wait for page to load:
        Do Until IEObject.Busy = False
            DoEvents
        Loop
        Do Until IEObject.ReadyState = READYSTATE_COMPLETE
            DoEvents
        Loop
        Do Until IEObject.Busy = False
            DoEvents
        Loop
        Do Until IEObject.ReadyState = READYSTATE_COMPLETE
            DoEvents
        Loop

        'Dump Mapquest page html into a variable
```

```
        theHtml = IEObject.Document.documentElement.outerhtml

        'Check to see if mapquest is suggesting an address
        ' (Note: these RegEx search strings may need updating if Mapquest makes
changes to their html...)
        mainRE.Pattern = "similar location"
        If mainRE.Test(theHtml) = True Then  'try and use the suggestion!
            mainRE.Pattern = Chr(34) & "\d+\s[A-Z]+\s[A-Z]+\s?[A-Z]{0,4}" &
Chr(34)
            If mainRE.Test(theHtml) = True Then
                Set colMatch = mainRE.Execute(theHtml)
                For Each mainMatch In colMatch
                    homeStreet = mainMatch.Value
                Next
                mainRE.Pattern = "\d+\s[A-Z]+\s[A-Z]+\s?[A-Z]{0,4}"
                If mainRE.Test(homeStreet) = True Then
                    Set colMatch = mainRE.Execute(homeStreet)
                    For Each mainMatch In colMatch
                        homeStreet = Replace(mainMatch.Value, " ", "+", , ,
vbTextCompare)
                    Next

                    'Try Again:
                    theUrl =
"http://www.mapquest.com/directions/main.adp?go=1&do=nw&rmm=1&un=m&cl=EN&ct=NA&r
sres=1&1a=" _
                        & homeStreet & "&1c=" & homeCity & "&1s=" & homeState _
                        & "&1z=&2a=" & workStreet _
                        & "&2c=" & workCity & "&2s=" & workState & "&2z="

                    'Load URL
                    IEObject.Navigate (theUrl)
                    ' Wait for page to load:
                    Do Until IEObject.Busy = False
                        DoEvents
                    Loop
                    Do Until IEObject.ReadyState = READYSTATE_COMPLETE
                        DoEvents
                    Loop
                    Do Until IEObject.Busy = False
                        DoEvents
                    Loop
                    Do Until IEObject.ReadyState = READYSTATE_COMPLETE
                        DoEvents
                    Loop

                    'Dump Mapquest page html into a variable
                    theHtml = IEObject.Document.documentElement.outerhtml

                End If
            End If
        End If


        'Find Commute Distance in html
        mainRE.Pattern = "Distance.+\d+\.\d+"
        If mainRE.Test(theHtml) = True Then
            Set colMatch = mainRE.Execute(theHtml)
            For Each mainMatch In colMatch
                commuteDistance = mainMatch.Value
            Next
        End If
        mainRE.Pattern = "\d+\.\d+"
        If mainRE.Test(commuteDistance) = True Then
            Set colMatch = mainRE.Execute(commuteDistance)
            For Each mainMatch In colMatch
                commuteDistance = mainMatch.Value
            Next
        End If
```

```
        'Find Commute Time in html...
        '  If this is multiple hours, then grab the hour number first:
        mainRE.Pattern = "Time.+\d+\shour"
        If mainRE.Test(theHtml) = True Then
            ' (commute time > 1 hour)
            Set colMatch = mainRE.Execute(theHtml)
            For Each mainMatch In colMatch
                commuteTime = mainMatch.Value
            Next
            mainRE.Pattern = "\d+"
            If mainRE.Test(commuteTime) = True Then
                Set colMatch = mainRE.Execute(commuteTime)
                For Each mainMatch In colMatch
                    commuteTime = mainMatch.Value * 60 'convert hours to minutes
                Next
            End If

            'Now add the minutes to the hour(s) portion of the commute time
            mainRE.Pattern = "hour.+\d+\sminute"
            If mainRE.Test(theHtml) = True Then
                Set colMatch = mainRE.Execute(theHtml)
                For Each mainMatch In colMatch
                    tempVar = mainMatch.Value
                Next
            End If
            mainRE.Pattern = "\d+"
            If mainRE.Test(tempVar) = True Then
                Set colMatch = mainRE.Execute(tempVar)
                For Each mainMatch In colMatch
                    commuteTime = CInt(commuteTime) + CInt(mainMatch.Value)
                Next
            End If
        Else
            ' (commute time < 1 hour)
            mainRE.Pattern = "Time.+\d+\sminute"
            If mainRE.Test(theHtml) = True Then
                Set colMatch = mainRE.Execute(theHtml)
                For Each mainMatch In colMatch
                    commuteTime = mainMatch.Value
                Next
            End If
            mainRE.Pattern = "\d+"
            If mainRE.Test(commuteTime) = True Then
                Set colMatch = mainRE.Execute(commuteTime)
                For Each mainMatch In colMatch
                    commuteTime = mainMatch.Value
                Next
            End If
        End If

        'Input commute time and distance into spreadsheet
        Cells(i, CommuteDistanceColNum).Value = commuteDistance
        Cells(i, CommuteTimeColNum).Value = commuteTime

        ' Reset so these values don't accidentally used next time...
        commuteDistance = ""
        commuteTime = ""
        tempVar = ""

