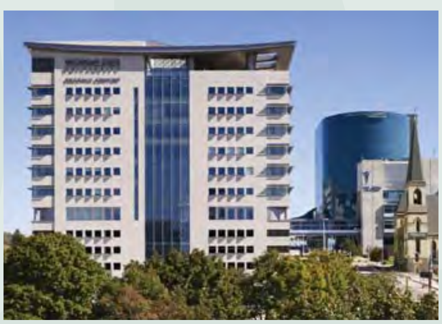
MICHIGAN STATE UNIVERSITY

FACILITIES AND INFRASTRUCTURE REPORT

February 2011



Clockwise from top: Solar array atop MSU Surplus Store and Recycling Center, Cyclotron Office Addition, Secchia Center

MICHIGAN STATE UNIVERSITY

Office of the Vice President for Finance & Operations

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Executive Summary

The infrastructure report is prepared annually to inform the Trustees of the state of the campus. We attempt to highlight the challenges and successes that have occurred throughout the year. The report also contains annual construction statistics, as well as the annual MSU property report. We have added a new section reporting on the status of the university's cyber infrastructure.

Over the last year we have piloted a new cleaning program for Custodial Services which has increased efficiency and enabled us to improve the level of cleaning in selected buildings. We plan to expand this program over the next two years to include other buildings.

We have also reported on the campus archeology program, housed in the Department of Anthropology and Archeology, which was created to ensure that new construction on campus would not obliterate important aspects of previous habitation. The program to date has turned up numerous interesting artifacts as well as documenting important aspects of our history.

The backlog of Just-In-Time maintenance needs has increased over the last two years. This is not surprising given that this paid for the vast improvement in meeting our maintenance needs from investment income in the stock market. At the lowest point we had reduced the backlog to $6 million, an unparalleled accomplishment in a major university. We anticipate reducing the current backlog again as the stock market improves.

The opening of the recycling facility as well as our enhanced recycling programs has had a profound impact on MSU. We have reduced our landfill wastes by 15%, while increasing the quantity of recycling by 54% which includes material from the drop-off center. We have expanded the items recycled significantly beyond those collected in the surrounding area.

Over the next year the development of a long-range energy plan will occupy much of our collective thoughts. We intend to develop a set of realistic goals to guide energy decisions over the next 20 years. I hope to submit a recommendation to the President and the Board in February 2012.

The infrastructure of MSU, while vast and complex has historically been managed with a view towards the future. Our predecessors maximized opportunities for growth while minimizing the investment. This approach continues to serve us well. It is imperative that we have adequate infrastructure to support our academic programs.

F.L. Poston, Vice President for Finance and Operations and Treasurer

JUST-IN-TIME

Summary

The Just-In-Time (JIT) facilities process is a comprehensive assessment of all campus infrastructure components which includes buildings, utility distribution systems, power and water systems, and roads. The process assesses the condition of a particular maintenance need, estimates and adjusts the replacement year closer to a failure date after the assessment, and then develops a priority list of repair, replacement and maintenance needs. The industry-predicted life-cycle of infrastructure systems (average number of years before a replacement is normally needed) is used as the starting point for projecting the timing of required work. This method is commonly referred to as deferred maintenance. At MSU, this estimated replacement year is adjusted as a result of observations made in the field by preventative maintenance and repair crews. As a result of these observations, the time for replacement or repair of a particular piece of equipment or utility is adjusted so that funding resources can be used most efficiently and effectively and closest to a predicted failure. The JIT annual maintenance and replacement costs are then projected over a 20 year period.

Just-In-Time needs are projected into five year time frames; six to ten years; and ten to twenty years. The JIT data provides the ability to coordinate JIT projects with other construction and renovation projects. These opportunities diminish, however, when available funding falls short from what is needed.

Analysis

In 2007, the annual funding coming from the set of endowment trusts dedicated for this purpose was able to reduce the $260 million backlog of unfunded maintenance projects to $6 million. However, the ten year projection still reflected a list of JIT projects projected to cost $289 million in the next ten years.

In 2008, the performance of the endowment trusts began to decline and, thus, impacted the available funding for JIT projects. As a result, the JIT projects were reassessed in terms of highest risk to the institution should a particular item fail. This “risk-based” approach for managing JIT reviewed each JIT item in light of a catastrophic system failure, but also for the degree to which a failure would cause an interruption or high risk of normal university business. For example, a steam tunnel failure would be deemed a higher risk than a window failure. At the end of 2010-11 a $42 million backlog of unfunded JIT projects has again accumulated. Of the $42 million backlog projects, about $22 million are high risk and critical. The ten year projections, from 11-12 forward, identify a JIT need of $409 million.

The large number of projects with pending failure which cannot be funded has created added pressure on maintenance budgets. As more repairs than usual are needed, often, temporary repairs are made to keep the systems operational. These repairs to ailing systems do not reduce the future cost of that system's replacement, and are generally only effective for a short period of time. Additionally, the unplanned work resulting from mechanical failures that cannot be repaired during daytime building hours sometimes requires overtime pay to fix the repair in time for the next day.

Evidence that deferring JIT needs results in emergency repairs is already apparent. In spring 2010, the air conditioning chillers in the Library were continuously failing. Replacement of the chillers had to be done immediately and was moved to the highest priority since temperature and humidity control is critical to the preservation of books. This resulted in an immediate $8 million repair in which funding had to be found. Additionally, over $1 million was allocated this year to temporarily shore up failing pipe supports in the North Campus steam tunnel system. It appears that in 2011-12 there may be more funds that will again be dedicated to the JIT backlog. Refinement and review of the JIT lists in terms of critical failures continues to be an ongoing process.

The general fund 20-year JIT forecast identifies $540 million of work that must be performed in order to preserve the safety, reliability, and risk of the university's infrastructure. Figure 1 shows JIT needs for the next 20 fiscal years.

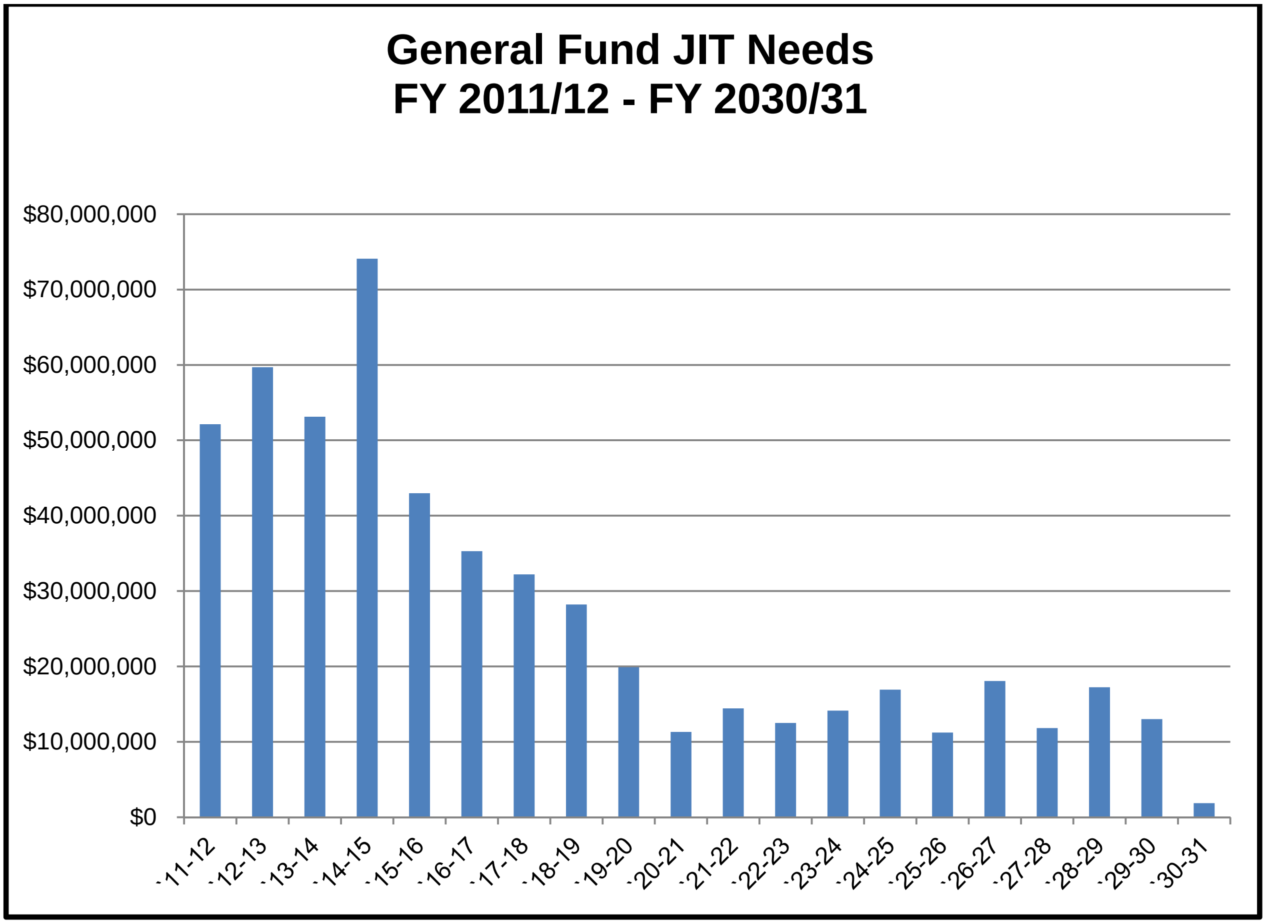


Figure 1. *Annual general fund JIT needs for next 20 fiscal years*.

Four categories comprise the JIT infrastructure needs for the general fund facilities: buildings, utility distribution systems, power and water systems, and roads. Figure 2 provides more detail of the issues facing the university as the next 10 years of JIT needs are sorted by category.

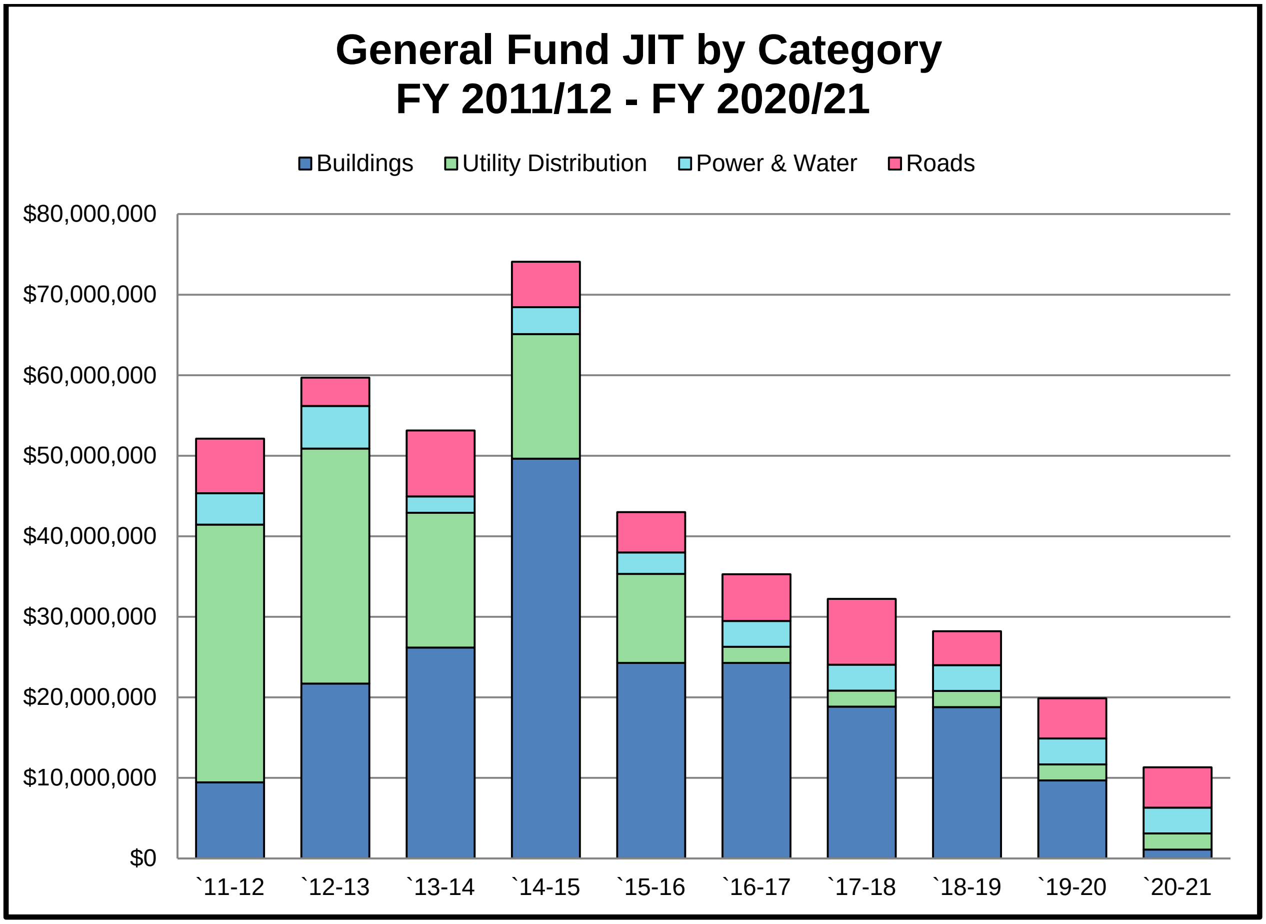


Figure 2. *Annual general fund JIT needs for 2011-12 through 2020-21 for buildings, utility distribution, power and water, and roads. The red line shows the annual funds available for JIT without the endowment funding.*

The 10 year data reveals developing trends within each category. Figure 2 shows that funding requirements for power and water and roads are more stable while building and utility distribution needs fluctuate. During this time, many of the building systems and campus utilities constructed in the 1950s and 60s will reach the end of their adjusted life cycles. Based on past experience, it is projected that a significant number will need major maintenance or replacement within this period.

Buildings

The largest percentage of JIT needs for the next 10 years are in the buildings category, which consists of three components: 1) the building envelope, 2) building systems, and 3) interior finishes.

Emphasis has been placed on building envelope projects as the highest priority, in order to preserve the protective barriers which shield the elements. Examples of these projects include roofs, exterior masonry, windows, and doors.

High priority is given to building systems projects, which include heating, ventilation and cooling (HVAC) systems, building electrical systems, elevators, and plumbing. If left unaddressed, building systems failures will result in significant interruptions to the operation of a particular facility. In fiscal year 2011-12, 37% of JIT needs are for building envelope projects, while 59% are related to building systems. These systems also negatively impact the energy use in a building.

The interior finishes component includes floors, walls, interior doors, toilet partitions, and ceilings. This area is given the lowest funding priority. In fiscal year 2011-12, however, it is projected that 4% of JIT needs for buildings will be related to interior finish projects. When funding for JIT is limited, only interior projects that could result in safety hazards, if neglected, are considered. If not addressed, the appearance of older campus buildings will decline further.

Utility Distribution

Significant attention has been given to the JIT category of utility distribution system, which includes both steam and electrical distribution to the campus. Figure 3 shows an example of a direct buried steam line. Over the past five-years, substantial progress has been made in upgrading the reliability of the campus steam distribution system through the JIT program. The quantity of direct buried steam piping has been reduced from 7.4 miles to 4.06 miles and replaced with tunnels.

Figure 3. *Direct buried steam line.*

Figure 4. *Steam tunnel under construction.*

Failure of certain components in the system would result in the loss of power to one or more of these buildings for several days, while emergency repairs are implemented.

Power and Water

The JIT power and water category remains stable over the next ten years, averaging between $2 and $6 million per year during this period. Examples of power and water JIT projects include work on turbines, generators, and wells. However, caution must be given as regulatory requirements could impact the financial ready to comply.

Roads

A significant number of JIT road projects have been completed in recent years. Remaining project work will continue as funding is available. Roads which have previously been reconstructed to current standards can usually be maintained by milling off the top layer of asphalt and recapping the surface with a new layer. As a result, the JIT need for campus roads is contingent on future assessments of pavement condition due to winter weather.

Cumulative Impact

Figure 5 shows the cumulative impact of JIT needs for the next 20 fiscal years. The annual funding need quickly compounds to a point where it reaches an unattainable level and such deferments increase the risk of infrastructure failure on each delayed project.

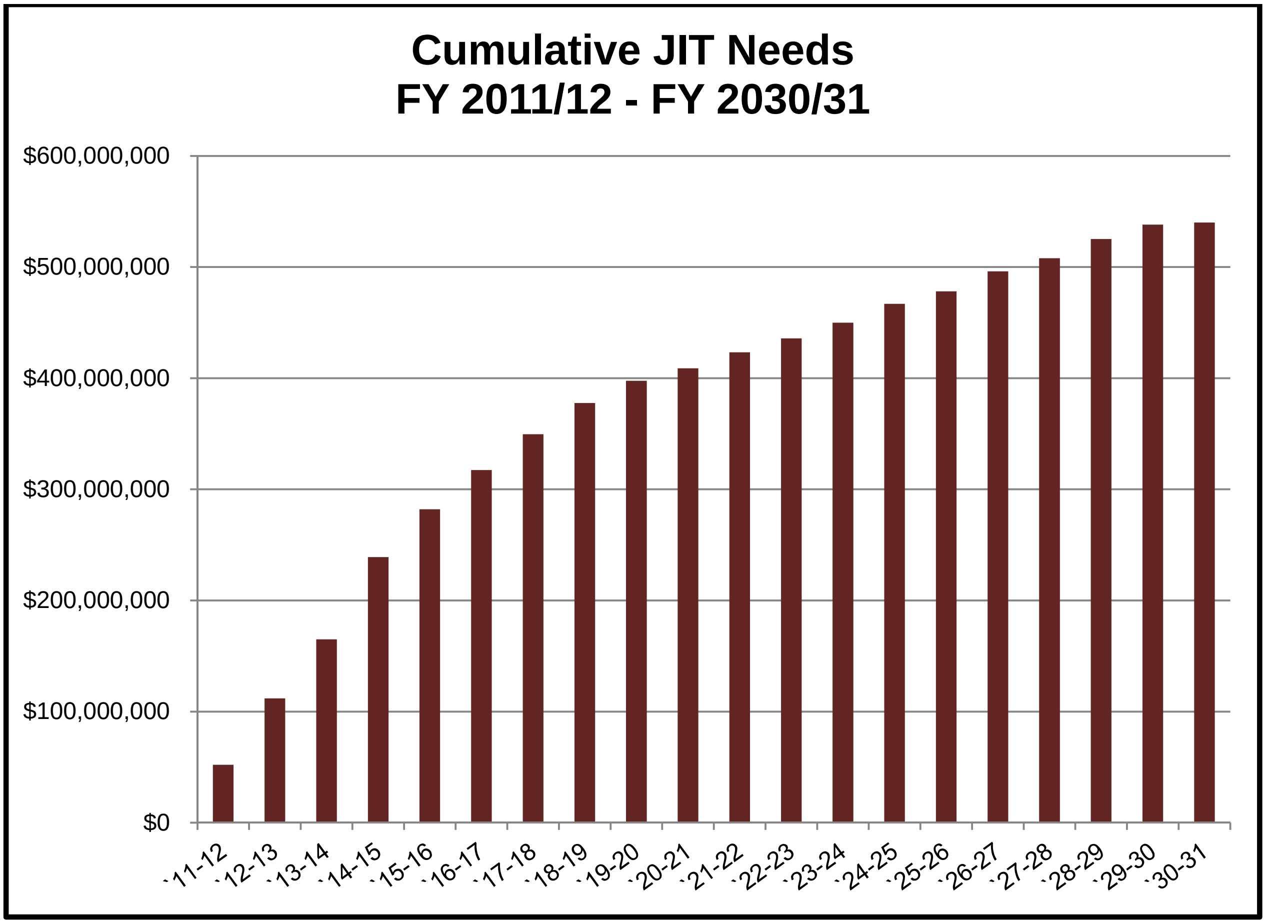


Figure 5. *The cumulative growth of general fund JIT needs for the next 20 fiscal years.*

If JIT funding was not provided for the next 20 years, the cumulative cost for deferred projects would escalate to $540 million by 2030-31. There is a critical concern for JIT funding needs occurring between fiscal years 2011-12 and 2016-17. During these years, the components of many buildings and systems which were constructed in the 1950s and 60s will reach the end of their adjusted life cycle. From 2017-18 through 2030-31, there is a much more gradual increase in JIT needs as the backlog of major maintenance challenges is addressed. It is possible, however, that these amounts may increase as more field observations are performed through time.

Future Directions

The summary of JIT requirements shows the financial challenges that must be met to preserve the university's infrastructure framework. Although, many infrastructure components continue to operate, the likelihood of a disruptive failure grows yearly due to their age and deteriorating condition. If an adequate and consistent source of funding cannot be established, the university runs the risk of multiple failures within the various infrastructure systems.

CONSTRUCTION

Summary

Adequate facilities are vital for Michigan State University (MSU) to perform its missions of education, research, and outreach. The university continues to invest heavily in design and construction projects.

Michigan State University's construction performance and delivery of projects has improved in many areas. Eighty-seven percent of substantial completion dates during fiscal year 2009-10 were met, and 98% of all closed projects were within budget. More feedback is provided to contractors to facilitate process improvements and improve overall performance.

The annual Construction Report reviews completed projects as part of a required reporting process for MSU's Board of Trustees. This report is included in Appendix A and lists 48 major and minor capital projects, with a total value of $139 million, which were closed in fiscal year 2009-10. These projects were completed 4.5% under budget, on average, resulting in the return of funds to the original funding sources. Of the $1.8 billion in university expenditures, $111.7 million was used to pay for either direct construction costs or design consulting for major capital projects, representing approximately 6% of the total university budget.

Analysis

The number of board actions for Authorization to Plan and Authorization to Proceed decreased in fiscal year 2009-2010, from prior years. This is largely attributable to the reduction in Just-In-Time funding and the impacts of reductions the university has taken over the last several years. While certain large projects planned for the Residential and Hospitality Services (RHS) Division are continuing according to the RHS Strategic Plan, the number of smaller projects, particularly those funded jointly by units and central sources, continue to decline. The reduction in the number of approvals for Authorization to Plan will most likely result in reductions in construction spending in the years 2012 through 2014, not including activity on the Facility for Rare Isotope Beams (FRIB).

The value of projects given Authorization to Proceed approached the prior high of 2007-08, but there was relatively little volume in the Authorization to Plan category. There is a correlation between the number and value of projects Authorized to Plan in a given year and Authorized to Proceed in the following year. If this trend continues, Authorization to Proceed projects will decrease again in 2010-11, pending FRIB activity. This also predicts a significant decrease in total construction payments in 2011-12 and in total construction spending for 2012-13.

Figure 1 shows the number of Board of Trustees' authorizations by project step for the past four fiscal years. Figure 2 shows the total value of those authorizations.

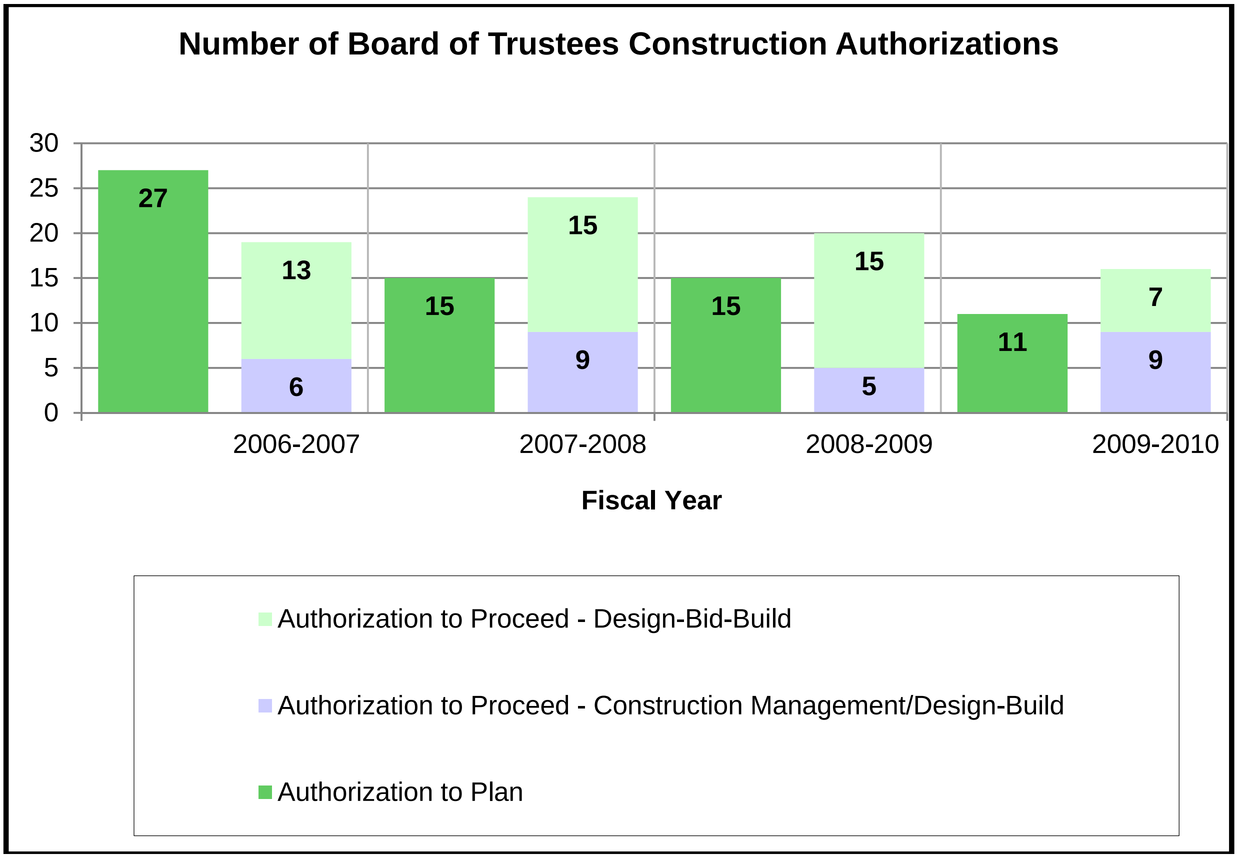


Figure 1. *Number of Board Authorizations.*

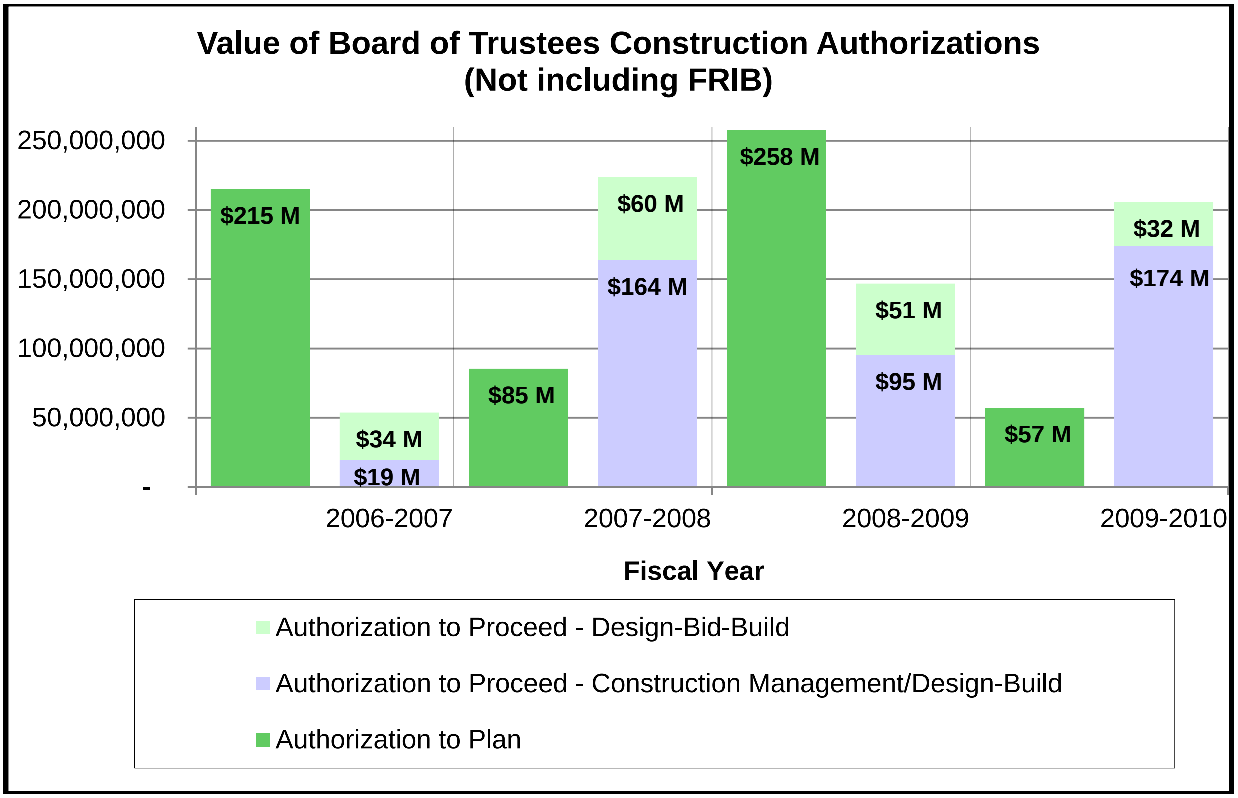


Figure 2. *Value of Board Authorizations.*

In the five years since the project approval process was changed, there have been 24% fewer Board of Trustees construction approvals than in the preceding four years. However, the university authorized the second highest volume of construction activity in its history. More than 60% of this total comes from the Plant Sciences expansion, Broad Art Museum, and Wells Hall addition. Other notable projects include the Life Sciences addition, Emmons Hall renovations, and the Cyclotron Office Addition II. It should be noted that there are relatively few large projects still in planning, with the notable exception of FRIB and RHS projects. Figure 3 shows the value of projects approved for construction by fiscal year.

Figure 3. *Value of Projects.*

Design activity reached an extraordinary level in 2007-08 due to the significant volume of projects approved for construction (which included the Secchia Center, Duffy Daugherty Addition, Mary Mayo Renovations, Cyclotron Addition, Recycling Center, and Holden Hall Renovations). In 2008-09 there was an increase in the number of projects Authorized to Plan, while a decrease in projects Authorized to Proceed. In the current year, construction and design payments are comparable to 2008-09. There are a number of significant projects completing or nearly completing design, including the Wells Hall addition, Plant Sciences expansion, Broad Art Museum, Life Sciences addition, and Emmons Hall Renovations.

Construction contractor payments were lower in 2009-10 than in 2008-09, but within 1% of the average for the past three fiscal years ($99 million). There was a considerable increase in construction payments in the year 2008-09, which may be attributable to the large number of projects Authorized for Proceed in 2007-08. Similar to 2007-08, there was over $200 million Authorized to Proceed with construction in 2009-10. Due to this similarity, the university will likely see construction payments rise in 2010-11. Also, due to the decrease in authorized projects, the university should see the total value of construction payments decrease in 2011-12, with a potential reduction in total construction spending for 2012-13. These projections exclude FRIB.

Figure 4 shows the total construction and design (non-FRIB) payments per fiscal year, as well as an estimate for design and construction payments for the next two years.

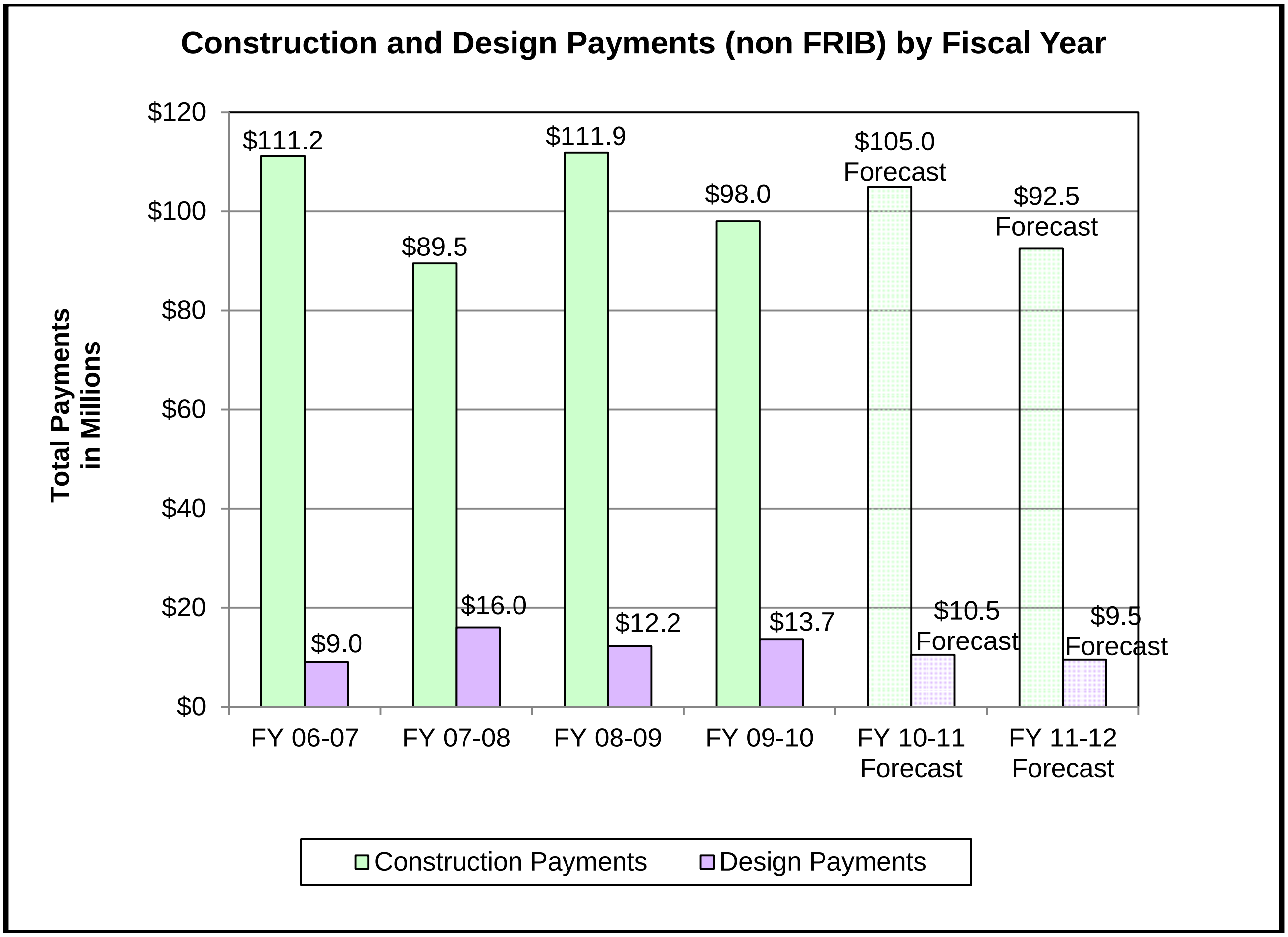


Figure 4. *Construction and Design Payments.*

Major Capital Improvement and Construction Projects are tracked through the Facilities Asset Management Information System (FAMIS) and Skire project management software (PMS). This PMS provides timely and accurate project information, and creates a reporting mechanism for project performance as a whole. The data offers an opportunity to analyze strengths and weaknesses in the management and delivery areas of construction projects. This analysis can be used to evaluate means and methods and to improve upon processes. As the projects continue to increase in volume and complexity, MSU is examining processes and implementing improvements in the project management practice to engage designers, contractors, and the campus community.

Table 1 summarizes the projects which have been completed and referred to as closed. There were approximately 20% fewer projects closed in fiscal year 2009-10 than in fiscal year 2008-09. The value of the 2009-10 projects was down almost 40% compared to the value of projects in the year prior. There was a significant spike in closed projects in 2008-09, resulting in almost $15 million being returned to the original funding sources. While the volume was down considerably in 2009-10, there was over $6 million returned at project close.

Table 1. *Budget for major and minor closed capital projects, by fiscal year.*

Budget for Closed Projects	**FY 05-06**	**FY 06-07**	**FY 07-08**	**FY 08-09**	**FY 09-10**
Authorized Budget:	$11,426,000	$52,928,587	$77,483,334	$206,398,900	$139,244,363
Final Cost:	$10,120,619	$50,353,767	$75,836,038	$198,930,659	$132,931,212
Returned:	$1,305,381	$2,574,820	$1,647,296	$14,890,367	$6,313,151
% Returned:	11.4%	4.9%	2.1%	7.2%	4.5%
Construction Contract:	$7,567,538	$41,163,906	$59,658,023	$164,066,096	$109,341,206
Number of Projects Closed	**17**	**42**	**53**	**59**	**48**

Table 2 summarizes the contingency use for the 48 projects closed in fiscal year 2009-10. The information details cost by the major categories of:

- Construction Contract (construction performed by contractors under general contractor, construction manager, or design-build delivery systems)
- Design
- Project administration costs
- Project development services or feasibility study costs
- Construction by owner (includes tasks such as keying, high voltage connection, landscaping, and technology installation performed by MSU)
- Movable furnishings and equipment
- Contingency (funds in reserve for potential project clarifications, particularly change orders for unforeseen conditions and document clarifications)

As is typical, the construction contract, work by owner, and the design costs have the largest impact on project contingency. As an aggregate, these projects returned one-third of contingency to the university. It is important to have an effective, timely closeout process to release and return funds to be repurposed.

Table 2. *Contingency Use Summary.*

Budget Code & Description	*Authorized Budget*	*Total Cost*	*Money (Over) / Under Budget*	*Percent (Over) / Under Budget*	*Percent of Contingency Used*
CONSTRUCTION CONTRACT	$99,504,413	$109,341,206	($9,836,793)	(9.9%)	59.0%
DESIGN	$11,363,937	$12,165,536	($801,599)	(7.1%)	4.8%
PROJECT ADMINISTRATION	$1,704,319	$1,692,650	$11,669	0.7%	0.1%
PROJECT DEVELOPMENT COSTS	$503,689	$359,961	$143,728	28.5%	0.0%
CONSTRUCTION BY OWNER	$5,954,320	$7,192,295	($1,237,975)	(20.8%)	7.4%
MOVEABLE FURNISHINGS AND EQUIPMENT	$3,548,155	$2,179,564	$1,368,591	38.6%	0.0%
CONTINGENCY	$16,665,530	$0			
Total Projects: 48	**$139,244,363**	**$132,931,212**	**$6,313,151**	**4.5%**	**62.1%**

It should be noted that of the $1.2 million dollars shown as over budget in the Construction by Owner category, 98% is attributable to four, large, scope of work changes. One of these scope additions was an emergency infrastructure repair to the Plant Science Greenhouse. The other three were either transferred or unidentified scope items that could have been performed by a contractor, but were performed by university forces instead. More effort needs to be put into budgeting and scope of work allocation at the onset of construction so that the estimated cost of work will be more precise.

Contract Change Order Analysis

As Campus Planning and Administration (CPA) and Engineering and Architectural Services (EAS) strive to make improvements, one of the earliest focus areas has been reducing the number of construction change orders. Construction change orders added 6.1% to base construction costs in the past fiscal year. Though often necessary, changes can lead to delays in construction and disputes with contractors. Often these disputes are not from a single change, but numerous small changes which may result in a contractor claiming that the volume of changes delayed the project or impacted their productivity, and therefore demanding substantial additional compensation. Change orders are a reality in the construction process for a number of reasons:

1) Undocumented field conditions, such as bad soils and concealed asbestos. It is important to perform as much investigative research of the existing conditions as possible in order to minimize the impact of field conditions on a project.

2) Document discrepancies where the work specified either cannot be built or does not meet the intent of the project. It is important to identify and correct recurring mistakes in order to reduce change orders; thereby limiting university exposure.

3) Scope changes requiring additional work at the discretion of the university. Scope changes modify the function or capacity of a facility, and may include changes to the quality of finishes and furnishings, or change the size of the building or program to be included in the project. These are the most easily controlled sources of changes, but can also increase the value gained by the project.

Michigan State University tracks change order rates by calculating the dollar value of change orders divided by construction payments (Figure 5). The initial efforts of tracking change orders were good, with overall changes generally trending downward since 2003-04. Until fiscal year 2008-09, scope changes and field changes declined steadily. Document changes continue to decrease on a year over year basis. The overall change order rate decreased significantly from the prior fiscal year and continues to progress toward the goal of 6%.

Decreasing the number of change orders has been a focused effort. There are several likely reasons for the overall decline in change order value, including increased communication during the planning and design process through the project planning team and a downturn in design activity in fiscal year 2007-08.

Building Information Modeling (BIM) is beginning to have an impact on change order performance. The BIM process helps the project team and customer to better visualize a project at the onset; thus, assisting the project team in detecting conflicts before the project is constructed.

Figure 5 represents the change order rate by reason versus construction payments for active and closed projects, by fiscal year. Each percentage point of change order rate represents a $1 increase per $100 of the construction bid price. For example, for every $100,000 in construction paid during fiscal year 2009-10, the university identified $6,100 in change orders.

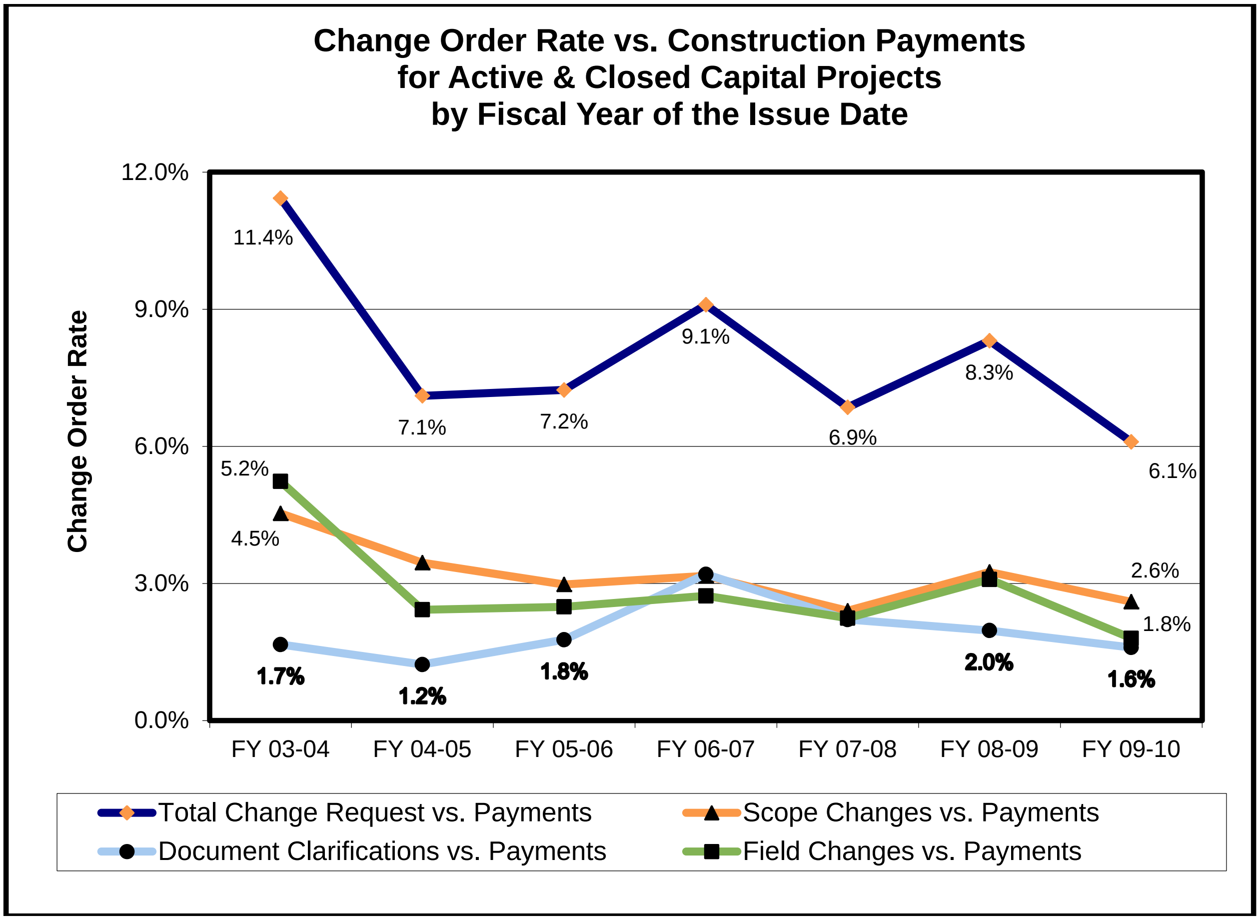


Figure 5. *Change Order Rates by Reason Code.*

It should be noted that in fiscal year 2008-09, there was a considerable spike in change order activity, which can be attributed to many factors. The significant rise in construction payments would predict a rise in aggregate change order value. In addition, there was a significant amount of scope additions, such as providing a photovoltaic system, adding security and surveillance systems, installing an additional freight elevator, and a flooring replacement, that were added after bids were submitted. Change orders related to scope changes were added after bidding, when there were available funds to perform the additional work. The top five scope changes of this type, from 2008-09, comprised over 25% of the total $9.4 million in change orders.

Tables 3 and 4, sort change orders according to other characteristics, such as construction and work discipline (e.g., roads, mechanical, utilities, etc.). Projects closed within the last four fiscal years have been categorized as New Construction and Additions Demolition, Renovation (such as reconstruction of existing space), and Infrastructure (such as roads, parking lots, and underground utilities). Table 3 shows that new construction generally has the smallest change order rate. This is due to a decrease in field condition changer orders. Additions and renovations generally have a higher rate of field conditions and design errors due to unknown issues in an existing facility. Often times, the coordination for additions and renovations cannot be fully completed until critical building components such as ceilings, walls, or foundations are exposed to entirely coordinate the design with the existing conditions. Table 4 shows the most significant areas of construction that require change orders, which are mechanical and electrical trades. Whether it is new construction, additions, renovations, or infrastructure work, mechanical and electrical trade work is consistently the largest impact on project contingency.