SkipThisOne:
    Next i

    ' All Done
    IEObject.Quit
End Sub
```

APPENDIX D: NORTH CAMPUS GROWTH AND RESEARCH EXPENDITURES

Figure D-1 illustrates the relationship between the growth in building floor area (gross floor area, or GFA) on North Campus and the University's total research expenditures between 1985 and 2000. The GFA considered here excludes housing, and so is primarily academic and research space.

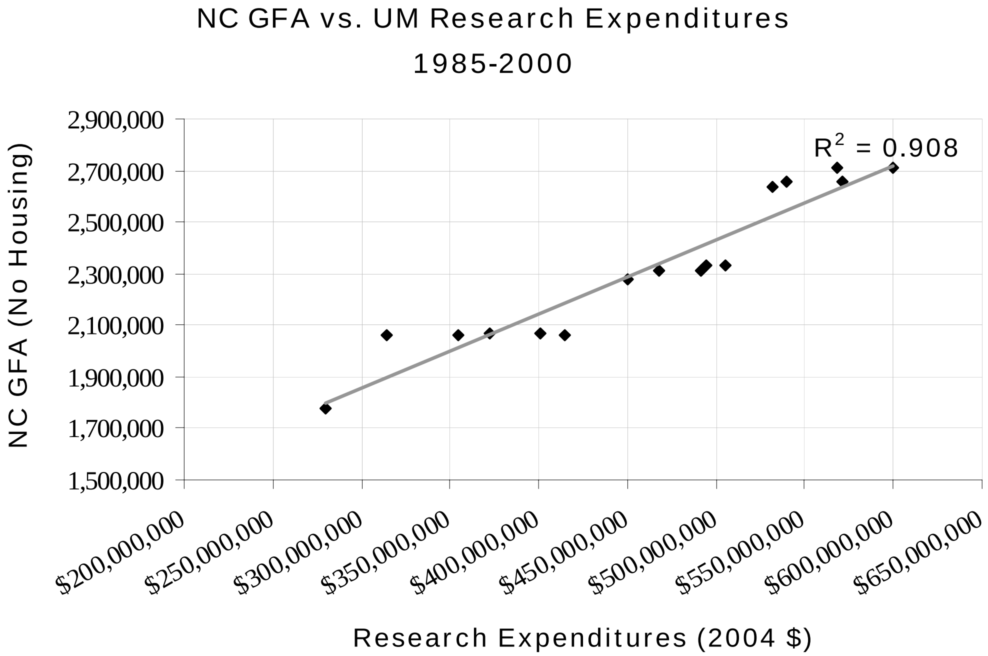

Figure D-1. North Campus building area must grow to accommodate increasing University research expenditures.

Though regressing the floor area on research expenditures shows a strong relationship (R^2=0.908), the relationship is not exactly linear; rather, North Campus GFA increases in discrete steps. This is not surprising, given that a new building is not put up every year, but a closer look at Figure D-1 reveals more: research expenditures at each "step" of building expansion grows for a few years, but then slows some before the next chunk of academic or research space is added. This suggests that while adding new space does not drive the growth in research, such research growth depends somewhat on having new space in which to conduct the research. This finding supports our use of the available academic and research floor area as a proxy for the institutional (or economic) health of the University, insofar as conducting research is one of U-M's core functions.

TABLE D-1. NORTH CAMPUS GROSS FLOOR AREA AND UM-ANN ARBOR RESEARCH EXPENDITURES

YEAR	NORTH CAMPUS GROSS FLOOR AREA (EXCLUDES HOUSING)[1]	RESEARCH EXPENDITURES (NOMINAL $)[2]	INFLATION ADJUSTER[3]	RESEARCH EXPENDITURES (2004 $)
1985	1,778,375	$159,300,000	0.57	$279,473,684
1986	2,061,510	$182,300,000	0.58	$314,310,345
1987	2,061,510	$213,000,000	0.60	$355,000,000
1988	2,068,978	$234,600,000	0.63	$372,380,952
1989	2,068,978	$264,500,000	0.66	$400,757,576
1990	2,061,510	$286,082,483	0.69	$414,612,294
1991	2,279,985	$324,100,000	0.72	$450,138,889
1992	2,309,120	$346,500,000	0.74	$468,243,243
1993	2,309,474	$373,700,000	0.76	$491,710,526
1994	2,330,382	$386,000,000	0.78	$494,871,795
1995	2,332,487	$409,235,763	0.81	$505,229,337
1996	2,638,364	$441,294,540	0.83	$531,680,169
1997	2,657,924	$458,478,301	0.85	$539,386,236
1998	2,659,146	$491,472,206	0.86	$571,479,309
1999	2,707,431	$499,673,610	0.88	$567,810,920
2000	2,709,447	$545,418,036	0.91	$599,360,479

[1] From Sven Sawin, Planning Assistant, University Planner's Office, University of Michigan.
[2] University of Michigan. "UM Annual Research Reports." Accessed via Internet on November 3, 2005 at: http://www.research.umich.edu/research_guide/annual_reports/annual_reports.html
[3] US Bureau of Labor Statistics. "Inflation Calculator." Accessed via Internet on November 5, 2005 at: http://data.bls.gov/cgi-bin/cpicalc.pl

APPENDIX E: POSTER SESSION

For the poster session, we created two identical displays, each consisting of three foam core boards on which we printed color images of Scenario A, Scenario B, and Existing North Campus as a point of reference. Next to each image we provided vital statistics about the scenario such as number of parking spaces, residential units, and square footage of building types. Each display also included a table on which we placed comment cards and pencils. Two group members were stationed at each display to provide brief explanations of the project, describe the maps, encourage onlookers to cast votes, and to field any additional questions. Although we did not actively recruit passersby to vote on our scenarios, we did employ the tactic when there were no participants at a display, in an effort to create a stir that would draw more people.

Figure E-1. Students give feedback on Scenarios A and B (Existing Trends and Smart Growth). The feedback was used to create the Public Input Scenario.

We set up the displays simultaneously at two indoor public locations on North Campus. In deciding where to place them we considered the amount of foot traffic, likelihood of passersby to participate given the setting, and the demographic of the public at that site. The two selected locations were the main hallway of Pierpont Commons (the North Campus student union) and the lobby of the Duderstadt Center, a media center that doubles as a throughway for people en route to the engineering area of North Campus. We displayed the boards during midday hours over the course of three midweek days. A total of 7.5 hours of display time was logged.

The public display boards elicited 310 responses, an average of 41.3 per hour of effort. Scenario B was the clear favorite, by a 2:1 margin. There were 207 votes for Scenario B (67%) and 103 for Scenario A (33%).

TABLE E-1. SCENARIO PREFERENCE.

	FREQUENCY	% OF VOTES
A	103	33%
B	207	67%
Total	310	100%

Because the questions asked on the comment cards were open-ended, there were very few responses that were exactly alike. There were, however, common themes throughout the responses. While the verbatim responses provide a very rich and detailed picture of respondents' feeling toward the scenarios, they need to be aggregated into broader categories if they are to be analyzed quantitatively. Therefore, we grouped similar responses together based on thematic similarity (e.g. a number of respondents chose Scenario B because it was "busier," "more lively" or because "there's more to do." We classified these responses under the category "Activity."). When aggregating responses, we were careful to not over-generalize; we wanted to preserve a sense of the diversity and specificity of the responses while reducing the absolute number of categories. It is important to emphasize that this process necessarily required a significant amount of subjectivity.

TABLE E-2. REASONS FOR CHOOSING SCENARIO A

REASONS	N	% OF VOTES	% OF REASONS
Natural Spaces	45	43.7%	34.9%
Suburban	30	29.1%	23.3%
Not Central Campus	12	11.7%	9.3%
Less Commercial	10	9.7%	7.8%
Likes North Campus	6	5.8%	4.7%
Academic	4	3.9%	3.1%
Commercial	3	2.9%	2.3%
Less Housing	2	1.9%	1.6%
Not Scenario B	2	1.9%	1.6%
Parking	1	1.0%	0.8%
Quality of Life	1	1.0%	0.8%
Less Academic	1	1.0%	0.8%
Second Diag	1	1.0%	0.8%
Centralized Parking	1	1.0%	0.8%
Large Buildings	1	1.0%	0.8%
Less Polluted	1	1.0%	0.8%
No cemetery	1	1.0%	0.8%
Not Res Colleges	1	1.0%	0.8%
Professional	1	1.0%	0.8%
Res Halls	1	1.0%	0.8%
Res Halls Grouped	1	1.0%	0.8%
Smaller	1	1.0%	0.8%
Student-Oriented	1	1.0%	0.8%
Total	129	125.2%	100.0%

For the first question, "Why do you prefer the scenario you selected above?" the coded responses are shown below in Table E-2 and Table E-3. Table E-2 lists the responses for participants who chose Scenario A while the reasons from those who selected Scenario B are shown in Table E-3. The coded responses to the second question "What could be improved about the scenario you chose?" are listed in Table E-4 and Table E-5. Note: For all tables, if there is no qualifier in front of a response category, the word "more" or the phrase "the presence of" is implied.

TABLE E-3. REASONS FOR CHOOSING SCENARIO B

REASONS	N	% OF VOTES	% OF REASONS
Activity	33	15.9%	11.3%
Commercial	29	14.0%	9.9%
Main Street	24	11.6%	8.2%
Parking	23	11.1%	7.8%
Quality of Life	21	10.1%	7.2%
Urban	51	24.6%	17.4%
Like Central Campus	17	8.2%	5.8%
Food	12	5.8%	4.1%
Rail	12	5.8%	4.1%
Housing	11	5.3%	3.8%
Self-sufficient	10	4.8%	3.4%
Staff/Fac Housing	9	4.3%	3.1%
Less Academic	7	3.4%	2.4%
Less Isolated	5	2.4%	1.7%
Res Colleges	5	2.4%	1.7%
Walkability	5	2.4%	1.7%
Second Diag	3	1.4%	1.0%
Green	2	1.0%	0.7%
Facilities	2	1.0%	0.7%
Stu/Fac Interaction	2	1.0%	0.7%
Visitor Destination	2	1.0%	0.7%
Academic	1	0.5%	0.3%
Centralized Parking	1	0.5%	0.3%
Building Layout	1	0.5%	0.3%
Employment	1	0.5%	0.3%
Flexibility	1	0.5%	0.3%
Less Auto-Oriented	1	0.5%	0.3%
Single-Family Housing	1	0.5%	0.3%
Student Housing	1	0.5%	0.3%
Water Bodies	1	0.5%	0.3%
Total	293	141.5%	100.0%

TABLE E-4. IMPROVEMENTS SUGGESTED FOR SCENARIO A FROM THOSE WHO PREFERRED SCENARIO A

IMPROVEMENTS	N	% OF VOTES	% OF SUGGESTIONS
Parking	18	17.5%	22.8%
Housing	13	12.6%	16.5%
Commercial	6	5.8%	7.6%
Food	6	5.8%	7.6%
Green	4	3.9%	5.1%
Water Bodies	3	2.9%	3.8%
Woods	3	2.9%	3.8%
Density	2	1.9%	2.5%
Less Commercial	2	1.9%	2.5%
Open	2	1.9%	2.5%
Parks	2	1.9%	2.5%
Rail	2	1.9%	2.5%
Academic	1	1.0%	1.3%
Centralized Housing	1	1.0%	1.3%
Centralized Parking	1	1.0%	1.3%
Centralized Res Halls	1	1.0%	1.3%
Commercial at Fringe	1	1.0%	1.3%
Connections to Non-UM Commercial	1	1.0%	1.3%
Covered Walkways	1	1.0%	1.3%
Densify Northwood	1	1.0%	1.3%
Height	1	1.0%	1.3%
Less Academic	1	1.0%	1.3%
Less Cemetery	1	1.0%	1.3%
Main Street	1	1.0%	1.3%
More Like B	1	1.0%	1.3%
Nature	1	1.0%	1.3%
Quiet	1	1.0%	1.3%
Res Halls	1	1.0%	1.3%
Total	79	76.7%	100.0%

TABLE E-5. IMPROVEMENTS SUGGESTED FOR SCENARIO B FROM THOSE WHO PREFERRED SCENARIO B

IMPROVEMENTS	N	% OF VOTES	% OF SUGGESTIONS
Natural Spaces	27	13.0%	25.0%
Parking	14	6.8%	13.0%
Less Development	8	3.9%	7.4%
Housing	6	2.9%	5.6%
Food	4	1.9%	3.7%
Entertainment	4	1.9%	3.7%

Sport Facilities	3	1.4%	2.8%
Transport Connections to Central Campus (CC)	3	1.4%	2.8%
Commercial	2	1.0%	1.9%
Rail	2	1.0%	1.9%
Academic Buildings	2	1.0%	1.9%
Less Like Central Campus	2	1.0%	1.9%
Main Street Placement	2	1.0%	1.9%
Transportation	2	1.0%	1.9%
Less Commercial	1	0.5%	0.9%
Academic	1	0.5%	0.9%
Centralized Res Halls	1	0.5%	0.9%
Building Height	1	0.5%	0.9%
Commercial in Res Halls	1	0.5%	0.9%
CVS	1	0.5%	0.9%
Housing on Crest Line (View of Campus)	1	0.5%	0.9%
Infill	1	0.5%	0.9%
Integrate with Non-UM	1	0.5%	0.9%
Keep Buses	1	0.5%	0.9%
Like CC Architecture	1	0.5%	0.9%
Likes A's Diag/'Majestic' Buildings	1	0.5%	0.9%
Local Food	1	0.5%	0.9%
Main Street/Village Connection	1	0.5%	0.9%
Multimodal Transportation	1	0.5%	0.9%
Organic Development	1	0.5%	0.9%
Parking over Woodlots	1	0.5%	0.9%
Ped Connections to Non-UM	1	0.5%	0.9%
Physical Connections to CC	1	0.5%	0.9%
Rail-centric Layout	1	0.5%	0.9%
Running Paths	1	0.5%	0.9%
Separate Housing from Academic	1	0.5%	0.9%
Summer Activity	1	0.5%	0.9%
Transit	1	0.5%	0.9%
Urban	1	0.5%	0.9%
Woodlands Evenly Distributed	1	0.5%	0.9%
Make Woods Into Parks	1	0.5%	0.9%
Total	108	52.2%	100.0%

APPENDIX F: ONLINE SURVEY RESULTS

FACULTY AND STAFF SURVEY OVERVIEW

The survey was sent to employees of the University of Michigan-Ann Arbor who work on North Campus. North Campus employees were identified by organizational group code ("org group code"; see Table F-1). In an attempt to capture as many North Campus employees, some org groups were used that also include Central Campus employees (such as the "University Unions" or "University Libraries" groups).

TABLE F-1. U-M NORTH CAMPUS EMPLOYEE "ORG GROUP CODES"

ORG CODE	DEPARTMENT
COLL_ARCH_URN_PLN	Taubman College of Architecture and Urban Planning
COLLEGE_ENGINEERING	College of Engineering
HOUSING_MANAGED_OPER	Housing
MICH_MEM_PHOENIX_PRO	Phoenix Lab
SCHOOL_ART_DESIGN	School of Art and Design
SCHOOL_INFORMATION	School of Information (Located on both North and Central Campus)
SCHOOL_MUSIC	School of Music
SERVICE_OPERATIONS	Grounds
STUDENT_RESIDENCES	Residence Hall Operations
UM_TRANS_RES_INST	UM Transportation Research Institute
UNIVERSITY_UNIONS	University Unions (Manages student unions on both campuses)
UNIV_LIBRARY	University Libraries (Manages libraries on both campuses)

The survey was posted online and an email was sent to the 2,821 University employees in the above org group codes. A reminder email was sent four days later. A total of 519 responses were recorded, of which 382 indicated that they work on North Campus, for a response rate of 13.5 percent (382 out of 2,821). Responses for non-North Campus employees were not recorded. The text of the email follows:

```
We are conducting this survey as part of an Urban Planning
Masters Project focusing on the sustainability of North
Campus.  We want to know what you think!  To take the survey,
follow the link below:

http://www.zoomerang.com/survey.zgi?p=NZR252NZNZ2525


The Fine Print:

In this survey, we will ask you a few questions and solicit
your opinion. The questions do not deal with any sensitive
topics and should cause you no discomfort. Please also note
that your participation is absolutely voluntary and you are
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always free to not answer a question. There are no direct
benefits to you by participating in this study however; your
opinion will help us in suggesting better informed
alternatives for the future growth of North Campus. Your
answers will remain confidential.

If you have questions about participation in this research
study, please contact the researcher: Sanjeev Vidyarthi,
Department of Urban & Regional Planning, Taubman College of
Architecture & Urban Planning, The University of Michigan,
2000 Bonisteel Boulevard, Ann Arbor, Michigan 48109-2069, USA,
email: svidy@umich.edu; Phone: 734-763-3075, Fax: 734-763-
8822.
Should you have questions regarding your rights as a
participant in research, please contact the Behavioral
Sciences Institutional Review Board, Kate Keever, 540 East
Liberty, Suite 202, Ann Arbor, MI 48104-2210, 734-936-0933,
email: irbhsbs@umich.edu.
```

FACULTY AND STAFF SURVEY RESULTS

Question 1: Do you work on North Campus?

382 of 519 survey respondents (73.6%) indicated that they work on North Campus. This group represents the sample for the survey. Interestingly, this suggests that up to 2,076 employees (73.6% of 2,821 who received the survey) work on North Campus, while data obtained from the University lists only 1,265 employees with North Campus work addresses: employees are working on both campuses. Most likely, the 73.6% figure (and therefore the 2,076 estimate of North Campus employees) is higher than for the actual population because of response bias: those employees who do not work on North Campus were less likely to respond to the survey.

Question 2: What is your primary affiliation with the University?

TABLE F-2. WORK ON NORTH CAMPUS?

AFFILIATION	NO N (%)	YES N (%)
Faculty	24 (18)	82 (21)
Staff	96 (70)	229 (60)
Student	16 (12)	71 (19)
No Response	1 (1)	0 (0)
Total	137 (100)	382 (100)

Question 3: Given the same job, would you prefer to work on North Campus or Central Campus?

TABLE F-3. WORK PREFERENCE: WHICH CAMPUS?

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
Central Campus	51 (62)	45 (20)	44 (62)
North Campus	29 (35)	180 (79)	26 (37)
No Response	2 (2)	4 (2)	1 (1)
Total	82 (100)	229 (100)	71 (100)

Question 4: Do you prefer the physical layout of North Campus or Central Campus?

TABLE F-4. LAYOUT PREFERENCE: WHICH CAMPUS?

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
Central Campus	52 (63)	68 (30)	44 (62)
North Campus	24 (29)	149 (65)	25 (35)
No Response	6 (7)	12 (5)	2 (3)
	82 (100)	229 (100)	71 (100)

Question 5: Pretend you are walking on North Campus. What do you like most about the built and natural environment of North Campus?

57 respondents left this question blank

TABLE F-5. LIKE MOST ABOUT NORTH CAMPUS

	N (%)
Natural Features	378 (67)
Quiet/Suburban	68 (12)
Buildings/Architecture	55 (10)
Diag	18 (3)
Parking	15 (3)
Nothing	6 (1)
Other	25 (4)
Total	565 (100)

Question 6: Pretend you are walking on North Campus. What do you dislike most about the built and natural environment of North Campus?

81 respondents left this question blank.

TABLE F-6. DISLIKE MOST ABOUT NORTH CAMPUS

	N (%)
Too Suburban	100 (24)
Buildings/Architecture	64 (16)
Lack of Retail Options	51 (12)
Parking	48 (12)
Too Urban	44 (11)
Not Enough Nature	27 (7)
Construction	24 (6)
Lack of Community	19 (5)
Nothing	9 (2)
Other	23 (6)
Total	409 (100)

Question 7: What types of facilities would you like to see added to North Campus?

TABLE F-7. FACILITIES TO ADD TO NORTH CAMPUS

FACILITY TYPE	RESIDENTIAL N (%)	RECREATION N (%)	BUSINESS/RETAIL N (%)	ACADEMIC N (%)	OTHER N (%)