Table 3. *Change Orders by Project Type for Projects Closed in 2009-10.*

Value of Change Orders by Type of Construction	FY 05-06		FY 06-07		FY 07-08		FY 08-09		FY 09-10	
	Change Order	% of Contract	Change Order	% of Contract	Change Order	% of Contract	Change Order	% of Contract	Change Order	% of Contract
New Construction & Addition:	$28,085	0.4%	$183,113	0.4%	$624,525	1.0%	$1,989,805	1.2%	$9,690	0.0%
Demolition:	$0	0.0%	$0	0.0%	$0	0.0%	$62,032	0.0%	$152,275	0.1%
Renovation:	$53,073	0.7%	$412,321	1.0%	$1,415,243	2.4%	$5,538,121	3.4%	$5,669,473	5.2%
Infrastructure:	$308,843	4.1%	$3,001,218	7.3%	$3,751,347	6.3%	$2,332,813	1.4%	$2,867,398	2.6%
Total:	**$390,001**	**5.2%**	**$3,596,652**	**8.7%**	**$5,791,116**	**9.7%**	**$9,922,771**	**6.0%**	**$8,698,836**	**8.0%**

Table 4. *Change Orders for Infrastructure and Maintenance Work for Projects Closed in 2009-10.*

Infrastructure Change Orders Breakdown by Project Type	FY 05-06		FY 06-07		FY 07-08		FY 08-09		FY 09-10	
	Change Order	% of Contract	Change Order	% of Contract	Change Order	% of Contract	Change Order	% of Contract	Change Order	% of Contract
Elevators:	$44,113	0.6%	$48,118	0.1%	$254,941	0.4%	$74,882	0.0%	$13,133	0.0%
Environmental:	$0	0.0%	$13,913	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Fire and Life Safety:	$0	0.0%	$20,511	0.0%	$75,002	0.1%	$80,989	0.0%	$201,765	0.2%
General Trades:	$0	0.0%	$0	0.0%	$299,087	0.5%	$189,790	0.1%	$198,535	0.2%
Laboratory:	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Mechanical & Electrical:	$44,835	0.6%	$2,362,755	5.7%	$2,503,778	4.2%	$455,855	0.3%	$1,846,930	1.7%
Office:	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Roads:	$0	0.0%	($126,901)	(0.3%)	$105,434	0.2%	$171,890	0.1%	$110,823	0.1%
Roofing:	$30,843	0.4%	$72,164	0.2%	$244,126	0.4%	$23,222	0.0%	($13,084)	(0.0%)
Site:	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Steam & Underground:	$187,956	2.5%	$610,658	1.5%	$206,184	0.3%	$1,336,185	0.8%	$509,296	0.5%
Telecommunications:	$1,096	0.0%	$0	0.0%	$62,797	0.1%	$0	0.0%	$0	0.0%
Total:	**$308,843**	**4.1%**	**$3,001,218**	**7.3%**	**$3,751,347**	**6.3%**	**$2,332,813**	**1.4%**	**$2,867,398**	**2.6%**

The use of BIM has benefits of reducing change orders on numerous trades, but the most significant area is the mechanical and electrical document changes. MSU's first pilot project for BIM, the Secchia Center, reached substantial completion this year. Figure 6 compares the Secchia Center project change order performance with the average of all projects above $250,000 in value. While the project close out process is still not complete, early data shows a significant improvement in the amount of document clarifications resulting from errors and omissions. The university's approach to BIM is further explained in the Future Directions section of this report.

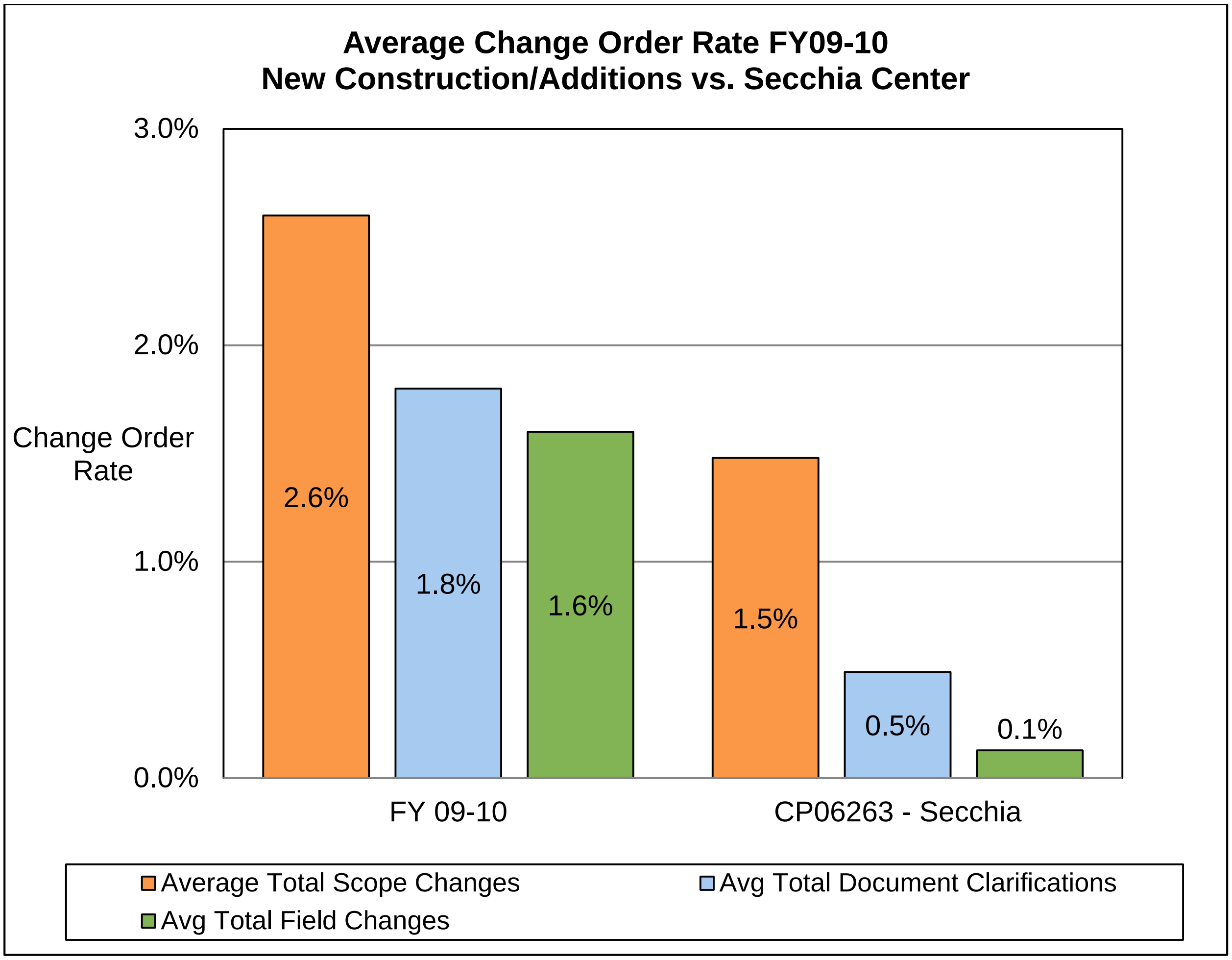


Figure 6. *Change Order Performance Comparison of Secchia Center vs. Other Project Types.*

The university is continuously exploring new methods of delivery to reduce change orders. In fiscal year 2010-11, the university is implementing Integrated Project Delivery (IPD). This innovative approach has shown in case studies to have a positive impact on quality and schedule performance, while substantially minimizing the impact of construction change orders on a project. Integrated Project Delivery is explained further in the Future Directions section of this report.

Over the course of the past fiscal year, the university has implemented new processes to include further review and justification of change order costs. Such new processes include architectural consultant review and recommendation, and pre-quote estimating of expected costs. Over time, this should result in a positive impact on change order performance.

Schedule Performance

Michigan State University emphasizes schedule requirements by setting realistic substantial completion dates with MSU clients; specifying those requirements clearly in the bid documents and then holding contractors to a high standard of compliance. Engineering and Architectural Services is using more demanding schedule specifications for most large projects and has emphasized schedule importance at contractor and consultant forums.

Substantial completion requires that a project is usable for its intended purpose (e.g., a road intersection is open, classes or research can be conducted in a laboratory, or an elevator is permitted to carry passengers). Figure 7 shows that 43 of 48 projects (89%) met substantial completion on time or ahead of schedule versus 79% and 85% in fiscal years 2007-08 and 2008-09, respectively. This continuous improvement is particularly noteworthy since the number of projects has substantially increased from the 2006-07 fiscal year.

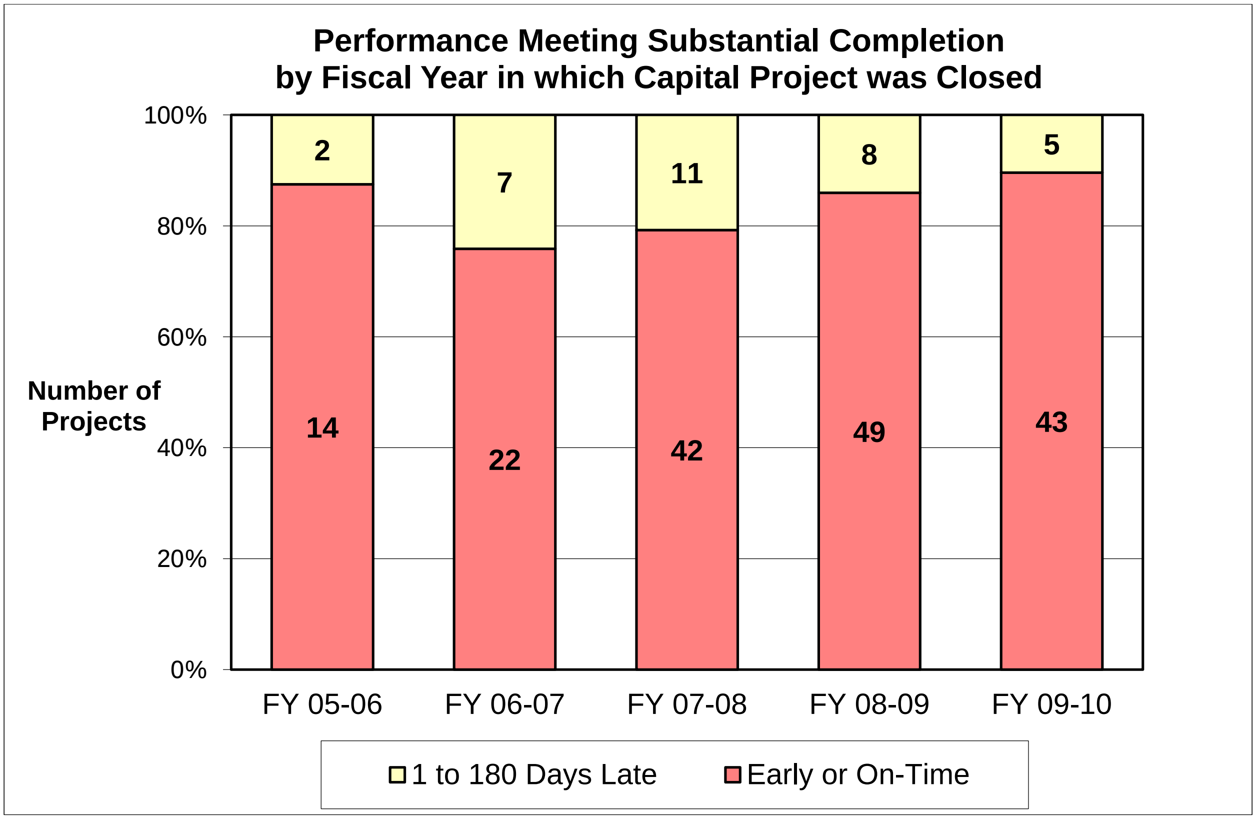


Figure 7. *Schedule Performance for Meeting Substantial Completion.*

Final completion is the task of closing out a project. It requires that all work be completed, no more unpaid expenses remain, and any unused funds be returned. There are a number of factors that hinder timely final completion. The university performs many work functions on a construction project, including landscaping, procurement of furnishings and equipment, computer and telecommunication networking, and the selection and installation of public art. These functions tend to occur toward the end of a project. Many projects have not had realistic schedules for accomplishing these activities. In many ways, the closeout process is controlled by the inputs at the beginning of the project, including realistic schedules and budgets, along with a clear understanding of the entire scope of MSU performed work.

In order to be successful in timely project completion, university performed work must be fully integrated into the planning schedule. The university is putting forth greater efforts to accurately identify and perform MSU work on schedule. Planning is done in advance of construction activities and with consideration of MSU performed tasks, rather than waiting for the completion of all other field activities. Campus Planning and Administration and EAS meet regularly to review the status of projects that are substantially complete and to communicate the status with customers and stakeholders.

Slightly more than half of the projects closed during fiscal year 2008-09 met final completion on schedule; a modest improvement from the prior year. While there is still room for improvement, in 2009-10 there was a significant increase in the number of projects that met final completion. Nearly 80% of all projects met the required final completion date. By closing projects more quickly, funding can be returned to the original source in a timely manner and used for other university needs. Figure 8 displays the results of the last five fiscal years.

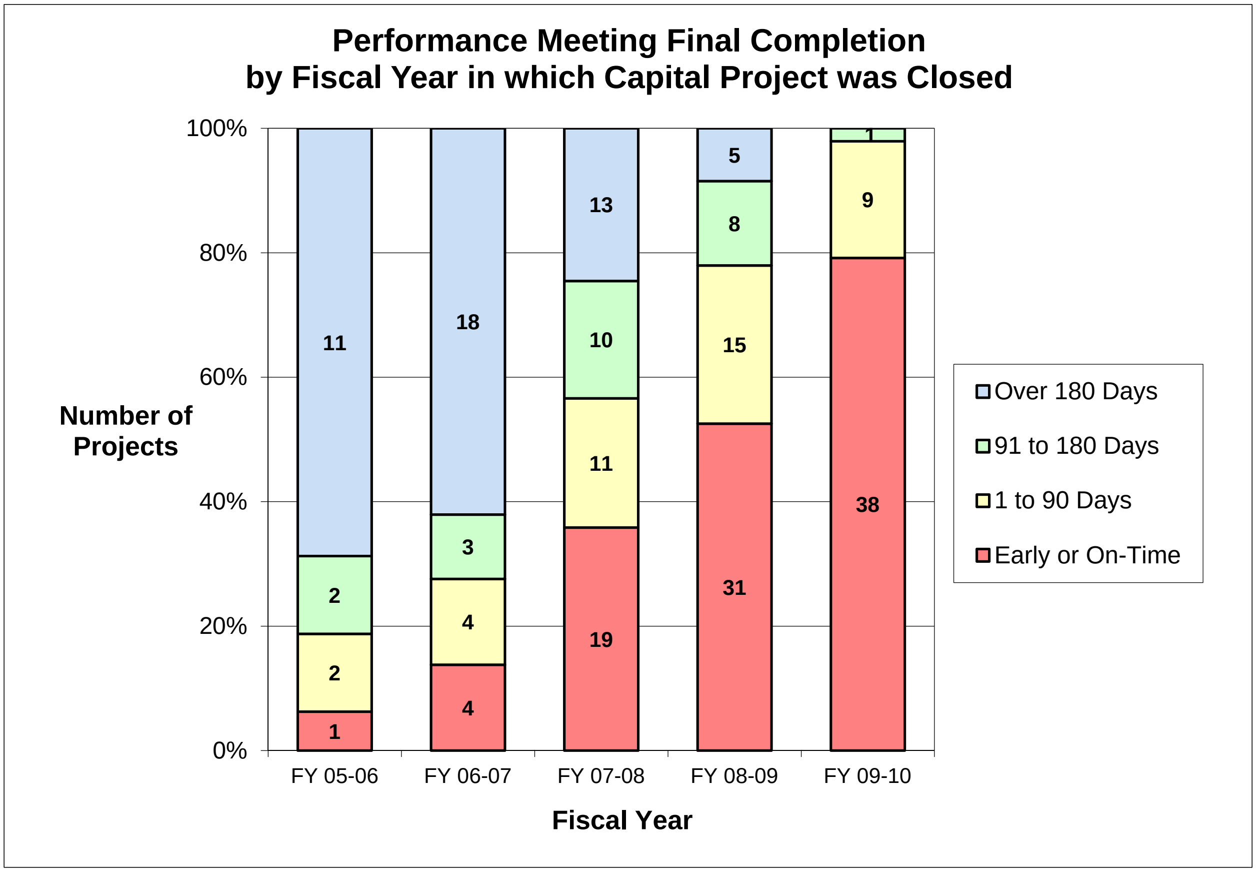


Figure 8. *Schedule Performance for Meeting Final Completion.*

In April 2008, the School of Planning, Design, and Construction (SPDC) completed a study evaluating the MSU project close-out process. Timelier project close-out was found to benefit all project stakeholders, including the MSU user, the project implementation team, contractors, and designers. One recommendation was to track the project closeout process in two segments: 1) T1, which is the time period from substantial completion to final payment to the contractor, and 2) T2, which is the period from final payment to final closeout of the project. Figure 9 displays the average closeout duration for capital projects by the T1 and T2 categories, for the last five fiscal years. Overall, closeout time decreased slightly in fiscal year 2009-10, showing the shortest duration of the close out phase in the last five years. The T2 segment has dropped considerably during the same time frame. This is a product of better planning for owner-performed work and closer reviewing of project budgets and status as construction proceeds. It should be noted that in fiscal year 2008-09 the spike in average close out duration was due to a single project (Spartan Stadium Expansion) that remained open for 1,350 days to settle budgetary issues.

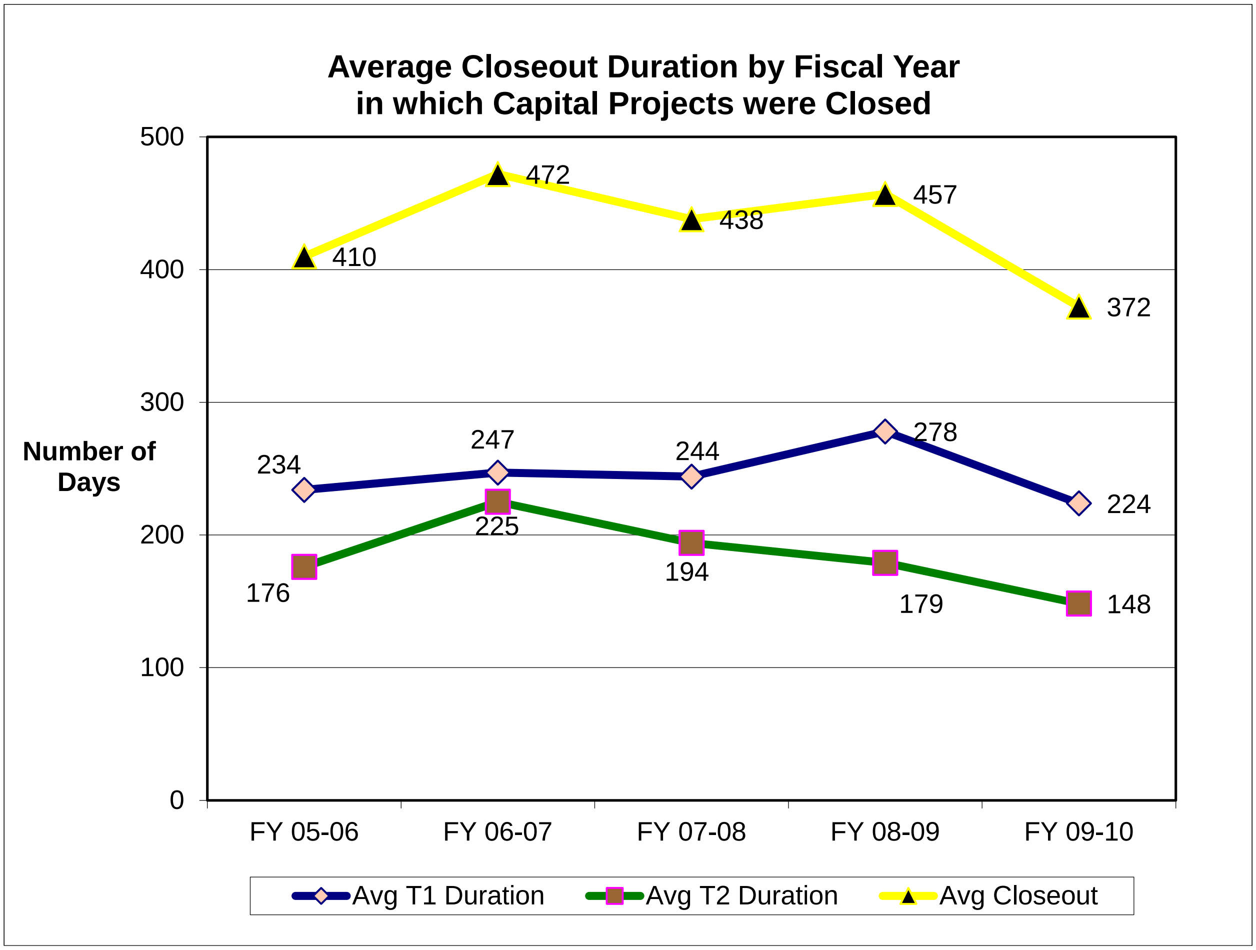


Figure 9. *Substantial and Final Completion Performance.*

The quality and cost of a project are considered to be of equal importance to schedule. The goal of measuring T1 or T2 is to close out all projects in as timely a manner as possible, without sacrificing quality or cost. The T1 duration should allow enough time for proper diligence to negotiate final costs of all change orders, complete all punch list work to the desired quality, and to perform any required seasonal functional testing. The T2 duration should allow enough time for all seasonal work or functional testing and evaluation to be performed as required. As Skire project management software continues to be implemented, it is MSU's hope that closeout requirements will be further automated, allowing more accurate project tracking and continued improvement with the end result of returning funds to MSU sources more quickly.

There is a direct correlation between budget performance and schedule performance on most projects. A well-managed project generally meets the project goals for both. Figure 10 shows aggregate schedule and cost information, by fiscal year, on a single graph. It is meant to assess the overall project closeout performance. This result demonstrates that the final completion, while higher than in previous years, still has room for improvement. Over 97% of projects were completed within budget and 87% met substantial completion. It should be noted that all factors are trending in a positive direction. There was one individual project that was closed over budget and that overage was negligible, having no impact on construction activity.

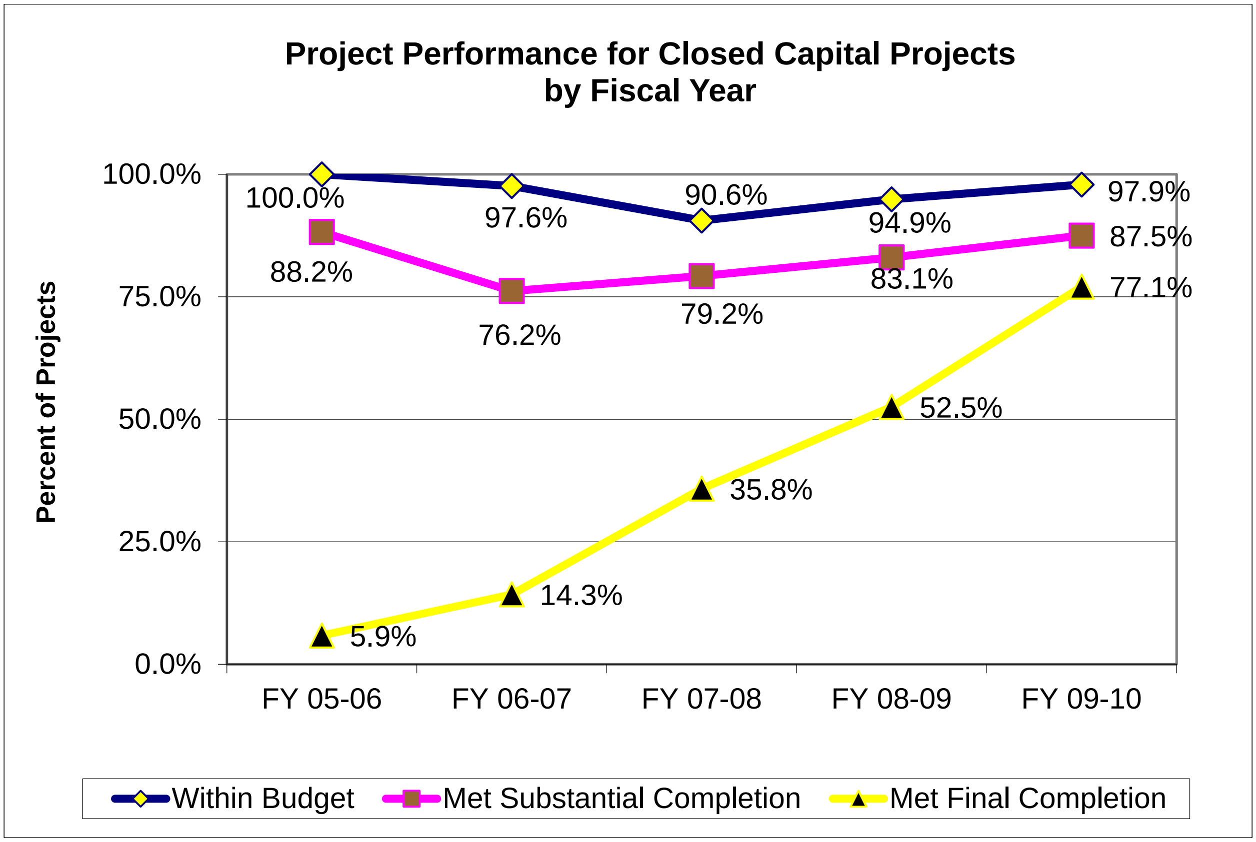


Figure 10. *Schedule and Cost Performance.*

Skire Unifier Project Management Application Software Update

As of March 2009, all projects commencing construction used the MSU standard project management software, Skire Unifier, for change order management, leading to rapid growth in the number of partner companies. In spring 2010, the Project Initiation business process went live, automatically adding projects as they are authorized to begin design, and causing another large growth spurt in partner companies. The number of projects in Skire Unifier will continue to increase, but at a slower pace in light of the university's budget challenges.

The number of users is also growing at an extraordinary rate. The increased usage of the system has created additional demand to support the system, including technical support, administration, and requests to optimize the current processes. This increased usage has slowed the implementation of other business processes and also the support to other MSU units interested in using Unifier for their project management requirements. Business processes have increased in phases. As units such as Academic Technology Services, Residential and Hospitality Services, and Land Management implement Skire Unifier for their own processes, there will be additional growth in both projects and business processes.

Figures 11 and 12, shows the growth in Skire participation by tracking the number of users and business processes in use.

	12/31/08	06/30/09	12/31/09	06/30/10
Partner Companies	0	34	46	85
Active Users	0	217	304	602

Figure 11. Skire Usage.

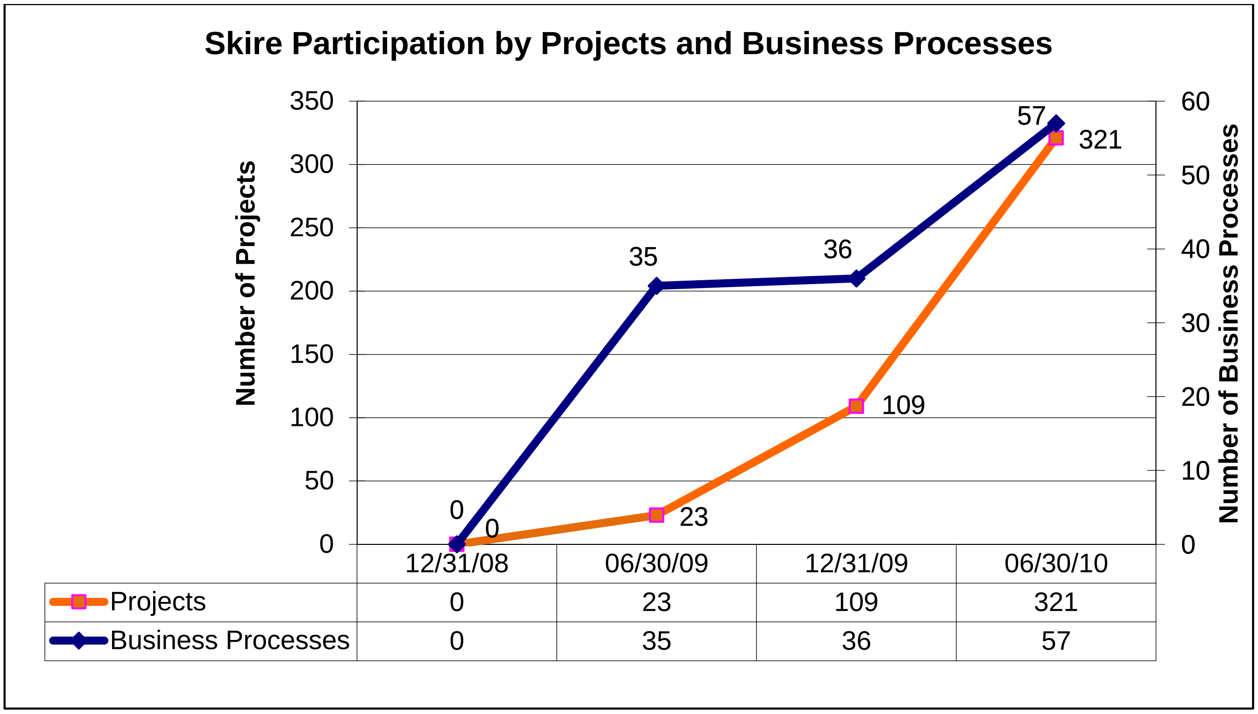


Figure 12. Skire projects and process.

Future Directions

Integrated Project Delivery (IPD)

Michigan State University is continuously trying to improve the delivery of facilities to the campus community. One of the key challenges is coordination between design and construction. Figure 13 details the loss of knowledge or understanding as a project moves through phases, with new team members added and others leaving. Once design is complete, the architect and engineer role subsides as the project is bid by contractor and subcontractor estimators. Once the project is bid and awarded, the contractors and subcontractors transfer the project from the estimators to the superintendents and project manager (PM). Once the project is complete, the owner's operations and maintenance staff then take control of the building with brief training and manuals.

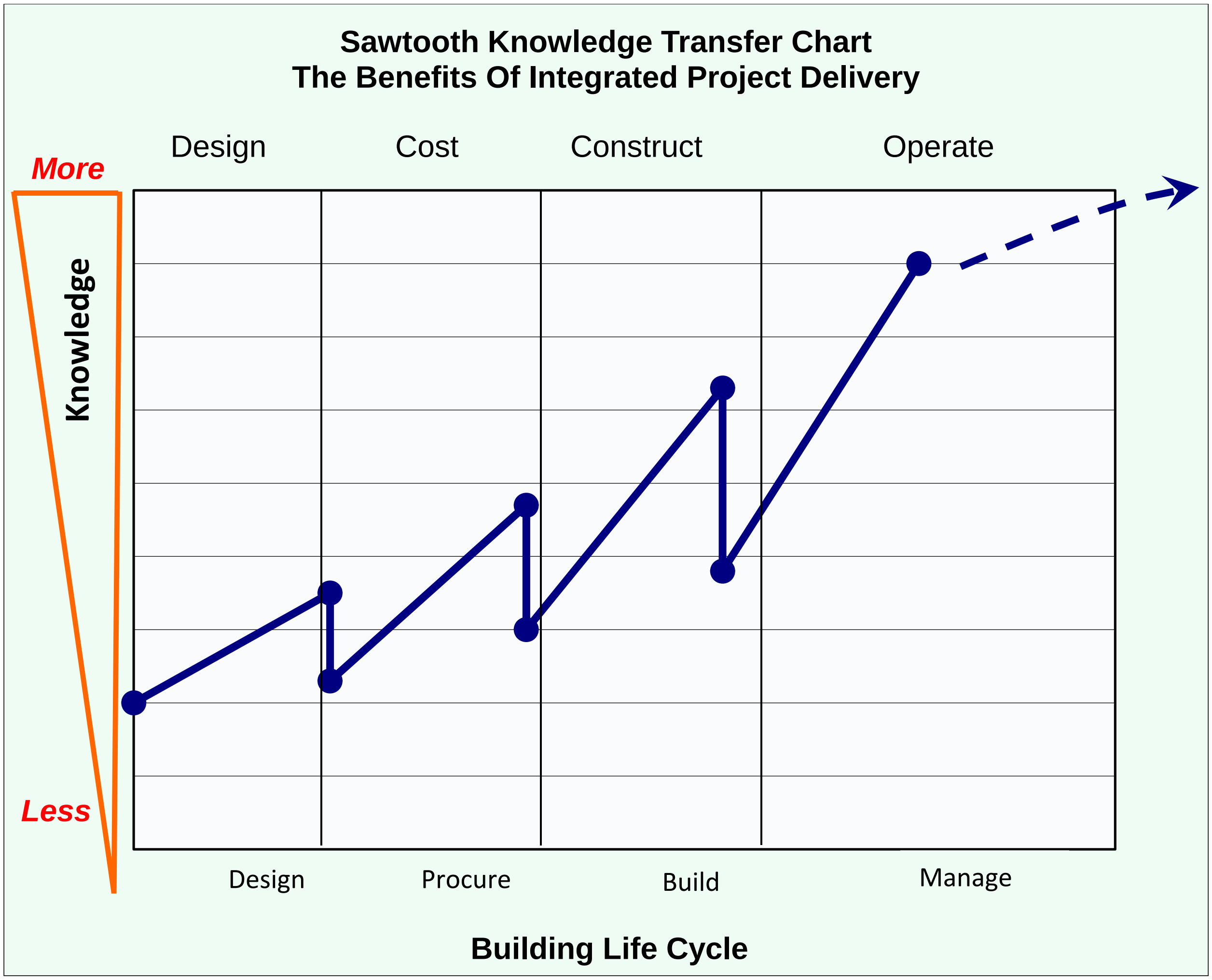


Figure 13. *Details the loss or transfer of knowledge or understanding as a project moves through phases, with new team members added and others leaving.*

Integrated Project Delivery is a more collaborative delivery method, where subcontractors and end users collaborate as a team during design. The team works together to create designs, solve problems and complete projects faster and less expensively. Factors to success require the team to be assembled early in the process, for all team members to have open and equal access to information, and share in the risks and rewards of the entire project, not just their particular stake. The process minimizes waste, resulting in fewer change orders, lower cost, and meeting more of the end user requirements. The university is piloting IPD on the Shaw Hall Food Dining Center and Food Emporium. Figures 14 and 15 represent the change in project team participation and understanding. In a traditional approach, as shown in figure 14, most of the project team is involved in the project relatively late, with no opportunity to add value to the critical decisions made early in the project. Figure 15 represents the IPD approach of engaging the critical team members earlier, and getting the value of that input. Integrated Project Delivery is closely related to Lean Construction, a movement to eliminate waste from the design and construction process. Dr. Tariq Sami Abdelhamid of MSU's School of Planning, Design and Construction is a recognized leader in Lean Construction and is advising the project team throughout the process.

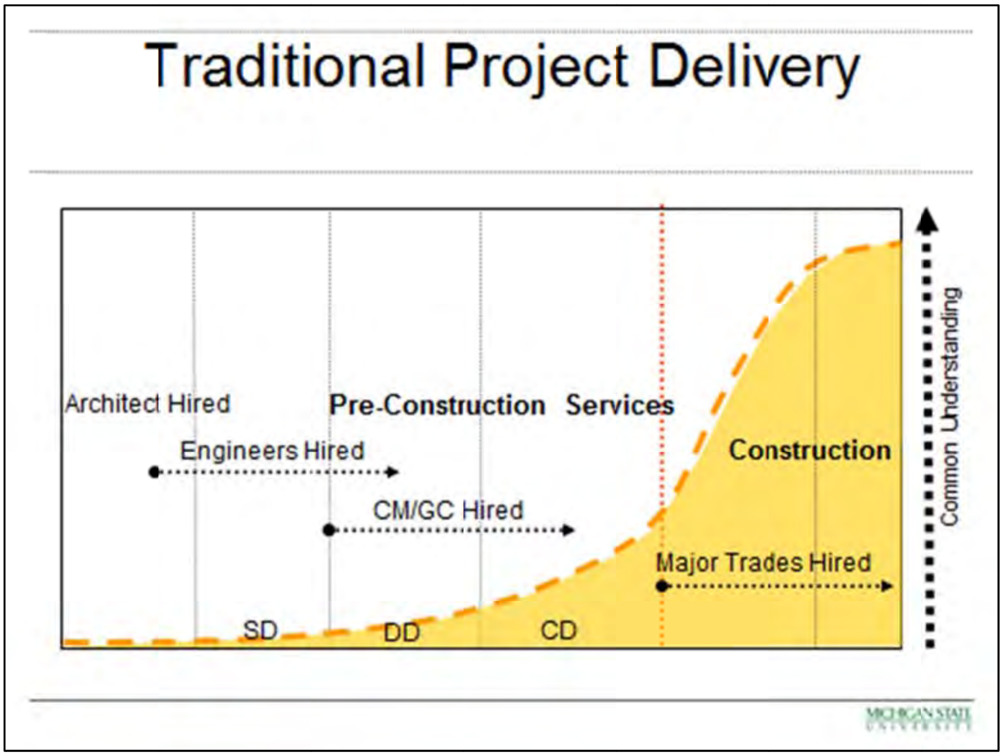


Figure 14. *Details the conventional project resource plan, where most of the team is brought into the project relatively late to impact the decisions that most affect the project.*

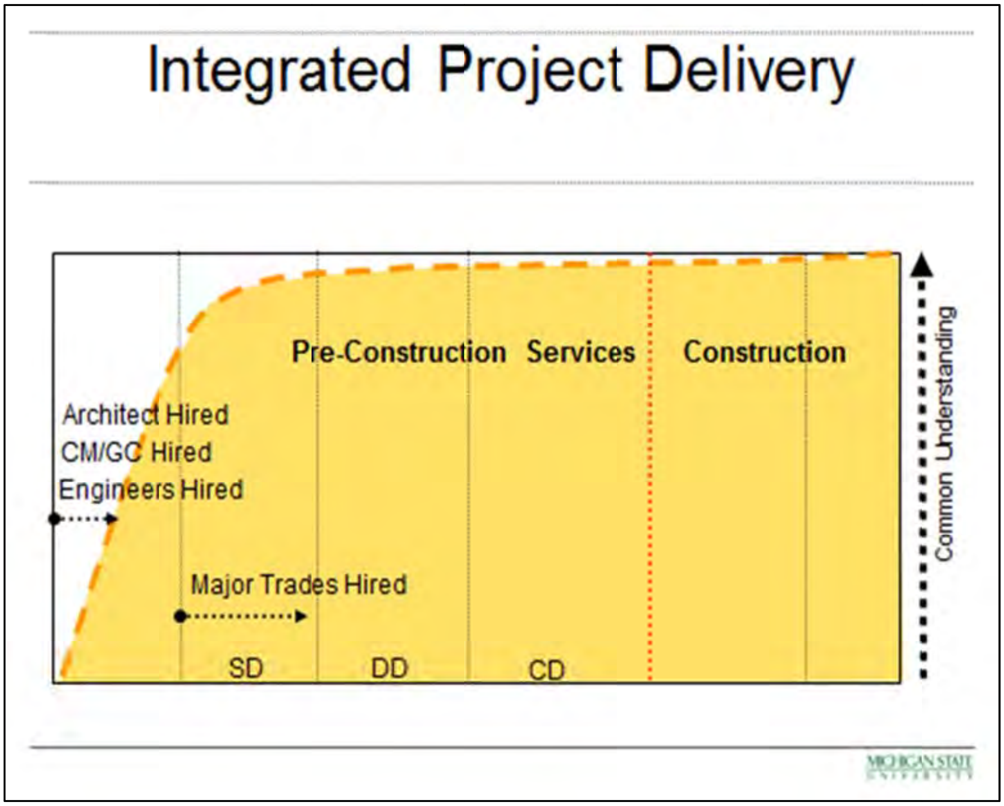


Figure 15. *Details an IPD project resource plan, where the team is selected early in design, and the project benefits from the common understanding of the requirements and the most efficient way to achieve project requirement.*

MSU as Construction Manager

In addition to IPD, MSU continues to explore methods of project delivery that bring value to the university. One of those methods is the implementation of Owner-Build or MSU as Construction Manager (CM) method of project delivery. The Physical Plant Engineering and Architectural Services group has identified an opportunity to utilize in-house construction management and trade expertise to benefit the university by self-performing construction management tasks. Some expected outcomes, as compared to contracting for external CM services, include reducing the overall delivery time of the projects and reducing costs to the university by utilizing fixed cost MSU employees and other associated resources.

An external analysis of the three pilot projects is being performed by the Center for Construction Project Performance Assessment and Improvement Organization in the School of Planning Design, and Construction. To this point, the projects have proven to be a success with a recognized cost savings due to the use of this delivery method. Table 5 lists the three on-going pilot projects that are using the MSU as CM Approach.

Table 5. *Pilot Projects using MSU as CM Delivery Method.*

Project	Status	Value	Estimated Cost Savings
The Biomedical Physical Science Building Renovations to Suite 1440	Active	$2.9 Million	$86,334
T.B. Simon Power Plant - Caustic Storage Containment System	Active	$850,000	$125,796
T.B. Simon Power Plant - Fuel Handling Modifications	Active	$18.5 Million	$1,562,353

Using the MSU as CM approach is not ideal for every project. The intent is to balance the benefits of resource utilization and control versus the amount of risk MSU is willing to incur to create added value. Each potential project is evaluated for complexity and coordination requirements to identify the correct circumstances for the use of MSU as CM. This limited selection will provide the flexibility to use MSU as CM method of delivery without any project taking on substantial risk to the university.

Self-Performed Work at MSU

MSU has traditionally self-performed a number of different tasks using internal occupational trades personnel on major capital projects. Tasks that can be performed on major projects can range from site work and landscaping to commissioning, or to simply installing the cores in the locksets near the end of the project. As MSU continues to improve the quality and reliability of their project delivery, procedures are being further developed and implemented to reduce waste on projects. Some of the enhancements that are currently being implemented and evaluated are:

- Using Skire Unifier to help create and track more accurate scopes of work.
- Using more price certain estimating to ensure compliance to budget.
- Creating more accurate schedules for self-performed work on major projects.

As an emphasis is placed on creating procedures to more accurately track self-performed work, the university expects to increase the level of reliability and realize increased adherence to project budgets.

Building Information Modeling

Building Information Modeling (BIM) is a revolutionary approach to design, construction, and maintenance operations. It has long been the goal of those involved in the design and construction of university facilities to work in a truly collaborative manner and to deliver value to meet the unique needs of the academic customer. BIM helps stakeholders coordinate and balance issues, such as end-user requirements and needs, against hard budget limits early in the design process. This helps to reduce project changes, shortens design and construction time, and helps to minimize errors and omissions. It can also help in the feasibility stage, when linked to a cost database, to determine if the project is within proposed budgets well before expensive design functions are performed and irreversible commitments are made. It can also help to detect potential interferences between trades (sometimes called “clashes”) and thus reduce change orders.

There are several types of software applications which can be used for BIM. Currently, the most prominent application in the industry is Revit. With the increase in large design projects performed by MSU in-house design staff, the university is in the process of standardizing the implementation of Revit for drafting and modeling software. Revit has numerous capabilities which are conducive to providing a complete design, including inter-disciplinary clash detection, as well as building model analysis, such as using a quantity takeoff utility to develop a materials list and display 3-D renderings. The MSU records staff is making strides to develop Revit models for all existing campus buildings. There are 40 buildings with a true Revit 3-D model at this point in time. As the implementation of Revit progresses, the university expects the quality of projects to benefit from the transformation to this standard.

Sustainability in Construction

In recent years, the United States Green Building Council (USGBC) has become the standard for measurement of sustainable construction practices. Leadership in Energy and Environmental Design (LEED), developed in 1993 by the USGBC, is a green building certification system that encompasses six categories that cover all aspects of design and construction processes. LEED sets the standard for the successful measurement and definition of “green building,” in addition to promoting integrated, whole-building design practices and recognizing environmental leadership in the building industry. There are four levels of LEED certification; certified, silver, gold, and platinum. Each level represents the number of sustainable attributes or energy consumption forecasts for an individual construction project. The different attributes are tracked via a scorecard system that awards points or credits which are accumulated to reach the different levels of certification. The costs required to attain LEED certification can range anywhere from 0-1% for a certified project and up to 8-10% or higher for gold or platinum level certification. These certification credits have a payback period through cost savings due to lower energy consumption and the productivity of building occupants over time.

In 2006, MSU performed a comprehensive analysis of internal sustainable construction practices in relation to this standard. Presently, there are seven Big Ten Universities that require all major construction projects to achieve LEED Certification. Of the four that do not require formal certification, sustainability goals are defined in their construction standards. MSU currently does not require that all construction projects go through the certification process, nor do all of MSU projects achieve LEED certification. Projects are designed and constructed to LEED standards but again this does not guarantee LEED certification. A review of the current LEED minimum requirements can be found in Appendix B.

Michigan State University has required a number of projects to be LEED Certified. The goals are different for each project registered for LEED Certification. Each LEED project is evaluated individually for the minimum required achievement and cost impacts to evaluate the return on investment. Michigan State University currently has approximately 20.9 million square footage of building space. Of that 20.9 million, 513,000 square foot is either LEED Certified or are progressing toward LEED Certification. This comprises approximately 2.5% of the total. Table 6 lists the projects that are registered for LEED at the USGBC.

Table 6. *LEED certified buildings at MSU.*

Building Name	Square Feet	LEED Status
Chemistry Addition	32,034	Certified Silver
MSU Surplus Store and Recycling Center	70,000	Certified Gold
Kellogg Dairy Center - Dairy Barn	*Off Campus Agricultural*	Certified Silver
Brody Hall	142,574	Pending Silver Cert.
Eli and Edythe Broad Art Museum	42,000	Pending Certified
Life Science Addition	47,000	Pending Silver Cert.
Secchia Medical Center - Grand Rapids	180,000	Pending Silver Cert.

A significant aspect of sustainable construction is the goal to divert construction waste from landfills. In the 2009-10 academic year, MSU established a formal construction waste reduction program. The intent of the program was to divert as much construction and demolition debris from disposal in landfills as possible, as well as to redirect all recyclable or re-usable resources back to the manufacturing process. The minimum requirements of the program are to recycle or salvage at least 50% of non-hazardous construction and demolition debris. The program is currently in the implementation stage. Table 7 shows the construction waste that has been diverted to date.