Yes	45 (12)	112 (71)	206 (54)	57 (15)	145 (28)
No OR *No Response*	337 (88)	270 (29)	176 (46)	325 (63)	374 (72)
Total	382 (100)	382 (100)	382 (100)	382 (100)	382 (100)

Question 8: Given your answer to the previous question, what *specific* facilities or uses would you like to see added to North Campus?

114 respondents left this question blank.

TABLE F-8. SPECIFIC FACILITIES TO ADD TO NORTH CAMPUS

	N (%)
Food	155 (37)
Retail	72 (17)
Parking	39 (9)
Alcohol	27 (7)
Recreation	27 (7)
Academic	16 (4)
Activity	16 (4)
Housing	10 (2)
Natural Features	5 (1)
Nothing	18 (4)
Other	30 (7)
Total	415 (100)

Question 9: What mode of transportation do you use most often to travel to North Campus?

TABLE F-9. MODAL SPLIT

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
Bicycle	4 (5)	2 (1)	3 (4)
Bus	9 (11)	12 (5)	27 (38)
Carpool	1 (1)	12 (5)	2 (3)
Drive alone	61 (74)	190 (83)	24 (34)
Other	4 (5)	4 (2)	1 (1)
Walk	2 (2)	6 (3)	13 (18)
No Response	1 (1)	3 (1)	1 (1)
Total	82 (100)	229 (100)	71 (100)

Question 10: On average, how many trips do you make to North Campus per week?

TABLE F-10. NORTH CAMPUS TRIPS PER WEEK

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
0-2	6 (7)	8 (3)	1 (1)
3-5	36 (44)	146 (64)	23 (32)
6-10	34 (41)	61 (27)	26 (37)
> 10	5 (6)	11 (27)	20 (28)
No Response	1 (1)	3 (1)	1 (1)
Total	82 (100)	229 (100)	71 (100)

Question 11: How far do you live from North Campus?

TABLE F-11. DISTANCE FROM NORTH CAMPUS

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
0-1 mile	2 (2)	3 (1)	14 (20)
1-5 miles	40 (49)	36 (16)	38 (54)
5-10 miles	12 (15)	47 (21)	8 (11)
10-20 miles	16 (20)	60 (26)	10 (14)
20-30 miles	2 (2)	35 (15)	0 (0)
> 30 miles	9 (11)	44 (19)	0 (0)
No Response	1 (1)	4 (2)	1 (1)
Total	82 (100)	229 (100)	71 (100)

Question 12: What do you like most about your commute to North Campus?

79 respondents (21%) left this question blank

TABLE F-12. LIKE MOST ABOUT COMMUTE TO NORTH CAMPUS

	N (%)
Short/Easy	148 (49)
Scenic	58 (19)
Parking	19 (6)
Time to Do Something	19 (6)
Nothing	34 (11)
Other	23 (8)
Total	301 (100)

Question 13: What do you dislike most about your commute to North Campus?

95 respondents (25%) left this question blank.

TABLE F-13. DISLIKE MOST ABOUT COMMUTE TO NORTH CAMPUS

	N (%)
Long/Difficult	165 (58)
Parking	50 (18)
Bus Freq/Routes/Etc.	21 (7)
Nothing	16 (6)
Other	31 (11)
Total	283 (100)

Question 14: For this question, refer to the maps below. In which zone do you live?

TABLE F-14. IN WHICH ZONE DO YOU LIVE?[1]

	N (%)
Zone 1 (<1 miles)	26 (7)
Zone 2 (1-2 miles)	65 (17)
Zone 3 (2-3 miles)	59 (15)
Zone 4 (3-5 miles)	48 (13)
Zone 5 (5-10 miles)	64 (17)
Zone 6 (10-20 miles)	52 (14)
Zone 7 (20-30 miles)	33 (9)
Zone 8 (>30 miles)	14 (4)
Other	13 (3)
No Response	8 (2)
Total	382 (100)

Question 15: What were the three most important factors in choosing where you live?

49 respondents (13%) left this question blank.

TABLE F-15. REASONS FOR CHOOSING RESIDENCE

	N (%)
Location/Neighborhood	286 (34)
Price	172 (20)
Close to Work	120 (14)
House/Unit/Lot	76 (9)
School District	71 (8)
Safety	32 (4)
Taxes	16 (2)
Other	75 (9)
Total Responses	848 (100)

Question 16: Do you own or rent your residence?

TABLE F-16. HOME OWNERSHIP

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
Own	69 (84)	180 (79)	16 (23)
Rent	9 (11)	38 (17)	52 (73)
Other	1 (1)	4 (2)	2 (3)
No Response	2 (2)	7 (3)	1 (1)
	82 (100)	229 (100)	71 (100)

[1] For a map showing the zones as they were shown to survey respondents, see page 146.

Question 17: Which of the choices below best characterizes your residence?

TABLE F-17. TYPE OF RESIDENCE

	N (%)
Apartment	70 (18)
Condominium	29 (8)
Detached House	255 (67)
Other	16 (4)
No Response	12 (3)
Total	382 (100)

Question 18: If you live in a detached house, please choose the option below that is closest to your lot size.

TABLE F-18. LOT SIZE

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
1/8 acre	25 (30)	38 (17)	11 (15)
1/4 acre	10 (12)	43 (19)	5 (7)
1/2 acre	13 (16)	27 (12)	1 (1)
1 acre	10 (12)	34 (15)	2 (3)
2 acres	6 (7)	9 (4)	0 (0)
5 acres	0 (0)	5 (2)	0 (0)
10 acres	0 (0)	7 (3)	0 (0)
> 10 acres	2 (2)	9 (4)	0 (0)
Not Applicable	1 (1)	13 (6)	7 (10)
No Response	15 (18)	44 (19)	45 (63)
Total	82 (100)	229 (100)	71 (100)

Question 19: What do you like most about your residential location?

52 respondents (14%) left this question blank.

TABLE F-19. LIKE MOST ABOUT RESIDENCE

	N (%)
Location/Neighborhood	170 (52)
Nature/Rural	60 (18)
House/Unit/Lot	28 (9)
Quiet	26 (8)
Price	17 (5)
School	11 (3)
Safety	4 (1)
Other	12 (4)
Total	328 (100)

Question 20: What do you dislike most about your residential location?

80 respondents (21%) left this question blank.

TABLE F-20. DISLIKE MOST ABOUT RESIDENCE

	N (%)
Crowded/Urban	69 (24)
Distance from Work	57 (20)
Location/Neighborhood	26 (9)
Distance from Amenities	23 (8)
House/Unit/Lot	18 (6)
Unsafe	12 (4)
Nothing	35 (12)
Other	52 (18)
Total	292 (100)

Question 21: Would you be willing to live on a smaller lot in exchange for living closer to North Campus?

TABLE F-21. LIVE CLOSER ON SMALLER LOT?

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)
Yes	19 (23)	49 (21)	24 (34)
No	61 (74)	169 (74)	45 (63)
No Response	2 (2)	11 (5)	2 (3)
Total	82 (100)	229 (100)	71 (100)

Question 22: Interest in Single-Family on Campus?

TABLE F-22. PURCHASE SINGLE-FAMILY LOT ON CAMPUS?

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)	TOTAL N (%)
Not Interested	40 (49)	142 (62)	46 (65)	228 (60)
Somewhat Interested	27 (33)	58 (25)	15 (21)	100 (26)
Very Interested	12 (15)	18 (8)	7 (10)	37 (10)
No Response	3 (4)	11 (5)	3 (4)	17 (5)
Total	82 (100)	229 (100)	71 (100)	382 (100)

Question 23: Interest in Condos on Campus?

TABLE F-23. PURCHASE CONDO ON CAMPUS?

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)	TOTAL N (%)
Not Interested	40 (49)	153 (67)	49 (69)	242 (63)
Somewhat Interested	29 (35)	53 (23)	13 (18)	95 (25)
Very Interested	10 (12)	12 (5)	6 (8)	28 (7)
No Response	3 (4)	11 (5)	3 (4)	17 (5)
Total	82 (100)	229 (100)	71 (100)	382 (100)

Question 24: Interest in Rental on Campus?

TABLE F-24. LONG-TERM RENTAL ON CAMPUS?

	FACULTY N (%)	STAFF N (%)	STUDENT N (%)	TOTAL N (%)
Not Interested	52 (63)	166 (72)	32 (45)	250 (65)
Somewhat Interested	19 (23)	37 (16)	33 (46)	89 (23)
Very Interested	8 (10)	15 (7)	3 (4)	26 (7)
No Response	3 (4)	11 (5)	3 (4)	17 (5)
Total	82 (100)	229 (100)	71 (100)	382 (100)

A Chi-Square test indicates that the difference between faculty and staff interest in single-family lots is significant at the 0.05 level, the difference in interest in condominiums is significant at the 0.01 level, and the difference in interest in rental housing is not significant.

STUDENT SURVEY

The student survey is similar to the faculty and staff survey, except that it contains fewer questions about housing decisions. The email sent to students was identical to that sent to University employees, except for the URL, which pointed to the student survey. The student survey instrument is reprinted in Appendix H below.

Question 1: Do you attend classes on North Campus?

TABLE F-25. ATTEND CLASS ON NORTH CAMPUS

	N (%)
No	4 (2)
Yes	178 (98)
Total	182 (100)

Question 2: Do you live on North Campus? What were your reasons for living where you live?

TABLE F-26. STUDENTS: LIVE ON NORTH CAMPUS

	N (%)
No	110 (62)
Yes	68 (38)
Total	178 (100)

TABLE F-27. STUDENTS: REASONS FOR CHOOSING RESIDENCE

	N (%)
Location/Neighborhood	47 (29)
Close to Classes	40 (25)
Price	17 (11)
House/Unit/Lot	16 (10)
Quiet	12 (8)
Other	28 (18)
Total	160 (100)

Question 3: Do you prefer the physical layout of North Campus or Central Campus?

TABLE F-28. STUDENTS: CAMPUS LAYOUT PREFERENCE

	N (%)
Central Campus	92 (52)
North Campus	81 (46)
No Response	5 (3)
Total	178 (100)

Question 4: Pretend you are walking on North Campus. What do you like most about the built and natural environment of North Campus?

TABLE F-29. STUDENTS: LIKE ABOUT NORTH CAMPUS ENVIRONMENT

	N (%)
Natural Features	120 (49)
Buildings/Architecture	54 (22)
Quiet/Suburban	32 (13)
Compact	12 (5)
Nothing	6 (2)
Other	21 (9)
Total	245 (100)