Table 7. *Construction Waste Diverted from landfill for the eight projects currently being piloted and tracked.*

Material	Diverted From Landfill (Tons)	To Landfill (Tons)	Total Construction Waste
Concrete	36,027	-	36,027
Crushed Asphalt	13,070	-	13,070
Dirt	323,273	-	323,273
Glass	28	-	28
Masonry	21	-	21
Mixed Construction Waste	-	2,360	2,360
Salvaged Items	6,005	-	6,005
Steel and Non-ferrous Metals	964	-	964
Wood	60	1	61
Total Construction Waste:	379,448	2,361	381,809
Total % Diverted From Landfill:	**99.4%**		

The goals for sustainable construction are continuously reviewed and modified. Each individual project is evaluated for achievement of the sustainability goals, as well as, return on investment. A few enhancements currently being implemented to the LEED evaluation system are:

- Energy Optimization credit includes a range from 22% up to 32% improvement as a standard.
- Innovation in Design credit for education will be included on every project as a standard to facilitate the energy conservation campaign on campus and inform visitors of what MSU is doing to reduce its footprint.
- Energy Modeling credit will be required on all projects. This requires design firms to submit their model to MSU when the project is complete, for future energy modeling and/or renovation projects.
- The LEED Measurement and Verification credit will not be officially included as a standard; but construction standards will be revised to include additional metering to facilitate verification of energy modeling.

Post Occupancy Evaluations

Post occupancy evaluation (POE) refers to the evaluation of a completed constructed facility during its occupancy. A POE process can answer several significant questions including: is the constructed building facility functioning as planned? If not, what corrective measures are necessary? And, how can buildings be better constructed in the future? The primary objective of the POE process is to feed forward 'lessons learned' from the review of completed capital projects into a process that would ensure that best practices are applied in future projects. Campus Planning and Administration, in conjunction with the Center for Construction Project Performance Assessment and Improvement at MSU, is currently developing a model in which all major capital projects will have some level of post occupancy evaluation. This is in partnership with all other campus organizations involved in project delivery to develop a step level POE protocol for implementation on newly completed projects.

The first pilot in-depth POE was performed at MSU in the summer of 2010. The Wharton Center Addition was evaluated for project success and lessons learned. The evaluation was also to serve as a template for future POEs performed at MSU. The POE heightened those processes that were particularly successful in order to encourage application in the future. Likewise, some processes were found in need of improvement and serve as areas to modify for future projects. Overall, this project was found to be a great success in supporting the arts at MSU. A sample of some of the possible enhancements recognized as part of the Wharton Center POE is found in Figure 16.

POE Recommendation

Project: **Wharton Center, Additions & Remodeling** Key Issue No. **D-2**

Key Issue: **Value Analysis (Value Engineering)** Date: **July 14, 2010***(application, process, designer involvement, life cycle costing, VCP's, benchmarking, use of POE lessons learned, etc.)*

Best Features:

- Application of VE to bring project into budget
- Ability to re-consider VE items to do later if money available
- Focused on keeping "must have" items
- VE team included management, A/E, CM
- Multiple VE sessions during design
- Selected items that could be done later if funding became available

Features of Concern:

- Applied mainly after bids indicated project significantly over budget
- Life cycle cost analysis not used in VE process

Ideas for Enhancement: **Evaluation (bold, high priority)**

1. **Apply VA early in design process to assure best value decisions (CM earlier) and focus on achieving "must do" project elements**
2. **VA team to include management, A/E, CM, maintenance staff and work as a team effort**
3. Hold multiple VA sessions at SD and DD project design stages
4. Task team members with individual VA responsibilities
5. Continue to monitor contingency during construction phase and release VA items for construction if money available
6. Monitor furniture costs to determine if cost savings is possible
7. Focus on items that could be done efficiently later if funding becomes available
8. **Clearly identify costs associated with owner supplied items & tasks to avoid cost overruns**
9. Explore deviations from MSU standards (rigid conduit, black steel pipe, etc.)
10. Capture space, if relatively low cost, for future occupant use
11. When VA study, also explore ideas to reduce life cycle cost
12. Include interior walls with some windows to allow daylight to interior windowless spaces
13. VA process should analyze all costs including general conditions of the contract
14. Consider including the "value change proposal" clause in the construction contract to encourage contractor VA ideas
15. Follow "value methodology standard" process as defined by SAVE International, the value analysis society

Recommendation:

35

Figure 16. *Sample extracted from the Wharton Center Post Occupancy Evaluation.*

The POE is intended to be continuously developed as a quality control and reliability tool to continuously improve the delivery of projects. Other major capital projects, which are scheduled to be evaluated in the year 2010-11, include the MSU Surplus Store and Recycling Center, Owen Hall Food Court Renovation, and Cyclotron Phase I Office Addition.

Project Scorecard Rating System

The university has established a scorecard system for general contractors and construction managers to provide feedback to MSU. Typically, contractors view MSU as a preferred customer and want to meet requested expectations. The scorecard system is a tool for making contractors and construction managers aware of opportunities for improvement in their work performance. It may also become a resource when considering contractors for hire. As part of project close-out for major capital projects, the construction representative or project manager evaluates contractor performance through a standardized score card to rate each project and vendor. It is the construction representative who shares the scorecard with the contractor, along with average scores. The construction superintendent reviews poor performance with contractors who have had multiple mediocre or unacceptable projects. A similar process is used for design professional evaluations. The implementation of the scorecard system has had a positive impact on the performance of contractors and designers working at MSU. This trend is shown in Figures 17 and 18.

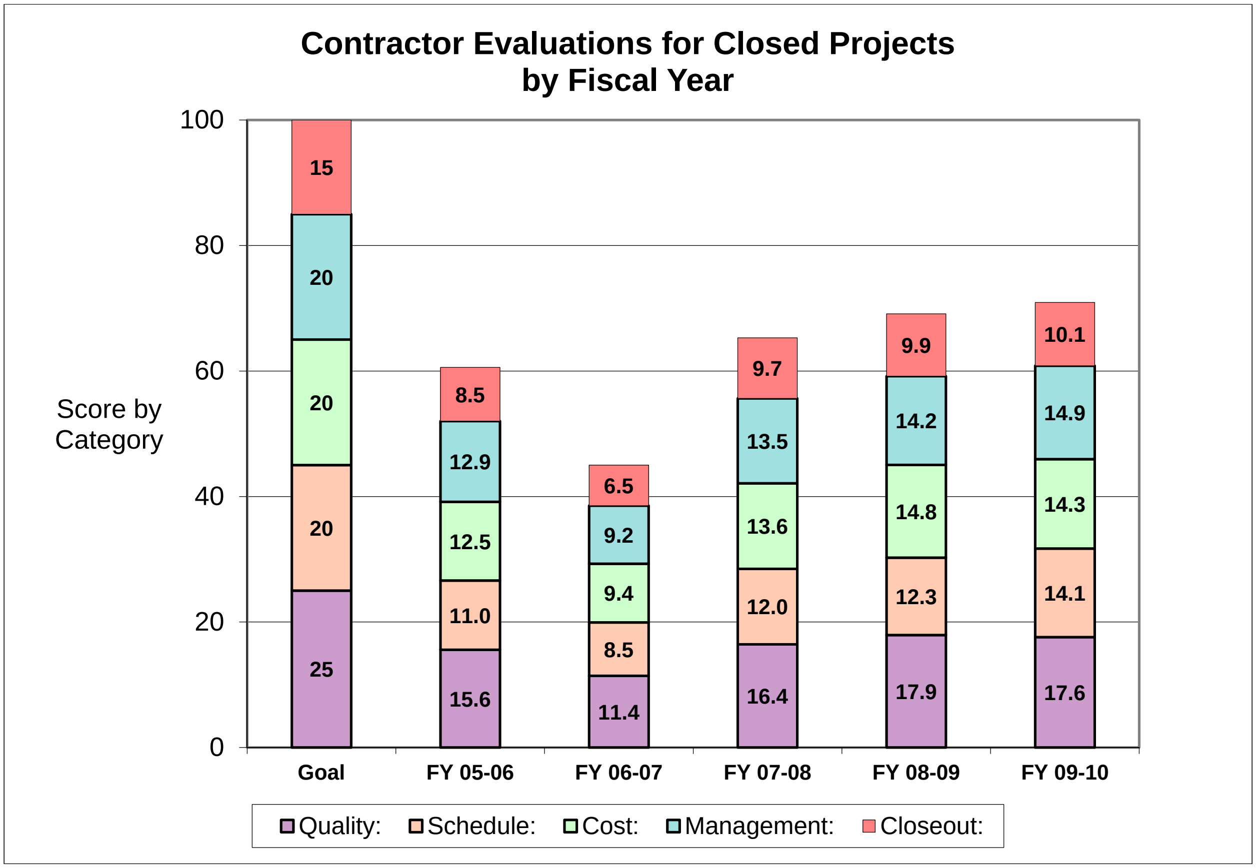


Figure 17. *Contractor scores to date by fiscal year. The goal column on the left represents perfect scores per category.*

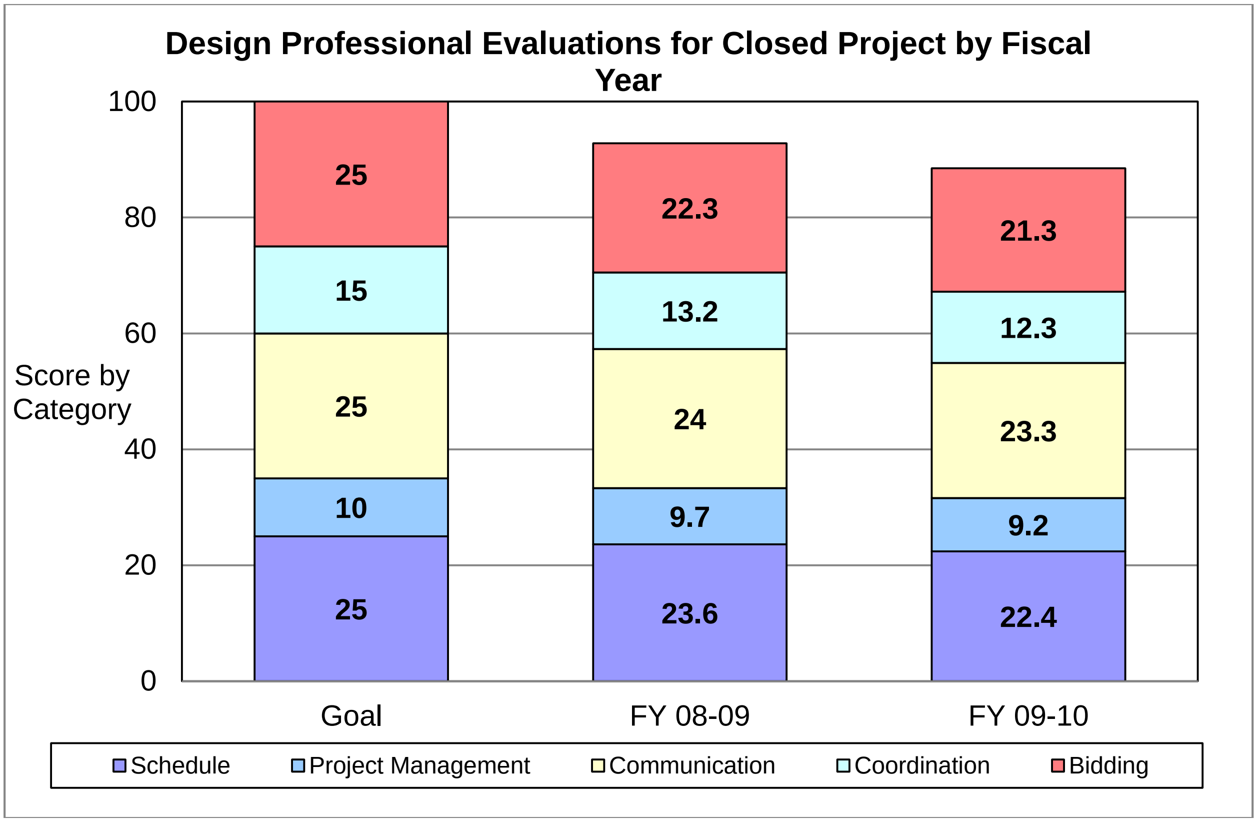


Figure 18. *Designer/consultant scores to date by fiscal year. The goal column on the left represents perfect scores per category.*

Project Labor Agreements

In February 2008, the Board of Trustees (BOT) approved a Responsible Contractor Policy. The policy is a commitment by MSU to use responsible and ethical contractors on construction projects, and sets minimum standards for contractor qualifications and contract specifications.

The policy outlines when a Project Labor Agreement (PLA) would be appropriate to implement in terms of advancing MSU's project-specific interests in cost savings, efficiency, timeliness, or quality; and would promote the institutional goals set forth in this policy. The policy directed the administration not to discourage a construction manager or general contractor from opting for a PLA.

Since February 2008 through the end of fiscal year 2009-10, the university has taken action on 53 projects totaling $500 million. The Board of Trustees has authorized PLA's on four projects currently under construction, worth approximately $85 million, combined. The construction manager self-elected to employ a PLA on four more projects totaling $128.6 million. The Board authorized PLAs on the remaining Brody Complex residence hall and utility renovations, none of which will start construction before May 2011. The estimated value of these projects is $77.7 million. Appendix C lists all 53 projects.

Table 8. *PLA status of BOT-approved projects. Note: the Board approved a PLA on the balance of the Brody Complex renovations in October 2009.*

PLA Status	Projects		Project Value	
No PLA	40	75%	203,331,500	41 %
PLA authorized by MSU	4	8%	84,690,000	17 %
PLA chosen by the Contractor	5	9%	134,890,000	27 %
Future phases of Brody Complex (Construction to begin in 2011 or later)	4	8%	77,700,000	16 %
Total:	**53**		**$ 500,611,500**	

The Responsible Contractor Policy identified four key factors to evaluate when recommending a PLA: cost savings, efficiency, timeliness, or quality. Not all must be present. The analysis will review the PLA impact on each. As of June 30 2010, the university or its construction managers had completely or partially bid seven projects using PLAs. Those projects include Brody Hall, Eli & Edythe Broad Art Museum, East Circle Drive Reconstruction, Plant Sciences Expansion, Facility for Rare Isotope Beams (FRIB) - Utility Relocation - Phase I, Emmons Hall, and Brody Steam & Communications Phase 2. The Broad Art Museum and East Circle Drive were bid combined, as were Plant Sciences and FRIB Utilities. Bids for all projects were at or below estimate, as were projects during this time period.

Table 9 details PLA bid results for FY 2009-10. There were 63 subcontracts bid out on construction management project, allowing the university detailed information on bidding. The construction managers advertised the project, seeking qualified subcontractors. There were 136 bidders on the various subcontracts; 125 of which were union organized. The construction manager also contacted known qualified subcontractors. There were 10 instances where non-union firms declined to bid because of the PLA. Bids, as detailed in Table 9, were $4.7 million (7.9%) under estimate.

Table 9. *PLA Bid Results for 2009-10.*

Project Name	Total Bid Estimate	Awarded Bid	Variance	% Variance to Estimate	Number of Union Bidders	Number of Non-Union Bidders	Union Awards	Non-Union Awards
ELI AND EDYTHE BROAD ART MUSEUM & EAST CIRCLE DRIVE RECONSTRUCTION	$14,163,266	$13,785,936	$377,330	2.66%	18	1	5	0
EMMONS HALL - RENOVATION	$11,500,000	$8,537,000	$2,963,000	25.77%	not available	not available	22	4
WELLS HALL - ADDITION NO. 2 (MORRILL HALL)	$3,331,075	$2,803,900	$527,175	15.83%	5	0	1	0
PLANT AND SOIL SCIENCES (ADDITION 1) & FRIB UTILITIES PHASE 1	$30,042,043	$29,224,242	$817,801	2.72%	102	10	26	5
Totals:	$59,036,384	$54,351,078	$4,685,306	7.94%	125	11	54	9

Evaluating the projects against the factors identified in the responsible contractor policy, there appears to be a moderate impact on construction. The projects are under budget, but this is consistent with the current market and it is difficult to attribute any of this to employing project labor agreements. There have been some efficiency gains through avoiding federally-mandated dual gates on a tight project jobsite at Plant Science expansion. There was time savings at Brody Hall by avoiding a short painters strike, though it is not clear this strike would have delayed opening food service. None of the construction managers or general contractors anticipates workforce shortages during these projects. Finally, there have been no quality issues related to labor on any of these projects. MSU has updated contract language to ensure all PLAs address certain baseline issues such as harmonizing work hours and work rules, safety, defining terms for non-union participation, and dispute resolution.

ENERGY – LONG TERM STRATEGIES AND PLANNING

Summary

Michigan State University (MSU) must look critically at the needs for the future to continue its teaching, research, and outreach missions, while being a responsible citizen. The campus has set goals of reducing greenhouse gas (GHG) emissions by 15% and reducing energy consumption by 15% by 2015. Key indicators measuring overall campus progress have been identified to benchmark MSU's performance. Research and operations projects continue to drive recommendations for process and infrastructure improvements. MSU has made gains; however, there are still significant challenges in meeting the 2015 goals and future energy demand.

The university has prepared for these challenges by thoughtfully creating tools that will enable the campus to use an engaged process to move toward a renewable future and reduce its impact on the environment.

Analysis

Energy Generation and Distribution Background

The majority of energy serving the campus has historically come from the T. B. Simon Power Plant through cogeneration of steam and electricity. Cogeneration is an efficient use of fuel by using steam to heat the buildings, while at the same time using steam to generate electricity for 90% of main campus. T. B. Simon Power Plant is a system of independent steam generating units operating on a common 900 pounds per square in gauge (psig) steam header, which can supply energy to 99 megawatts (MW) of cogeneration electric capacity. Cogeneration of energy can range from 60 to 80% efficient, while a typical electric only generating facility operates at 30% efficiency. The T. B. Simon Power Plant is a co-generation facility which provides steam and electricity to the campus with 60% efficiency. The existing campus energy distribution system includes underground steam tunnels and electrical lines that provide heating and power to the buildings. The power plant has fuel flexibility and currently operates reliably with one of the six generating units out of service for maintenance. The T. B. Simon Power Plant has an interconnection to the local utility for reliability and back up in the event a single unit is unavailable to generate electricity. In case of an entire plant outage, the plant has "black start" capability that allows restarting the plant in a very short time period. The campus energy demands are driven by the size of the buildings, the energy intensity of the facilities, and the growth of campus in terms of new buildings. Michigan State University's campus grew close to two million square feet in the past 10 years.

Energy and greenhouse gas (GHG) emissions data is highly correlated. Although not all GHSs come from energy consumption on campus, all energy consumption can be translated into GHGs. (The total GHGs also includes emissions from the MSU owned transportation fleet.) Reduction in GHGs can be the result of two factors: 1) reduced energy consumption and 2) switching to lower emission fuels. Figure 1 shows MSU's performance in total GHG emissions. The unit of measure displayed in the graph is equivalent metric tons of CO2 which converts all six GHG emissions to metric tons of CO2 for ease of benchmarking total GHG emissions.

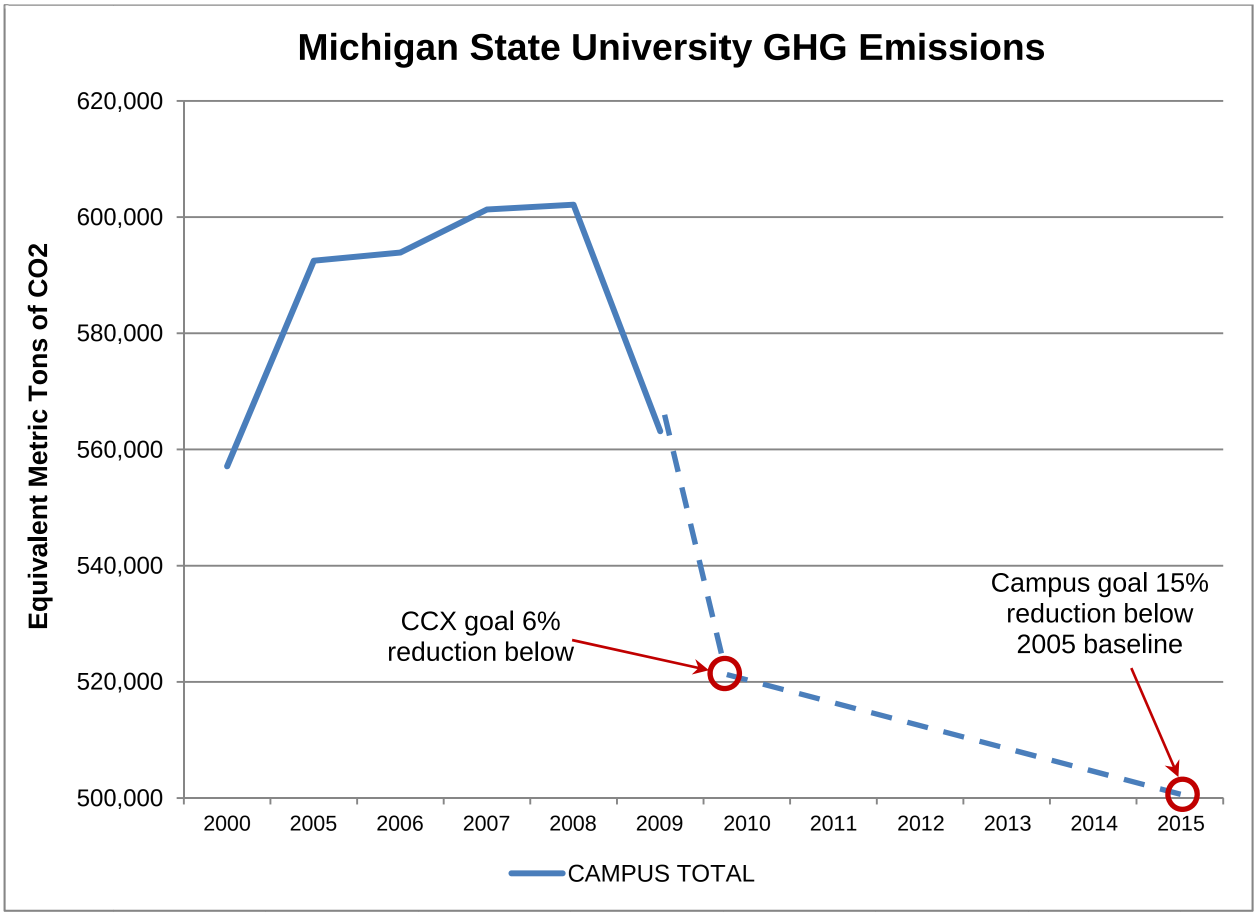
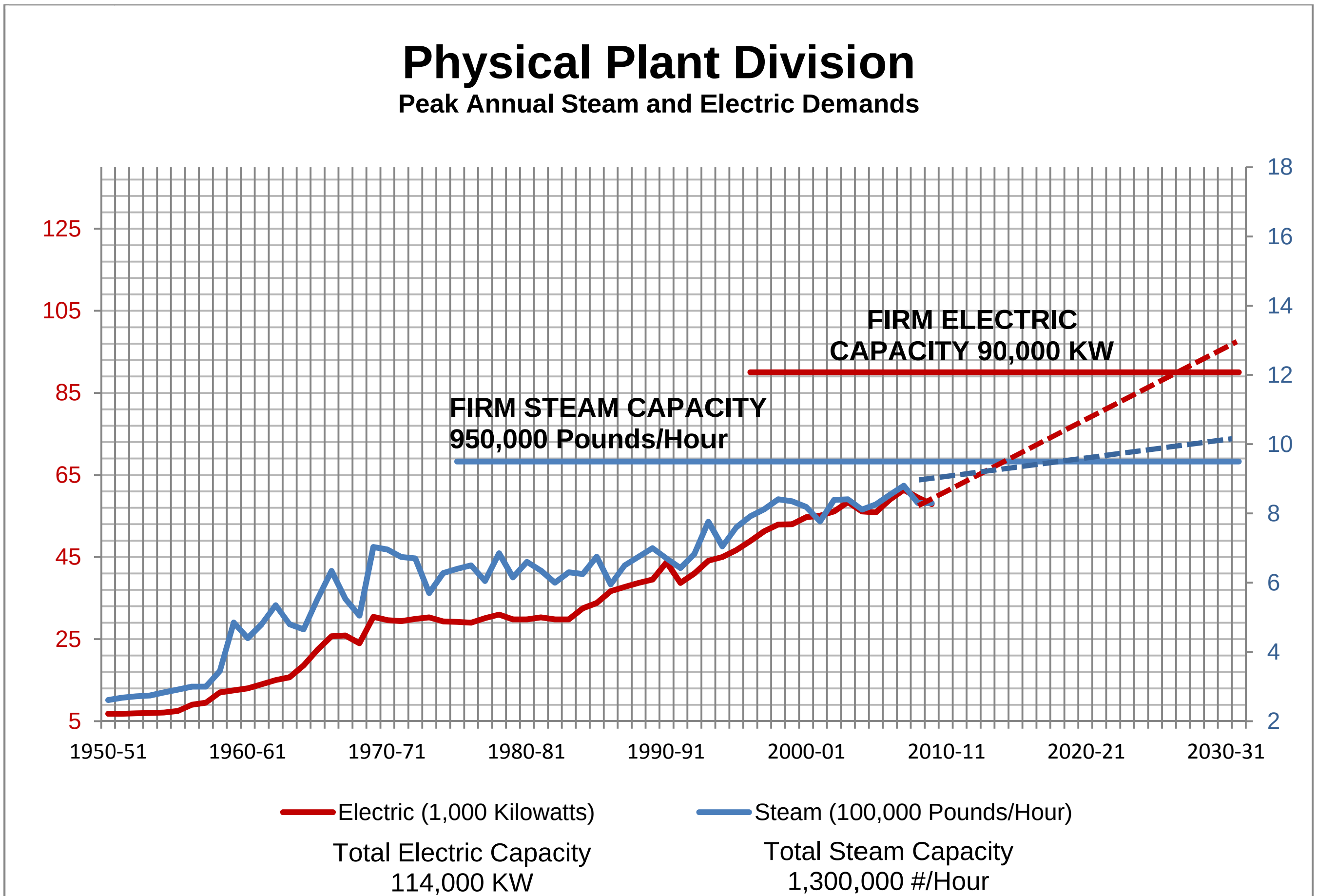


Figure 1. *Greenhouse Gas Emissions as Reported to Chicago Climate Exchange.* GHGs are measured in equivalent metric tons of CO2. The data is collected by calendar year, January-December, and includes emissions from the university automotive fleet, power plant, and natural gas from farms and buildings.

While the campus continues to grow and construct new buildings to support the research and teaching mission, energy conservation and fuel choices at the power plant have reduced GHG emissions. The campus is on track to meet the Chicago Climate Exchange goal of a 6% reduction of GHG emissions below year 2000 baseline. The reduction in 2009 shows a 6.5% decrease in GHG emissions for campus from 2008.

This is largely due to burning more natural gas (fuel switching) when natural gas prices dropped. The second major contributing factor was energy conservation efforts on campus which included retro-commissioning (tuning up) of building systems and classroom consolidations. The 6.5% decrease is significant, as campus square footage continued to increase during this time as well. Although the decrease is positive, it should be noted that the main driver was the market condition of lower natural gas prices, which the university cannot predict or control. In order to sustain this decrease, the T.B. Simon Power Plant will continue to look at increasing natural gas burning as well as using renewable sources such as bio-fuels. Currently, the T. B. Simon Power Plant is permitted to burn 8,000 tons of bio-fuel in the power plant; future strategies will include pursuing a permit to increase the permitted amount to 24,000 tons.

A more immediate challenge is that, based on steam projections, the power plant will need to expand in 2023. Michigan State University's campus grows an average one million square feet in new construction every 10 years. The most recent 10 year campus growth was close to two million square feet. The projected need for additional energy generation is based on historical growth (Figure 2). Planning for additional capacity at the power plant should begin five to seven years prior to the need for additional capacity. Alternative strategies are being develop that will delay the need for an addition to the T. B. Simon Power Plant.



DESCRIPTION: This graph presents the historical campus electric demand and the projected future demand. Future demand is based on the 2020 Master Plant assumption that 1 million square feet of new space will be added over the next decade.

ANALYSIS: Electric and steam demand determines generation capacity requirements. A plant addition has been required on an average of every 12 years. Based on the potential to have our large unit out of service at any time, the MSU firm steam capacity date is 2023.

August 2010

Figure 2. *Peak Steam and Electric Demand.* This graph presents the historical campus electric demand and the projected future demand for both steam and electricity. Firm capacity is the maximum capacity available.

Electric and steam demand determines generation capacity requirements. The planning and permitting process for additional capacity at the power plant needs to begin in 2016 if the typical growth pattern continues and no changes are made.

According to energy consultants, the emerging new technologies that could fulfill the capacity needs for the power plant are not developed to a point to make a sound implementation and fiscal decision. The best future technology options would utilize the current co-generation infrastructure, significantly reduce emissions, incorporate a high renewable energy portfolio, and be fiscally sustainable. For this reason, the campus strategy is to implement multiple strategies to extend the amount of time needed to implement a plant expansion, in order to give the appropriate time to make a sustainable decision.

Energy conservation projects have been successful. Figures 3 and 4 show how MSU is using energy more efficiently.

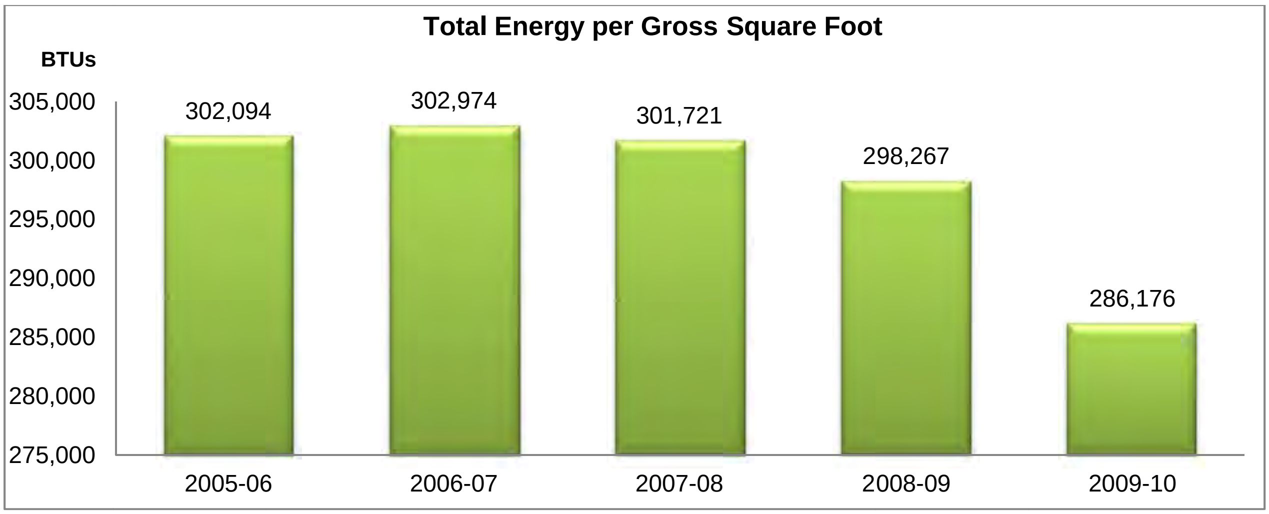


Figure 3. *Total Energy per Gross Square Foot.* Total energy is measured in British Thermal Units or BTUs, which is a standard unit of energy. The gross square footage is the square footage of campus building space.

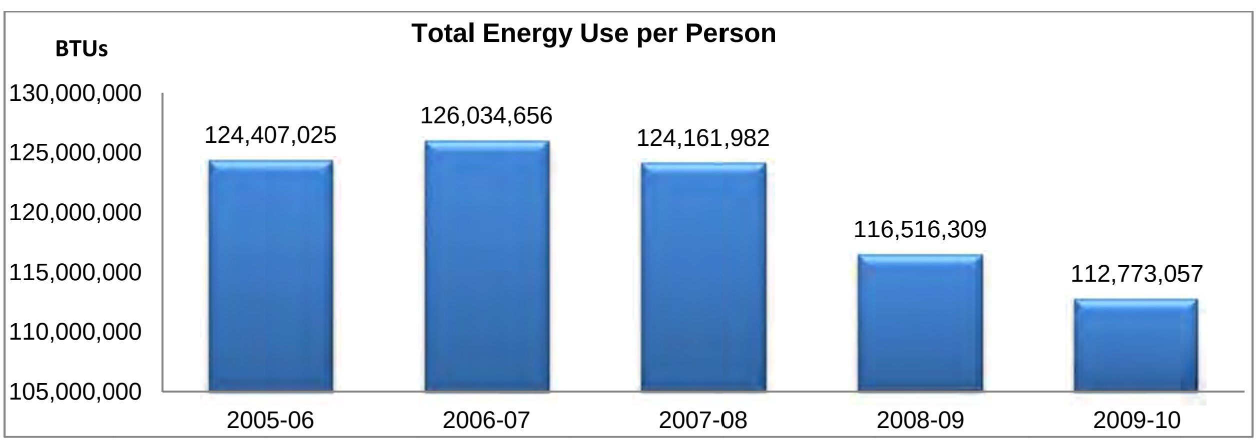


Figure 4. *Total Energy per Person.* The total energy is measured in BTUs and the campus population figure was provided by the Office of Planning and Budgets for fall semester 2010.

Since 2005-06, campus square footage increased by 2.74% and campus population increased by 7.37%. Despite these gains, energy use per square foot decreased by

5.23% and energy per person decreased by 9.35%. The following projects have significantly contributed to these results:

Projects

Energy consumption and demand reduction strategies allow the campus to grow sustainably, put off the need for additional generation capacity at the power plant, and increase building efficiency. Demand reduction strategies are being increasingly incorporated into new construction projects. Examples include distributed generation technologies such as the geothermal system being installed in the Bott Nursing addition to the Life Sciences building and the photovoltaic (solar) array included on the roof of the Surplus Store and Recycling Center. In an effort to reduce environmental impacts of campus growth, MSU construction standards currently include the United States Green Building Council Leadership in Energy and Environmental Design (LEED) design requirements for all new construction on campus.

Another energy conservation strategy in existing buildings includes retro-commissioning over 100 major buildings on campus during the next 10 years. This work involves improving building mechanical systems and controls to reduce energy consumption and improve occupant comfort. Some examples of items found during the retro-commissioning process include outdoor air dampers that will not close, excessive operation of chillers, and leaking steam coil valves (Figure 5). Retro-commissioning results in energy savings and has the potential to reduce energy demand, delaying the need for additional generation capacity. Retro-commissioning program results, to date, can be seen in Figures 6 and 7.

FLIR

Inspection Report

Report Date	7/7/2010		
Company	Michigan State University	**Customer**	Michigan State University
Address	Physical Plant	**Site Address**	Holden Hall
Thermographer	John Wilson	**Contact Person**	Bob Nowicki

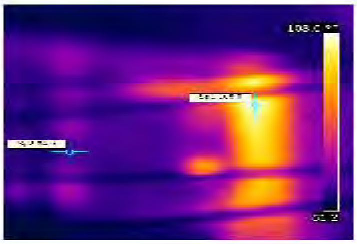


Image and Object Parameters

Camera Model	Flir i60
Image Date	7/6/2010 9:33:33 AM
Image Name	IR_0472.jpg
Emissivity	0.69
Reflected apparent temperature	82.0 °F
Object Distance	4.0 ft

Text Comments

Description

HV-1A Steam Coil when steam is comanded off.

1 (1)

Figure 5. *Retro-commissioning program infrared photo/report for Holden Hall.*

Figure 5 is an infrared photo and report of an air handler serving Holden Hall. The black and white photo on the right was taken standing inside the air handler facing towards the heating coil, inside the unit. The infrared photo on the left was taken from the same position inside the air handler and indicates the steam coil valve is leaking, which is shown in bright orange. This leak causes additional heat to be added in the supply air stream to the building during the summer months. This is wasted energy and causes occupant discomfort. The retro-commissioning process is a systematic method to go through all the mechanical systems in a building and identify items that need maintenance, repair, and energy conservation measures, (ECMs). The results are improved occupant comfort and reduced energy consumption. The analogy would be "tuning up" a car to run efficiently and use less gas.

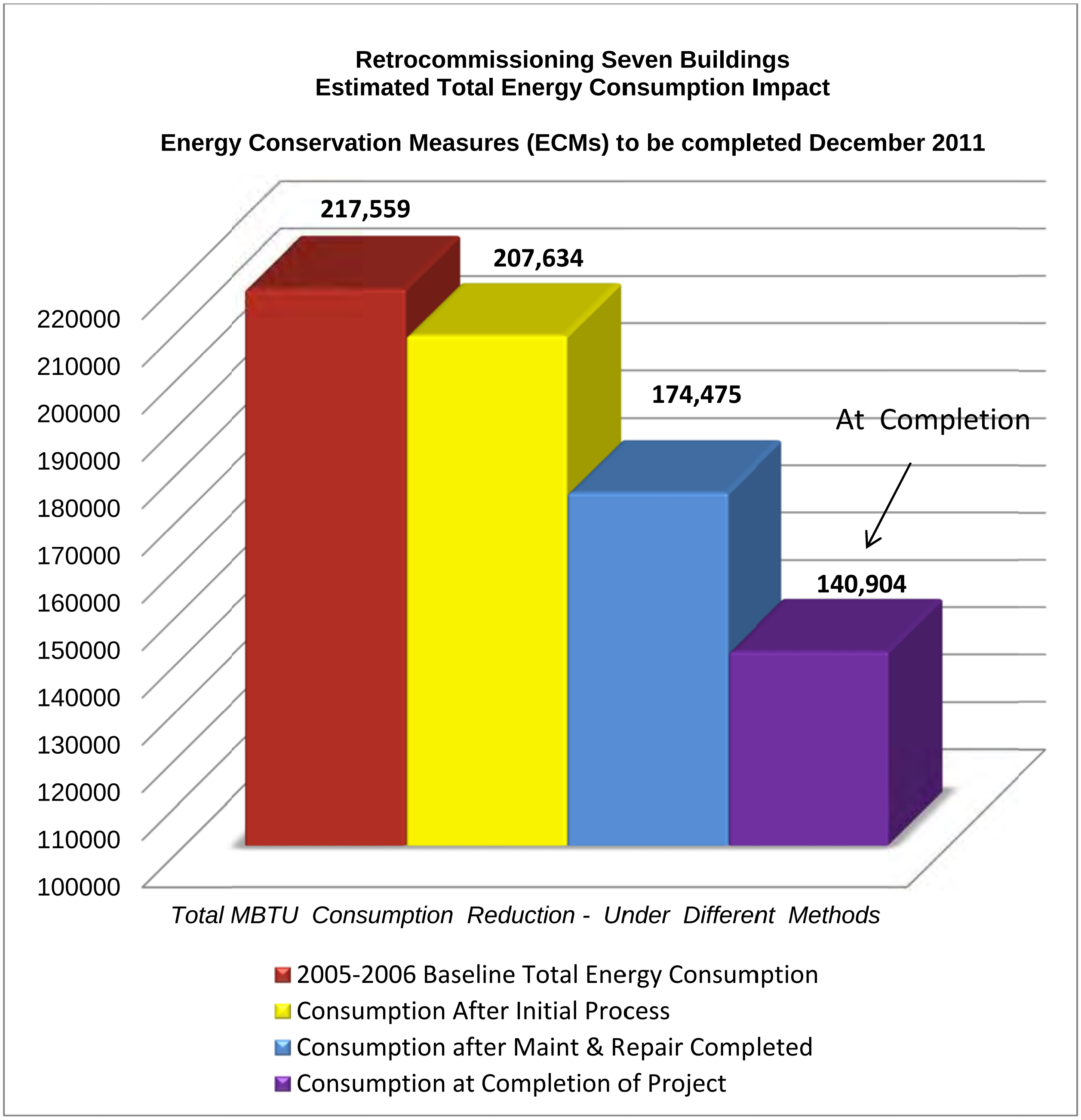


Figure 6. *Retro-Commissioning Program Energy Reduction to Date. MBTU is thousand units of British Thermal Units, a standard unit of measurement for total energy.*

Figure 6 reflects data for the first seven buildings in the retro-commissioning program. The red column is baseline energy data for fiscal year 2005-06. The commissioning process alone saved close to 5% in total energy consumption for seven buildings, as represented by the yellow column. Once the mechanical repairs and ECMs that have been identified by the commissioning process are completed, the energy savings are projected to be 35% for the first seven buildings, as represented by the purple column.

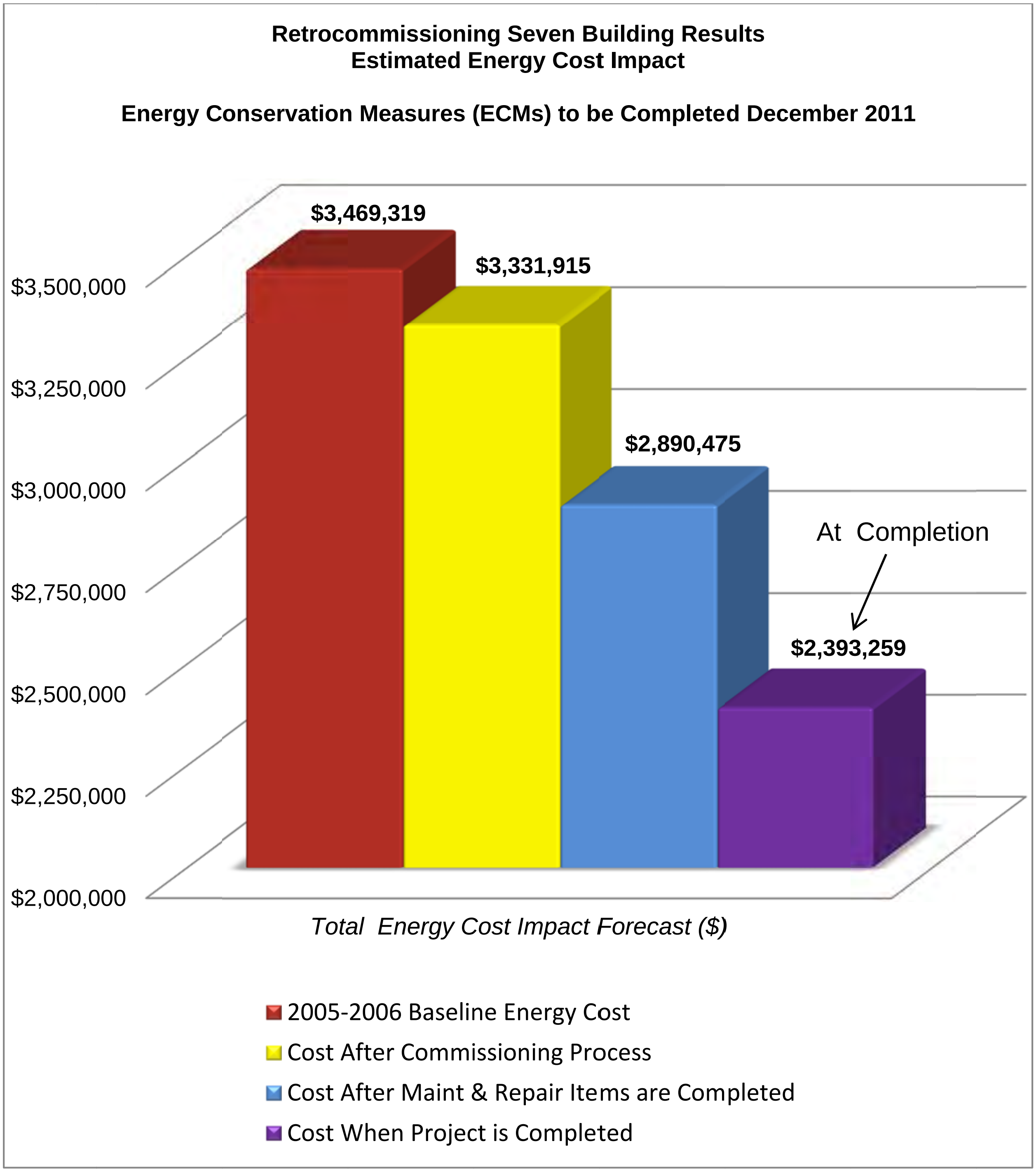


Figure 7. *Retro-commissioning program utility avoided costs to date. Cost savings are based on engineering calculations of avoided energy use of mechanical systems in the seven buildings.*

Figure 7 reflects data for the first seven buildings in the retro-commissioning program. The data indicates the commissioning process alone is saving 4% in total energy costs for the seven buildings, as represented by the yellow column. Once the mechanical repairs and ECM that have been identified by the process are completed, cost savings are projected to be 32% for the first seven buildings, as represented by the purple column.

Classroom consolidation efforts are other methods in progress to reduce energy consumption. These efforts include scheduling classes in core buildings during evening hours, in order to shut down underused buildings earlier to conserve energy (Figure 8). This is an ongoing effort involving a team of people from the Office of the Registrar, Residential and Hospitality Services, Academic Technology Services, and Physical Plant.

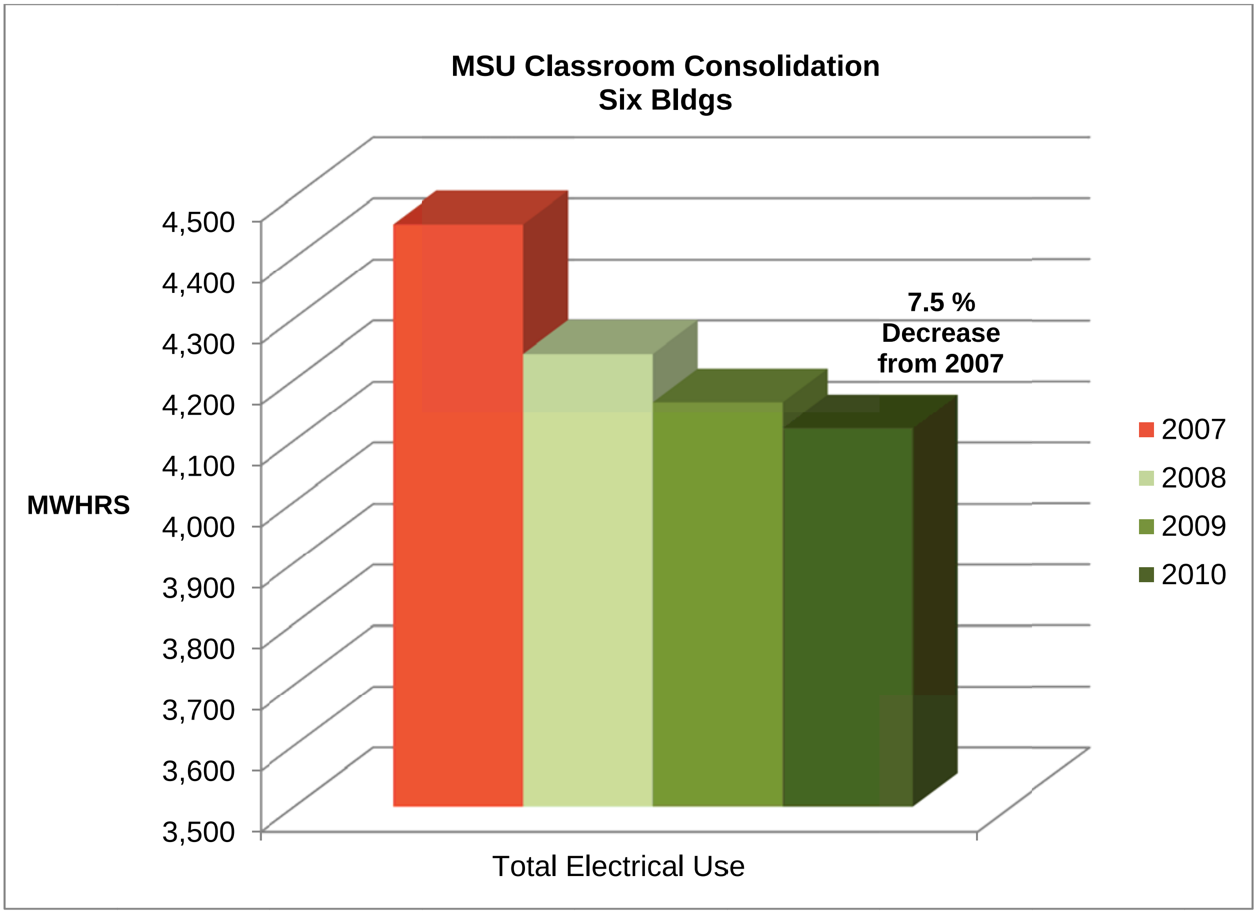


Figure 8. *Classroom Consolidation Energy Reduction Results through 2010.* The program reduced energy by 837.5 Mega-Watt-Hours (MWHRS). Avoided utility costs of $76,700 and avoided 545 metric tons of GHG emissions to date.

Results shown have been maintained since the first year of implementation in 2007. The team continues to strive for additional consolidation of classroom scheduling and space to achieve further energy reductions. Next steps include exploring opportunities to automate the consolidation process using a scheduling software product that is flexible to handle the variety of inputs necessary for the various departments.

Server room consolidation and server virtualization, to conserve energy by reducing air conditioning requirements for data equipment rooms, is a potential source of energy conservation. Academic Technology Services is currently collecting information on server rooms and performing an audit of space used to identify potential efficiencies.

Technology improvements are part of the solution; however, energy conservation by the campus community is also required to achieve and sustain real energy reductions on campus. The environmental stewards program, with over 500 employees participating, encourages energy conservation by turning off lights and equipment when not in use. This is core to achieving the mission of energy conservation and sustainability. While the campus infrastructure continues to grow, the GHG emissions have been reduced through a combination of energy conservation measures such as behavior change and fuel switching at the power plant. MSU also continues to hold the title of lowest electrical consumption per square foot in the Big Ten (Figure 9).

Physical Plant employed an Energy Analyst in 2008 dedicated to providing data analysis of existing energy consumption in MSU facilities; make recommendations regarding policies to increase energy conservation; and develop methods and models to predict energy consumption for the future. The energy analyst is a unique position that looks at the entire energy system from generation at the power plant all the way down to the end use, or electrical plug. Taking a systems approach and analysis of the entire energy process on campus will identify efficiencies; provide opportunities to improve operations; avoid energy costs; and keep campus on track to continue to reduce GHs.

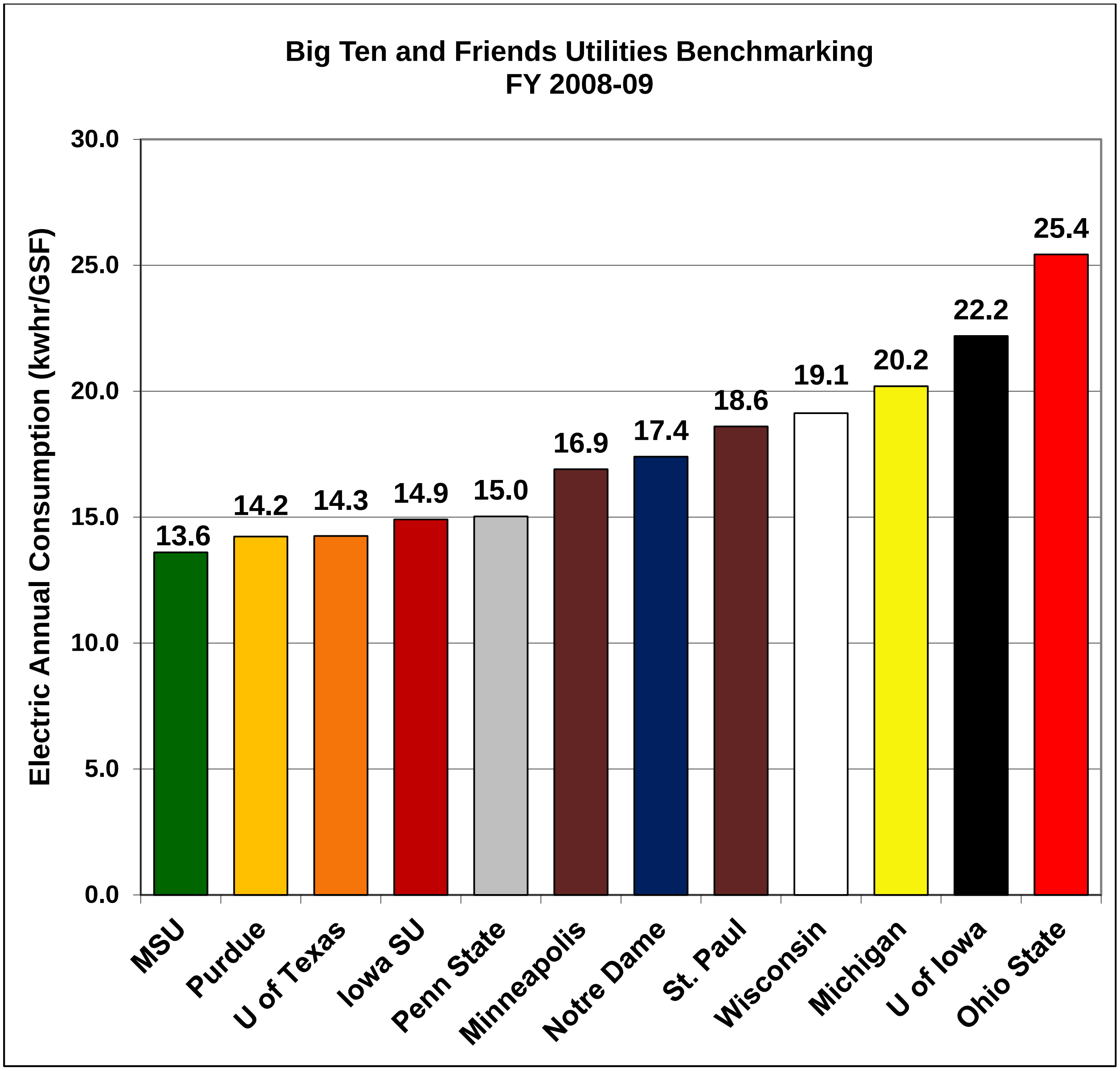


Figure 9. *Big Ten Utility Benchmarking – MSU Lowest Electrical Consumption per Square Foot.* The graph shows the Big Ten Utility Benchmarking data collected bi-annually. Independent sources, such as Sightlines, have confirmed the data through the energy benchmarking survey for universities across the country.

As the university moves forward, keeping a constant vigilance for opportunities to conserve energy will be critically important. In the future, MSU will need to manage its energy portfolio very differently. This transition will need to occur over time and within the financial and regulatory constraints the institution faces.

Preliminary Work by an Energy Advisory Committee

One of the phase II recommendations, from the Environmental Stewardship Systems Team, was, *Initiate a study regarding future power generation for Michigan State University main campus and MSU research and extension facilities. The study should include investigating new "best of breed" technologies including carbon sequestration, carbon scrubbers, distributed generation, renewable generation and a reliability and life cycle cost analysis to determine optimal power configuration and technology for each scenario.*

The university approached this in a collaborative manner by creating an Energy Advisory Committee, consisting of faculty, staff, and students who worked with consultant Black and Veatch to compile an analysis of next generation energy technologies. This report serves as an excellent educational resource in understanding the complexity of issues with current, new, and emerging technologies. The committee believes that the university should continue to reduce energy consumption and GHG emissions but should also move forward with establishing a set of future energy goals.

Developing an Energy Transition Plan

As Michigan State University seeks to shape its future, energy is at the center of the conversation. Clearly, the long term solution is to transition to renewable energy sources. MSU needs to create a set of achievable goals to get there. Opinions vary greatly regarding the appropriate course of action for the university. Regardless of the path chosen, it must be assumed that the cost of energy as a part of the university budget will proportionally increase. The implementation of some strategies, however, is more costly than others. Likewise, it should not be anticipated that the university will continue to emit current levels of greenhouse gases and other pollutants. On the other hand, the university must have adequate and reliable power to meet its energy needs, and the costs must not be overly burdensome on tuition or appropriations. MSU must also integrate sources of renewable energy as they become economically viable.

The university is poised to participate in a classical public policy debate to develop a set of recommendations regarding a long-range energy plan for the campus. As with most public policy debates, there is no clear right or wrong answer. Rather, an attempt will be made to reach consensus on a course of action to guide energy decisions for the future. Plans include appointing a steering committee to represent various points of view and levels of expertise to engage the community in the debate and guide MSU towards the ultimate goal. A set of recommendations will be provided to the Board of Trustees by February 2012.

Tools and Resources to Support Planning

As goals and strategies are developed for the Energy Transition Plan, it will be important to validate the various set of strategies. An integrated Energy Model has been developed that incorporates a set of variables, which can be changed, and provides a long range view of the impact of these changes. The MSU Power Plant and the demands for energy on this campus is a complex issue. Knowing how a decision impacts other areas will be critical. This model should be able to provide the ability to assess the reasonableness and feasibility of such strategies and decisions.

In addition, an MSU research team has developed a model tool that will allow the campus community to build a future energy generation portfolio for MSU. The tool will allow selection of a variety of energy generation sources including renewable generation, such as wind and solar, to build a virtual portfolio for campus. This tool will provide valuable feedback from the community, educate the user on a complete set of energy issues, and engage the community in the understanding of various energy options for MSU.

Future Direction

The development of the Energy Transition Plan will be challenging. But as an institution of higher education, it is the power of the MSU community and knowledge along with outside views that will reach the needed success.

Figure 10. *Photovoltaic array (solar panels) mounted on the roof of the new MSU Surplus Store and Recycling Center.* The solar array generates 7-8% of the electrical needs for the new building, reducing the demand on the power plant, and is an example of how campus will move to renewable technologies T.B. Simon Power Plant is in the background.

Over the past year, MSU has been preparing itself to engage in an energy transitioning process. Staff and administrators have collected data, created educational and financial models, and commissioned a study to evaluate energy infrastructure.

A steering committee has been identified, comprised of students, faculty, staff, and administrators to lead the identification of goals and strategies. These goals and strategies must represent a compromise with which the MSU community is comfortable. Communication strategies have been employed to keep the community informed of progress and provide multiple opportunities for feedback. Traditional and non-traditional methods, including social media, will be used in the communications strategy. In addition, an external advisory group comprised of industry experts will review the plan at critical steps.

The steering committee includes individuals who have critical knowledge in engineering, economics, health, conservation, and behavior. This committee will create draft goals and strategies for public feedback and external review.

In late fall 2011/early winter 2012; the steering committee will submit the transition plan to the Board of Trustees. If adopted, the energy transition plan will govern future energy decisions for the university, much the way that the 2020 Campus Master Plan has guided the development of the campus. This document will be reviewed and updated every five years to incorporate changes in circumstances and technology.

ENVIRONMENTAL STEWARDSHIP

Summary

As a land-grant institution, Michigan State University (MSU) has always been mindful of its impact on the environment. In 2005, MSU renewed its commitment to environmental stewardship by establishing the Environmental Stewardship Initiative as part of the Boldness by Design strategic positioning framework. Since then, the university continues to make strides in reducing its impact on the environment but still has more to do.

The campus has set goals of reducing greenhouse gas (GHG) emissions by 15%, reducing energy consumption by 15%, and reducing waste by 30%, by 2015. This report measures the university's progress toward these goals. Key indicators measuring overall campus progress have been identified to benchmark MSU's performance. Research and operational pilot projects continue to drive recommendations for process and infrastructure improvement. MSU has made gains; however, there are still significant challenges in meeting the 2015 goals.

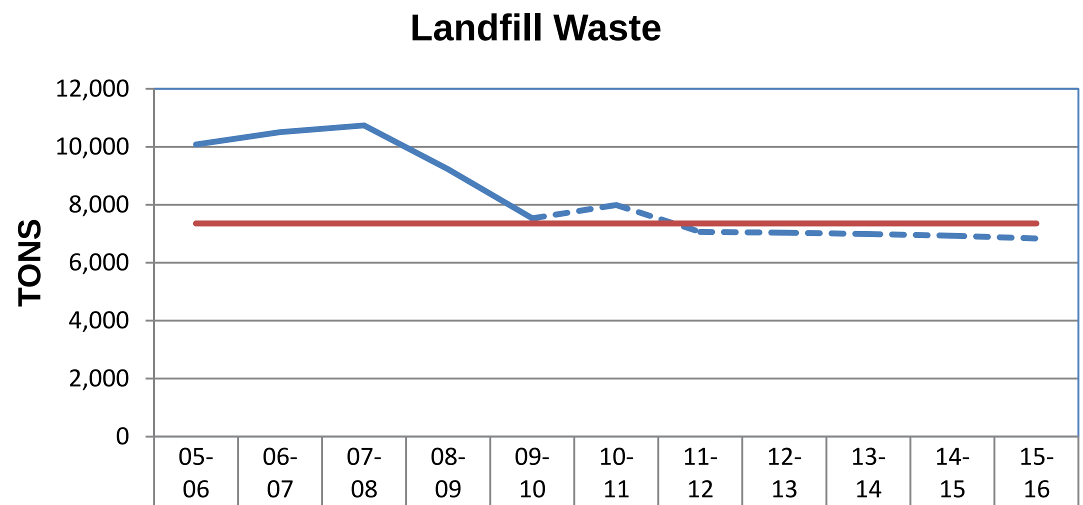
The campus is challenged to look into the future to set longer term goals and strategies to prepare for a more tightly regulated future. To prepare, MSU is participating in national benchmarking programs, networking with Big Ten peers, and improving data infrastructure systems.

Conducting research and implementing recommendations have led to thoughtful, sound changes on campus. Nevertheless, the pace of change must increase to meet potential regulations, address increasing social pressure, and use resources as efficiently as possible.

Analysis

Materials Management

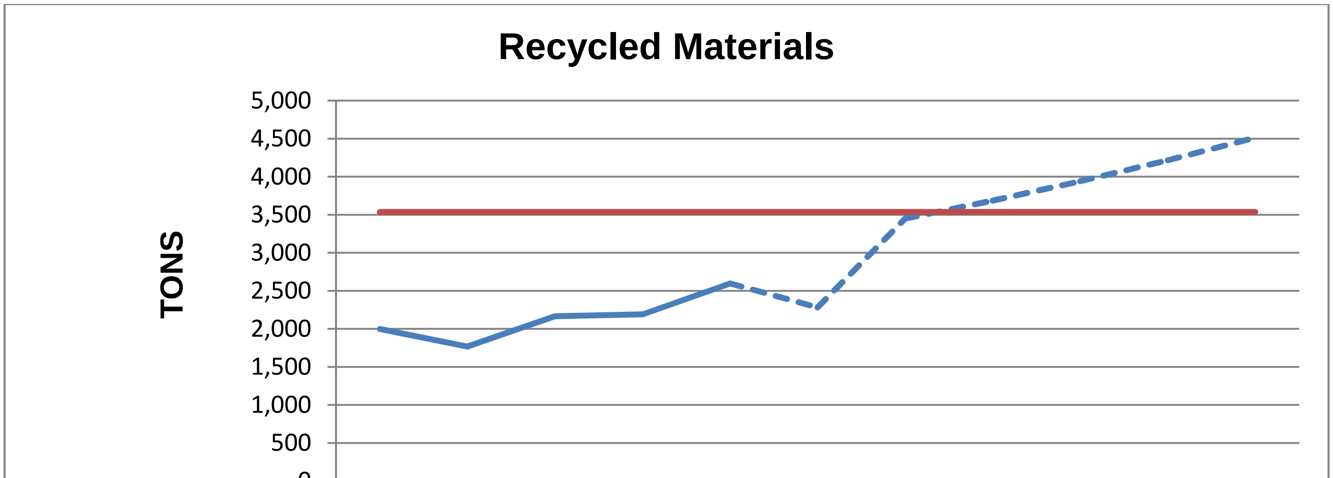
Michigan State University has been practicing a sustainable materials management approach, looking at procurement, reuse and recycling, and waste as a set of indicators to determine if campus is reducing material inputs and outputs for campus. Figure 1 and Figure 2 show the progress toward reducing overall landfill waste and increasing recycled materials, respectively.



	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16
Landfill - Actual & Projected	10,083	10,504	10,735	9,227	7,535	7,989	7,061	7,037	6,993	6,928	6,839
Landfill Goal 2015	7,353	7,353	7,353	7,353	7,353	7,353	7,353	7,353	7,353	7,353	7,353

Figure 1. *Landfill Waste.* This graph shows total campus waste in tons, not including hazardous waste or coal ash, measured in tons from 2005-06 to 2015-16. The solid blue line indicates the actual waste, and the dotted blue line represents the projected waste through.

There has been a steady reduction in landfill waste since 2007. This can be attributed to a massive recycling and the waste campaign included increasing the number of recycling containers throughout campus which causes waste to be diverted from the landfill.

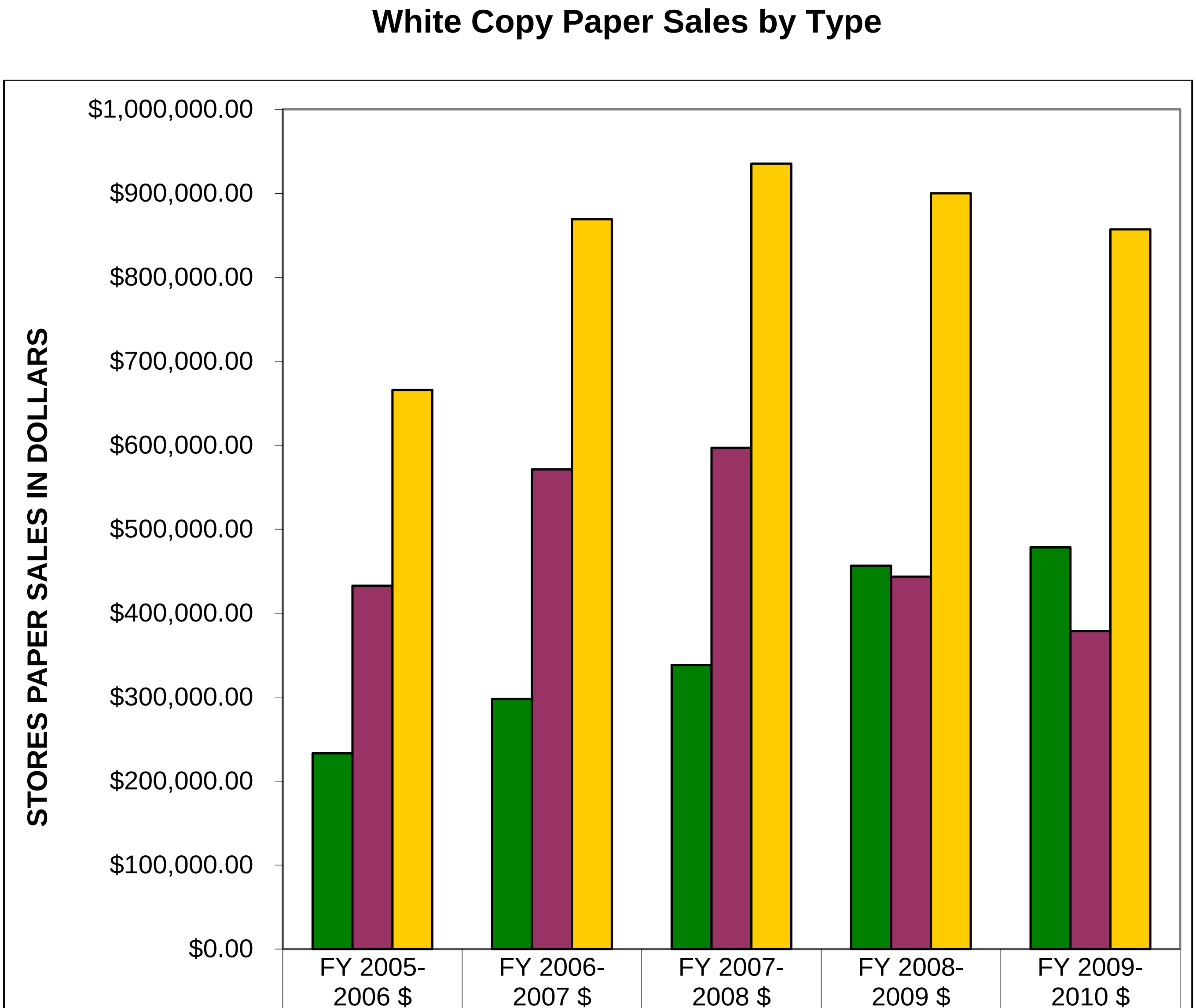


	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16
Total Recycled Tons	2,000	1,767	2,166	2,191	2,597	2,282	3,450	3,686	3,941	4,216	4,513
Recycling Goal	3,535	3,535	3,535	3,535	3,535	3,535	3,535	3,535	3,535	3,535	3,535

Figure 2. *Recycled Materials.* This graph shows the actual (solid blue line) and projected data (dotted blue line) in tons for materials collected from campus recycling containers and the public drop off at the recycling facility. Materials included are cardboard, newspaper, plastics #1-#7, household metal, white paper, mixed paper, and glass.

Recycled material collection has been increasing since 2006-07, which coincides with new initiatives to expand recycling collection in campus buildings. Since 2007, more recycled materials have been collected through the placement of more exterior recycling containers and increased outdoor event recycling. In fall 2009, the MSU Surplus Store and Recycling Center opened, which led to the expansion of the types of materials that could be collected across the campus. In addition, a public drop off recycling area was added to the center. Originally the drop off area was scheduled to be expanded in November 2011, but due to overwhelming demand, it was expanded in August 2010 to double its capacity.

Surplus operations have also diverted materials from the landfill through creating an efficient re-use program. University property is sent to the MSU Surplus Store to be sold to other departments or to the public. Through this method, Surplus returns a portion of the funds generated from the sale to the department. Since July 1, 2010 the landfill/waste diversion rate is approximately 26%, but when one includes materials from Surplus, the landfill/waste diversion rate climbs to 51%. The new Surplus Store and Recycling Center has allowed Surplus sales to increase along with increased sales from online auctions. Storage service is also provided for the campus.



	FY 2005-2006 $	FY 2006-2007 $	FY 2007-2008 $	FY 2008-2009 $	FY 2009-2010 $
Recycled Content	$233,181.70	$297,822.14	$338,284.27	$456,628.38	$478,454.38
Virgin	$432,795.58	$571,391.17	$596,986.01	$443,507.65	$378,778.08
Total	$665,977.28	$869,213.31	$935,270.28	$900,136.03	$857,232.46

Figure 3. *White Copy Paper Sales by Type*. This chart shows the sales totals for recycled content and virgin white copy paper from 2005-06 through 2009-10 and the overall total sales as purchased through university stores.

Paper use is one campus input measured to indicate overall trends in decreasing material brought to campus. White copy paper sales spiked in 2007-08, but have steadily declined, likely due to efforts to eliminate paper in business practices and a two-sided printing campaign but also the economy and the electronic technology advances in publishing, printing, and the way individuals now read and review documents. Additionally, virgin copy paper (paper made from non-recycled sources) sales have decreased, while sales of recycled content copy paper have increased.

Food Waste

Michigan State University dining operations serve 30,000 meals per day. Residential and Hospitality Services reduces food waste by minimizing prep waste and serving appropriate food portions, but food waste is still generated. As a result, food waste was identified as an area targeted to meet waste reduction goals.

Two studies were funded to find sustainable solutions to campus food waste. The Anaerobic Digester pilot study seeks to find the optimal mix of food and manure waste to produce bio-gas through anaerobic digestion. Figure 4 below shows the anaerobic digestion process. Bio-gas can be used as fuel for various purposes on campus.

Anaerobic Digestion Process Flow Chart

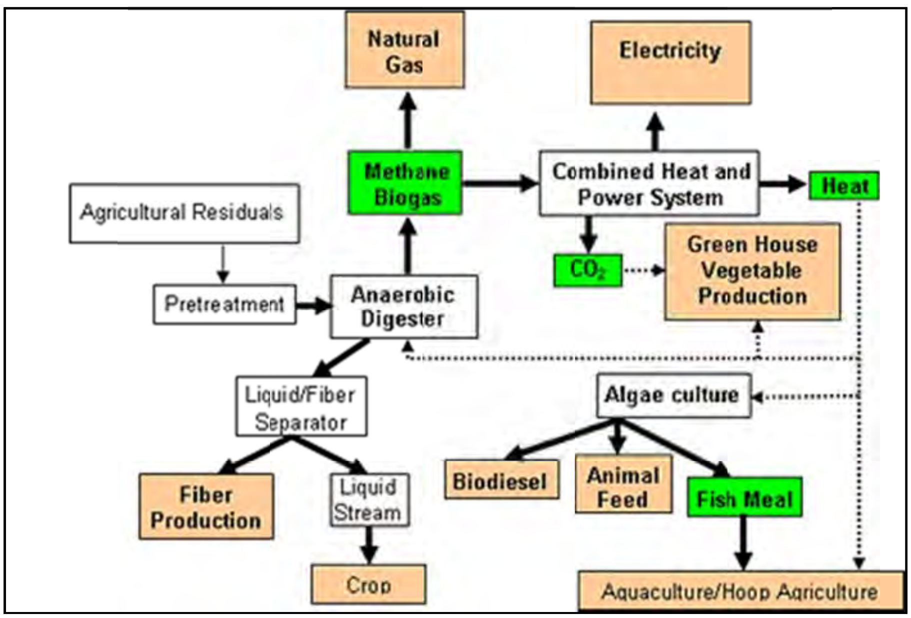


Figure 4. *Anaerobic Digestion Process Flow Chart.* This figure shows the process of extracting energy and other products by using anaerobic digestion.

Once the research determines the best combination of food and manure waste for the digestion process, the next phase of the project would include "scaling up" the process for a larger scale operation for south campus farms.

The Student Organic Farm collected food waste to test multiple methods for vermi-composting (composting with worms). The high-grade compost produced can be used for research application or sold for profit. The project synergistically delivers organic food products and collects organic food waste from Yakely Hall. Figure 5 shows the vermi-compost facility constructed at the Student Organic Farm. Manure, food waste, and other organic material are placed in the compost bin and the worms break down the food waste into high value compost.

Figure 5. *Vermi-compost facility.* The vermi-compost structure was constructed in September 2010 and composts approximately 250-300 pounds of food per week.

The next step is to test thermophilic (using heat) composting and partnering with the anaerobic digester project for synergies.

Both projects will also review the potential to ‘scale up’ operations to accommodate more food waste. The studies will be complete by summer 2011.

Construction Waste

Construction waste has been another means to reduce waste going to landfill and increase reuse of materials. A team was formed to capture waste data and developed a process to be sure that Surplus and Recycling units had an opportunity to capture items for recycling or resale. The Chemistry building addition, which recycled 95% of its construction waste, and the MSU Surplus Store and Recycling Center, which recycled 75% of its construction waste.

Waste Reduction Research and Pilot Programs

Green Sweep

Green Sweep was a program piloted in the Administration building to reduce the amount of materials being stored in campus buildings and to encourage reuse of materials. Many units stored unneeded items or had accumulated a surplus of supplies that could be re-used between units, resold, or recycled. During Green Sweep, departments were asked to clean out their areas and purge unneeded items and from this step there was a free internal “marketplace” where units could take what was available for their own use, thereby eliminating the need to purchase new materials. Next, MSU Surplus Store staff collected the remaining items for resale. The pilot captured 7,331 pounds of material and 200 pounds was redistributed throughout the Administration Building. The collection of materials represented approximately $534 in potential revenue and $95 in landfill savings. The next steps are to review and refine the Green Sweep program to make it more efficient. Surplus will conduct the next Green Sweep event in spring 2011.

Niche Recycling – Research Labs

As the first and second phases of the campus-wide recycling program were launched, it became clear that there could be opportunities for specialized recycling or reuse, particularly in the research laboratories. Researchers identified a sample set of labs and asked them to keep a diary of all of the materials they put in the trash. The results revealed opportunities to capture niche materials such as laboratory glass, wood, and cold packs that could be used for recycling or re-use. Consequently, Recycling and the research team are working together to identify pilot sites for lab glass recycling. In addition, Recycling and Residential and Hospitality services will be piloting clear, brown, and blue glass collection in Holmes, Akers, and Hubbard Halls in January 2011.

Recycling Bin Sensor Study

Custodial staff is responsible for moving material waste from internal building locations to the loading docks. Both trash and recycled material is removed by the custodial staff. In attempt to make the recyclable collection process more efficient and because recycling containers and trash containers are not always in the same location, a research team created recycling bin sensors to alert custodians when the bin was full. Custodians would have access to a simple computer program that would show which containers were full within their building. If successful, custodians would gain efficiency in servicing buildings.

Waste Audits

The data in Figures 1 and 2 indicate that the recycling program has been successful. Landfill waste is decreasing and recycled materials are increasing. However, it is not clear how many recyclables still remain in the waste stream. As a result, waste audits are being conducted by Recycling staff. During a waste audit, an entire building's waste is taken to the recycling facility. Students and staff, go through the materials to determine what percentage is recyclable or reusable. Waste audits help Recycling and Surplus understand how much material can still be diverted from the landfill. When followed by a survey and in-person visit, waste audits also identify roadblocks to recycling and reusing materials. For example, an audit in Engineering found concrete cores in the trash. Consequently, Surplus staff found a market for the concrete cores. Preliminary waste audits in Fee Hall revealed that 33% of the materials in the waste stream could be recycled. Waste audits have also proven to be an excellent way to engage students in experiential work and create a living, learning laboratory. Students from ACR 187, a course in the sustainability specialization curriculum, assisted with waste audits as part of their coursework.

Building Recycling Centers

Part of the environmental stewardship recommendations included determining how to improve the flow of building recycling areas. The implementation team talked to key audiences – building occupants, environmental stewards, recycling and surplus staff, and drivers to determine ways to improve recycling in the areas. The groups concluded that building users preferred the local stations within the buildings, but better signage and contact information would make it easier for those who used the recycling areas – drivers, custodians, and some building staff – to use the centers. New, consistent, recycling signs that described the area as a recycling center and included the Be Spartan Green logo were purchased. A contact number was also provided so users could reach someone if there was an issue or question. Furthermore, to ensure that abandoned items were not left in recycling areas, Surplus created a general form that would allow custodial staff to request abandoned items to be removed, which would improve the flow in the areas. Signage was delivered in the fall and is being installed by Custodial and Recycling staff in all buildings.

Transportation

Emissions from the MSU fleet account for less than 10% of total emissions. However, MSU Transportation is still working towards decreasing its environmental impact. There are 1,037 vehicles in the MSU fleet including cars, vans, and service vehicles. Figure 6 indicates the vehicles by type.

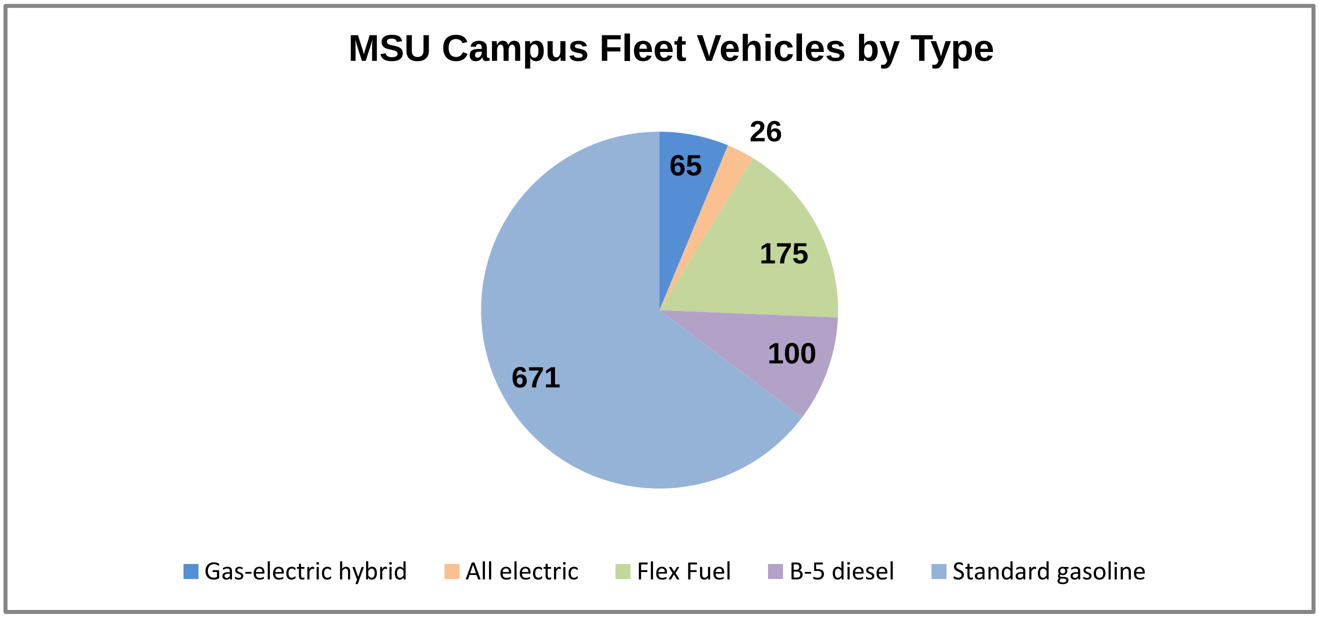


Figure 6. *Michigan State University Fleet Vehicles by Type.* This chart shows the breakdown of MSU fleet vehicles by fuel type.

The total campus fleet contains 1,037 vehicles. Forty percent of them are part of the motor pool (rental) fleet and 60% are department owned. Thirty-five percent of the fleet is comprised of alternative fuel vehicles (gas-electric hybrid, all electric, B-5 diesel, or flex fuel vehicles). All diesel engine vehicles use B-5 fuel. B-5 fuel is a mix of 5% bio-fuel; 95% conventional diesel. Originally B-20 fuel was used (20% biofuel; 80% conventional diesel), but due to fuel becoming gel-like in low temperatures, B-20 use was discontinued. MSU Transportation has been right-sizing the fleet by ensuring the vehicles are appropriate for their use.

Transportation Services would like to incorporate more all-electric vehicles; however, the high cost of the vehicles has been a barrier to purchasing them. To address this challenge, Transportation Services has been applying for grants to help offset the cost. No grants have been awarded yet.

In 2009, after doubling the number of hybrid vehicles in its fleet, MSU led the Big Ten institutions in the number of hybrid vehicles in motor pool fleets.

The campus fleet only represents one aspect of efforts to reduce the environmental impact of transportation. In 2009, the results of a commuter survey of over 2,400 employees were published. Eighty-one percent of respondents drove alone to and from work, but many indicated that they would take alternative forms of transit if it were made more convenient or less expensive. Based on the survey results, the following strategies were identified to increase commuter behavior.

- Increasing the use of bicycles

  Overall, 34.7% of respondents would be very likely or somewhat likely to ride bicycles to campus if they had better bicycle routes between their home and campus. This varied by how far one lives from campus. About three-fifths (61.3%) of those who lived within five miles of campus said they would be very likely or somewhat likely to bicycle if the routes from home were better for bicycles. In addition a quarter (25.3%) of those living more than five miles from campus said they would be very likely or somewhat likely to bicycle if these routes were better.

- Increasing the cost (or perceived cost) of driving

  At the time of the survey (Jan-Feb 2009) the cost of fuel was between $1.50 and $2 per gallon. Among those whose primary means of commuting is driving alone, 15.9% said they would do this less if fuel rose to between $ 3.00 to $3.50 per gallon and this increased to 23.9% if fuel were between $ 3.50 to $4 per gallon.

- Increasing the cost of parking

  Almost one-third (32.8%) were “likely” or “very likely” to carpool if the annual cost of a parking permit increased to $800. Nearly 26% said they were likely” or “very likely” to take a CATA bus, if the cost of parking increased that much. Some said they would do both if the parking rate increased to $800. The total percentage who said they were likely or very likely to take *at least one* of those actions was 39.2%.

- Increased convenience of busses

  Having park and ride lots with commuter busses at rush hour, making busses closer to where people lived, and faster routes (no more than 10 minutes more than taking a car) offered possibilities of increasing bus ridership. According to the survey, neither of these will make *most* people use the bus, but they might increase bus ridership noticeably from the current percentage of less than 2%. It is important to note that many of these issues are controlled by the regional bus provider and that users are generally satisfied with on-campus bus service.

- Opportunities for employees to come to work less often

  One way for employees to consume less fuel, spend less money, and less time commuting is to travel to work fewer days per week. Two major ways of accomplishing this have been discussed in various work organizations. One is to restructure the work week to allow the total work week to be divided into fewer days. (e.g.,four ten hour days instead of five eight hour days). The other is to allow for telecommuting, whereby the employee works from home part of the time.

  Respondents were asked if *they thought* they could do their jobs as well if these practices were available and asked how many would be interested. Over half (57.8%) of these respondents thought they could do their job as well if they came in fewer but longer days each week. Another 21.7% thought "maybe" they could do their jobs as well. Of these people, 53.7% were definitely interested in this possibility and another 29.1% were possibly interested.

As a result of the survey, the environmental stewardship transportation committee began to explore options to increase environmentally friendly commuting behavior, such as improving bike routes on campus to increase the use of bicycles and bringing a car share service to campus.

A bike utilization study was completed in October 2010 to establish bike patterns and trends so that future enhancements could be prioritized and targeted. The study identified the highest volume routes for bike traffic, safety issues such as lack of helmets, and additional data needs for future studies.

The transportation committee also recommended bringing in a car share service provider. Other universities that added car sharing as part of their transportation options observed that people felt more comfortable using mass transportation because they still have the convenience of having access to a car if needed. This fall, MSU signed an agreement with Zipcar, a national car share company, to bring a car sharing service for campus. It is estimated that every shared car eliminates 15-20 individual vehicles from the road. The car sharing service began in January 2011.

Benchmarking and Assessment

Ranking and rating organizations have become a popular, and likely, a permanent fixture in the sustainability field. Although there are several rating systems, the most well-known are the Association for the Advancement of Sustainability in Higher Education's Sustainability Tracking and Rating System (AASHE STARS), Greenopia, National Wildlife Federation, Peterson's Guide, Princeton Review, Sierra Magazine, Sustainable Endowments Institute, and the U.S. Green Building Council.

Completing multiple surveys has several challenges. Surveys are resource intensive, requiring a heavy investment of time and resources to pull data that sometimes is not normally collected. Some surveys are "one size fits all" which is challenging to a large institution such as MSU. Few surveys are transparent. Institutions do not know how rankings are calculated and ratings are often subjective. A university that receives a top ranking in one survey may receive a mediocre ranking in another.

Lately, there have been several discussions in the sustainability field about sustainability ranking organizations. Many have come under fire for having subjective scoring rubrics, being completed without the permission of the institution, accepting money from the organizations they rank, and having questions that do not measure the institution's overall progress toward its goals.

Several institutions, including those that have solid 'green' reputations, recently signed an open letter to some of the top rating systems asking that all surveys follow a set of eight principles that range from having an open scoring process to avoiding conflicts of interest.

As a result, MSU decided to use a rating/ranking instrument that it felt would be the most transparent, objective, and useful tool in benchmarking its progress in sustainability - the AASHE STARS. This is a new tool that has been vetted by several institutions, including large research institutions. The system is similar to the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program in the sense that points are earned for certain achievements. All answers are made public on the AASHE STARS' website and scoring is straightforward and transparent. Since this is the first year of the STARS program and most institutions are still collecting and reporting data, no rating is available yet. The first broad set of ratings will be available in February 2011.

In the past, MSU has completed the Sustainable Endowment Institute's Green Report Card and earned the highest grade in several categories, however, recent changes to the system has made it nearly identical to STARS, such that administrators feel like it is a poor use of resources to complete both. Furthermore, in the future, Sustainable Endowments Institute will charge a fee for institutions to be included in the report card. MSU has raised its grade from a C+ on its first assessment to a B+ in its most recent assessment in 2010, and is tied for second place among Big Ten schools.

Michigan State University has been recognized by the National Wildlife Federation as one of the top five campuses for sustainability. The Princeton Review and U.S. Green Building Council gave MSU a favorable review in its green campus publication. These recognitions were awarded without MSU submitting survey materials.

Michigan State University has also taken a leadership role in creating the Big Ten Environmental Stewardship Group that meets twice a year to discuss progress in environmental stewardship. The group compares progress and shares ideas to make sure Big Ten (and friends) Institutions are adopting cutting edge methods to reduce each university's environmental footprint. There are two meetings per year, with one meeting dedicated solely to energy. The second meeting focuses on materials management, behavior, and other infrastructure and operational changes. Because of these meetings, institutions have increased the number of project collaborations and shared critical information on funding and new technologies.

Future Directions

Environmental stewardship and sustainability are recognized as being important topics in the future of the university, the state and the world. MSU continues to challenge itself to be a leader and best practices example in these areas. Current activities help MSU improve environmental performance now, while preparing for the next wave of challenges in the future.

The Sustainability Working Group continues to support on-campus environmental stewardship research to reduce GHG emissions, energy consumption, and waste. To continue supporting a living-learning laboratory environment, the Office of Campus Sustainability created an internal request for funding proposals open to faculty, staff, and students. As a result, new researchers and students became engaged in finding solutions for reducing MSU's environmental footprint.

A second committee, the Sustainability Visioning Group, was formed to consider future issues of sustainability so that MSU can proactively address future issues. Group members include representatives from faculty, staff, students, industry, and government. This think-tank style group will help to identify several issues that will be important in the next 10-20 years.

Among the next wave of important issues are GHG emissions. Although no legislation is currently in place, many experts agree that is not a matter of if, but when, limits on GHG emissions will be implemented. To prepare for this future, MSU has worked with a company, Trucost, to assess its GHG impact from its suppliers or supply chain. If the university can identify potential strategies for reducing its GHG impact, then it may be in a better position once legislation is enacted. MSU is the first institution of higher education to undertake this assessment.

MSU is aggressively seeking to test emerging technologies such as smart microgrids and electric vehicle charging stations (Figure 7). Smart microgrid research has the potential to decrease demand by using sophisticated communications systems for customers to control energy settings; and as more alternative vehicles come onto the market, MSU is challenged with making sure they can be accommodated and perhaps even providing incentive for these lower emission vehicles.

Figure 7. *Charge Point Station.* Example of an electric vehicle charging station from Charge Point America.

With new programs being implemented and reporting becoming more sophisticated, it will be important for MSU to have a robust data repository. Efforts are underway to develop a complete environmental data set that is updated on a regular basis. The system will be designed so that information can be accessed quickly and for a variety of purposes such as internal reporting, benchmarking surveys, and environmental performance analysis.

Environmental stewardship will continue to be a core issue and MSU is taking several steps to proactively be prepared for the future while supporting the key missions of the university.

TECHNOLOGY CYBERINFRASTRUCTURE

Summary

Technology is used to enhance teaching and learning, facilitate research and innovation, and improve the day-to-day business functions of Michigan State University (MSU). Any higher education technology plan must support teaching, research, and engagement. Adequate funding to support this technology will help enable MSU's success in its mission as a world-class research-intensive institution.

The technology needs of MSU are supported by a combination of central and local information technology (IT) organizations and infrastructures. As the technology needs of the university change, so too does the balance between local and central provisioning of IT services.

Centrally-supported technologies at MSU have two main objectives: (a) to provide basic technology infrastructure and services to support the fundamental work of any person, program, or unit at MSU; and (b) to provide basic technology, infrastructure, and related services that are robust and capable enough not to impede more sophisticated, state-of-the-art tools and functions that may be added.

This Technology Cyberinfrastructure Report will further review some of the centrally-supported cyberinfrastructure available on campus to determine current usage and the ways usage may change in the future. Cyberinfrastructure includes computational facilities and computing resources, data management and storage, and data networks.

As an example, Academic Technology Services (ATS) and Administrative Information Services (AIS) currently utilize central datacenter facilities to house servers controlling mission critical MSU services such as the network, e-mail, Enterprise Business Systems, and StuInfo. ATS and AIS work together to mirror important academic and administrative resources in the datacenters in the Computer Center and the Hannah Administration Building for disaster recovery purposes. A smaller datacenter in the Engineering Building is also currently being used for high performance computing purposes.

Using centralized enterprise datacenter facilities enables other departments and units to colocate servers or virtualize servers. Colocation and virtualization offer space and energy savings by consolidating equipment in a centralized, energy efficient datacenter providing a high level of security to maintain and store the university's intellectual property.

Perhaps the most widely used technology cyberinfrastructure is the wired and wireless data network. In 2010, the MSU network and border security were upgraded to prepare for growth. The network upgrade provides a new centralized security model offering superior performance, ease of management, and lower overall recurring support costs. The demands on the campus network, both wired and wireless, and the expectations of network users will grow dramatically each year as new technology and innovation demand more intense computing capabilities.

Analysis

Cuts in state funding will most likely continue, as will reductions to university IT costs to meet overall budget targets. Long-range technology needs must be balanced with adopted budget tactics and the university's ability to maintain the expected level of IT service and innovation. This will involve in part a substantial change as to how technology is managed across the university. The extent to which technology is viewed as an expense or an asset to invest in will need to be weighed with the expectations for the role of technology in MSU's mission and future goals.

IT cost management strategies should focus on total institutional costs and seek to save money without affecting service. One example of this is increasing awareness of the centralized datacenter facilities on campus. Support and incentives for some strategic central IT services may be needed from university leadership in order to encourage adoption. Additionally, some cost reduction strategies like consolidating server rooms across campus, migrating to standardized technologies (e.g., consolidating e-mail systems), or leveraging new technologies (e.g., virtual servers) may require some additional investments now to save more in the future.