Question 5: Pretend you are walking on North Campus. What do you dislike most about the built and natural environment of North Campus?

TABLE F-30. STUDENTS: DISLIKE ABOUT NORTH CAMPUS ENVIRONMENT

	N (%)
Too Suburban	52 (28)
Buildings/Architecture	24 (13)
Construction	24 (13)
Parking	16 (9)
Lack of Retail Options	11 (6)
Lack of Community	8 (4)
Not Enough Nature	7 (4)
Nothing	9 (5)
Other	32 (17)
Total	183 (100)

Question 6: What types of facilities would you like to see added to North Campus?

TABLE F-31. STUDENTS: ADD FACILITIES TO NORTH CAMPUS?

	RESIDENTIAL N (%)	RECREATION N (%)	BUSINESS/RETAIL N (%)	ACADEMIC N (%)	OTHER N (%)
Yes	33 (19)	78 (44)	98 (55)	37 (21)	51 (29)
No or No Response	145 (81)	100 (56)	80 (45)	141 (79)	127 (71)
Total	178 (100)	178 (100)	178 (100)	178 (100)	178 (100)

Question 7: Given your answer to the previous question, what *specific* facilities or uses would you like to see added to North Campus?

TABLE F-32. STUDENTS: SPECIFIC FACILITIES DESIRED ON NORTH CAMPUS

	N (%)
Food	67 (39)
Retail	22 (13)
Recreation	21 (12)
Parking	13 (8)
Housing	11 (6)
Activity	9 (5)
Academic	7 (4)
Natural Features	1 (1)
Nothing	2 (1)
Other	17 (10)
Total	170 (100)

Question 8: For this question, refer to the maps below. In which zone do you live?

TABLE F-33. STUDENTS: IN WHICH ZONE DO YOU LIVE?

		N (%)
Zone 1	(<1 miles)	60 (34)
Zone 2	(1-2 miles)	77 (43)
Zone 3	(2-3 miles)	27 (15)
Zone 4	(3-5 miles)	3 (2)
Zone 5	(5-10 miles)	0 (0)
Zone 6	(10-20 miles)	4 (2)
Zone 7	(20-30 miles)	4 (2)
Zone 8	(>30 miles)	0 (0)
Other		2 (1)
No Response		1 (1)
Total		178 (100)

Question 9: Do you own or rent your residence?

TABLE F-34. STUDENTS: OWN OR RENT?

	N (%)
Own	2 (1)
Rent	142 (80)
Other	31 (17)
No Response	3 (2)
Total	178 (100)

Question 10: What mode of transportation do you use most often to travel to North Campus?

TABLE F-35. STUDENTS: MODAL SPLIT

	N (%)
Drive alone	34 (19)
Carpool	3 (2)
Bus	111 (62)
Bicycle	4 (2)
Walk	22 (12)
No Response	4 (2)
Total	178 (100)

Question 11: On average, how many trips do you make to North Campus per week?

TABLE F-36. STUDENTS: WEEKLY NORTH CAMPUS TRIPS

	N (%)
0-2	5 (3)
3-5	40 (22)
6-10	63 (35)
> 10	67 (38)
No Response	3 (2)
Total	178 (100)

Question 12: What do you like most about your commute to North Campus?

TABLE F-37. STUDENTS: LIKE MOST ABOUT COMMUTE

	N (%)
Short/Easy	46 (35)
Buses	26 (20)
Time to Do Something	14 (11)
Scenic	4 (3)
Parking	1 (1)
Nothing	23 (18)
Other	17 (13)
Total	131 (100)

Question 13: What do you dislike most about your commute to North Campus?

TABLE F-38. STUDENTS: DISLIKE MOST ABOUT COMMUTE

	N (%)
Bus Freq/Routes/Etc.	52 (37)
Long/Difficult	45 (32)
Parking	17 (12)
Weather	9 (6)
Other	17 (12)
Nothing	2 (1)
Total	142 (100)

Question 14: Do you have any additional comments, concerns, or suggestions regarding North Campus?

This question was not coded due to time constraints.

APPENDIX G: FACULTY AND STAFF SURVEY INSTRUMENT

North Campus Faculty and Staff Survey

1

Do you work on North Campus?

YES NO

2

What is your primary affiliation with the University?

Faculty
Staff
Student

SUBMIT

Survey Page 1

North Campus Faculty and Staff Survey

3

Given the same job, would you prefer to work on North Campus or Central Campus?

- North Campus
- Central Campus

4

Do you prefer the physical layout of North Campus or Central Campus?

- North Campus
- Central Campus

5

Pretend you are walking on North Campus. What do you like most about the built and natural environment of North Campus?

6

Pretend you are walking on North Campus. What do you dislike most about the built and natural environment of North Campus

7

What types of facilities would you like to see added to North Campus?

- Residential
- Recreational
- Business/Retail
- Academic
- Other, Please Specify

8

Given your answer to the previous question, what *specific* facilities or uses would you like to see added to North Campus?

SUBMIT

Survey Page 2

North Campus Faculty and Staff Survey

9

What mode of transportation do you use most often to travel to North Campus

- Drive alone
- Carpool
- Bus
- Bicycle
- Walk
- Other, Please Specify

10