Data Management: Datacenters

The 5,900-square-foot ATS Datacenter was redesigned in 2008 with energy efficiency, redundant power systems, and increased security in mind. The 3,931-square-foot AIS Datacenter was redesigned a year earlier with similar design ideas. Both datacenters use hot and cool aisles for efficient temperature control in order to not waste cooling areas where there are no computers.

Figure 1. ***Data Management: Datacenters – Efficient Design:*** *Hot and cold aisles, like in the ATS Datacenter (pictured) and the AIS Datacenter, aid in efficient energy usage.*

The design of the datacenters involves using ceiling and floor tiles to help regulate heating and cooling. For every half of a floor tile that is open, a full open tile in the ceiling is needed to maintain the correct ratio and pressure for cooling. Cooling is also maintained using Liebert cooling systems throughout the datacenters. All the Computer Room Air Conditioning (CRAC) units are monitored for things like water under the floor or air compression problems. Temperature gauges are placed in the datacenters and are monitored by ATS, AIS, and the Physical Plant.

Both utility and Uninterrupted Power Supply (UPS) systems are available in the ATS Datacenter. Wattage per rack is limited to about 4,500 watts so that in the event utility power goes out, the UPS systems can maintain 20 minutes of uptime. This uptime is designed to allow enough time for the Physical Plant to cold-start a gas-fired turbine and restore utility power. Power testing is performed once a year; UPS battery testing is performed once a month. The AIS Datacenter uses a similar configuration but employs small UPS systems in individual server/network racks.

Figure 2. ***Data Management: Datacenters – Power Supply:*** *Power transfer units (green boxes) enable generators to be hooked up for a manual power flip in the event of a prolonged power outage.*

Currently, the ATS Datacenter houses 324 virtually hosted servers used by ATS and other MSU departments. These virtual servers are hosted on 6 physical servers. The AIS Datacenter currently supports 342 virtual servers used by AIS and other MSU departments. These virtual servers are hosted on 72 physical servers.

By moving to a virtual environment in the two datacenters there is an estimated savings of roughly 4,800 kilowatt hours a day, which equates to more than $148,000 in savings a year. Additionally, there are significant equipment savings for the university through consolidation in centralized virtual datacenter facilities. Incentivizing centralized datacenter usage by other units on campus could help increase large-scale adoption. Currently the two main datacenters that serve the academic and administrative needs of the university are housed in the Computer Center and Hannah Administration Building. (A smaller datacenter facility is located in the Engineering Building for high performance computing.) While these two datacenters have allowed MSU to mitigate some risk through redundancy, both buildings are in close proximity to each other and are in the Red Cedar River flood plain.

Each of the two main datacenter facilities lacks sufficient power and cooling capacity to meet growing computing needs campuswide. The ATS Datacenter is currently running cooling systems at 100% capacity and anticipates needing another Liebert cooling system within the year to maintain its current operational efficiencies. The two datacenters also have a finite amount of space to offer to other units for colocation and virtualization.

To address some of the near-term capacity needs, it is critical that the university construct a primary datacenter. Additionally, this primary datacenter will mitigate business continuity risks in the event of a natural or man-made disaster including flood, wind, fire, power, and possible gas leaks from a train derailment. New capital construction of a facility to house the primary datacenter for the university is in the early discussion and study phases.

Using centralized enterprise datacenter space can save the university in the long term because MSU will not have to invest in separate power and cooling systems for individual server rooms and spaces across campus. It will also help consolidate the university's assets in one primary facility for academic, administrative, and high performance computing. The ATS Datacenter would serve as a backup facility to the primary datacenter upon its completion.

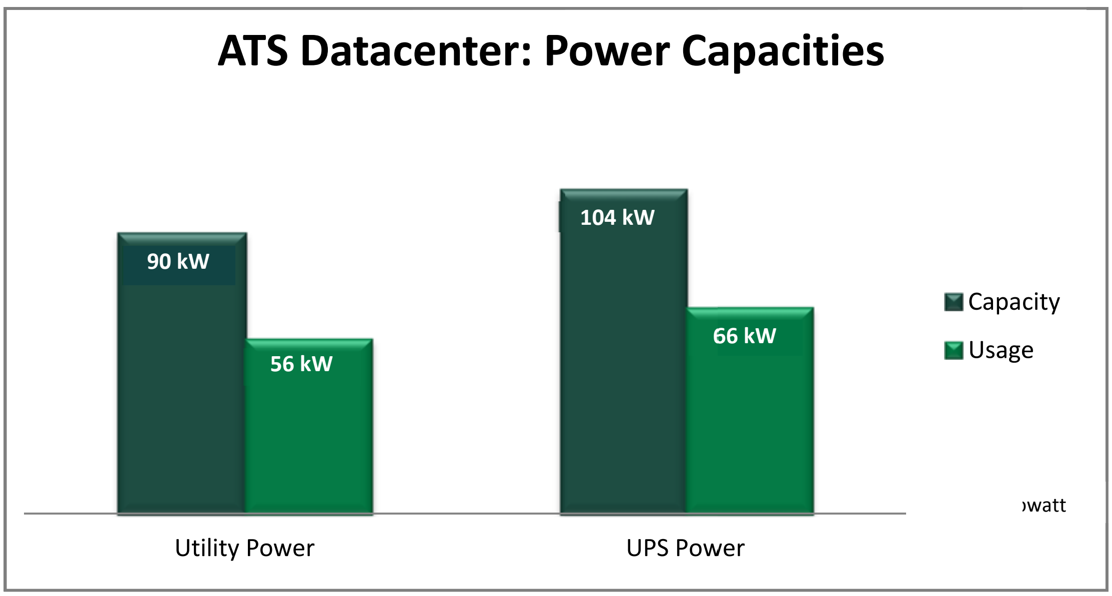


Figure 3. ***Data Management: Datacenters – Power Capacities:*** *Power usage in the ATS Datacenter is currently at more than 60% of the maximum recommended normal power load.*

Network Backbone

The MSU campus network is connected to a regional network, a national backbone, and a worldwide network. The better the alignment among the providers of each link, the better the experience for MSU users. MSU is a governing member of Merit Network Incorporated. Merit is Michigan's regional network provider and also provides MSU with connectivity to Internet2, a national research and education network backbone.

MSU completed upgrading the MSUnet campus backbone in August 2010 to allow for expected growth in network traffic across campus and to the Internet. The upgrade also provides higher reliability and offers new services and features for the MSU community.

The new multi-tier network architecture was designed with two carrier-class 10-gigabit-per-second (Gbps) routers at the Internet border. These two routers, located in separate buildings, provide automatic failover and support multiple paths to the Internet. Six geographically-disperse buildings with backup power systems house core network switch gear. Redundancy was also designed into deeper layers of the backbone to increase overall network reliability; the failure of one network device or the loss of power in one building will not isolate other buildings from the Internet.

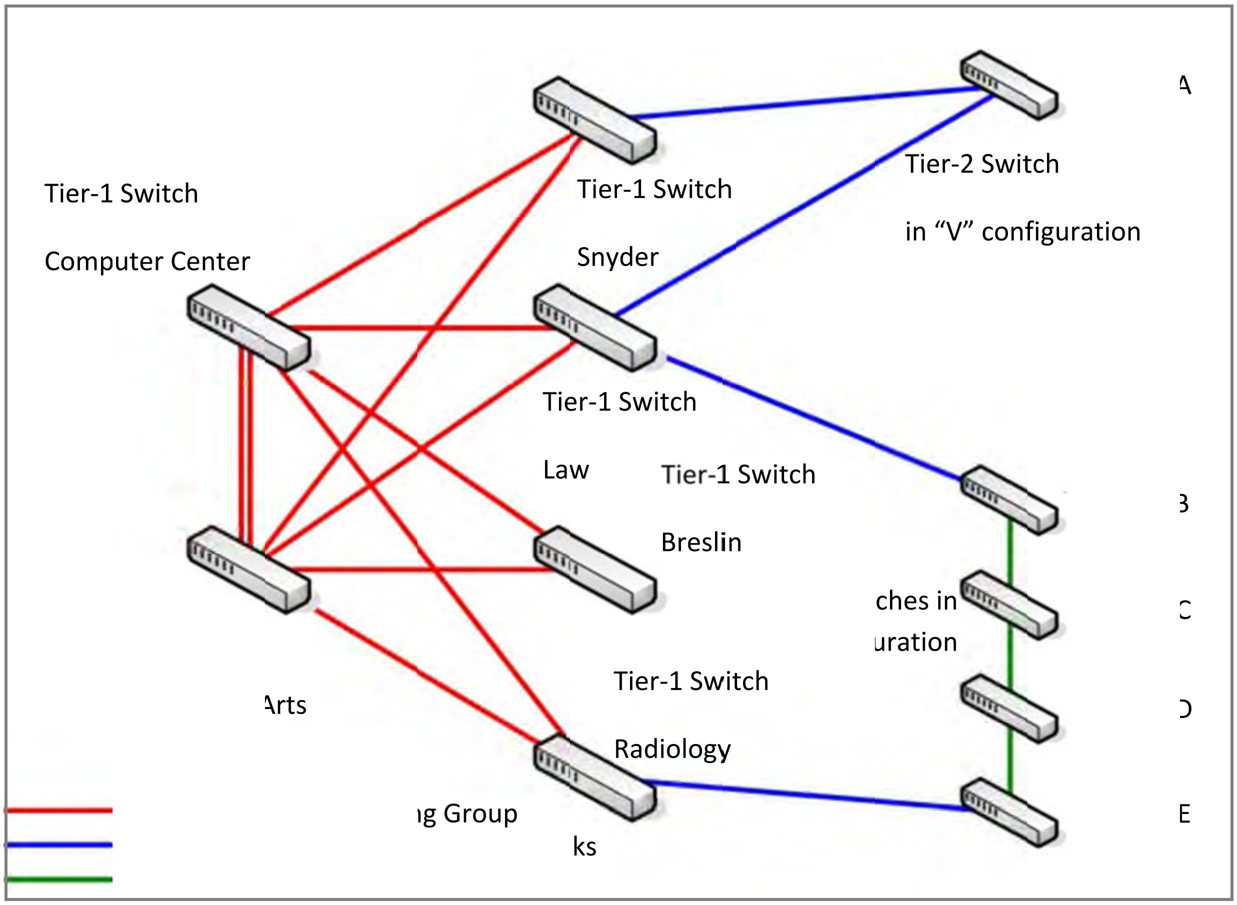


Figure 4. ***Network Backbone – Network Architecture:*** *Six geographically-disperse buildings with backup power systems house core network Tier-1 switch gear. Tier-2 switches are used in spur building connections.*

Core components of the network were deployed in August 2009. Individual campus buildings were migrated to the new network backbone between October 2009 and August 2010. There are 75 buildings attached directly to the core network at 10Gbps with Tier-2 switches; an additional 57 buildings have 1Gbps spur connections.

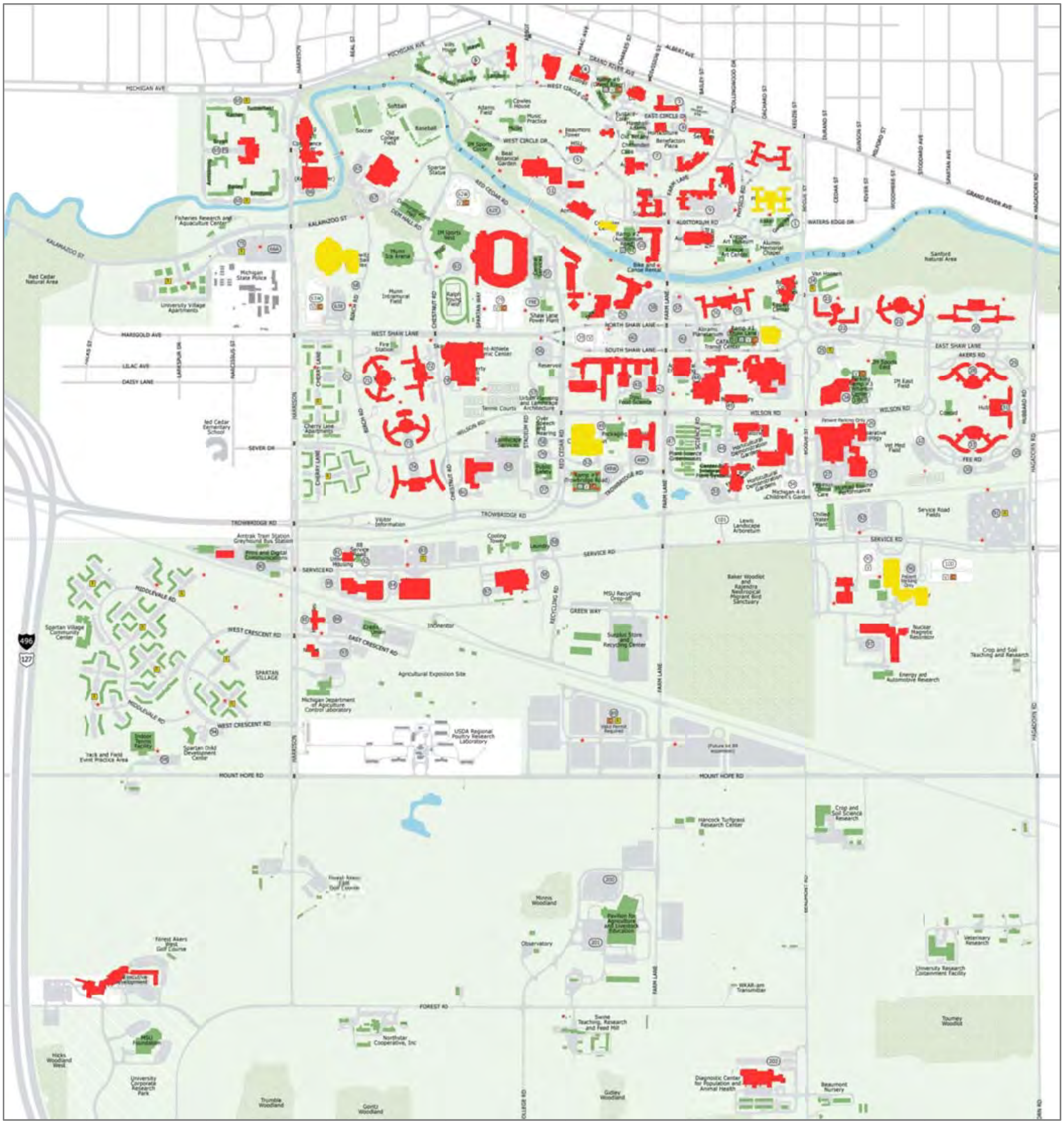


Figure 5. *Network Backbone – Building Connections:* *The red buildings have Tier-2 equipment installed in them and are on the 10Gbps backbone network. The yellow buildings have backup power systems that house core network Tier-1 equipment (See Figure 4).*

The centralized network routing enables ATS to offer campus wide virtual local area networks (VLANs) and the ability to customize traffic handling based on individual, department, or group requirements. Additionally, ATS can now offer centralized security enforcement using virtual firewalls and intrusion prevention systems (IPS) between MSU campus subnets and the Internet.

Other highlights of the upgraded MSUnet backbone include increases in the core network backbone speed to 10Gbps and core network continuity during power outages. The upgraded network allows regular maintenance to occur without network interruption and accommodates security features and scalability to meet increased demands over the next five to 10 years. Additionally, the upgraded backbone network reduces energy by 30% through the use of more energy efficient network equipment.

Wireless Networking

The current MSUnet Wireless 2.0 is an upgrade to the original wireless system, though the two systems run concurrently on campus. MSUnet Wireless 2.0 features 802.11n technology with speeds up to 300 megabits per second (Mbps), roughly six times faster than MSU's original wireless equipment. The newer wireless system also supports about 50 users per access point (AP) compared to the original wireless system which supports about 20 users per AP.

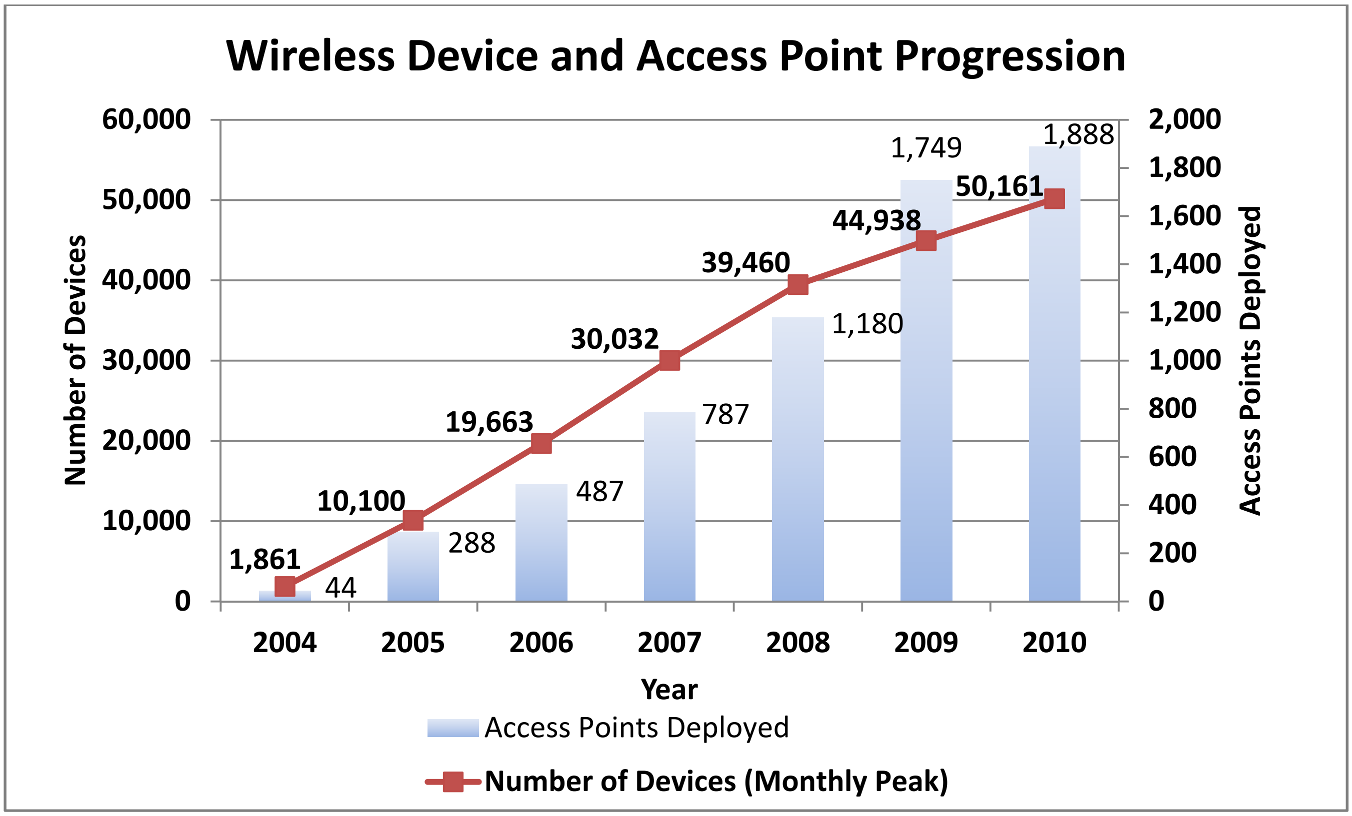


Figure 6: ***Wireless Networking – Wireless Devices and Access Points:*** *This chart shows in red the monthly peaks of wireless devices using MSUnet Wireless services between 2004 and 2010. In blue are the numbers of APs deployed yearly in campus buildings between 2004 and 2010.*

Wireless network usage has increased dramatically each year, and the growing adoption of Wi-Fi-enabled mobile devices is increasing wireless needs on campus.

As budget allows, ATS continues converting original wireless equipment to the MSUnet Wireless 2.0 system, as well as adding wireless services to new academic spaces. In 2010, ATS added MSUnet Wireless 2.0 to eight complete buildings on campus.

Figure 7: ***Wireless Networking – Campus Coverage:*** *This map illustrates the percent of wireless coverage available in specific buildings at Michigan State University. Dark purple buildings offer 80% to 100% wireless coverage. Light blue buildings offer 60% to 79% wireless coverage. Yellow buildings offer 40% to 59% wireless coverage. Orange buildings offer 20% to 39% wireless coverage. Red buildings offer less than 20% wireless coverage. (Wireless services in residence halls are achieved mostly through AP hotspots in community areas.)*

In November 2010, ATS rolled out a new MSUnet Wireless login across campus in order to improve the function of the service. With the new login, MSUnet Wireless users need to register the address of their device on the DHCP network registration website. This is the same site used to register access to the wired MSU network. (MSUnet Wireless Guest authentication was not affected at this time.) This change has provided much greater usability for mobile device/phone users, as well as laptop users.

The changes in the wireless login and MSUnet Wireless eliminate the need for users to login each time the service is accessed across campus while still maintaining authentication security. The updated wireless login using DHCP registration is one step in the process toward a more seamless user experience when using both the MSU wired and wireless network.

Data Storage

Data storage needs will only multiply as MSU increases its involvement in research projects and scholarship. Looking for new ways to offer storage based on emerging technologies will be integral in providing a safe and secure data storage environment for students, faculty, and staff.

Since 1992, MSU has provided remote file storage to students, faculty, staff, and organized student groups. The remote storage AFS (Andrew File System) is available through users' NetIDs. AFS space can be used to backup all types of files and to post personal websites. Files stored through the AFS system are secure and easily accessible from anywhere with any workstation offering Internet connectivity. In August 2009, AFS space was increased to 1 gigabyte (GB) per user from its previous 100 megabytes (MB) of storage. Each student also receives .5GB of MSU e-mail storage, and faculty and staff each receives 1GB of e-mail storage.

Additional storage is available to departments and other units on campus through ATS. This storage is available in high-speed, medium speed, and low-speed options. Currently, ATS provides approximately 175 terabytes of low-speed storage, 20 terabytes of medium-speed storage (40 terabytes mirrored for disaster recovery purposes), and 10 terabytes of high-speed storage (20 terabytes mirrored for disaster recovery purposes) to campus units based on their requests.

In November 2009, the Google Apps for Education Edition at MSU was launched for students, faculty, and staff. Libraries, Computing and Technology (LCT) negotiated an Education Edition contract with Google providing improved terms of service compared to the standard terms of service given to individual, public users. MSU Google Apps uses current MSU NetID and password authentication. It includes Google Docs, Google Calendar, and Google Sites, offering additional online storage and collaboration options to the MSU community.

Future Directions

Technology has quickly become an indispensible part of daily life for students, faculty, and staff. The infrastructure needs at Michigan State University continue to grow in order to provide for a range of new technologies and usability expectations. Technology supports the daily workings of the university, as well as paves the way for innovation in learning and partnerships.

Figure 8. ***Future Directions:*** *In general, students have a high level of comfort with technology and expect services like wireless availability campus wide, not just in spaces like the MSU Union, as pictured.*

Future initiatives include re-evaluating the structure and form of classrooms, finding new ways to provision software and manage software licenses, and building support models for a diverse set of mobile devices and platforms in classrooms. Learning management systems, such as ANGEL, will continue to be important and will shift toward better integration with central IT systems and the Office of the Registrar systems.

MSU also needs to assess long-term changes to technology and technology management. With the demand for both computing space and energy growing, LCT is trying to find ways to better utilize the available central IT resources and space in order to enable local IT staff to pursue new innovations in line with individual unit needs. An early step in this endeavor is a server room inventory, in which LCT is collecting data from all units and departments on campus about their server room space and equipment. Since server rooms use critical university space and energy resources, this inventory is one way LCT is trying to better grasp the overall IT climate at MSU and find ways to move forward in collaboration.

The server room inventory survey has been evaluated and is supported by the Academic Information Technology Planning Group (AITPG) and the Information Services and Technologies Coordinating Council (ISTeCC). It is expected that data collection will go into spring 2011. The results will be pulled together in a report to share initially with the AITPG and ISTeCC groups and with Provost Wilcox and Vice President Poston.

Virtualization and colocation in centralized datacenter facilities represent a couple of ways MSU can create new efficiency. These services can optimize server hardware costs for departments and the university, as well as reduce the overall amount of energy the university uses. Additionally, centralized campus datacenter space can provide a high level of security for university data and departmental IT assets. An incentive for units to use centralized datacenter space is lacking and is one of the barriers to adoption.

Before existing central datacenter resources reach their full capacities, MSU is appraising future storage requirements for units on campus and budgeting for new datacenter space. It is critical that this cyberinfrastructure be built in a way in which it can be managed reliably, securely, and efficiently.

Preliminary discussion and study has begun for a 65,000-square-foot building south of campus, which would house the primary datacenter for academic, administrative, and high performance computing. Facility plans also incorporate office and support space for staff supporting the datacenter operations.

This new facility would address power and cooling equipment needs for the day-to-day academic and administrative functions of the university, as well as the increasing demand for high performance computing capacity. If this project becomes a reality, the AIS Datacenter would be phased out, as would the small Engineering Building datacenter that currently houses high performance computing. The ATS Datacenter would serve as a backup to the primary datacenter.

The broadest and most widely used IT service on campus is the network. The health, functionality, flexibility, and security of the network will remain focal points with a special focus being placed on supporting network enhancements related to teaching, learning, and research endeavors. The upgraded MSU campus network provides for expected growth in the immediate future, but needs should be continually evaluated. The upgraded network allows for new unit services including departmental firewalls and VLANs offering greater autonomy to users. Despite these new offerings, some individual units continue to support their own networks leading to greater redundancy in IT services and resources.

Ubiquitous wireless networking across campus continues to be a long-term goal, especially as more students, faculty, and staff use mobile devices to connect to wireless networks. Cost and staffing remains a barrier to full wireless access campus wide. The need for mobile devices to seamlessly connect to the MSU wireless network is also apparent, and the December 2010 launch of the Mobile MSU beta website will increase this need. Additional technology support for mobile devices may be necessary in the future. At that time, current support staff resources would need to be re-evaluated.

Figure 9. *Future Directions:* *The usage of mobile devices is growing across the MSU community. These devices, including smartphones and the Apple iPad, are a popular way many people access information on the go.*

Personal storage space (the AFS service) and external storage for academic pursuits will continue to be built out with larger volumes made available. As computational technology increases over time, the ability to generate and analyze massive data sets demands vast storage space for temporary storage, retention, and curation of research data. ATS will endeavor to provide these options to researchers, and the construction of a larger, primary datacenter could offer new space and resource opportunities.

IT will remain highly relevant to MSU in order to maximize online learning, improve the utilization of assets through efficient administrative operations, improve student retention, track academic progress with improved advising, and leverage data analytics for decision making. IT optimization when constrained by limited resources will not involve just putting resources to good uses; it will involve putting resources to their highest and best uses.

Local IT optimization alone cannot achieve this. MSU will need to optimize IT resources across organizational boundaries and purposes encouraging greater collaboration among units. Technologies are available that would permit provisioning of IT services across the university in order to further efforts toward greater effectiveness and efficiency. Additionally, consolidating some technology where it makes sense will increase overall IT efficiencies across the university, as well as help move MSU ahead to ultimately greater diversity of thought and innovation.

EFFICIENCIES – CUSTODIAL CLEANING CHANGE

Summary

Michigan State University's (MSU) Custodial Department is introducing a new cleaning system called Operating System One (OS1). Operating System One was developed by ManageMen, Inc., of Salt Lake City, Utah. The web site for ManageMen concisely describes their process as follows, "(OS1) is a comprehensive high performance cleaning system. It employs in-depth training based on standardized tools and procedures. The process is work loaded to teams and each worker is trained and certified on specialized tasks. Workers are 'kitted' with specific tools and chemicals for each job function, which have been benchmarked as the best practice by the (OS1) users. This new system simplifies the cleaning process and results in a safer, healthier and easier working environment."

Traditional housekeeping practices, in most operations that employ multiple workers to clean moderate to large size buildings, have structured work in a "zone cleaning" approach. Zone cleaning achieves many positive outcomes including a strong sense of ownership with the workers' zone and the potential for strong tenant relations. In transitioning to a team cleaning approach there are greater opportunities to capture efficiencies through more equitable work loading, specialization of task, and reduced equipment needs.

A study performed at the University of North Carolina, Chapel Hill, compared team cleaning using (OS1) tools and methods to traditional zone style cleaning. The study results demonstrated that the (OS1) system produces a measurable cleaning result that is, (at least in their study), a factor of two to five times more effective in removing unwanted dust from the building. Cleaning effectiveness was measured in terms of the quantity of unwanted matter removed. To aid in the assessment of cleaning effectiveness, environmental sampling of dusts, fungi, bacteria, and particulate matter (PM) 10 air quality was conducted prior to and during the (OS1) pilot study.

MSU's Phase I pilot building was Natural Resources. As the new program was implemented, cleaning that had been eliminated due to budget reductions have been reintroduced on a trial basis. Among the restored services was regular office cleaning and dusting. In contrast to our traditional schedule based on frequencies, the new objective is to spot clean all space daily and clean one quadrant of the building or "core" wall to wall one day a week. Offices are included in the core cleaning.

Based on the feedback from the building occupants, the level of cleanliness has improved in Natural Resources and the building occupants are pleased with the restored office cleaning. After a learning period, the custodians who have participated in the pilot program were eager to introduce this new cleaning system in other buildings.

Phase II began in early November 2010 in Agriculture Hall, Food Science, and the Main Library. One week into cleaning the Library with (OS1), the occupants indicated that the building felt cleaner. It is anticipated that three buildings will be added as Phase III in

February 2011. These phases will help determine if the improved level of cleanliness can be sustained, along with the dusting and office cleaning, through the winter season.

Analysis

Operating System One team cleaning is a restructuring of our traditional, zone cleaning approach as well as, procedures, frequencies, and management. By using, what could be characterized as industrial engineering, jobs are structured to achieve maximum efficiency and consistency. All space is inventoried based primarily on hard floor or carpet, cleaning industry time standards are then applied to individual tasks. Tasks are based on work load and specialist flow work, and then built into four hour jobs. All jobs are outlined on job cards that indicate the approximate time each task should take.

With (OS1), all cleaning is structured according to specialists following a flow of work. The work flow starts with a “Light Duty Specialist” who serves as the advance, emptying waste baskets, and picking up debris, followed by a “Vacuum Specialist.” These first two specialists manage the bulk of the space cleaning. The next worker in the process is the “Utility Specialist” who handles the logistics of waste removal, recycling and stock as well as all mopping. The “Restroom Specialist” rounds out the team by performing daily restocking and disinfection of the restrooms.

Operating System One touts a “Philosophy of Cleaning” that lists several guiding statements. Workers and supervisors receive intensive training based on each philosophy. Management is encouraged to make decisions that support this philosophy. Cleaning for health, elevating the worker, simplicity, keep it clean, compliance, and environmentalism are all values of this system that will help the custodial department exceed expectations. Success will be achieved when all team members share the vision and embrace what amounts to a significant culture shift at all levels.

Three months into the pilot program, our pilot building was audited by representatives from the (OS1) developers. The audit reviews over 300 points including team training quality, safety and compliance, environmental stewardship and management participation; to site a few. The audit is broken down to evaluate the cleaning worker, supervision, management, training, purchasing and senior management. The team received an overall rating of 80%. A score of 80% is indicative of an (OS1) green cleaning program.

By subscribing to the (OS1) cleaning system, MSU Custodial Services has entered a restructuring process that is anticipated to yield many benefits for employees, building tenants, and facilities.

With any change, comes the challenge of increased communication to maximize benefit and minimize anxiety for all affected. Full implementation will take several years, but continued success will provide inspiration for future phases.

Future Direction

As OS1 continues to be implemented, it is anticipated that all general fund buildings at MSU will transition to this new process in a three to five year period. Implementation is scheduled for three to six buildings per quarter. Once the department reaches a point where a majority of the general fund facilities are being serviced, a similar restructure of the current “zone” based supervision model can be explored.

CAMPUS ARCHAEOLOGY PROGRAM

Summary

The purpose of the Michigan State University Campus Archaeology Program (CAP) is to: 1) evaluate, mitigate, and protect archaeological resources on Michigan State University's (MSU) campus; 2) work with multiple departments and the community to be good stewards of the cultural heritage of MSU and East Lansing; 3) educate employees, students, alumni, and the larger community about the history of MSU and the importance of cultural heritage preservation; and 4) train students to be good archaeologists and scholars who understand the importance of public engagement.

Engagement is a significant part of the mission. Engagement here means the incorporation and education of various communities in all aspects of CAP's research, the discovery of MSU's past, and lessons in how good stewardship can be accomplished.

CAP consists of Professor Lynne Goldstein from the Department of Anthropology as Director, a Department of Anthropology graduate student as Campus Archaeologist, three additional graduate students working on specific projects, and a total of six undergraduates who work as unpaid interns (serving at varying times over the year). The undergraduate students receive academic credit for their efforts. In addition, CAP occasionally hires undergraduate and graduate student workers when conducting fieldwork and the program uses a variety of student volunteers as needed.

CAP engages the public on multiple levels and in many ways. Anytime CAP works on campus, visitors are encouraged (a CAP banner is placed prominently near our worksite), and CAP maintains an active online presence. The public includes faculty, staff, graduate and undergraduate students, alumni, and the Greater Lansing community, as well as the archaeological profession and the broader public.

Examples of CAP's activities over the past academic year include:

- CAP has responded to 44 construction or planting projects (large and very small) which Physical Plant or others indicated were planned or about to begin.
- Detailed archaeological survey and/or testing in 11 areas on campus.
- Discovery of the remains of College Hall, MSU's first academic building.
- Discovery of an intact, 16,000 year-old sand dune on campus, behind Demonstration Hall.
- Relocation of one of Dr. Beal's early botanical laboratories and greenhouse.
- Coordination and assistance with consequences of planning and construction of the FRIB facility.
- Development of partnerships across campus and with local community entities.

- Development of undergraduate training program resulting in several award winners and four students accepted to elite archaeology graduate programs.
- Significant progress in coordination and integration of archaeological data with Physical Plant's MunSys project.
- Successful completion of an on-campus archaeological field school.
- Two summers of successful Grandparents University program in campus archaeology.
- Professional presentations and publications, as well as invitations to advise other universities on possible campus archaeology programs.
- Public lectures, talks, and development of significant online presence.

Analysis

Excavation and Survey Projects

Since July 1, 2009, the CAP has responded to a total of 44 construction or planting projects (large and very small) which Physical Plant or others indicated were planned or about to begin. In each case, a "response" means that CAP goes to MSU Archives and the State Archaeological Records to determine whether or not it is likely that there are any historic or prehistoric sites that may be disturbed by the planned activity. Part of the work includes an evaluation of the original land surface and topography. Depending on the project, the process can take an hour or several days. In most cases, there is little likelihood of disturbing archaeological resources, and there is no need for CAP to be involved.

CAP has monitored many construction and ground-disturbing projects during the last year. Of these 44 projects, CAP has performed archaeological survey in 11 specific areas. Of those 11 areas, four required prolonged test excavations. The test excavations resulted in discovering the remnants of College Hall (MSU's first academic building); location of the placement of the remains of College Hall (dumped as fill along the Red Cedar River); dating an intact, 16,000 year-old sand dune on campus (which received extensive press coverage); and possible relocation of one of the earliest of Dr. Beal's botanical laboratory and greenhouses. CAP also worked with the FRIB project and prepared a statement for the State Historic Preservation Office regarding the proposed FRIB site and possible impacts on archaeological and historic resources. The evaluation led to the approval of a permit to begin work on the site.

Figure 1 visually and spatially presents examples of CAP's work and some of the artifacts recovered. The artifacts in the upper right section of the photo are not the result of work associated with planned construction, but instead represent excavations associated with an on campus archaeological field school held during June 2010. A total of 15 undergraduate and four graduate students worked in an area that was the location of a 19th century trash deposit. In addition, the field school students found (in nearby test excavations) evidence of a prehistoric Native American site.

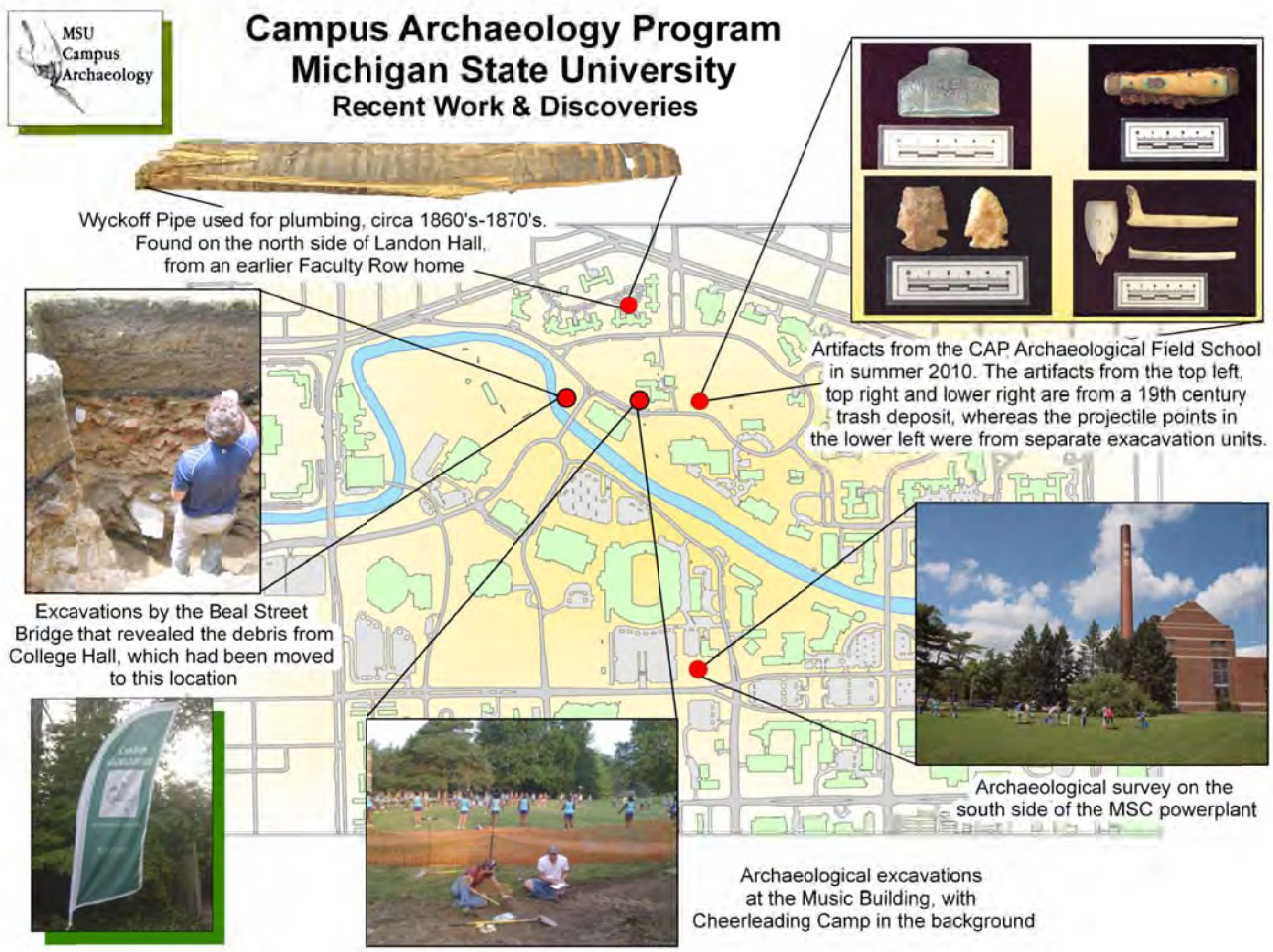


Figure 1. *Distribution of areas worked and some examples of artifacts recovered.*

Partnerships

Archaeological investigations were conducted in partnership with MSU Physical Plant, particularly Landscape Services, Engineering and Architectural Services, and Campus Planning. These partnerships have led to ongoing positive working relationships, as Campus Archaeology becomes a regular part of project planning. CAP has also made progress in developing an integrated mapping system that will work within MunSys; sensitive archaeological areas will now be more visible during all of Physical Plant's planning phases.

Additional partnerships and collaborations have been established with the Beal Botanical Garden, University Historical Archives and Collections, MSU Museum, MATRIX, Department of Geography, Department of Geology, MSU Alumni Association, the Michigan State Historical Museum, and the Office of the State Archaeologist.

Education

CAP's structure has provided the opportunity for an archaeology graduate student to act as principal investigator on a number of archaeological investigations. This student also has the responsibility of attending meetings as a principal investigator, negotiating and discussing specific plans with Physical Plant employees, engaging with the public, and gaining valuable research experience. The CAP position provides real-world experience and training. Additional funding from the Graduate School has given other Anthropology graduate students the opportunity to work on individual research projects related to Campus Archaeology. These projects help the overall program reach specific goals and these students conduct detailed research and resolve problems which might otherwise not be possible. One such project is the examination of MSU campus sustainability over time. All are outlined below in Future Directions.

Six undergraduates have served as interns for the Campus Archaeology Program during the past year. The intern's complete individual research projects on different elements of Campus Archaeology, and all present their work at the University Undergraduate Research and Arts Forum in April of each year. In 2010, two of the six were awarded first prize for their presentations in their respective sections. As of fall 2010, four undergraduate interns have graduated MSU and been accepted to elite graduate anthropology programs. A major factor in their success is the experience they received working for CAP and the independent research projects they were able to develop and complete.

Figure 2 provides examples of CAP field work in action, year-round.

Figure 2. *Some examples of Campus Archaeology in action, in the field.*

Public Engagement

The press, fieldwork, and laboratory work provide unique opportunities to share knowledge with members of Physical Plant, others on campus, and outside contractors. CAP tries to continually engage and work with the MSU community to share the importance of campus resources. Other examples of this engagement include requests to develop Campus Archaeology exhibits in residence dining halls, a request from the MSU Union to create an exhibit for one of their spaces, and general promotion and “re-tweeting” of our announcements by units and individuals across campus.

CAP continues to work directly with University Historical Archives and Collections to develop an MSU Heritage Network that will include Archives, the MSU Museum, Campus Planning and Administration, Physical Plant, MATRIX, MSU Library Special Collections, the MSU Alumni Association, and the City of East Lansing. Works are ongoing with MATRIX, the College of Education, and University Historical Archives and Collections to develop an

NEH Digital Humanities Start-Up grant for a special Campus Archaeology mobile application.

Future Directions

- Continued collaboration across campus and with the larger community. Collaborations, such as the CHI program, close cooperation with various sections of Physical Plant, and a Munsys layer for archaeological data will be high priorities.
- Student projects this year will help standardize the data collected and displayed, and by the end of 2011, there should be a number of reference sets available to all on the archaeological resources, historic resources, and maps of campus.
- Development of an artifact database so that analysis of materials will be simplified.
- Online publication of all of the reports of CAP's work.
- Continue to present and publish the results of CAP's work for both public and professional audiences.
- Become more involved with MSU's environmental stewardship plans.
- Become more involved in plans for building and interior design to suggest and plan exhibits in the context of the structures and places they were found. It would be great if people knew what once existed below the ground where a new building now stands.

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

Construction Project Data Summary

The Annual Construction Report, as requested by the Board of Trustees, includes construction projects which have been completed and project accounts which have been closed.

Major capital projects are those that are $1 million or greater and require Board approval. Minor capital projects are greater than $250,000 and less than $1 million. The Board requests a listing of these projects on an annual basis. In addition to the annual report, the Board receives quarterly construction reports reflecting current construction projects.

The Closed Major Capital Projects Report highlights three areas for the 15 major capital projects that were closed during fiscal year 2009-10. These areas include authorized budget, final cost of the project, contingency use, schedule adherence, and change order management. The reports are utilized to provide timely and accurate project information, and report on project performance in the aggregate, analyzing strengths and weaknesses, and improving processes.

The Closed Minor Capital Projects Report highlights final cost for the 33 minor capital projects that were closed during the fiscal year.

Of the 48 closed projects, 15 are major capital projects and 33 are minor capital projects. The approved budgets for the projects totaled $139,244,363. The final cost of these projects was $132,931,212, a difference of $6,313,151 (4.5%), which was returned to the appropriate unit.

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP02041 - T.B. SIMON POWER PLANT - UNITS 5 AND 6

Authorized Budget:	39,500,000	**Final Cost:**	39,408,102	**Classification:**	Clinical
Construction:	34,419,326	**Returned:**	91,898	**Delivery Method:**	Construction Manager
Professional Services:	2,375,218			**Contractor:**	THE CHRISTMAN COMPANY/TIC
Owner Work and Material:	0			**A/E (Consultant):**	CUMMINS & BARNARD, INC
Contingency:	2,705,456			**Funds returned to:**	Bond Funded

Change Orders		**% of Contract**	**% of Contingency**
Scope:	13,202	0.0%	0.5%
Document:	970,855	2.8%	35.9%
Field:	772,045	2.2%	28.5%
Total:	1,756,102	5.1%	64.9%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	12/31/2005	1/5/2006	5
Close Out:	4/30/2010	3/8/2010	(53)

CP03226 - SNYDER AND PHILLIPS HALL - RENOVATION

Authorized Budget:	47,906,000	**Final Cost:**	46,849,621	**Classification:**	Clinical
Construction:	35,405,637	**Returned:**	1,056,379	**Delivery Method:**	Construction Manager
Professional Services:	4,292,953			**Contractor:**	THE CHRISTMAN COMPANY
Owner Work and Material:	3,250,774			**A/E (Consultant):**	EYP/NEUMANN-SMITH
Contingency:	4,956,636			**Funds returned to:**	2007 Bonds-Project Proceeds

Change Orders		**% of Contract**	**% of Contingency**
Scope:	61,100	0.2%	1.2%
Document:	2,751,302	7.8%	55.5%
Field:	1,458,140	4.1%	29.4%
Total:	4,270,542	12.1%	86.2%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	12/1/2007	12/1/2007	0
Close Out:	12/31/2009	1/14/2010	14

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP035006 - ROADS - RED CEDAR/WILSON ROAD INTERSECTION - RECONSTRUCTION 2007

Authorized Budget:	3,520,000	**Final Cost:**	2,886,342	**Classification:**	Clinical
Construction:	2,467,256	**Returned:**	633,658	**Delivery Method:**	Design Bid Build
Professional Services:	561,246			**Contractor:**	SIX-S, INC
Owner Work and Material:	179,440			**A/E (Consultant):**	DLZ CORPORATION
Contingency:	312,058			**Funds returned to:**	JIT End Trust Savings Reserve

Change Orders		**% of Contract**	**% of Contingency**
Scope:	0	0.0%	0.0%
Document:	0	0.0%	0.0%
Field:	0	0.0%	0.0%
Total:	0	0.0%	0.0%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	8/17/2007	8/17/2007	0
Close Out:	6/17/2009	9/28/2009	103

CP04128 - SPARTAN VILLAGE ELEMENTARY/UNIVERSITY HOUSING OFFICE - RENOVATION

Authorized Budget:	3,550,000	**Final Cost:**	3,332,206	**Classification:**	Clinical
Construction:	1,818,000	**Returned:**	217,794	**Delivery Method:**	Design Bid Build
Professional Services:	376,479			**Contractor:**	E & L CONSTRUCTION, INC.
Owner Work and Material:	812,112			**A/E (Consultant):**	DESIGN PLUS
Contingency:	543,409			**Funds returned to:**	H&FS Deferred Maintenance

Change Orders		**% of Contract**	**% of Contingency**
Scope:	73,433	4.0%	13.5%
Document:	106,411	5.9%	19.6%
Field:	130,816	7.2%	24.1%
Total:	310,660	17.1%	57.2%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	4/25/2008	4/25/2008	0
Close Out:	11/30/2009	9/25/2009	(66)

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP05036 - VETERINARY MEDICAL CENTER - SAC - ALTERATIONS TO ENTRANCE & RECEPTION

Authorized Budget:	600,000	**Final Cost:**	544,911	**Classification:**	Clinical
Construction:	366,980	**Returned:**	55,089	**Delivery Method:**	Design Bid Build
Professional Services:	80,050			**Contractor:**	NIELSEN COMMERCIAL CONST. CO.
Owner Work and Material:	45,500			**A/E (Consultant):**	DESIGN PLUS
Contingency:	107,470			**Funds returned to:**	Internal Loan

Change Orders		**% of Contract**	**% of Contingency**
Scope:	37,447	10.2%	34.8%
Document:	17,552	4.8%	16.3%
Field:	7,225	2.0%	6.7%
Total:	62,224	17.0%	57.9%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	11/6/2007	11/6/2007	0
Close Out:	6/30/2010	6/9/2010	(21)

CP06298 - ERICKSON HALL - EXTERIOR RENOVATIONS

Authorized Budget:	3,700,000	**Final Cost:**	3,382,165	**Classification:**	Clinical
Construction:	2,965,000	**Returned:**	317,835	**Delivery Method:**	Design Bid Build
Professional Services:	333,931			**Contractor:**	IRISH CONSTRUCTION COMPANY
Owner Work and Material:	55,604			**A/E (Consultant):**	DESIGN PLUS
Contingency:	345,465			**Funds returned to:**	JIT

Change Orders		**% of Contract**	**% of Contingency**
Scope:	0	0.0%	0.0%
Document:	28,399	1.0%	8.2%
Field:	7,485	0.3%	2.2%
Total:	35,884	1.2%	10.4%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	5/31/2009	4/23/2009	(38)
Close Out:	1/2/2010	12/8/2009	(25)

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP06521 - ROADS - CRESCENT/MIDDLEVALE - PHASE 4

Authorized Budget:	1,500,000	**Final Cost:**	1,282,690	**Classification:**	Clinical
Construction:	865,400	**Returned:**	217,310	**Delivery Method:**	Design Bid Build
Professional Services:	294,700			**Contractor:**	E.T. MACKENZIE COMPANY
Owner Work and Material:	57,000			**A/E (Consultant):**	CTE
Contingency:	282,900			**Funds returned to:**	JIT

Change Orders		% of Contract	% of Contingency
Scope:	0	0.0%	0.0%
Document:	71,171	8.2%	25.2%
Field:	-35,390	-4.1%	-12.5%
Total:	35,782	4.1%	12.6%

Schedule	Planned	Actual	Days (Under)/Over
Substantial Completion:	8/1/2008	7/28/2008	(4)
Close Out:	11/30/2009	10/15/2009	(46)

CP06538 - HOLDEN HALL - ELEVATOR REPLACEMENTS

Authorized Budget:	1,300,000	**Final Cost:**	1,188,455	**Classification:**	Clinical
Construction:	1,050,000	**Returned:**	111,545	**Delivery Method:**	Design Bid Build
Professional Services:	104,000			**Contractor:**	KARES CONSTRUCTION CO., INC.
Owner Work and Material:	25,500			**A/E (Consultant):**	EAS
Contingency:	120,500			**Funds returned to:**	Housing & Food Services

Change Orders		% of Contract	% of Contingency
Scope:	0	0.0%	0.0%
Document:	8,580	0.8%	7.1%
Field:	3,982	0.4%	3.3%
Total:	12,562	1.2%	10.4%

Schedule	Planned	Actual	Days (Under)/Over
Substantial Completion:	12/12/2008	11/14/2008	(28)
Close Out:	5/28/2009	7/15/2009	48

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP06585 - SPARTAN VILLAGE - DEMOLITION OF 1420-27, 1512-20,1526-1534

Authorized Budget:	4,800,000	**Final Cost:**	3,663,980	**Classification:**	Clinical
Construction:	2,393,000	**Returned:**	1,136,020	**Delivery Method:**	Design Bid Build
Professional Services:	600,050			**Contractor:**	PITSCH COMPANIES
Owner Work and Material:	509,500			**A/E (Consultant):**	FLEIS & VANDENBRINK
Contingency:	1,297,450			**Funds returned to:**	RHS & Physical Plant

Change Orders		**% of Contract**	**% of Contingency**
Scope:	0	0.0%	0.0%
Document:	86,431	3.6%	6.7%
Field:	65,844	2.8%	5.1%
Total:	152,275	6.4%	11.7%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	11/13/2008	11/8/2008	(5)
Close Out:	9/26/2009	12/8/2009	73

CP07075 - STEAM, ELECTRICAL AND WATER DISTRIBUTION WEST CIRCLE HOUSING COMPLEX - PHASE I - REPLACE ELECTRICAL

Authorized Budget:	6,500,000	**Final Cost:**	5,903,693	**Classification:**	Clinical
Construction:	3,023,029	**Returned:**	596,307	**Delivery Method:**	Design Bid Build
Professional Services:	1,415,700			**Contractor:**	SANDBORN CONSTRUCTION, INC.
Owner Work and Material:	829,971			**A/E (Consultant):**	FTC&H
Contingency:	1,231,300			**Funds returned to:**	JIT

Change Orders		**% of Contract**	**% of Contingency**
Scope:	-1,325	0.0%	-0.1%
Document:	94,803	3.1%	7.7%
Field:	138,193	4.6%	11.2%
Total:	231,671	7.7%	18.8%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	8/15/2008	8/15/2008	0
Close Out:	7/30/2010	5/6/2010	(85)

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP07078 - ROADS - CRESCENT/MIDDLEVALE PHASE 5 (SOUTH SECTION) - 2009

Authorized Budget:	1,000,000	**Final Cost:**	914,569	**Classification:**	Clinical
Construction:	583,301	**Returned:**	85,431	**Delivery Method:**	Design Bid Build
Professional Services:	200,553			**Contractor:**	CAROL'S LLC
Owner Work and Material:	85,887			**A/E (Consultant):**	CTE ENGINEERING
Contingency:	130,259			**Funds returned to:**	JIT

Change Orders		**% of Contract**	**% of Contingency**
Scope:	5,177	0.9%	4.0%
Document:	3,438	0.6%	2.6%
Field:	64,526	11.1%	49.5%
Total:	73,141	12.5%	56.2%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	8/1/2009	8/1/2009	0
Close Out:	2/1/2011	5/20/2010	(257)

CP07123 - ENGINEERING BUILDING - BARRIER FREE PARKING & VESTIBULE

Authorized Budget:	1,100,000	**Final Cost:**	1,040,129	**Classification:**	Clinical
Construction:	606,932	**Returned:**	59,871	**Delivery Method:**	Design Bid Build
Professional Services:	255,993			**Contractor:**	LAUX CONSTRUCTION, LLC.
Owner Work and Material:	168,850			**A/E (Consultant):**	DLZ
Contingency:	68,225			**Funds returned to:**	Office of Planning & Budgets

Change Orders		**% of Contract**	**% of Contingency**
Scope:	0	0.0%	0.0%
Document:	19,511	3.2%	28.6%
Field:	14,269	2.4%	20.9%
Total:	33,780	5.6%	49.5%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	9/12/2008	9/12/2008	0
Close Out:	3/30/2010	1/26/2010	(63)

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP07218 - HUMAN ECOLOGY - SPDC RENOVATIONS

Authorized Budget:	3,600,000	Final Cost:	3,572,262	Classification:	Clinical
Construction:	2,100,000	Returned:	27,738	Delivery Method:	Construction Manager
Professional Services:	271,831			Contractor:	GRANGER CONSTRUCTION COMPANY
Owner Work and Material:	527,863			A/E (Consultant):	INTEGRATED ARCHITECTS
Contingency:	700,306			Funds returned to:	Bond Funded

Change Orders		% of Contract	% of Contingency
Scope:	-6,532	-0.3%	-0.9%
Document:	442,612	21.1%	63.2%
Field:	235,665	11.2%	33.7%
Total:	671,745	32.0%	95.9%

Schedule	Planned	Actual	Days (Under)/Over
Substantial Completion:	8/31/2008	8/31/2008	0
Close Out:	5/31/2010	5/17/2010	(14)

CP08163 - STEAM DISTRIBUTION - REPAIR/REPLACE DETERIORATED PIPE SUPPORTS FROM VAULT 184 EAST

Authorized Budget:	1,350,000	Final Cost:	1,298,590	Classification:	Clinical
Construction:	888,000	Returned:	51,410	Delivery Method:	Design Bid Build
Professional Services:	170,135			Contractor:	NIELSEN COML CONSTRUCTION CO
Owner Work and Material:	24,440			A/E (Consultant):	FTC&H
Contingency:	267,425			Funds returned to:	JIT

Change Orders		% of Contract	% of Contingency
Scope:	-57,178	-6.4%	-21.4%
Document:	276,184	31.1%	103.3%
Field:	19,619	2.2%	7.3%
Total:	238,626	26.9%	89.2%

Schedule	Planned	Actual	Days (Under)/Over
Substantial Completion:	7/24/2009	6/26/2009	(28)
Close Out:	6/1/2010	11/24/2009	(189)

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

CP08209 - HOLDEN HALL - INSTALL FIRE ALARM AND SPRINKLER SYSTEM

Authorized Budget:	3,636,000	**Final Cost:**	3,290,964	**Classification:**	Clinical
Construction:	2,260,702	**Returned:**	345,036	**Delivery Method:**	Design Bid Build
Professional Services:	408,200			**Contractor:**	NIELSEN COMMERCIAL CONST. CO.
Owner Work and Material:	451,964			**A/E (Consultant):**	IDS
Contingency:	515,134			**Funds returned to:**	H&FS Deferred Maintenance

Change Orders		**% of Contract**	**% of Contingency**
Scope:	40,167	1.8%	7.8%
Document:	83,647	3.7%	16.2%
Field:	77,950	3.4%	15.1%
Total:	201,765	8.9%	39.2%

Schedule	**Planned**	**Actual**	**Days (Under)/Over**
Substantial Completion:	8/7/2009	8/7/2009	0
Close Out:	11/6/2010	5/11/2010	(179)

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

Closed Minor Capital Projects for Fiscal Year 2008 - 2009

CP Number	Project Description	Budget	Final Costs	Returned
CP07093	I.M. SPORTS CIRCLE - ALTERATIONS TO ROOM 26	942,000	941,981	19
CP04246	VETERINARY RESEARCH - SMALL ANIMAL - REPLACE HVAC SYSTEM IN BARN J	800,000	760,993	39,007
CP06319	T.B. SIMON POWER PLANT - REPLACE GRAVITY ROOF VENTILATORS	800,000	728,717	71,283
CP07469	COMPUTER CENTER - ALTERATIONS TO ROOM 204, PHASE II	765,000	761,285	3,715
CP06553	CLINICAL CENTER BUILDING - D-WING - HVAC MODIFICATIONS	725,000	694,349	30,651
CP07461	WILSON HALL - ROOF REPLACEMENT AREAS, 2,3,5-11, AND 21-29	700,000	616,952	83,048
CP06442	ATHLETIC FIELDS - IMPROVEMENTS TO IM EAST SPORTS FIELD	658,000	581,937	76,063
CP05467	DEMONSTRATION HALL - REPLACE BARRIER FREE RAMP	600,000	524,289	75,711
CP07013	WELLS HALL-EXTERIOR RESTORATION	600,000	558,089	41,911
CP07359	CHEMISTRY - ALTERATIONS TO ROOMS 204 AND 205	600,000	360,310	239,690
CP08337	CLINICAL CENTER - ALTERATIONS TO ROOMS D142 & D143	600,000	578,999	21,001
CP07539	CASE HALL - ALTERATIONS TO ROOMS 325 AND S351 THRU S372	536,363	536,363	0
CP09236	STEAM DISTRIBUTION - EMERGENCY REPAIR TO VAULT 260 (GROUNDS)	500,000	381,854	118,146
CP07522	PLANT BIOLOGY LABORATORY - REPLACE ROOFS 1 & 3-10	445,000	402,130	42,870
CP07018	VETERINARY MEDICAL CENTER - REPLACE HEAT EXCHANGERS	440,000	437,047	2,953
CP06304	NATURAL RESOURCES - REPLACE FIRE ALARM SYSTEM	420,000	373,675	46,325
CP07102	ENGINEERING RESEARCH COMPLEX - EARL - ROOM 160 FIT-UP	405,000	369,310	35,690

Appendix A: 2010 Closed Capital Projects for Fiscal Year 2009-2010

Closed Minor Capital Projects for Fiscal Year 2008 - 2009

CP Number	Project Description	Budget	Final Costs	Returned
CP06569	LAUNDRY BUILDING - ROOF REPLACEMENT AREAS 1, 2, 3, AND 4	400,000	392,582	7,418
CP07270	WELLS HALL - ROOF REPLACEMENT 1, 2, 14 & 15	390,000	352,001	37,999
CP08298	FEE HALL - ROOF REPLACEMENT - PHASE II 1-7, 21, 22 AND 25	390,000	351,280	38,720
CP06308	DEMONSTRATION HALL - EXTERIOR RESTORATION	372,000	352,529	19,471
CP06296	JENISON FIELDHOUSE - EXTERIOR MASONRY RESTORATIONS	365,000	356,514	8,486
CP08308	WATER DISTRIBUTION - REPLACE CAST IRON WATER MAIN - CHEMISTRY TO SHAW/BOGUE INTERSECTION	355,000	354,832	168
CP08166	STEAM DISTRIBUTION - EMERGENCY REPAIR - PLANT SCI. GREENHOUSE (BLDG 0093) REPLACE FAILED BELLOWS E	350,000	339,234	10,766
CP07269	FEE HALL - ROOF REPLACEMENT AREAS 15-20, 23, 24, AND 26	310,000	263,362	46,638
CP08245	CENTRAL CONTROL - UPDATE DDC CONTROL TO APOGEE SYSTEM - PHASE 5 OF 5	310,000	310,096	-96
CP07464	BRYAN HALL - ELEVATOR REPLACEMENT	305,000	280,608	24,392
CP06594	WELLS HALL - B AND D WING CEILING REPLACEMENTS	290,000	288,472	1,528
CP07328	T.B. SIMON POWER PLANT - REPLACE HEATING COIL FOR UNIT NO. 3	265,000	234,101	30,899
CP09089	COMMUNICATION DISTRIBUTION INSTALL NEW DUCTLINE AND RESURFACE PARKING LOT EAST OF SNYDER HALL	265,000	217,477	47,523
CP07222	ENGINEERING BUILDING - LOBBY RENOVATION	265,000	263,314	1,686
CP05556	POULTRY TEACHING & RESEARCH CENTER - ROOF REPLACEMENT	257,000	229,428	27,572
CP08397	KEDZIE HALL - NORTH - ACCESS CONTROL EXTERIOR DOORS	257,000	178,425	78,575
Total Projects: 33		**15,682,363**	**14,372,533**	**1,309,830**

Appendix B: MSU LEED Minimum Requirements

Appendix B – MSU LEED Minimum Requirements

LEED 2009 for New Construction and Major Renovations

Project Checklist

Project Name

Date

Y	N	?		Sustainable Sites	Possible Points: 26
10					
Y			Prereq 1	Construction Activity Pollution Prevention	
			Credit 1	Site Selection	1
			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

Y	N	?		Water Efficiency	Possible Points: 10
2					
Y			Prereq 1	Water Use Reduction—20% Reduction	
			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
2			Credit 3	Water Use Reduction	2 to 4

Y	N	?		Energy and Atmosphere	Possible Points: 35
2		16			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
y		11	Credit 1	Optimize Energy Performance	1 to 19
y		3	Credit 2	On-Site Renewable Energy	1 to 7
		2	Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
Rev. Std.			Credit 5	Measurement and Verification	3
			Credit 6	Green Power	2

Y	N	?		Materials and Resources	Possible Points: 14
3					
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
			Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1 to 2

Y	N	?		Materials and Resources, Continued	
1			Credit 4	Recycled Content	1 to 2
1			Credit 5	Regional Materials	1 to 2
			Credit 6	Rapidly Renewable Materials	1
			Credit 7	Certified Wood	1

Y	N	?		Indoor Environmental Quality	Possible Points: 15
10		2			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1		1	Credit 1	Outdoor Air Delivery Monitoring	1
			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
			Credit 8.1	Daylight and Views—Daylight	1
			Credit 8.2	Daylight and Views—Views	1

Y	N	?		Innovation and Design Process	Possible Points: 6
2					
1			Credit 1.1	Innovation in Design: Education of the Occupants and Visitors	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Y	N	?		Regional Priority Credits	Possible Points: 4
			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1

Y	N	?		Total	Possible Points: 110
29		18			

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Appendix C: PLA Status on BOT Projects since February 2008

Appendix C – PLA Status on BOT Projects since February 2008

Title	PLA Authorized?	Comment	Delivery	Authorized Budget	Status	Step 2 Date
Brody Hall Renovation	Yes	Advantages: reduced risk of delay, improved efficiency in project management	CM	49,800,000	Released for Construction	12/2/2008
Bailey Hall Renovation	Yes	PLA authorized in BOT resolution of 10/30/2009	BC	17,700,000	Construction to start in May 2011	6/18/2010
Emmons Hall renovation	Yes	Consistent with BOT resolution of 10/30/2009	BC	15,500,000	Released for Construction	2/12/2010
Brody Water and Communications Improvements - Phase II	Yes	Consistent with BOT resolution of 10/30/2009	BC	1,690,000	Substantially Complete	12/2/2009
Eli and Edythe Broad Art Museum	CM	CM has opted for PLA iaw Responsible Contractor Policy; being constructed with East Circle Drive	CM	45,000,000	Released for Construction	12/11/2009
Plant Science Expansion	CM	CM has opted for a PLA iaw Responsible Contractor Policy	CM	43,200,000	Released for Construction	12/11/2009
Wells Hall Addition and Old Horticulture Renovations	CM	CM has opted for a PLA iaw Responsible Contractor Policy	CM	38,000,000	Released for Construction	6/18/2010
Facility for Rare Isotope Beams - Utility Relocation - Phase I	CM		CM	6,300,000	Released for Construction	4/16/2010
East Circle Drive Reconstruction	CM	CM has opted for PLA iaw Responsible Contractor Policy; being constructed with Broad Art Museum	CM	2,390,000	Released for Construction	12/11/2009
Wharton center for performing arts - alterations and expansion	No		CM	18,500,000	Substantially Complete	4/9/2008
T.B. Simon power plant - fuel handling modifications	No	MSU is holding trade contracts and unable to sign PLA	CM	18,500,000	Released for Construction	12/2/2008

Appendix C – PLA Status on BOT Projects since February 2008

Title	PLA Authorized?	Comment	Delivery	Authorized Budget	Status	Step 2 Date
Cyclotron - Low energy experimental research and office additions	No		CM	18,100,000	Substantially Complete	2/4/2009
Cyclotron Building - office addition phase II	No		CM	14,500,000	Released for Construction	10/21/2009
MSU Surplus Store and recycling center	No		BC	13,300,000	Substantially Complete	5/7/2008
Mary Mayo Hall Renovations	No		BC	12,750,000	Substantially Complete	2/13/2008
West Circle Housing Complex - Steam, Electrical, water districbution enhancements - phase I	No		BC	10,300,000	Closed	2/13/2009
Steam distribution and road reconstruction - Wilson and Birch roads	No		BC	10,000,000	Substantially Complete	11/26/2008
Owen Graduate Hall - Space improvement	No		CM	10,000,000	Substantially Complete	2/4/2009
Holden Hall - Space improvements	No		CM	9,450,000	Substantially Complete	2/13/2008
Parking Lot 89 East Expansion	No		BC	5,200,000	Authorized to proceed, but project now on hold.	2/4/2009
Spartan Village apartments - zone 1 demolition - phase II	No		BC	4,800,000	Closed	5/7/2008
Utility Distribution - Repairs and Improvements between Chestnut and Red Cedar along Stadium Drive	No		BC	4,300,000	Substantially Complete	12/2/2009
Hubbard Hall - Renovations to first floor common area	No		CM	4,050,000	Substantially Complete	10/21/2009

Appendix C – PLA Status on BOT Projects since February 2008

Title	PLA Authorized?	Comment	Delivery	Authorized Budget	Status	Step 2 Date
Old College Field renovations - phase III - baseball	No		CM	4,000,000	Substantially Complete	6/4/2008
Holden Hall - Live Safety System upgrades	No		BC	3,756,000	Closed	2/4/2009
Erickson Hall - exterior restoration	No		BC	3,700,000	Closed	5/7/2008
Food Stores – Alterations to Freezer Walls	No		BC	3,500,000	Substantially Complete	9/2/2009
Bio Medical and Physical Sscience building - alterations to suite 1440	No	MSU is holding Trade Contracts, and unable to sign PLA	CM	2,900,000	Substantially Complete	12/11/2009
Kellog Biological Station - Pasture - based diary facility	No	Neither market (Hickory Corners) nor type of construction (Agricultural) well covered by signatory contractors	Design Build	2,800,000	Substantially Complete	6/4/2008
Brody Complex - Steam and Communications master plan	No	Bid to signatory trade contractors	CM	2,400,000	Substantially Complete	2/4/2009
Old College Field Master Plan - Phase VI - Softball Grandstand and Press Box	No		BC	2,050,000	Released for Construction	10/30/2009
Spartan Stadium - East upper stand maintenance	No		BC	2,000,000	Substantially Complete	2/13/2008
Administration Building-ground floor asbestos abatement	No		BC	2,000,000	Released for Construction	12/2/2009
Old college field - renovations phase II - Athletic fields	No		BC	1,800,000	Substantially Complete	4/9/2008
Giltner Hall - Roof Replacement	No		BC	1,740,000	Substantially Complete	4/15/2009
WKAR - New tower and broadcast antennas	No	Not bid with PLA language	BC	1,650,000	Closed	4/9/2008
Natural Sciences building - window replacement	No		BC	1,550,000	Substantially Complete	6/4/2008

Appendix C – PLA Status on BOT Projects since February 2008

Title	PLA Authorized?	Comment	Delivery	Authorized Budget	Status	Step 2 Date
Crescent Middlevale Road reconstruction - phase IV	No		BC	1,500,000	Closed	2/13/2008
Steam Distribution - Repair/replace pipe supports along Wilson road of Bogue Street	No		BC	1,350,000	Closed	11/26/2008
Holmes Hall - Elevator replacement	No		BC	1,300,000	Substantially Complete	6/10/2009
Chemistry - alterations to rooms 407, 408 and 412	No		CM	1,200,000	Substantially Complete	6/4/2008
Shaw hall - loading dock renovations	No		BC	1,200,000	Substantially Complete	6/4/2008
Wilson Hall - Elevator Replacement	No		BC	1,200,000	Released for Construction	2/13/2009
Engineering building - parking and loading dock improvement	No		BC	1,100,000	Closed	4/9/2008
Forest Akers Golf Course - East Driving range enclosure	No		BC	1,000,000	Substantially Complete	6/4/2008
Crescent Middlevale Road reconstruction phase V	No		BC	1,000,000	Closed	2/4/2009
Engineering Research Complex – Office Addition	No		CM	998,500	Substantially Complete	6/10/2009
Giltner Hall - Alterations to Suites 31 and 32	No		BC	987,000	Substantially Complete	9/2/2009
Old College Field Renovations – Phase IV – Concessions/Restroom Building	No		BC	900,000	Substantially Complete	6/19/2009
Note--excluding balance of Brody Complex - steam and communications; with JIT funding, completion is uncertain.						

Appendix D: Michigan State University Real Property Holdings Report

Real Property Holdings

MICHIGAN STATE UNIVERSITY

As of July, 2010

Secchia Center

Prepared by:

Land Management Office

Real Property Holdings - Table of Contents

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Real Property Holdings - Real Estate Facts

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Summary of Acres

- Michigan State University (MSU) lands comprise 25,419.280 acres.
- Main campus lands (North of Mt. Hope) comprise 2,049.577 acres.
- Research, education, and outreach lands (South of Mt. Hope) comprise 2,737.492 acres.
- The golf course is 325 acres.
- Campus lands leased to others include 83.156 acres.
- Off-campus properties include 20,224.055 acres.
- Property for sale comprise 7.831 acres (included in off-campus total).

Acreage Changes

- Approximately 1,531 acres in Grand Ledge were gifted to MSU through the David Morris Trust.
- Noel Stuckman and Sandy Clarkson gifted 40 acres in St. Johns to MSU.
- MSU received a gift of 2.14 acres in the City of Kentwood from Four-D Investments, LLC.

Long-Term Leases

- Leases of a term of ten years or greater require Board of Trustee approval. A long-term lease was entered into with Dr. Mark R. McMurray, with MSU as Tenant.
  A long-term crop lease with Pete Clark on approximately 1,385 acres was assigned to MSU through the David Morris Trust.

State Building Authority Projects

- MSU has four State Building Authority bond-financed projects. The project site is deeded to the State Building Authority and leased back to MSU. Current projects are: Anthony Hall Dairy Plant and Meat Lab (to be repaid 2032); Biomedical and Physical Sciences Building (to be repaid 2037); Diagnostic Center for Population and Animal Health (to be repaid 2040); and the Chemistry Building renovation project (to be repaid 2043). State Building Authority bonds are typically issued for 35 years but the State may retire them before their maturity date.

Agreement to Restore Title

- A 50-year lease between MSU and the State of Michigan was entered into February 1956 for approximately six acres on Harrison Road. The Department of Agriculture constructed a lab on the parcel known as the Geagley Laboratory. In 2002, the parcel was deeded to the State of Michigan in order for the State to convey the property to the State Building Authority to obtain bond financing for needed improvements. An "Agreement to Restore Title" requires the State to deed the parcel to MSU at the time the property is conveyed back to the State from the State Building Authority. At that time, a lease will be entered into between MSU (landlord) and the State (tenant) in order for the State to continue occupancy at the Geagley Laboratory. The "Agreement to Restore Title" is on file in the MSU Office of General Counsel and the Land Management Office.

Real Property Holdings - Summary

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

PROPERTY	**ACRES**
East Lansing Campus	
North of Mt. Hope	2,049.577
Golf Course	325.000
Research, Education, and Outreach south of Mt. Hope	2,737.492
Campus Property Leased to Others	83.156
Total Campus Acres	**5,195.225**
Off-Campus	20,224.055
Total Deeded Acres	**25,419.280**
Property Leased to MSU Long-Term	264.000
Total Leased and Deeded Acres	**25,683.280**

Real Property Holdings - Acquisitions and Properties Sold

MICHIGAN STATE UNIVERSITY

July 1, 2009 - June 30, 2010

ACQUISITIONS		**ACRES**
Property:	Gantos Property 4055 Broadmoor Avenue SE Kentwood, Michigan Kent County	2.140
Acquisition Date:	12/29/2009	
Appraised Value:	$210,000.00	
How Acquired:	Donation	

Property:	Morris Property Grand Ledge, Michigan Clinton and Eaton Counties	1,531.000
Acquisition Date:	12/16/2009	
Fair Market Value:	$6,591,098*	
How Acquired:	Estate Gift	

*The gift value is distributed 55 percent to MSU and 45 percent to the Clark Retirement Community, per the terms of the trust.

Property:	Stuckman Property 1600 N. Scott Road St. Johns, Michigan Clinton County	40.000
Acquisition Date:	4/21/2010	
Appraised Value:	$402,500.00	
How Acquired:	Gifted to the MSU Foundation and transferred to MSU	

PROPERTY FOR SALE		**ACRES**
Property:	Hulett Road Engineering	5.691
Property:	Gantos Property	2.140

Real Property Holdings - Active Mineral Leases

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

MSU owns the Martin Property, MacCready Reserve, Rogers Reserve, the Management Education Center, and Hidden Lake Gardens. The Mancelona Property and Homer Nowlin Property were sold; MSU retained the mineral rights on both properties.

PROPERTY	**ACRES**
Mancelona Property (MSU owns mineral rights) Section 16, Mancelona Township, Antrim County Leased to Mercury Exploration Co. Lease is continued with producing well	31.400
Martin Property (Rose-Dell Seed Orchard, MSU owns surface and mineral rights) Sections 23 and 24, Albion Township, Calhoun County Leased to West Bay Exploration Three-year lease (commenced December 2007)	160.000
MacCready Reserve (MSU owns surface and mineral rights) Sections 11 and 14, Liberty Township, Jackson County Leased to West Bay Exploration Three-year lease (commenced December 2007)	408.000
Rogers Reserve (MSU owns surface and mineral rights) Section 4, Liberty Township, Jackson County Leased to West Bay Exploration Three-year lease (commenced December 2007)	77.373
Homer Nowlin Property (MSU owns mineral rights) Sections 28 and 23, Rich Township, Lapeer County Leased to Total Petroleum, Inc. Lease is continued with producing well	313.000
Management Education Center (MSU owns surface and mineral rights) Section 9, Troy Township, Oakland County Leased to West Bay Exploration Company Lease is continued with producing well	24.320
Hidden Lake Gardens (MSU owns 750.265 surface acres and 712.655 mineral acres) Sections 17, 18, 19, and 20, Liberty Township, Lenawee County Leased to West Bay Exploration Company Three-year lease (commenced August 2009)	712.256
Total Acres Under Mineral Leases	**1,726.349**

Real Property Holdings - Mineral Rights Reserved on Sold Properties

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

PROPERTY	ACRES
Allegan County	
Section 21, Saugatuck Township	53.275
Antrim County	
Section 16, Mancelona Township	29.900
Clinton County	
Section 22, Eagle Township	24.000
Sections 22 & 27, Eagle Township	61.300
Ingham County	20.369
Section 1, Delhi Township	
Lapeer County	
Section 28, Rich Township	10.000
Section 33, Rich Township	303.000
Lenawee County	
Section 29, Adrian Township	80.000
Monroe County	
Section 21, Milan Township	80.000
Oakland County	
Sections 2, 11, 12, Avon Township	234.434
Section 32, Bloomfield Township	5.000
Ontonagon County	
Section 6, Bohemia Township; Section 12, Greenland Township	78.000
Section 23, Bohemia Township	40.000
VanBuren County	
Section 6, Geneva Township	29.000
Section 23, South Haven Township	53.230
Total Mineral Acres Reserved:	**1,101.508**

Real Property Holdings - Gas and Oil Royalty Income

MICHIGAN STATE UNIVERSITY

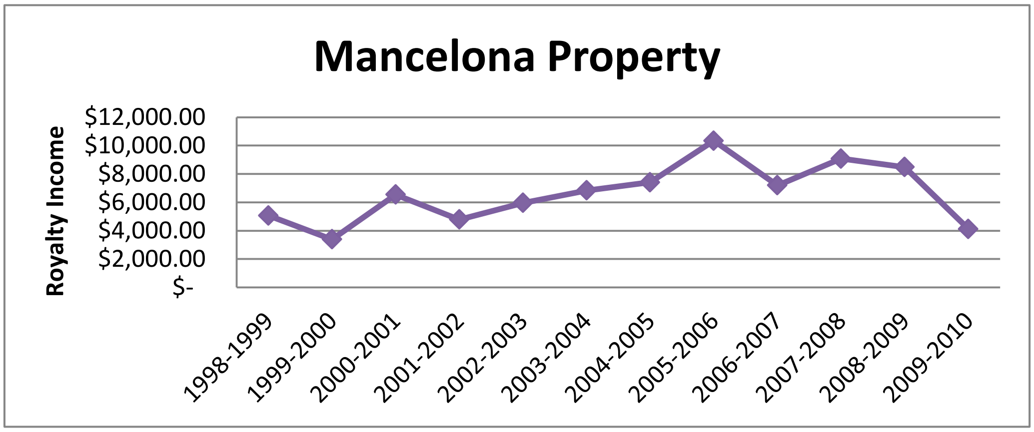
As of July 1, 2010

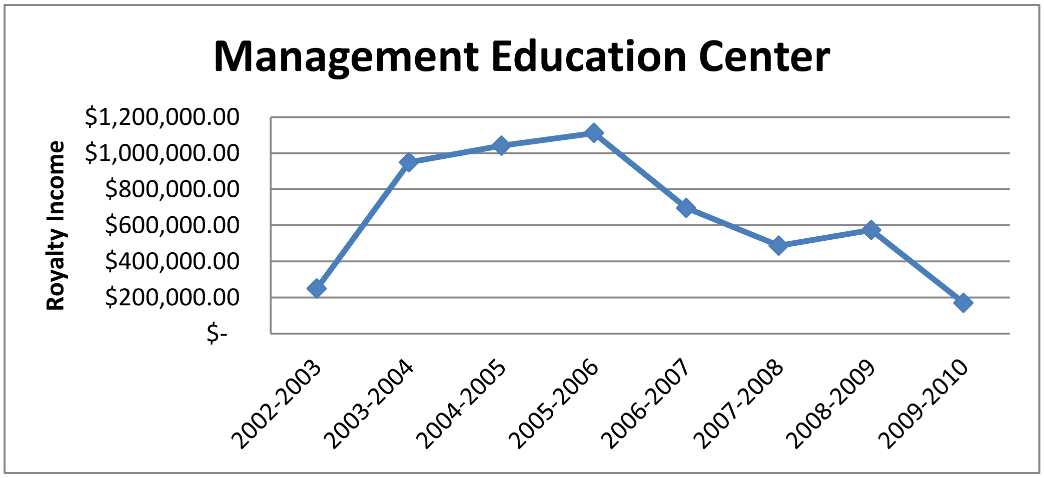
Mancelona Property
(Income funds the Land Fund Account)

1998-1999	$ 5,068.62
1999-2000	$ 3,390.42
2000-2001	$ 6,547.95
2001-2002	$ 4,789.45
2002-2003	$ 5,958.69
2003-2004	$ 6,833.60
2004-2005	$ 7,415.27
2005-2006	$ 10,337.62
2006-2007	$ 7,192.83
2007-2008	$ 9,082.79
2008-2009	$ 8,484.09
2009-2010	$ 4,114.23

Management Education Center
(Income funds Eli Broad College of Business Programs)

2002-2003	$ 248,679.62
2003-2004	$ 949,191.09
2004-2005	$ 1,041,242.41
2005-2006	$ 1,111,581.83
2006-2007	$ 695,627.95
2007-2008	$ 486,734.28
2008-2009	$ 573,939.94
2009-2010	$ 169,303.36





Real Property Holdings - Gas and Oil Royalty Income

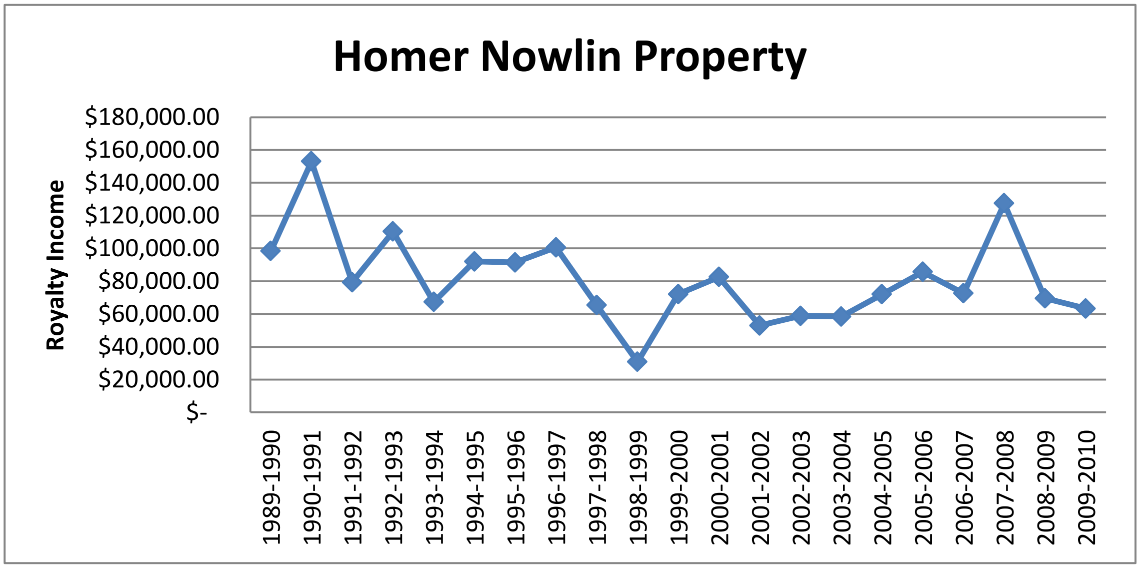
MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Homer Nowlin Property

(Income funds endowed chair in the College of Agriculture and Natural Resources)

1989-1990	$ 98,404.78
1990-1991	$ 153,008.72
1991-1992	$ 79,323.99
1992-1993	$ 110,311.26
1993-1994	$ 67,355.68
1994-1995	$ 91,965.81
1995-1996	$ 91,421.59
1996-1997	$ 100,641.83
1997-1998	$ 65,468.04
1998-1999	$ 30,788.53
1999-2000	$ 72,118.88
2000-2001	$ 82,535.99
2001-2002	$ 53,000.00
2002-2003	$ 58,819.50
2003-2004	$ 58,386.86
2004-2005	$ 71,997.24
2005-2006	$ 85,676.23
2006-2007	$ 72,534.18
2007-2008	$ 127,494.63
2008-2009	$ 69,521.30
2009-2010	$ 63,304.32



Real Property Holdings - Leased/Licensed Properties

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Leases of 10 years or longer require MSU Board of Trustee approval. The following leases meet that criteria. Only real property leases are included in the Real Property Holdings annual report.

MSU as TENANT	**ACRES**
Trevor Nichols Research Complex (Kalamazoo Orchard site) Administrative Unit: College of Agriculture and Natural Resources Department of Entomology	45.000
Northwest Michigan Horticulture Research Station Administrative Unit: College of Agriculture and Natural Resources Department of Horticulture MSU Extension	100.000
Tollgate Education Center Administrative Unit: College of Agriculture and Natural Resources Land Management Office MSU Extension	100.000
Forest Biomass Innovation Center Administrative Unit: College of Agriculture and Natural Resources Department of Forestry	9.000
Forest Biomass Innovation Center Administrative Unit: College of Agriculture and Natural Resources Department of Forestry	10.000
Total Leased Acres:	**264.000**

Real Property Holdings - Leased/Licensed Properties

MICHIGAN STATE UNIVERSITY

As of July 10, 2010

Leases of 10 years or longer require MSU Board of Trustee approval. The following leases meet that criteria. Only real property leases are included in the Real Property Holdings annual report.