On average, how many trips do you make to North Campus per week?

0-2
3-5
6-10
more than 10

11

How far do you live from North Campus?

0-1 miles
1-5 miles
5-10 miles
10-20 miles
20-30 miles
more than 30 miles

12

What do you like most about your commute to North Campus?

13

What do you dislike most about your commute to North Campus?

SUBMIT

Survey Page 3

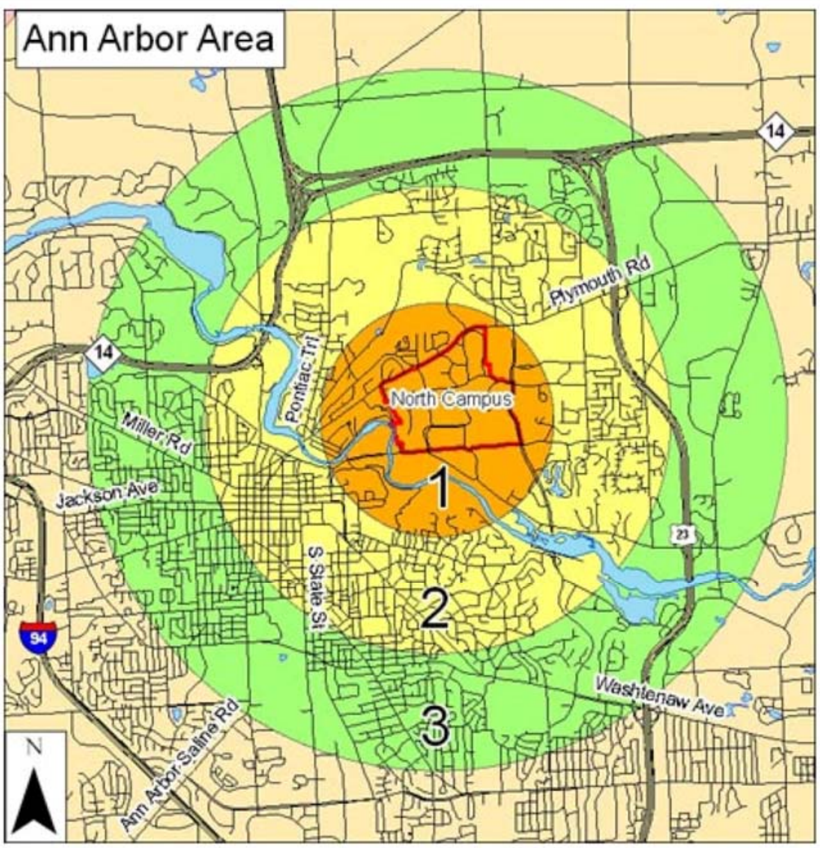
North Campus Faculty and Staff Survey

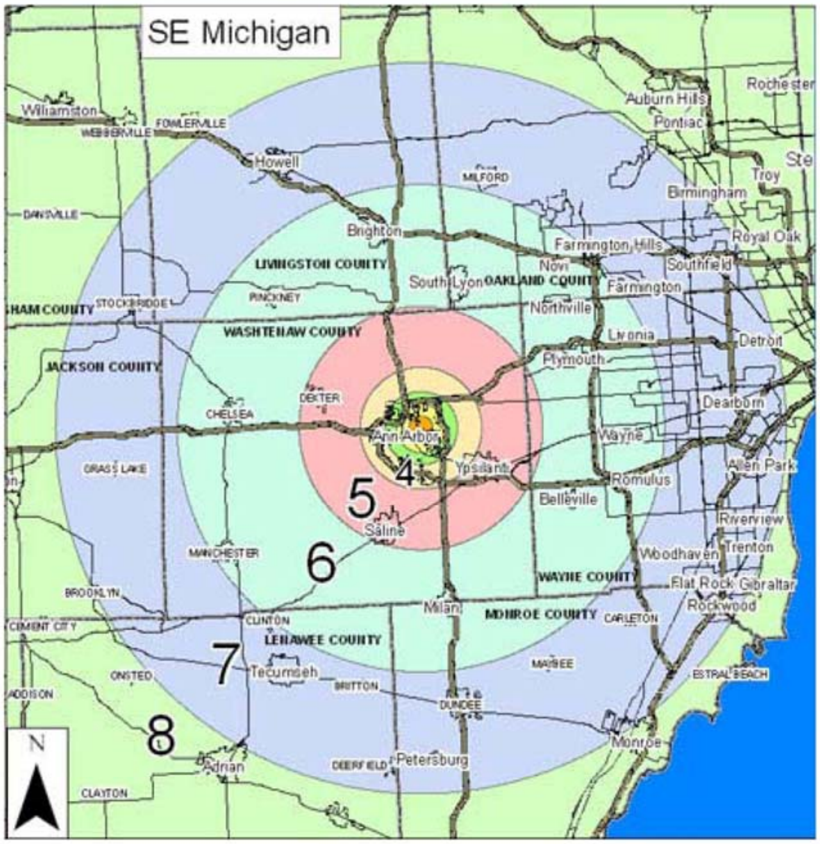
14

For this question, refer to the maps below. In which zone do you live?

Zone 1
Zone 2
Zone 3
Zone 4
Zone 5

Zone 6
Zone 7
Zone 8
Other





SUBMIT

Survey Page 4

North Campus Faculty and Staff Survey

15

What were the three most important factors in choosing where you live?

16

Do you own or rent your residence?

- Own
- Rent
- Other

17

Which of the choices below best characterizes your residence?

- Apartment
- Condominium
- Detached Home
- Other

18

If you live in a detached house, please choose the option below that is closest to your lot size.

- 1/8 acre
- 1/4 acre
- 1/2 acre
- 1 acre

- 2 acres
- 5 acres
- 10 acres
- more than 10 acres

19

What do you like most about your residential location?

20

What do you dislike most about your residential location?

SUBMIT

North Campus Faculty and Staff Survey

21

Would you be willing to live on a smaller lot in exchange for living closer to North Campus?

YES NO

There has never been a University proposal to build faculty or staff housing on North Campus, but we are curious what interest there is in on-campus housing.

For the following three housing arrangements, please indicate your level of interest:

22

The University sells lots on North Campus for single family homes.

Not Interested
Somewhat Interested
Very Interested

23

Condominium development on North Campus such that the residents would own the buildings but not the land.

Not Interested
Somewhat Interested
Very Interested

24

The University builds units and offers long-term rental of these units.

Not Interested
Somewhat Interested
Very Interested

25

Do you have any additional comments, concerns, or suggestions regarding North Campus?

SUBMIT

APPENDIX H: STUDENT SURVEY INSTRUMENT

North Campus Student Survey

1

Do you attend class on North Campus?

YES NO

SUBMIT

Survey Page 1

North Campus Student Survey

2

Do you live on North Campus?

YES NO

What were your reasons for living where you live?

3

Do you prefer the physical layout of North Campus or Central Campus?

- North Campus
- Central Campus

4

Pretend you are walking on North Campus. What do you like most about the built and natural environment of North Campus?

5

Pretend you are walking on North Campus. What do you dislike most about the built and natural environment of North Campus

6

What types of facilities would you like to see added to North Campus?

- Residential
- Recreational
- Business/Retail
- Academic
- Other, Please Specify

7

Given your answer to the previous question, what *specific* facilities or uses would you like to see?

SUBMIT

Survey Page 2

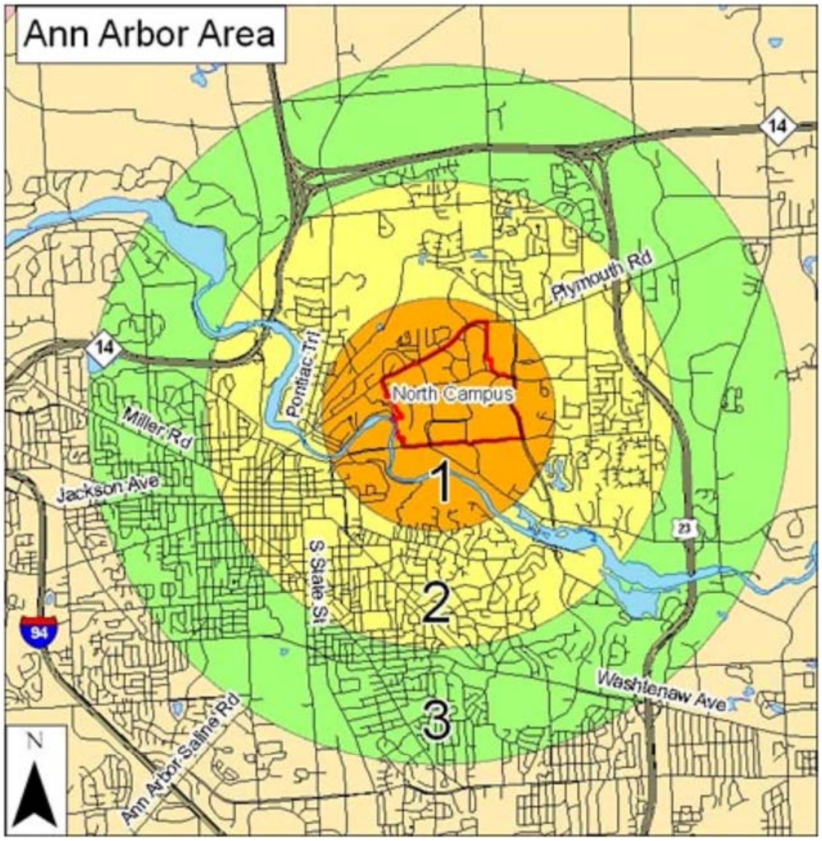
North Campus Student Survey

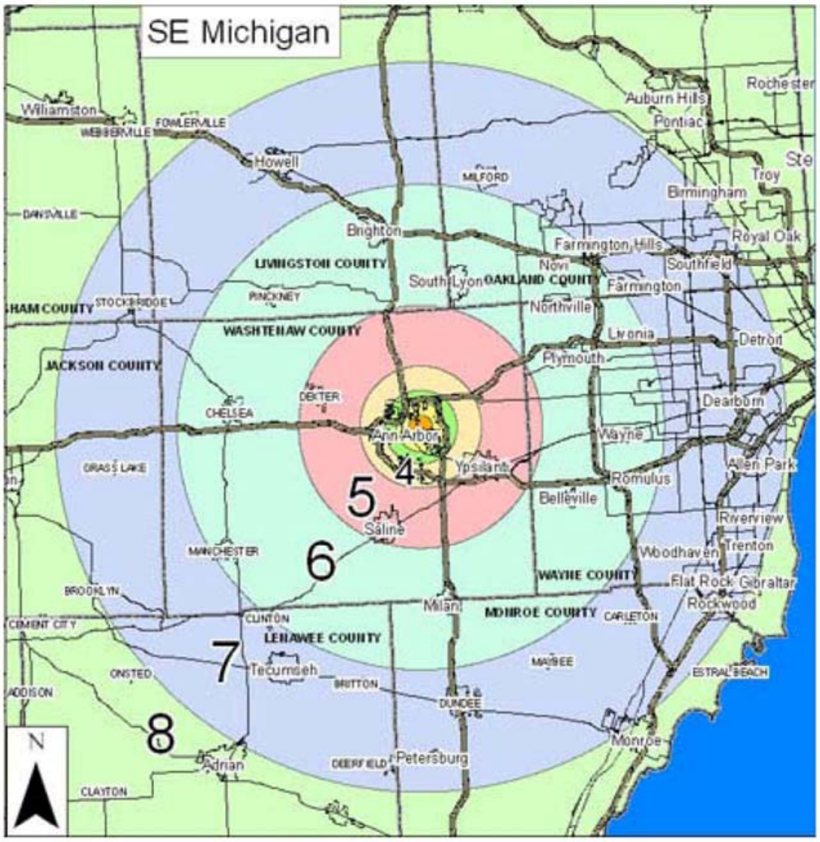
8

For this question, refer to the maps below. In which zone do you live?

Zone 1
Zone 2
Zone 3
Zone 4
Zone 5

Zone 6
Zone 7
Zone 8
Other





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Survey Page 3

North Campus Student Survey

9

Do you own or rent your residence?

- Own
- Rent
- Other

10

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- Drive alone

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- Bus
- Bicycle
- Walk
- Other, Please Specify

11

On average, how many trips do you make to North Campus per week?

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3-5
6-10
more than 10

12

What do you like most about your commute to North Campus?

13

What do you dislike most about your commute to North Campus?

14

Do you have any additional comments, concerns or suggestions regarding North Campus?

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Survey Page 4