TENANT	MSU PROPERTY	ACRES
Prairieville Township	Lux Arbor Reserve	0.800
Berrien County Extension Service	Southwest Michigan Research & Extension Center	1.380
Cass County Historical Commission	Fred Russ Forest	1.800
Cass County Park & Recreation Commission	Fred Russ Forest	14.000
Marcellus Community School	Fred Russ Forest	21.450
Department of Natural Resources	Dunbar Forest	9.400
Michigan State Police Headquarters	Campus	13.000
MSU Federal Credit Union	Campus	4.711
Sewage Plant	Campus	16.500
Consumers Energy	Campus	0.100
Northstar Cooperative, Inc.	Campus	9.710
University Rehabilitation Alliance	Campus	35.000
Candlewood/Vista I, LLC	Campus	3.235
LBWL/METC	Campus	0.900
Gull Lake Bible Conference	Kellogg Biological Station	10.000
Sheridan Lake YMCA (License)	Brook Lodge	415.000
Sheridan Lake YMCA (Lease)	Brook Lodge	40.000
Leland Township	Leland Property	0.700
Avon Players	VanHoosen Jones	1.793
Pete Clark	Morris Property	1,385.000
	Total Acres Leased/Licensed to Others:	**1,984.479**

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

BioEconomy Research and Development Center
Holland, Ottawa County

Purpose	Status	Acres
Research	Active Land use or resource use restrictions	6.300

Administrator	Comment
Vice President for Research and Graduate Studies	None

Brook Lodge
Augusta, Kalamazoo County

Purpose	Status	Acres
Conference center, teaching, research, and outreach	Inactive	633.240

Administrator	Comment
Kellogg Center Land Management Office	Long term lease on 40 acres to Sherman Lake YMCA

Clarksville Horticultural Experiment Station
Clarksville, Ionia County

Purpose	Status	Acres
Horticulture research on small fruit and tree fruit	Active	440.000

Administrator	Comment
Department of Horticulture Land Management Office	Agricultural Research Station Coordinator: Dr. Doug Buhler & Charles Reid Farm Manager: Gerald Skeltis

Dobie Road
Okemos, Ingham County

Purpose	Status	Acres
Wildlife research	Active	114.431

Administrator	Comment
Department of Fisheries & Wildlife Land Management Office	Location of WKAR tower T-Mobile tower

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Dunbar Forest Experiment Station
Sault Ste. Marie, Chippewa County

Purpose	Status	Acres
Forest research and demonstration	Active	5,759.815
	Title restricted on 4,668.84 acres	
	Land reverts to State if not used	
	solely for forestry purposes	

Administrator	Comment
	Agricultural Research Station
Department of Forestry	None
Land Management Office	

Forest Biomass Innovation Center
Escanaba, Delta County

Purpose	Status	Acres
Research and demonstration in	Active	1,737.260
forestry and crops		

Administrator	Comment
	Agricultural Research Station
Department of Forestry	Coordinator: Dr. David McFarlane
Land Management Office	Resident Forester: Dr. Ray Miller

Gantos Property
City of Kentwood, Kent County

Purpose	Status	Acres
Donation for resale	Property is for sale	2.140

Administrator	Comment
Land Management Office	None

Hidden Lake Gardens
Tipton, Lenawee County

Purpose	Status	Acres
Arboretum and plant conservatory	Active	756.618

Administrator	Comment
Land Management Office	Manager: Steven Courtney

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Hulett Road Engineering
Okemos, Ingham County

Purpose	**Status**	**Acres**
Former facilities and site for	Property is for sale	5.691
College of Engineering research	Building vacant	

Administrator	**Comment**
Land Management Office	None

Human Medicine, College of
Grand Rapids, Kent County

Purpose	**Status**	**Acres**
Medical School	Active	1.735

Administrator	**Comment**
	Includes Condominium #5
College of Human Medicine	.005 acres sold to MDOT

Jolly Road Engineering
Okemos, Ingham County

Purpose	**Status**	**Acres**
Facilities and site for	Active	3.260
College of Engineering research		

Administrator	**Comment**
College of Engineering	None
Land Management Office	

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Kellogg, W.K. Biological Station
(Including Farm and Bird Sanctuary)
Hickory Corners, Kalamazoo County

Purpose	Status	Acres
Teaching, research, and extension activities in the environmental sciences focusing on the interdependence of natural and managed landscapes. The programs treat integrated study of biology, wildlife, and production agriculture, including animal input.	Active Title on original gift restricted. Property needs to be maintained and operated for educational purposes.	1,690.850

Administrator	Comment
Director, Biological Station College of Agriculture & Natural Resources College of Natural Science Land Management Office	Agricultural Research Station Director: Dr. Katherine Gross Farm Manager: Jim Bronson Bird Sanctuary Coordinator: Tracey Kast Farm Acreage: 944.674 Bird Sanctuary Acreage: 746.176 4.92 acres acquired in 2009

Kellogg, W.K. Biological Station
Lux Arbor Reserve
Delton, Barry County

Purpose	Status	Acres
Research and education in the agricultural, biological, botanical, and horticulture sciences	Active	1,323.000

Administrator	Comment
Same as Kellogg Biological Station	Included with Kellogg Biological Station as an Agricultural Research Station Farm Manager: Steve Norris

Kellogg, W.K. Experimental Forest
Augusta, Kalamazoo County

Purpose	Status	Acres
Forestry research, teaching, demonstration, and public use	Active Title restricted on 280 acres. To be used for reforestation, education, and experimental purposes	715.995

Administrator	Comment
Department of Forestry Land Management Office	Agricultural Research Station Coordinator: Dr. David McFarlane Resident Forester: Greg Kowalewski

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Lake City Experiment Station
Lake City, Missaukee County

Purpose	Status	Acres
Research in beef cattle, forages, and potatoes	Active	810.010

Administrator	Comment
Department of Animal Science Land Management Office	Agricultural Research Station Coordinator: Dr. Jason Rountree Farm Manager: Doug Carmichael

Leland Property
Leland, Leelanau County

Purpose	Status	Acres
Long-term lease to Leland Township	Active	0.700

Administrator	Comment
Land Management Office	None

MacCready Forest and Wildlife Reserve
Clark Lake, Jackson County

Purpose	Status	Acres
Wildlife and forestry demonstration	Active	408.000

Administrator	Comment
Department of Forestry Department of Fisheries & Wildlife Land Management Office	None

Management Education Center
Troy, Oakland County

Purpose	Status	Acres
Advanced management training center	Active	24.327

Administrator	Comment
College of Business	Manager: Tom Freed None

Martin Property (Rose-Dell Seed Orchard)
Calhoun County

Purpose	Status	Acres
Tree seed orchard and demonstration site	Active Proceeds from leases and timber sales to be used for farm maintenance and scholarships	160.000

Administrator	Comment
Department of Forestry Land Management Office	None

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Mason Research Farm
Mason, Ingham County

Purpose	Status	Acres
Cereal grains and soybean research	Active	117.000

Administrator	Comment
Department of Crop & Soil Sciences Land Management Office	None

Michigan State University Campus
East Lansing, Ingham County

Purpose	Status	Acres
Research, education, and outreach	Active	5,195.225

Montcalm Experimental Farm
Lakeview, Montcalm County

Purpose	Status	Acres
Potato production research and cash crops	Active	57.250

Administrator	Comment
Department of Crop & Soil Sciences Land Management Office	Agricultural Research Station Coordinator: Dr. Dave Douches Farm Manager: Bruce Sackett

Morris Property
Grand Ledge, Clinton and Eaton Counties

Purpose	Status	Acres
Income generating property to fund endowments established by David and Betty Morris	Active	1,531.000

Administrator	Comment
Land Management Office	Long-term crop lease restricts near-term sale of property; includes eight residential leased properties, cell tower lease, research crop lease, billboard lease, and option to the Grand Ledge School District

MSU Sailing Club
Haslett, Ingham County

Purpose	Status	Acres
Sailing and wind surfing lessons	Active	0.760

Administrator	Comment
Intramural Sports and Recreatvie Services	None

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Muck Soils Research Farm
Laingsburg, Clinton County

Purpose	Status	Acres
Organic soil vegetable and crops research	Active	447.048

Administrator	Comment
Department of Crop & Soil Sciences	Agricultural Research Station
Land Management Office	Coordinator: Dr. Doug Buhler
	Farm Manager: Mitch Fabis

River Terrace Property
East Lansing, Ingham County

Purpose	Status	Acres
Investment	Active	1.210

Administrator	Comment
Land Management Office	None

Rogers Reserve
Jackson, Jackson County

Purpose	Status	Acres
Botantical and horticultural sciences	Active	115.850
research and teaching		

Administrator	Comment
Department of Plant Pathology	Coordinator: Dr. Dennis Fulbright
Land Management Office	

Russ Forest Experiment Station
Decatur, Cass County

Purpose	Status	Acres
Forestry plantings and genetics research	Active	938.750
Demonstration and public use	Title restricted on 269 acres	
	Land to be used for educational purposes	

Administrator	Comment
Department of Forestry	Agricultural Research Station
Land Management Office	Coordinator: Dr. David MacFarlane
	Non-Resident Forestor: Greg Kowalewski

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Saginaw Valley Research and Extension Center
Frankenmuth, Saginaw and Tuscola Counties

Purpose	Status	Acres
Dry bean, sugar beet, and crop research research, outreach, and teaching	Active	249.520

Administrator	Comment
Department of Crop & Soil Sciences	Agricultural Research Station
Land Management Office	Coordinator: Dr. James Kelly
	Farm Manager: Paul Horny

Southwest Michigan Research and Extension Center
Benton Harbor, Berrien County

Purpose	Status	Acres
Horticultural research and extension center	Active	350.000

Administrator	Comment
Department of Horticulture	Agricultural Research Station
Cooperative Extension Service	Coordinator: Dr. Thomas Zabadal
Land Management Office	Farm Manager: Dave Francis

Stranahan-Bell (WaWaSum)
Grayling, Crawford County

Purpose	Status	Acres
Inland stream and reforestation research Small conference center	Active	251.000

Administrator	Comment
Land Management Office	None

Stuckman Property
St. Johns, Clinton County

Purpose	Status	Acres
Educational and or research	Active	40.000

Administrator	Comment
Land Management Office	MOU on file in Land Management Office

Real Property Holdings - Inventory

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Sycamore Creek
Holt, Ingham County

Purpose	Status	Acres
Support campus water managemetn plan; controlled access to Sycamore Creek flood plain	Active Title restricted on 52 acres Deed covenants restrict use	54.500

Administrator	Comment
Land Management Office	None

Tollgate Education Center
Novi, Oakland County

Purpose	Status	Acres
Agricultural and environmental education and leadership training	Active	56.675

Administrator	Comment
Cooperative Extension Service Land Management Office	Farm Manager: Roy Prentice

Trevor Nichols Research Complex
Fennville, Allegan County

Purpose	Status	Acres
Fruit pest research	Active	156.100

Administrator	Comment
Department of Entomology Land Management Office	Agricultural Research Station Coordinator: Dr. John Wise Farm Manager: Matt Daly

Upper Peninsula Experiment Station
Chatham, Alger County

Purpose	Status	Acres
Dairy, forestry, and crops research	Active	1,262.227

Administrator	Comment
Department of Animal Science Land Management Office	Agricultural Research Station Coordinator: Dr. Herb Bucholtz Farm Manager: Paul Naasz

VanHoosen Property
Rochester, Oakland County

Purpose	Status	Acres
Long-term lease to Avon Players	Active	1.793

Administrator	Comment
Vice President for Finance and Operations Land Management Office	Remaining land of Sarah Van Hoosen gift acquired in 1956

Total Acres: 25,412.980

Real Property Holdings - Agricultural Research Stations

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Agricultural Research Stations owned by MSU

Clarksville Horticultural Experiment Station
9302 Portland Road
Clarksville, MI 48815

Forest Biomass Innovation Center
6005 J. Road
Escanaba, MI 49829

Kellogg, W.K. Experimental Forest
7060 N. 42nd Street
Augusta, MI 49012

Montcalm Experimental Farm
4747 McBride Road
Lakeview, MI 48850

Russ Forest Experiment Station
20673 Marcellus Highway
Decatur, MI 49045

Southwest Michigan Research and
Extension Center
1781 Hillandale Road
Benton Harbor, MI 49022

Upper Peninsula Experiment Station
E3774 University Drive
P.O. Box 168
Chatham, MI 49816

Dunbar Forest Experiment Station
12839 S. Scenic Drive
Sault Ste. Marie, MI 49783

Kellogg, W.K. Biological Station
3700 E. Gull Lake Drive
Hickory Corners, MI 49060

Lake City Experiment Station
5401 W. Jennings Road
Lake City, MI 49651

Muck Soils Research Farm
Route 3
9370 E. Herbison Road
Laingsburg, MI 48848

Saginaw Valley Research
and Extension Center
9923 Krueger Road
Frankenmuth, MI 48734

Trevor Nichols Research Complex
6237 124th Avenue
Fennville, MI 49408

Agricultural Research Stations leased by MSU

Northwest Michigan Horticultural
Experiment Station
6686 S. Center Highway
Traverse City, MI 49684

Real Property Holdings - Land Acquisition by Decade

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

	Acres	
	Campus	Off-Campus
Prior to 1920	1,026.380	1,060.327
1920's	564.350	2,007.112
1930's	284.614	795.026
1940's	1,605.236	6,281.322
1950's	1,266.862	862.190
1960's	767.850	2,417.390
1970's	188.747	861.049
1980's	13.943	3,265.245
1990's	66.338	1,775.765
2000's	1.069	1,566.310
2010's	0.000	1,573.140

Real Property Holdings - Land Available for Agricultural Research

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Off-Campus	**Acres**
13 Outlying Stations (owned)	15,937.825
1 Outlying Station (leased)	100.000
Dobie Road Property, Okemos	114.431
Off-Campus owned land used for agricultural research (Not designated as a research station)	1,146.350
Off-Campus leased land used for agricultural research	264.000
Campus	
Land used for agricultural research - south of Mt. Hope	2,733.249
Total Acres:	**20,295.855**

Real Property Holdings - Warranty Deeds to State Building Authority

MICHIGAN STATE UNIVERSITY

As of July 1, 2010

The following parcels have been or will be deeded to and leased back from the State Building Authority, for financing pursuant to earlier Board of Trustees approval.

- Anthony Hall Dairy Plant and Meats Lab
- Biomedical and Physical Sciences Building
- Diagnostic Center for Population and Animal Health
- Chemistry Building Renovation Project

The following parcels have been deeded to the State of Michigan, pursuant to Board of Trustees approval, in connection with a State of Michigan financing of improvements. A written agreement obligates the State to deed the property back to MSU at a later date.

- The Geagley Laboratory

Real Property Holdings - Maps

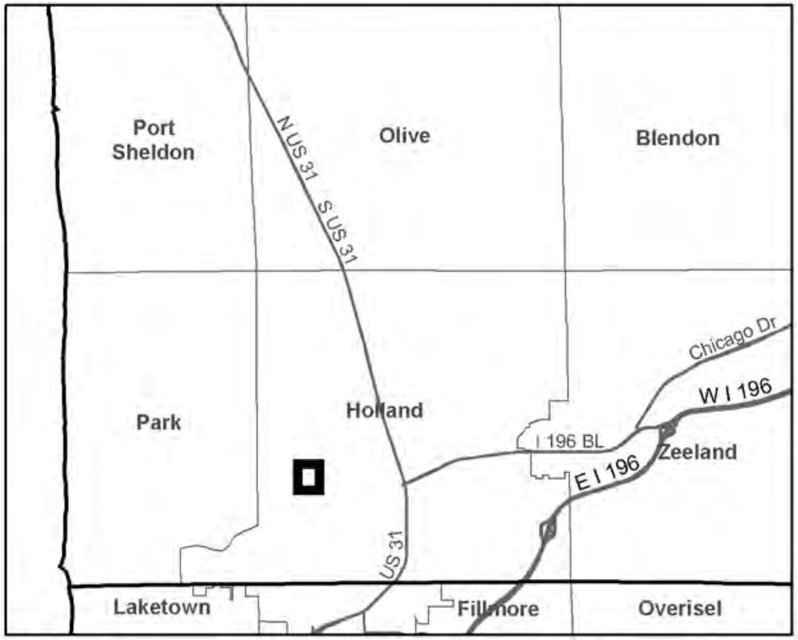
MICHIGAN STATE UNIVERSITY

As of July 1, 2010

Location Maps
of
Michigan State University Properties
Alphabetical by Name

BioEconomy Research and Development Center

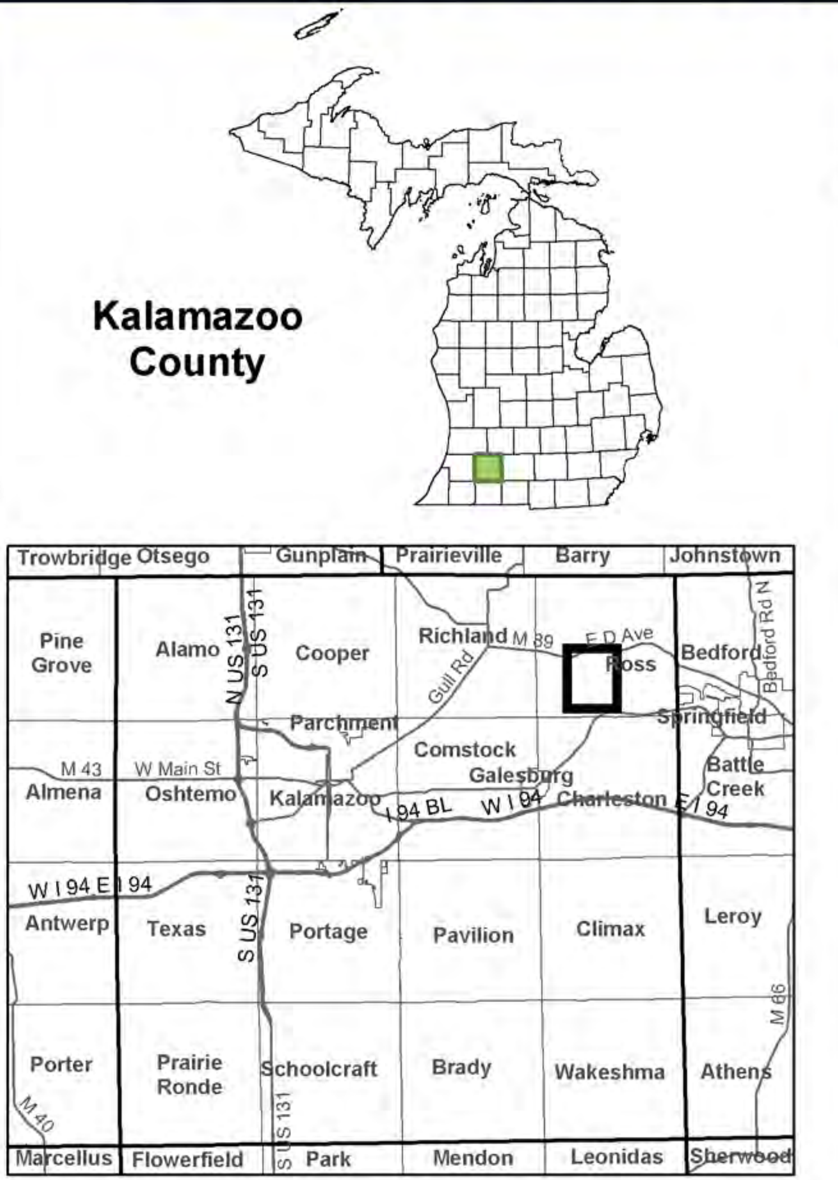
Holland Township, Section 19

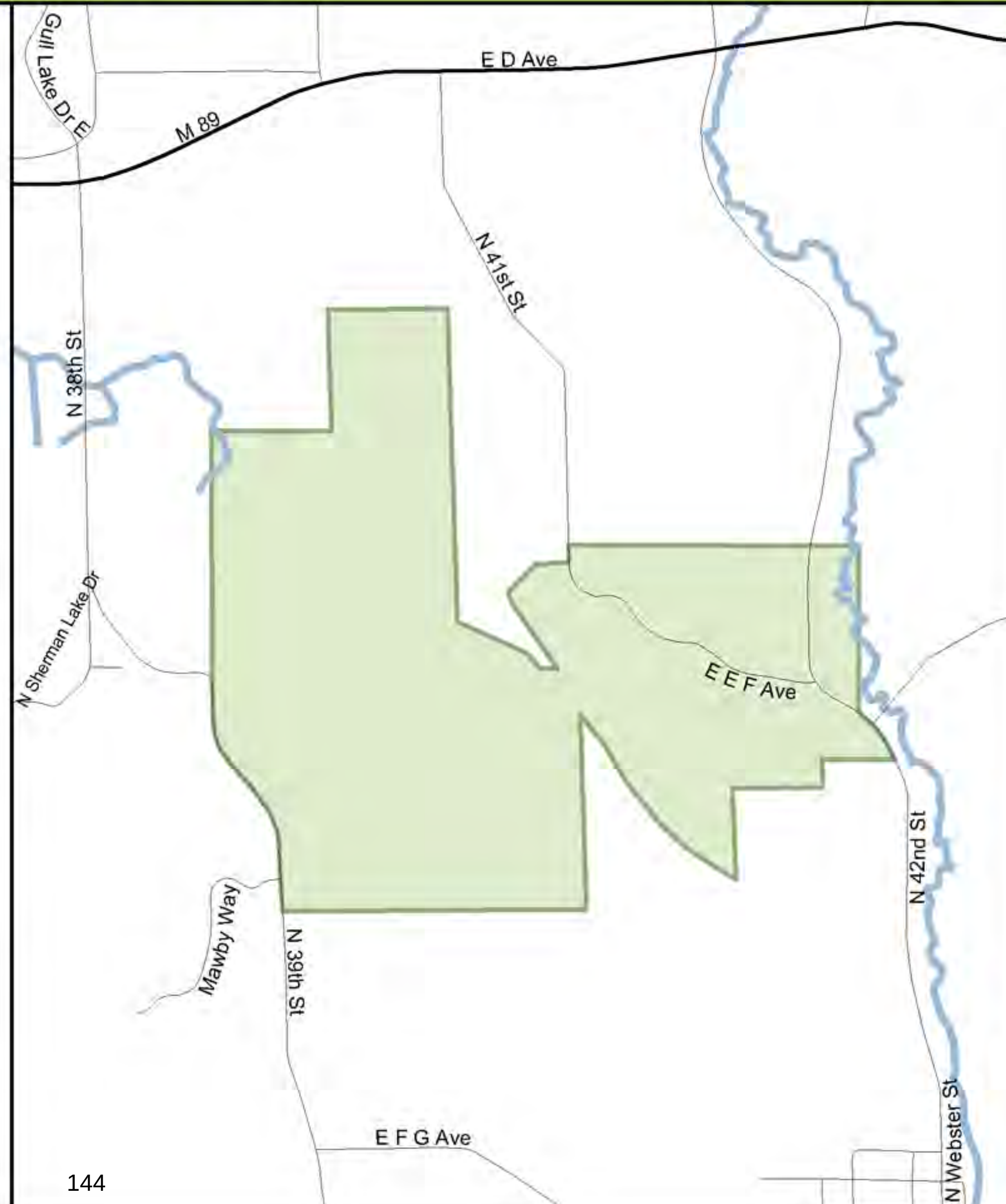


MSU Real Property

Brook Lodge

Ross Township, Section 21, 27, 28, and 29

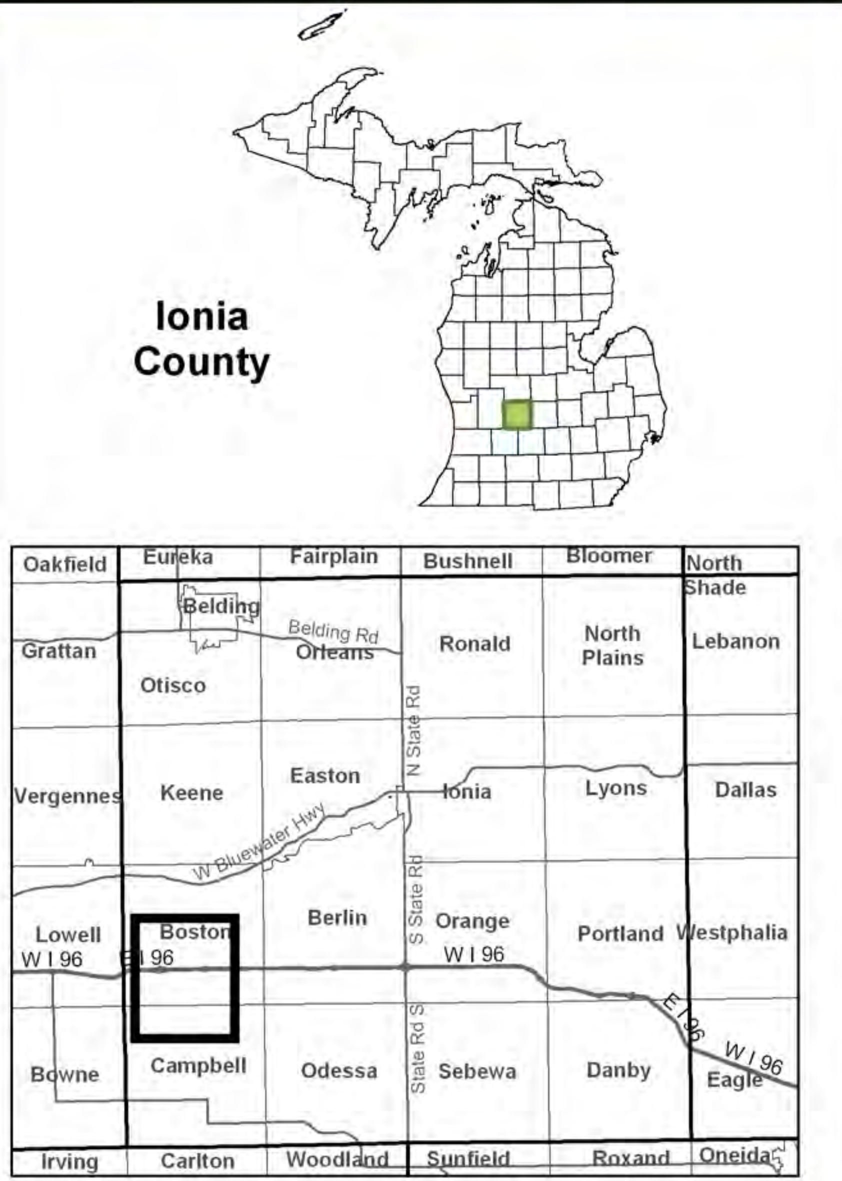




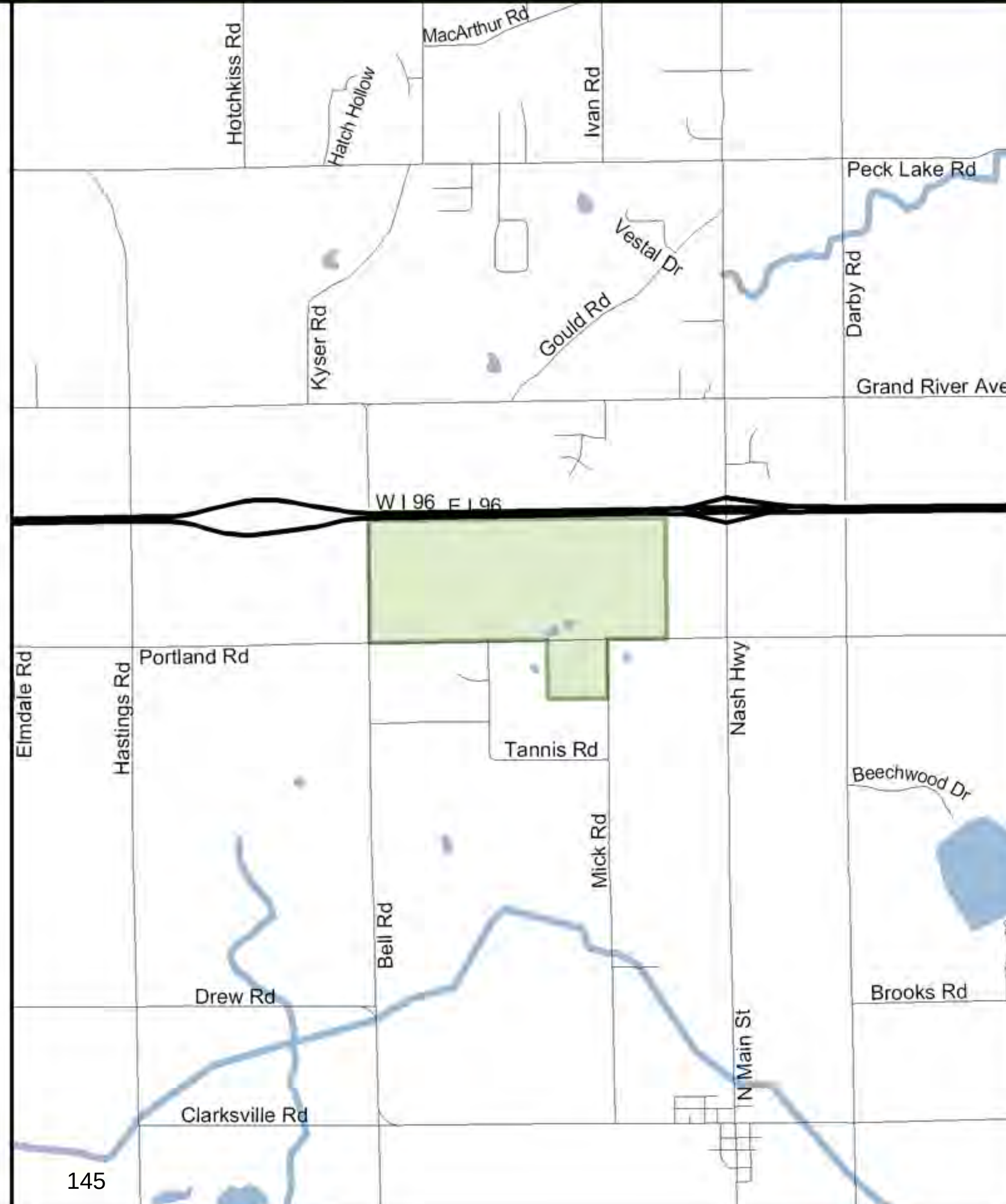
MSU Real Property

Clarksville Horticultural Experiment Station

Boston Township, Sections 27, 28, and 33



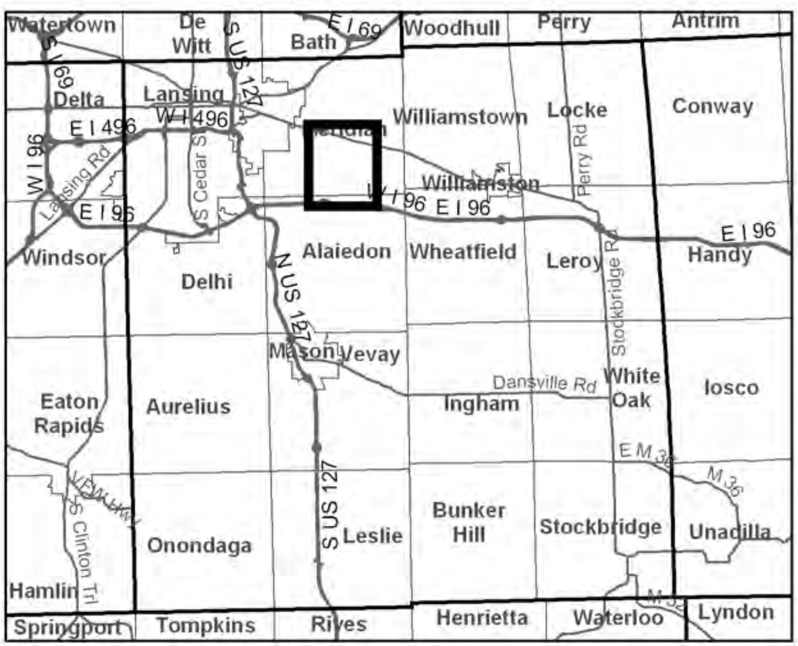
MSU Real Property



Dobie Road Property

Meridian Township, Section 27

Ingham County

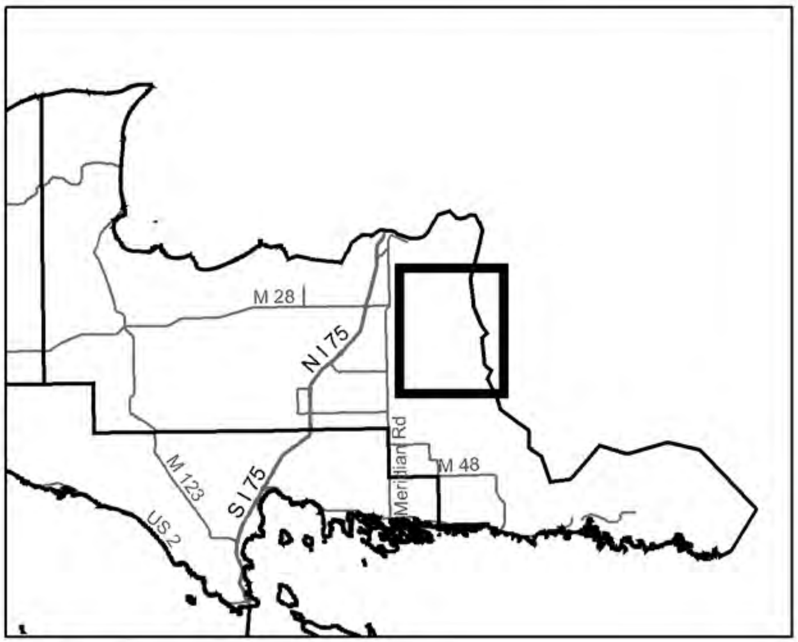


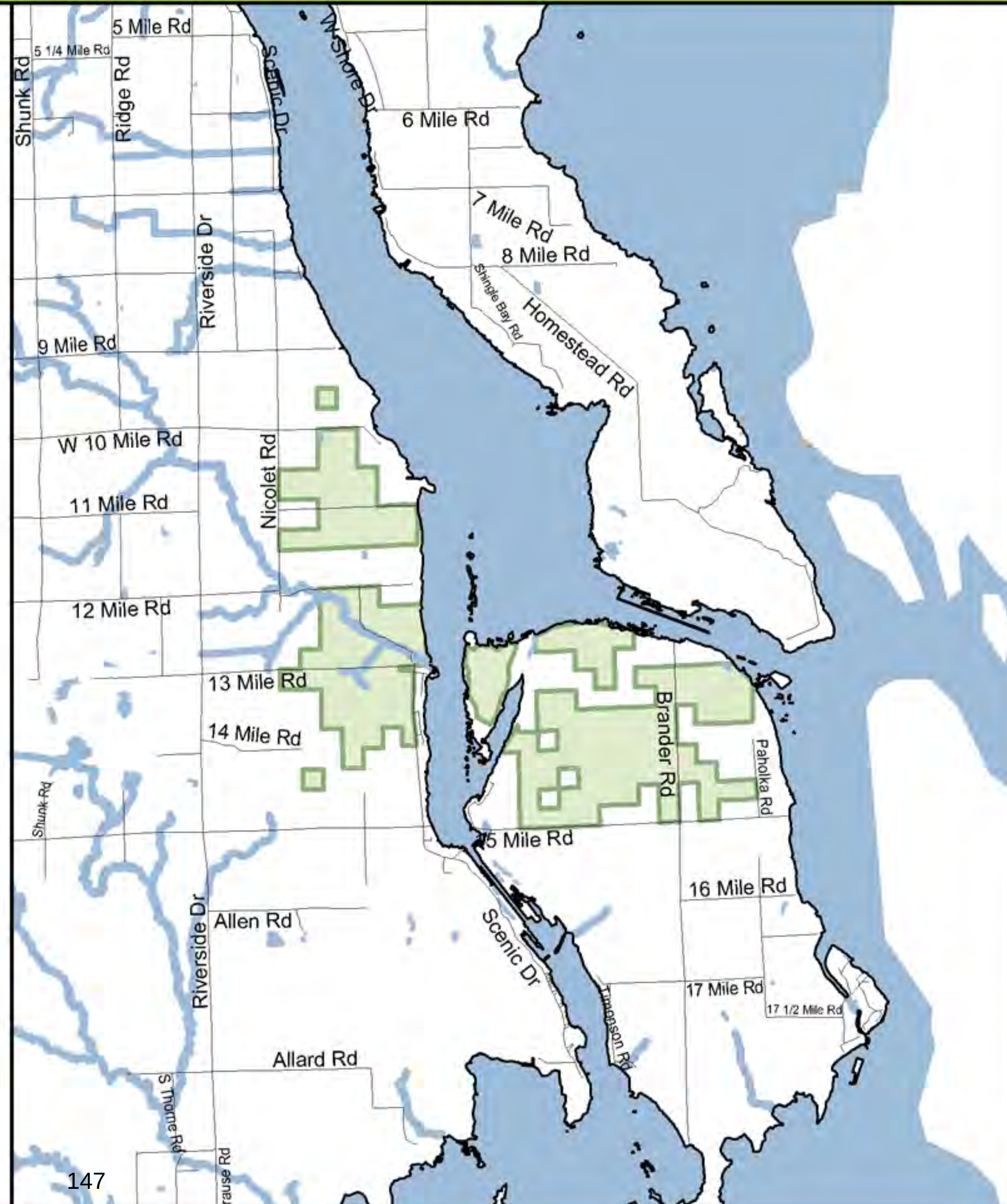
MSU Real Property

Dunbar Forest Experiment Station

Soo Township, Sections 3, 4, 5, 8, 9, 10, 11, 14, 15, and 16; Bruce Township, Sections 1, 6, 7, 12, 13, 24, 25, 30, 31, and 36

Chippewa County

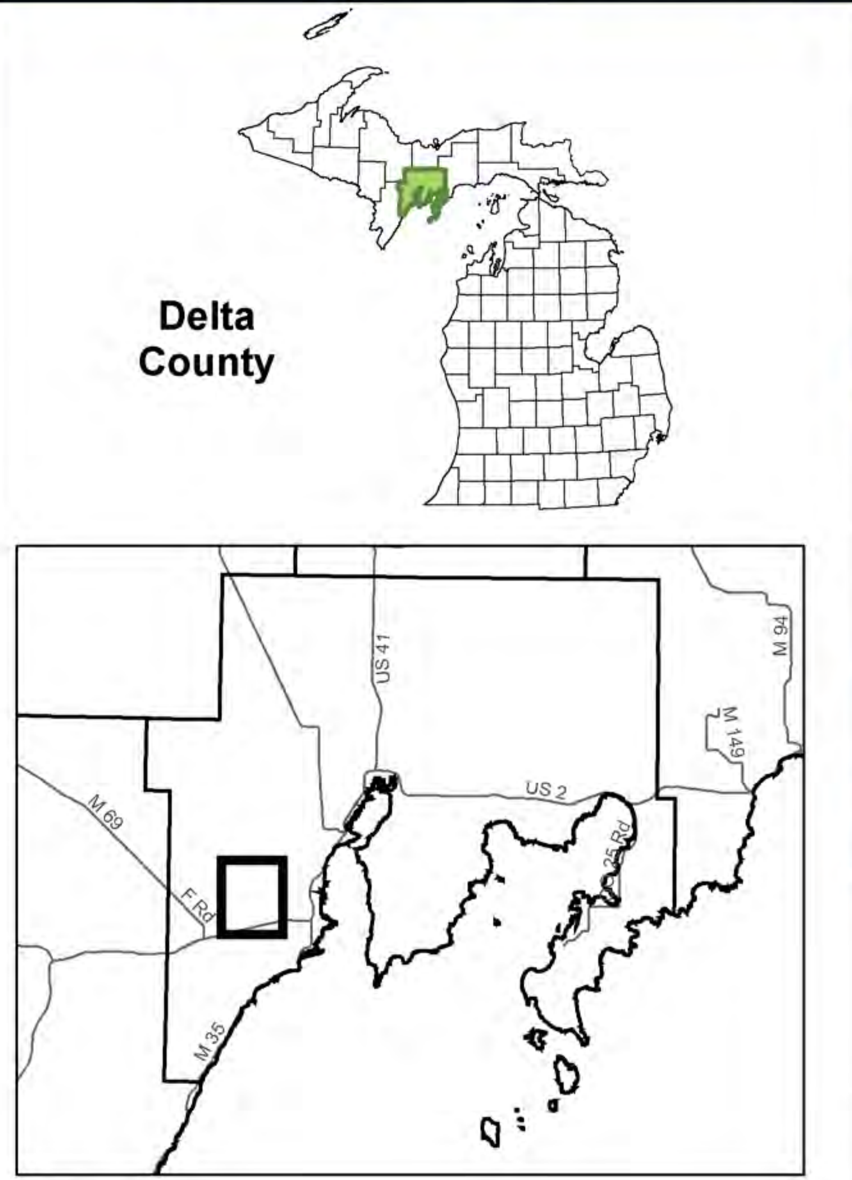


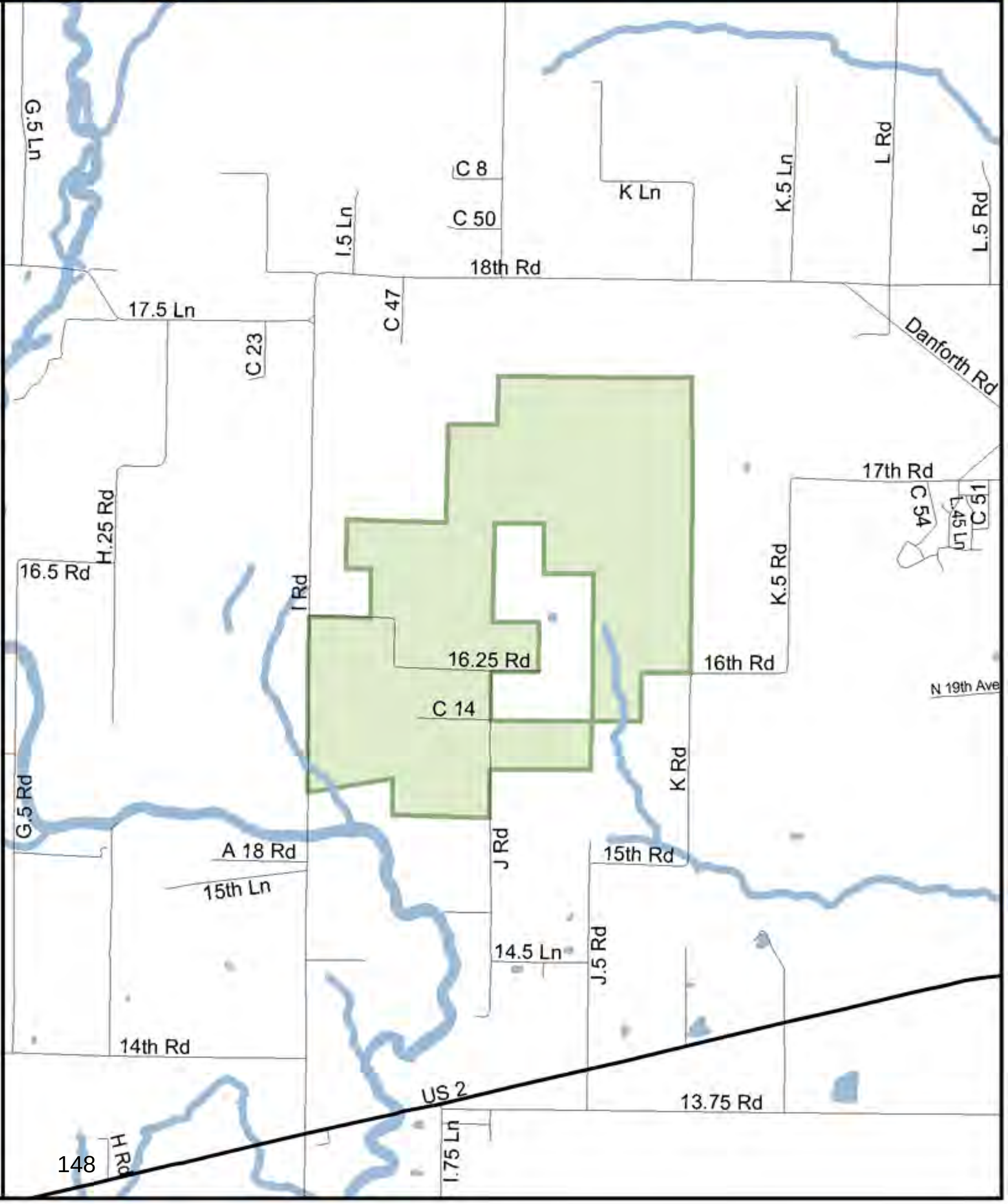


MSU Real Property

Forest Biomass Innovation Center

Wells Township, Sections 8, 17, 18, 19, and 20

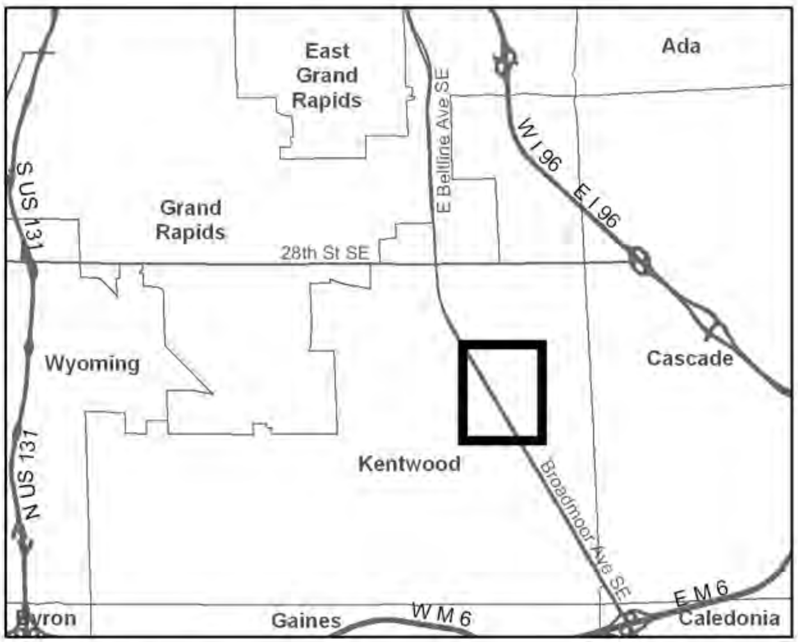




MSU Real Property

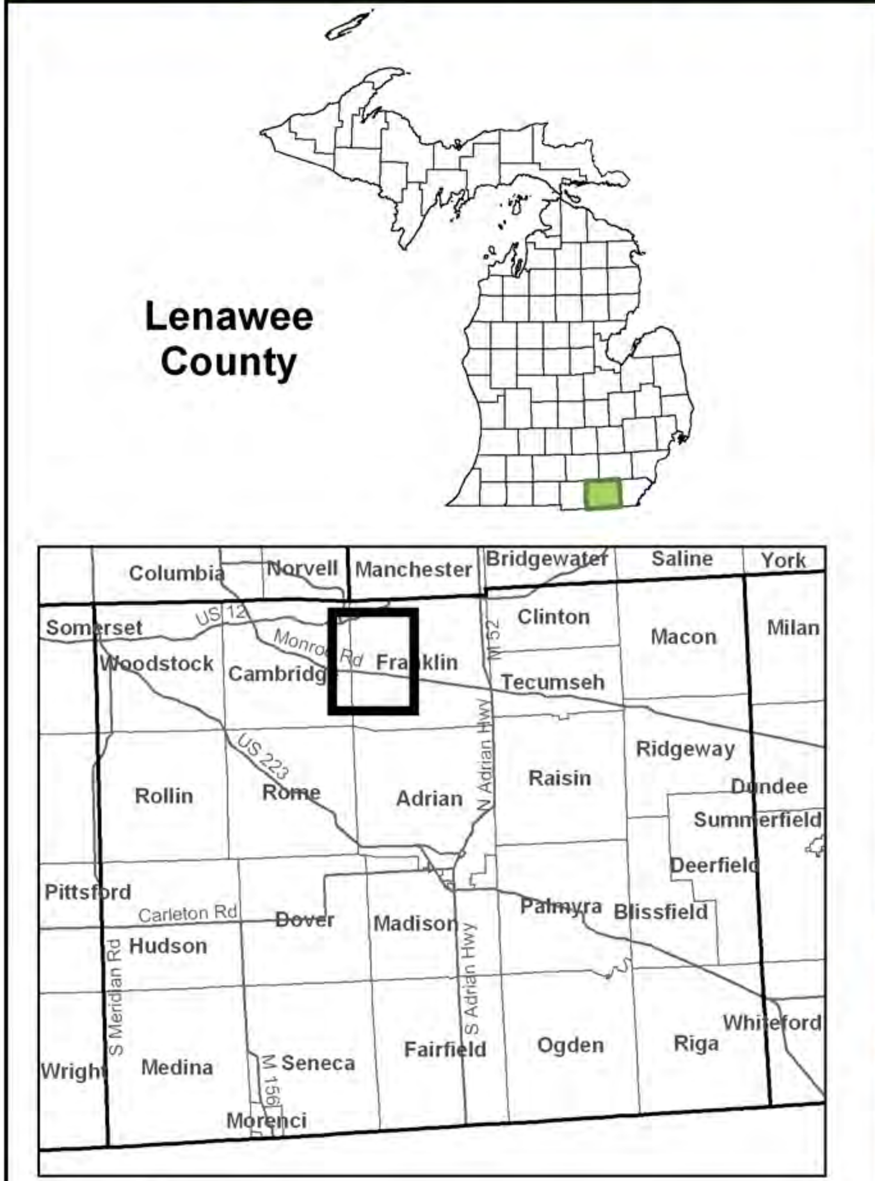
Gantos Property

Kentwood Township, Section 23



Hidden Lake Gardens

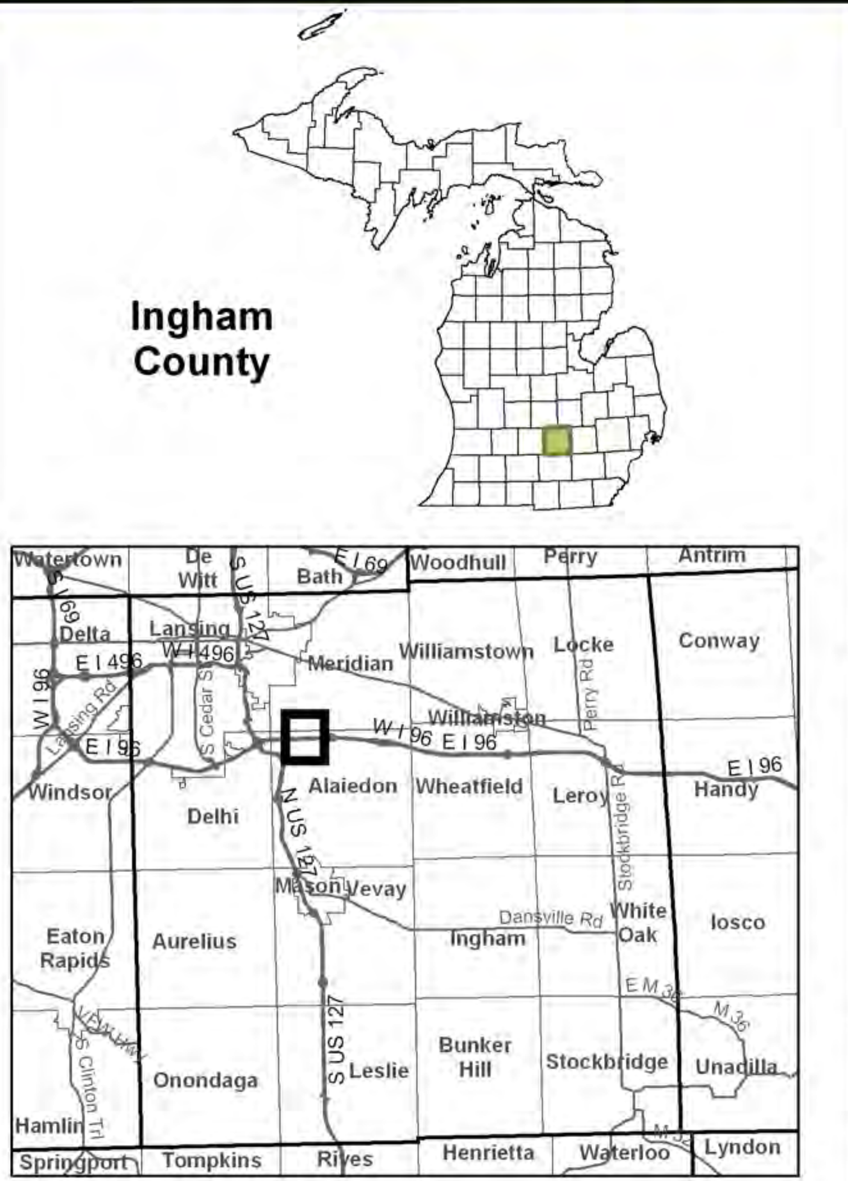
Franklin Township, Sections 17, 18, 19, and 20



MSU Real Property

Hulett Road Engineering

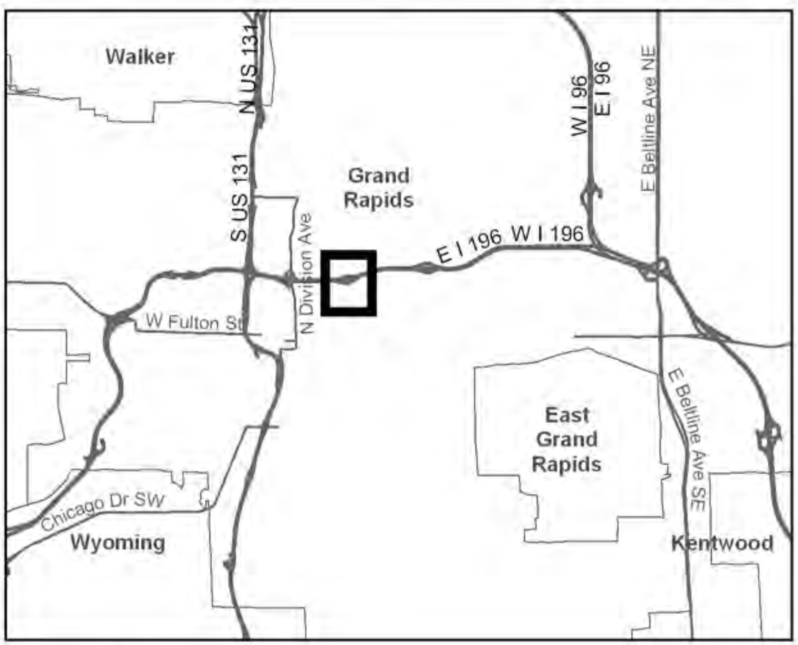
Alaiedon Township, Section 5



MSU Real Property

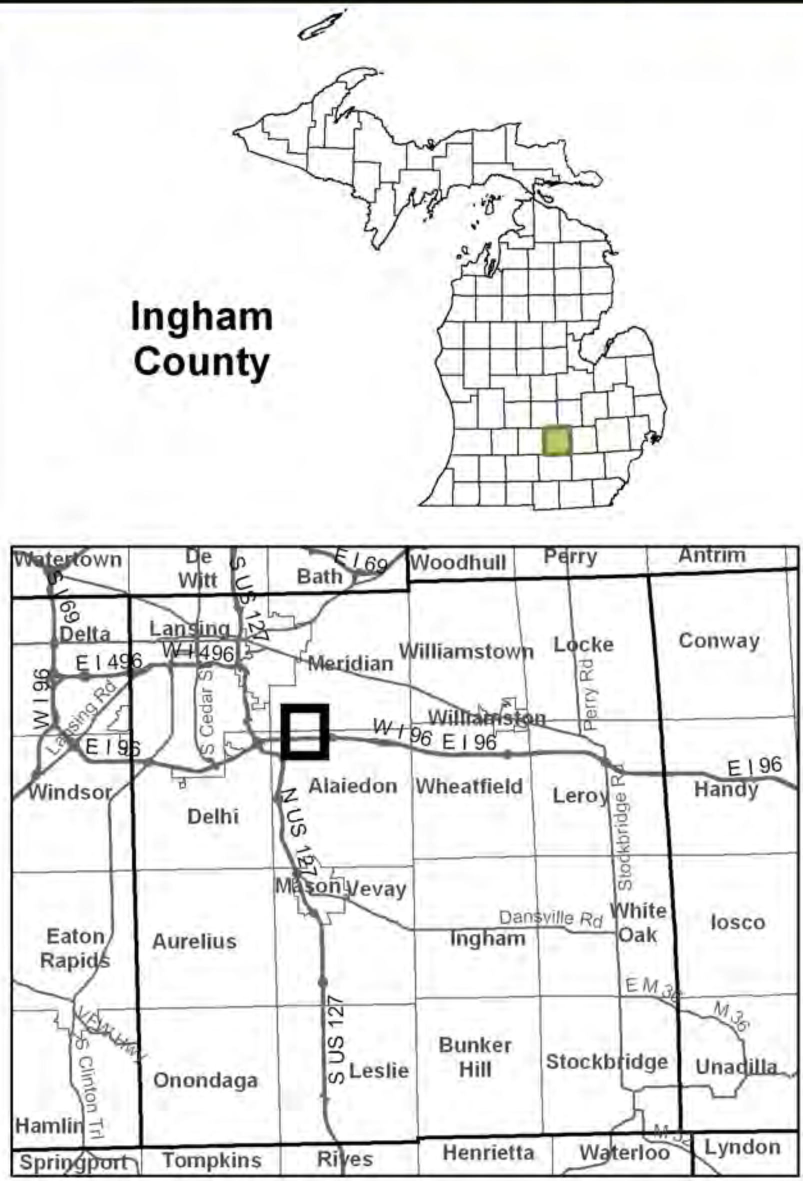
College of Human Medicine

Grand Rapids Township, Section 19



Jolly Road Engineering and Civil Infrastructure Lab

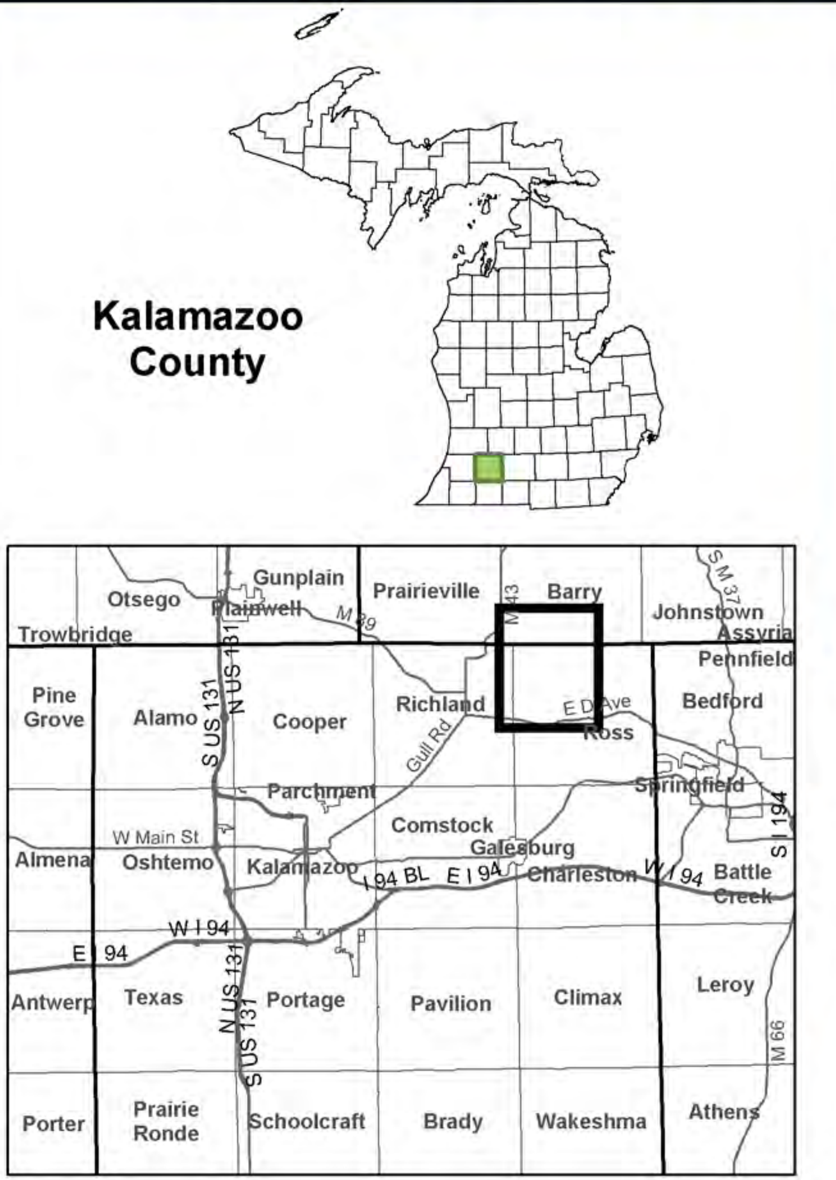
Alaiedon Township, Section 5



MSU Real Property

W.K. Kellogg Biological Station, Bird Sanctuary, and Farm

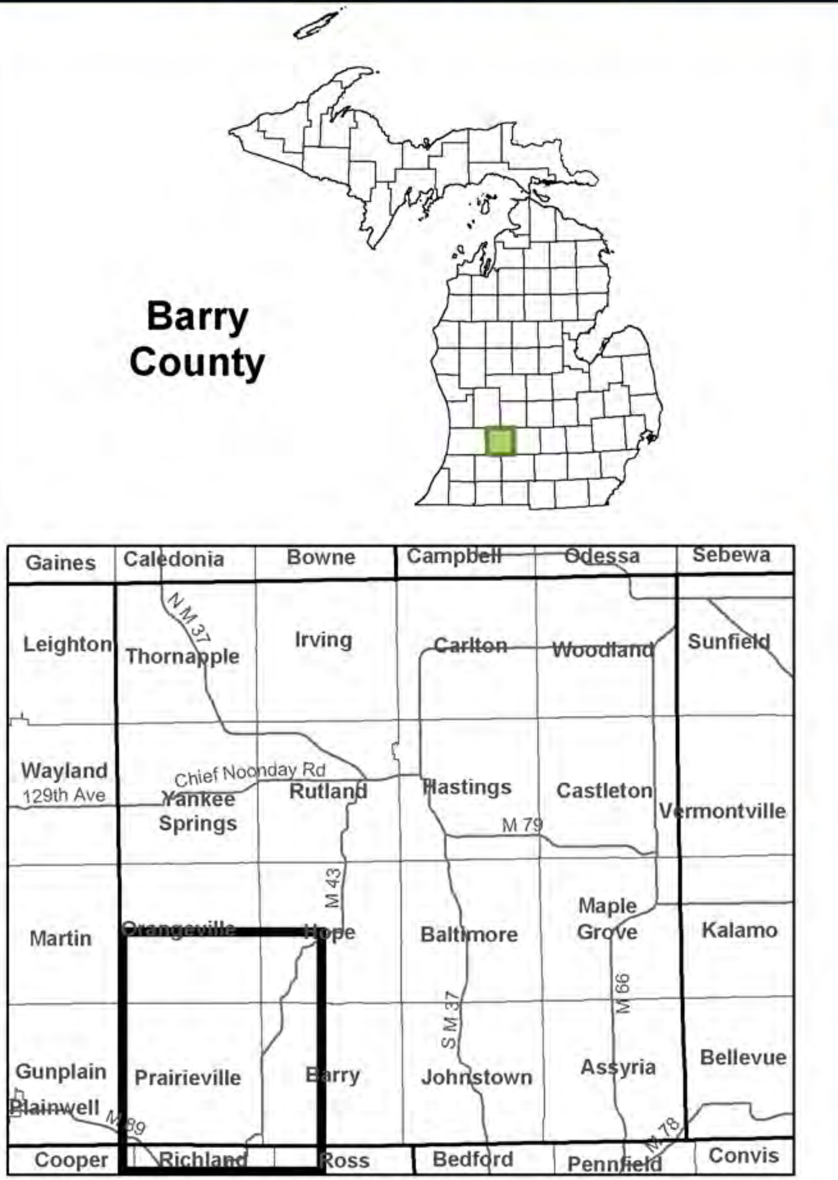
City of South Gull Lake and Ross Township, Sections 4, 5, 6, 8, and 9

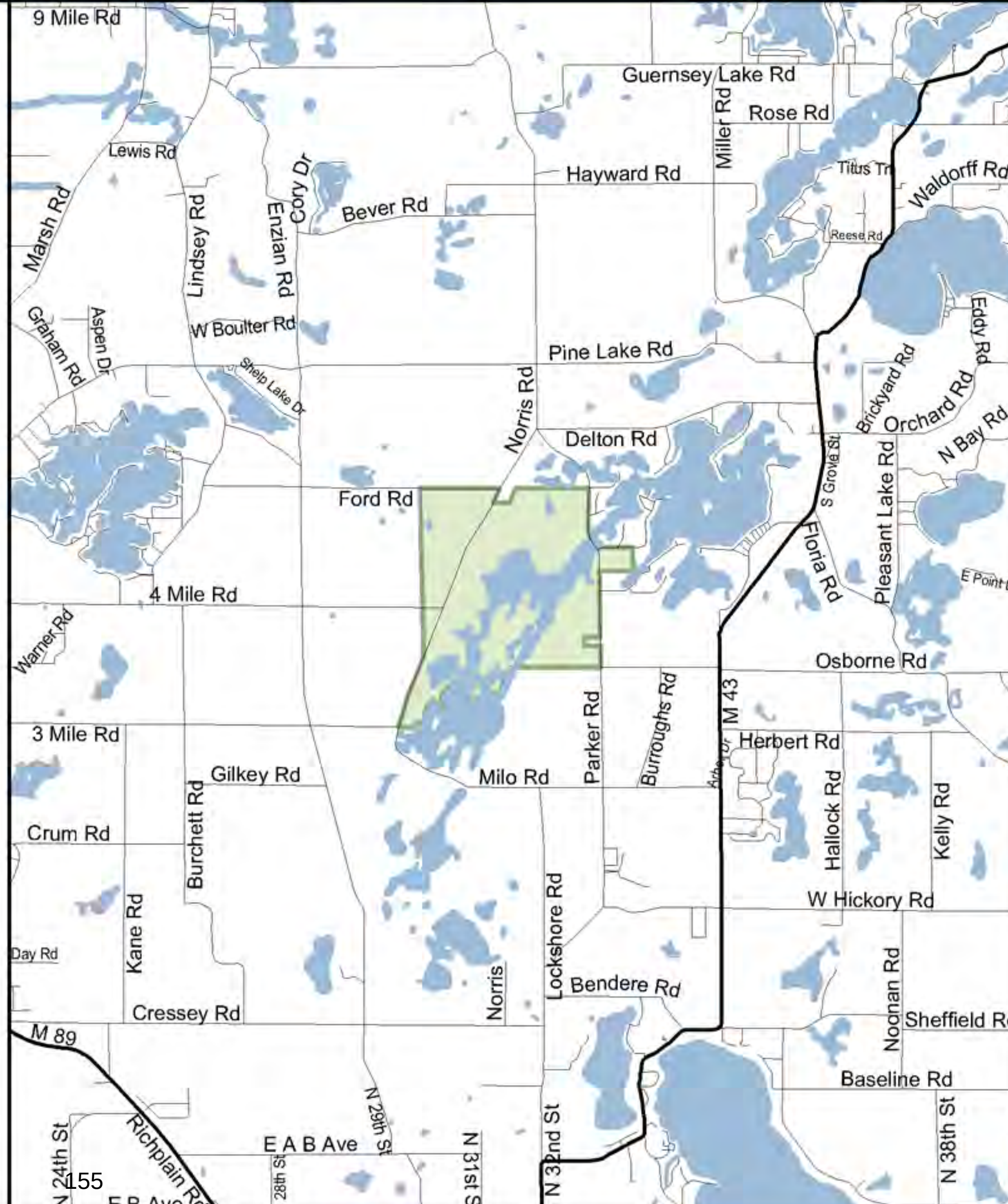


MSU Real Property

W.K. Kellogg Biological Station (Lux Arbor Reserve)

Prairieville Township, Sections 10, 11, 14, and 15



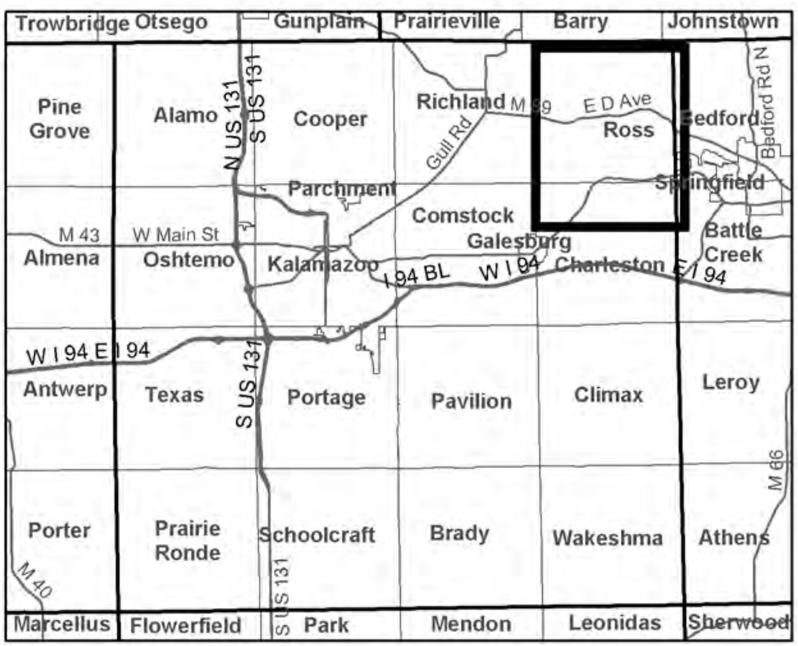


MSU Real Property

W.K. Kellogg Experimental Forest

Ross Township, Sections 21, 22, 27, and 28

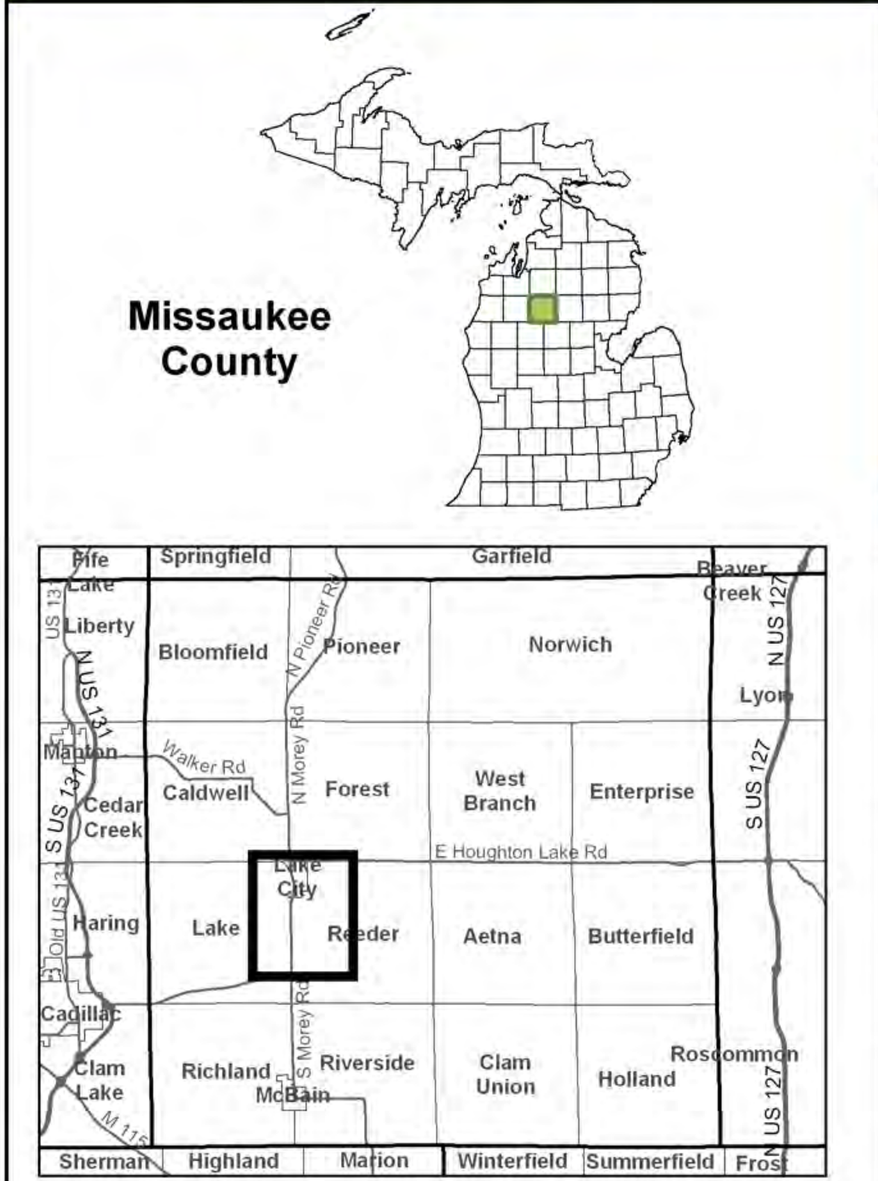
Kalamazoo County



MSU Real Property

Lake City Experiment Station

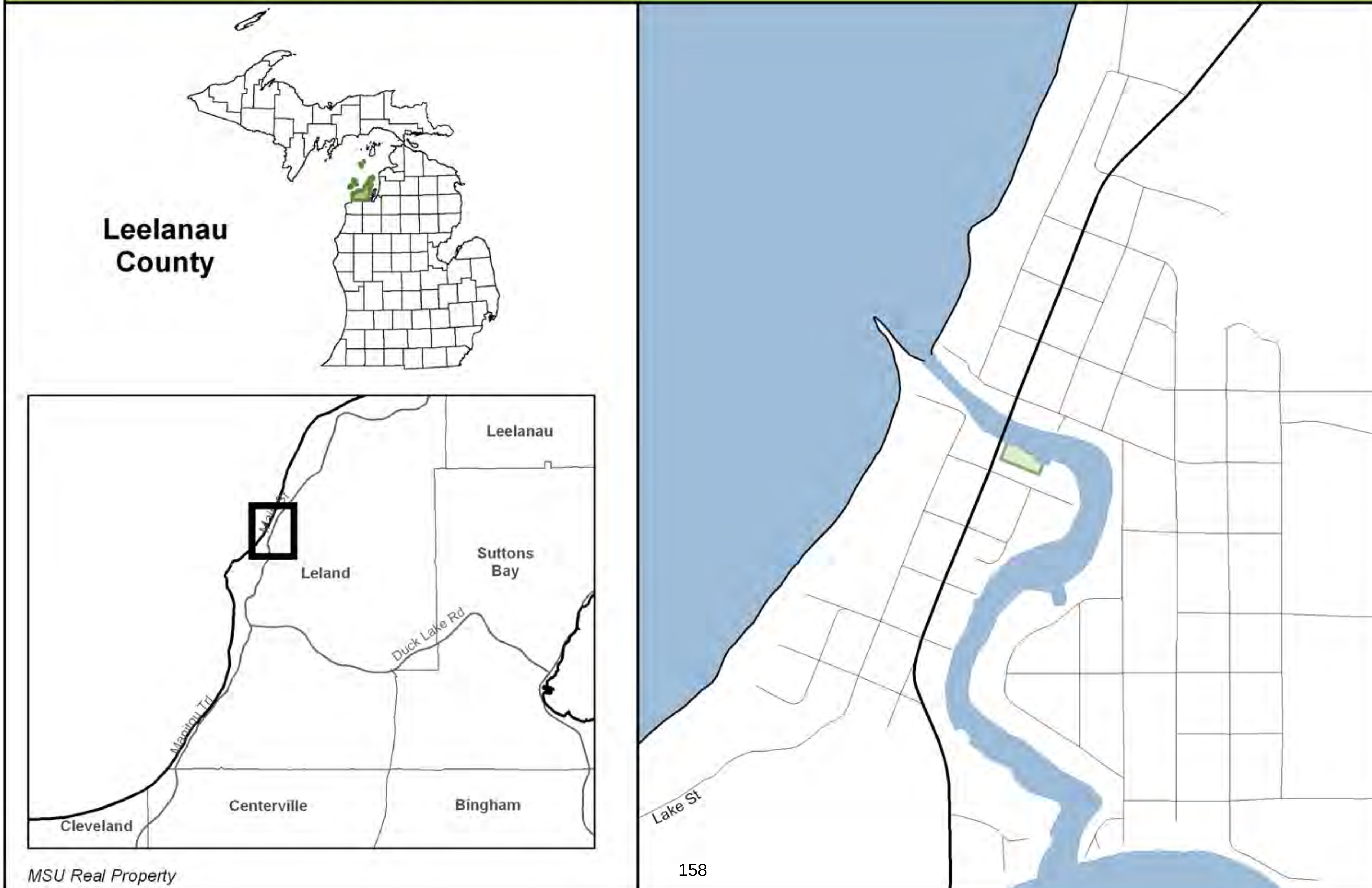
Reeder Township, Sections 7 and 18



MSU Real Property

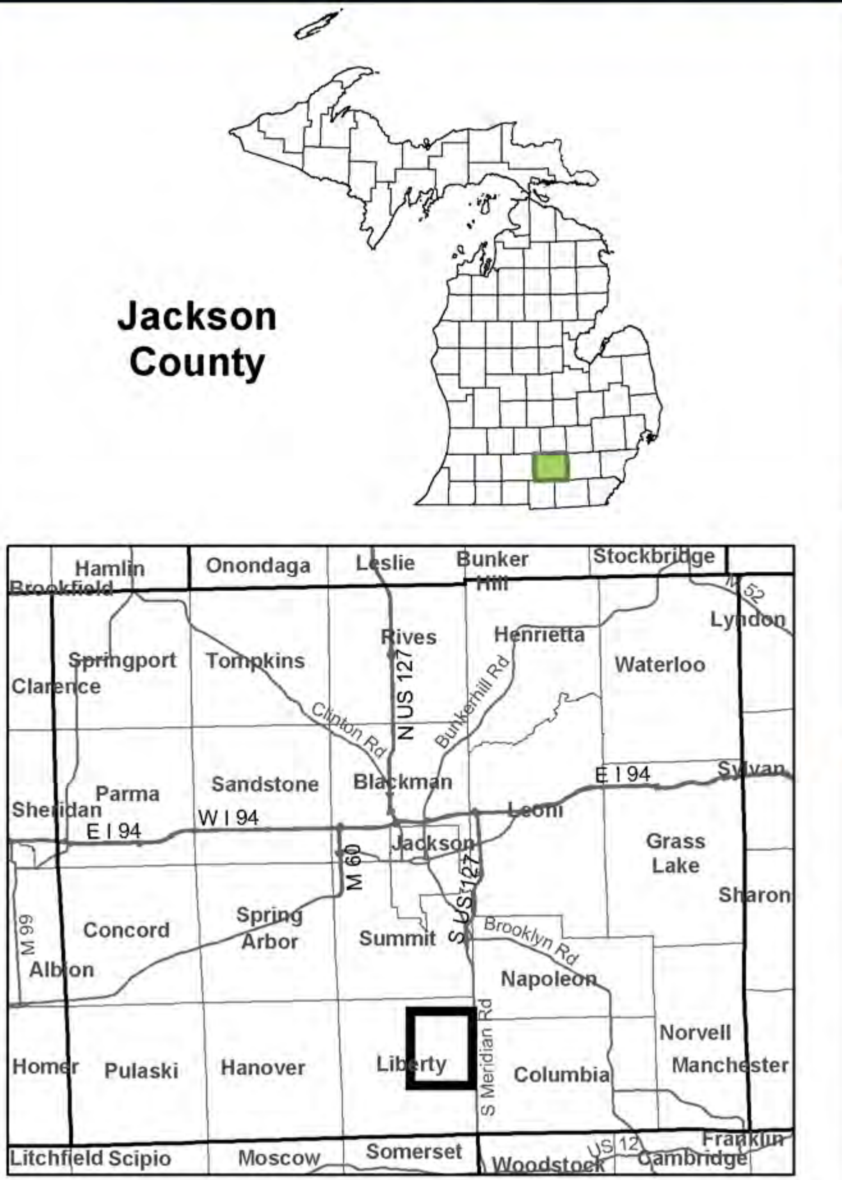
Leland Property

Leland Township, Section 9



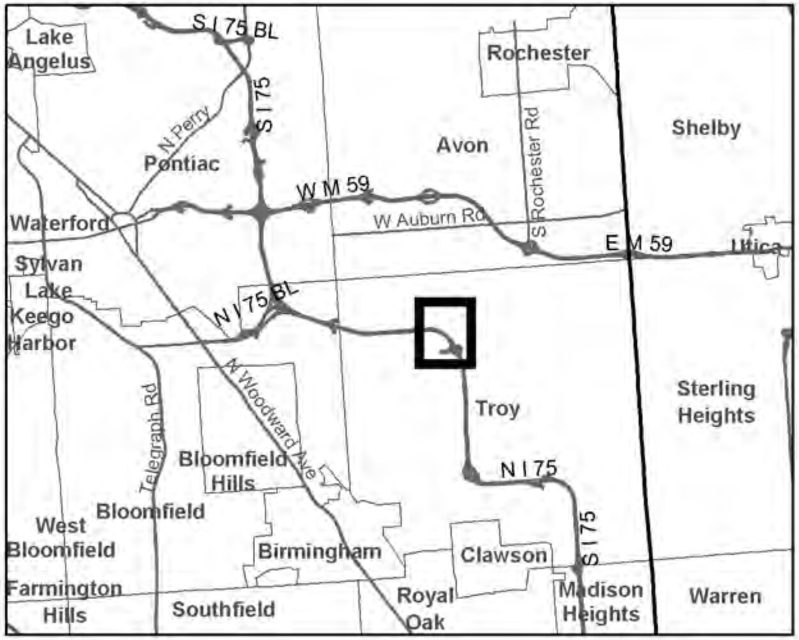
MacCready Forest and Wildlife Reserve

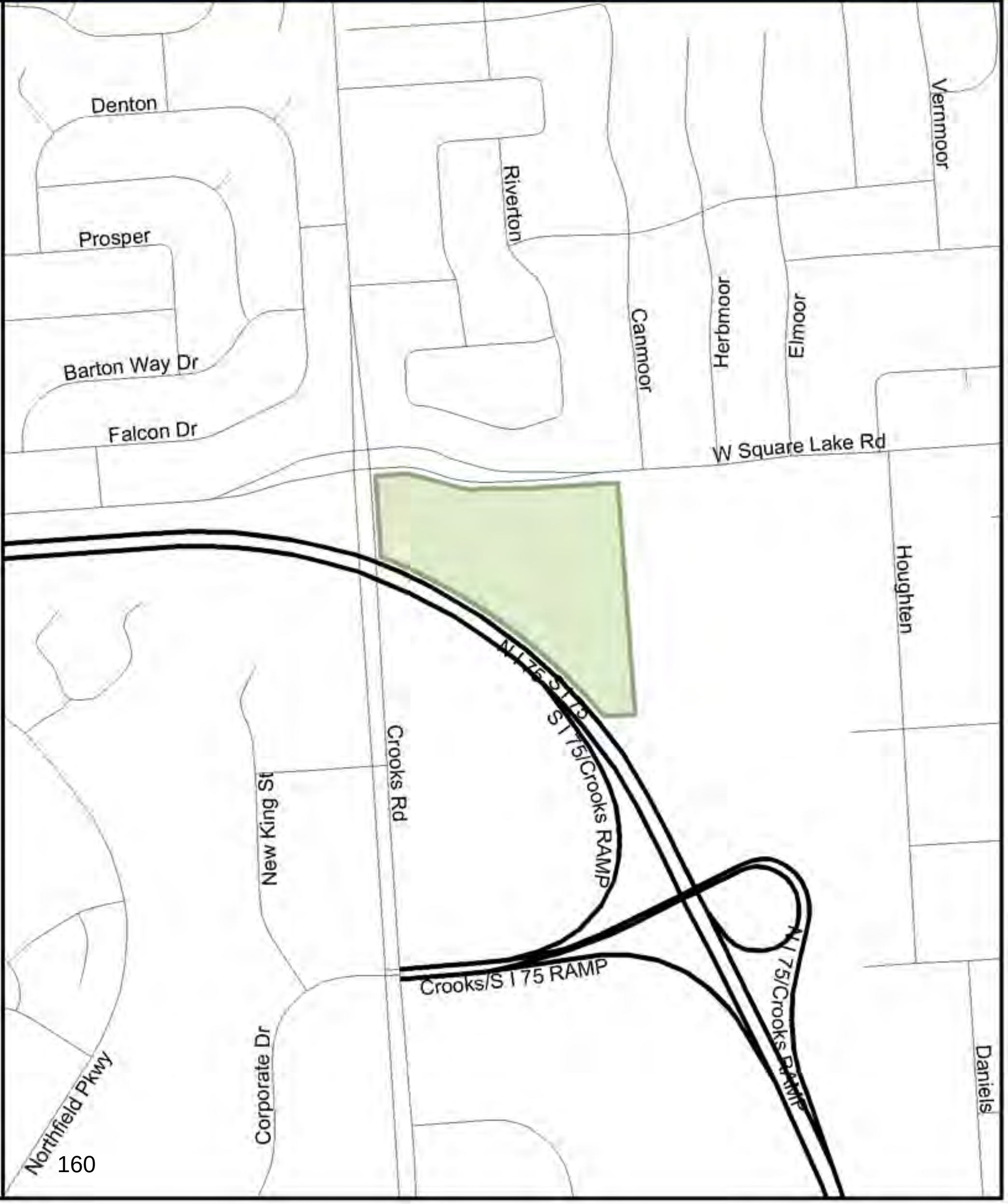
Liberty Township, Sections 11 and 14



Management Education Center, Troy

City of Troy, Section 9



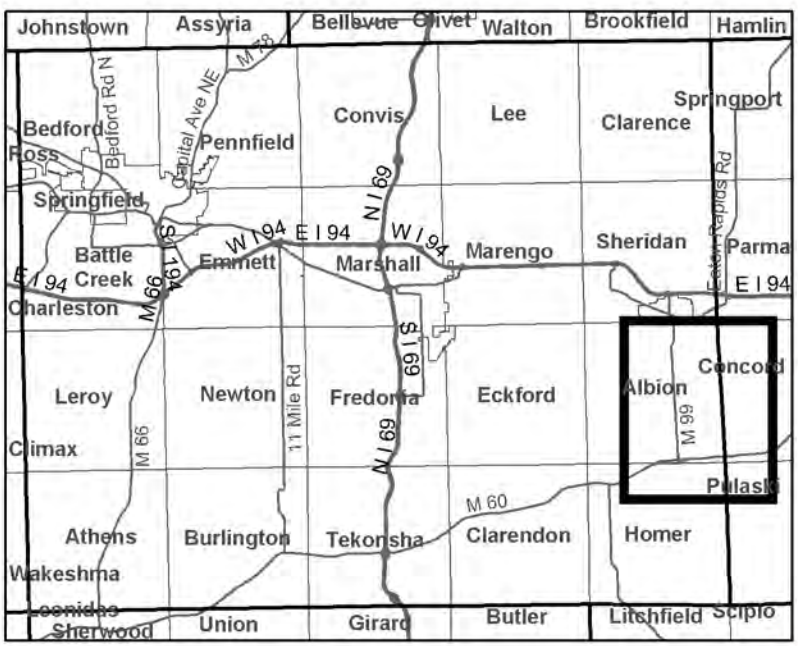


MSU Real Property

Martin Property (Rose-Dell Seed Orchard)

Albion Township, Sections 23 and 24

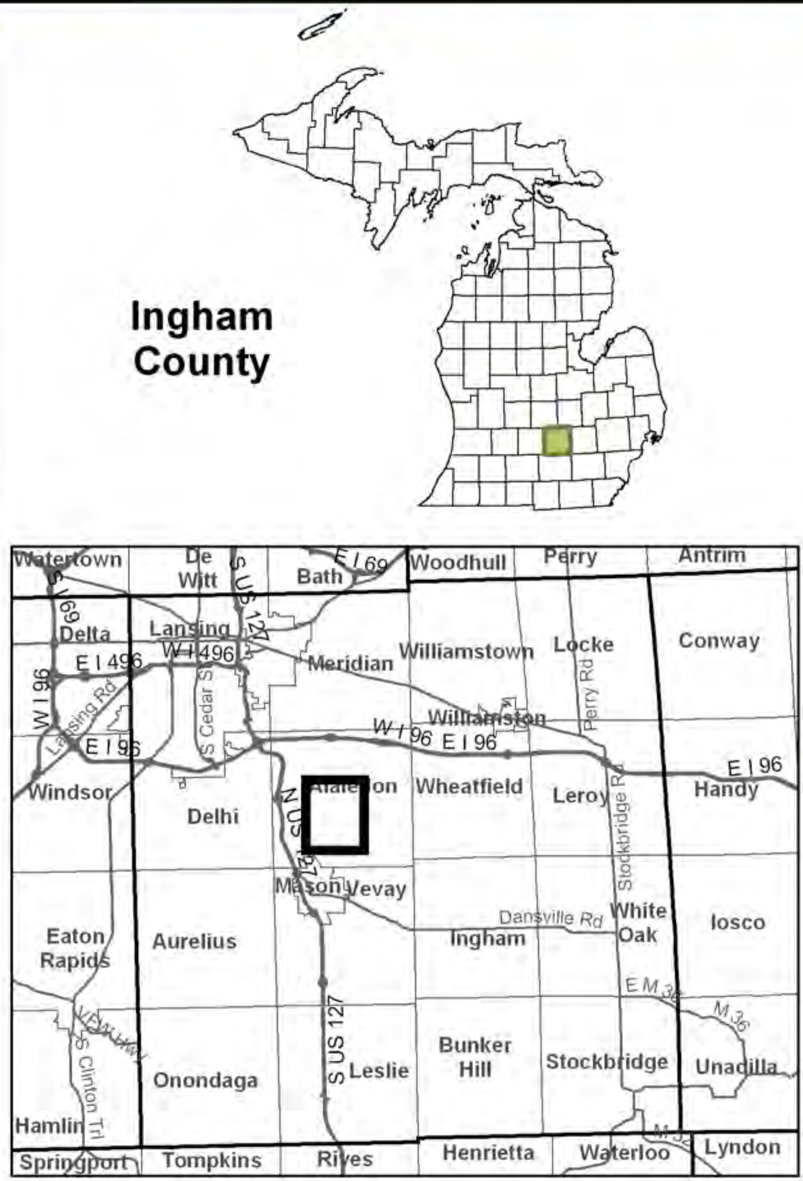
Calhoun County



MSU Real Property

Mason Research Farm

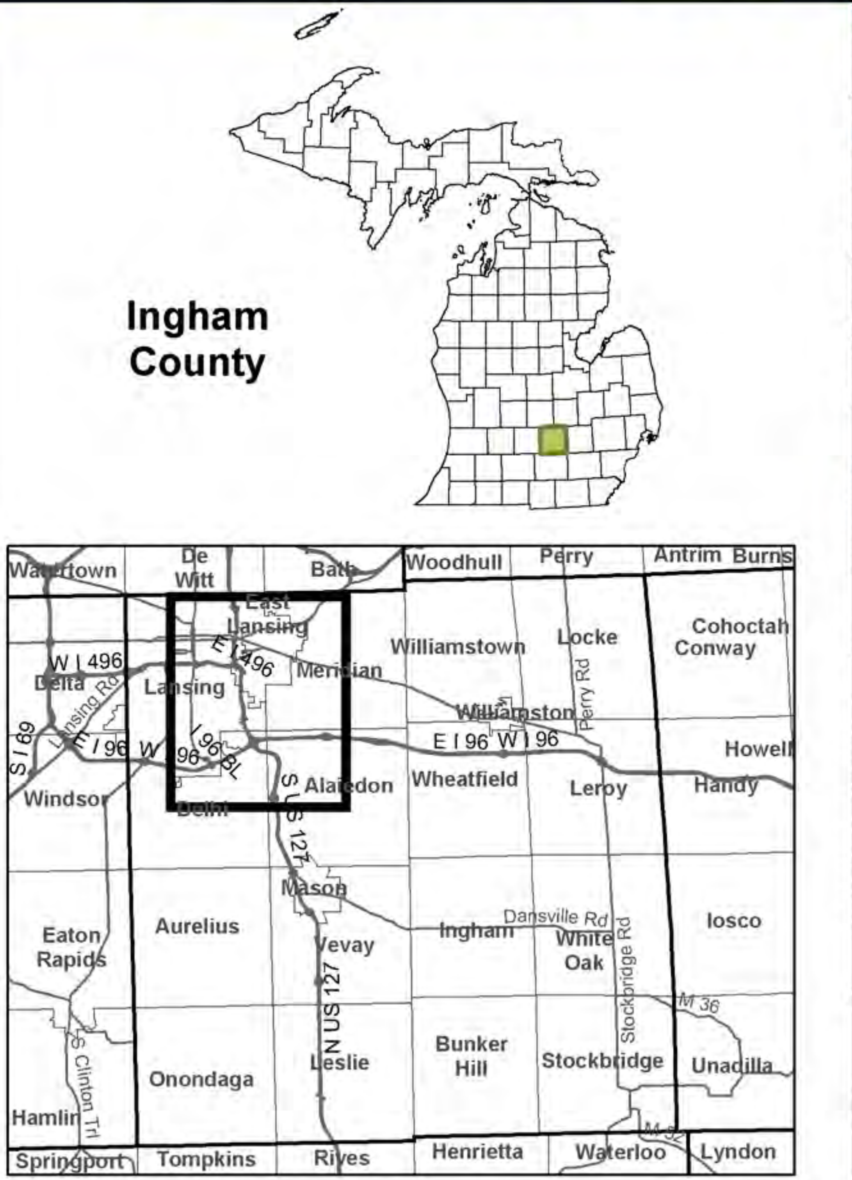
Alaiedon Township, Section 21



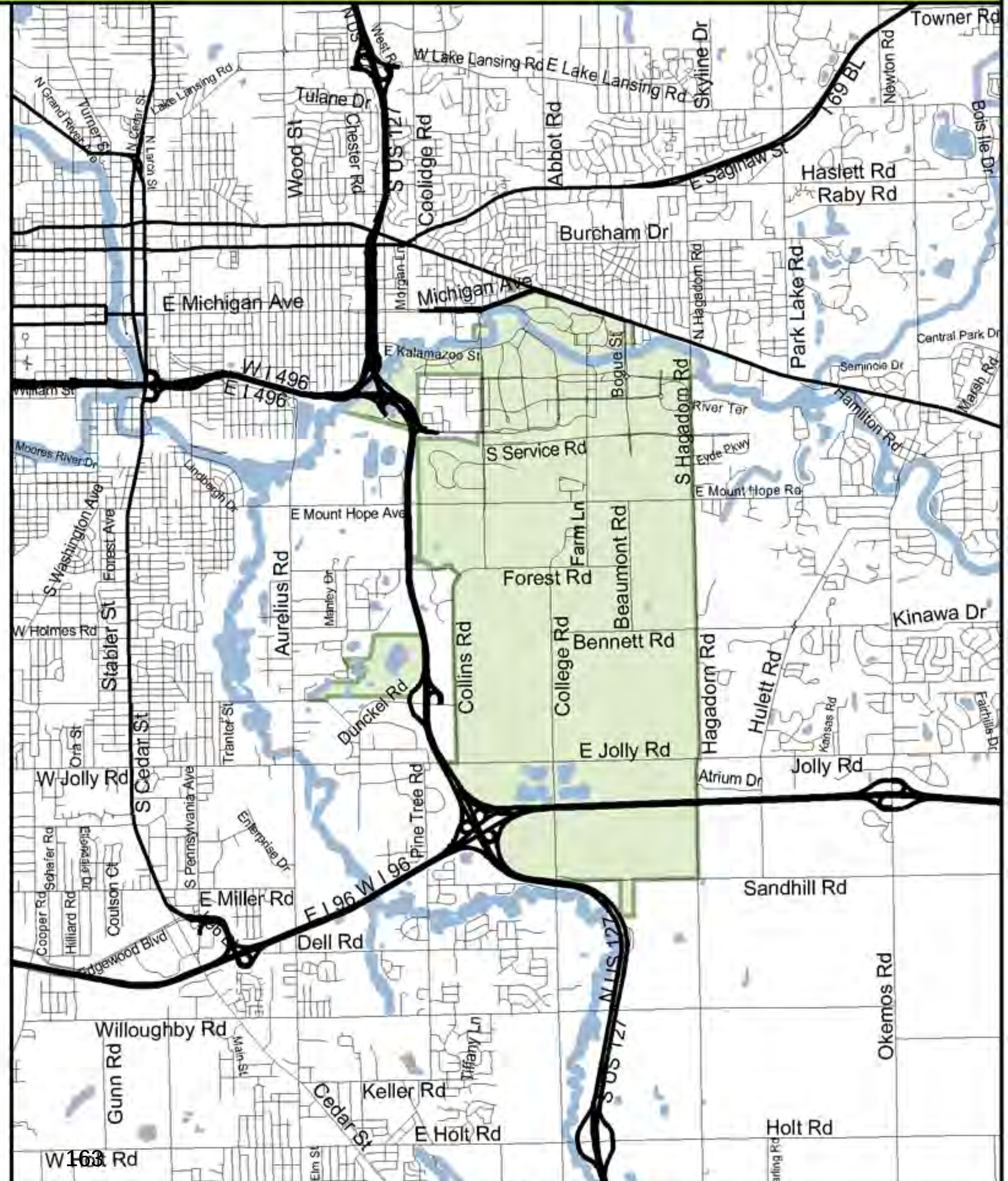
MSU Real Property

Michigan State University Campus, East Lansing

Alaiedon, Delhi, Lansing, and Meridian Townships



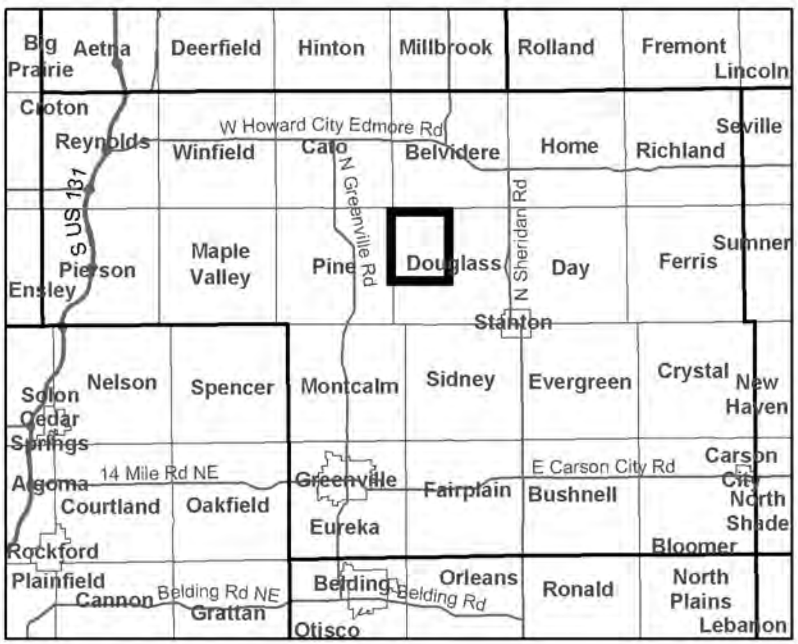
MSU Real Property

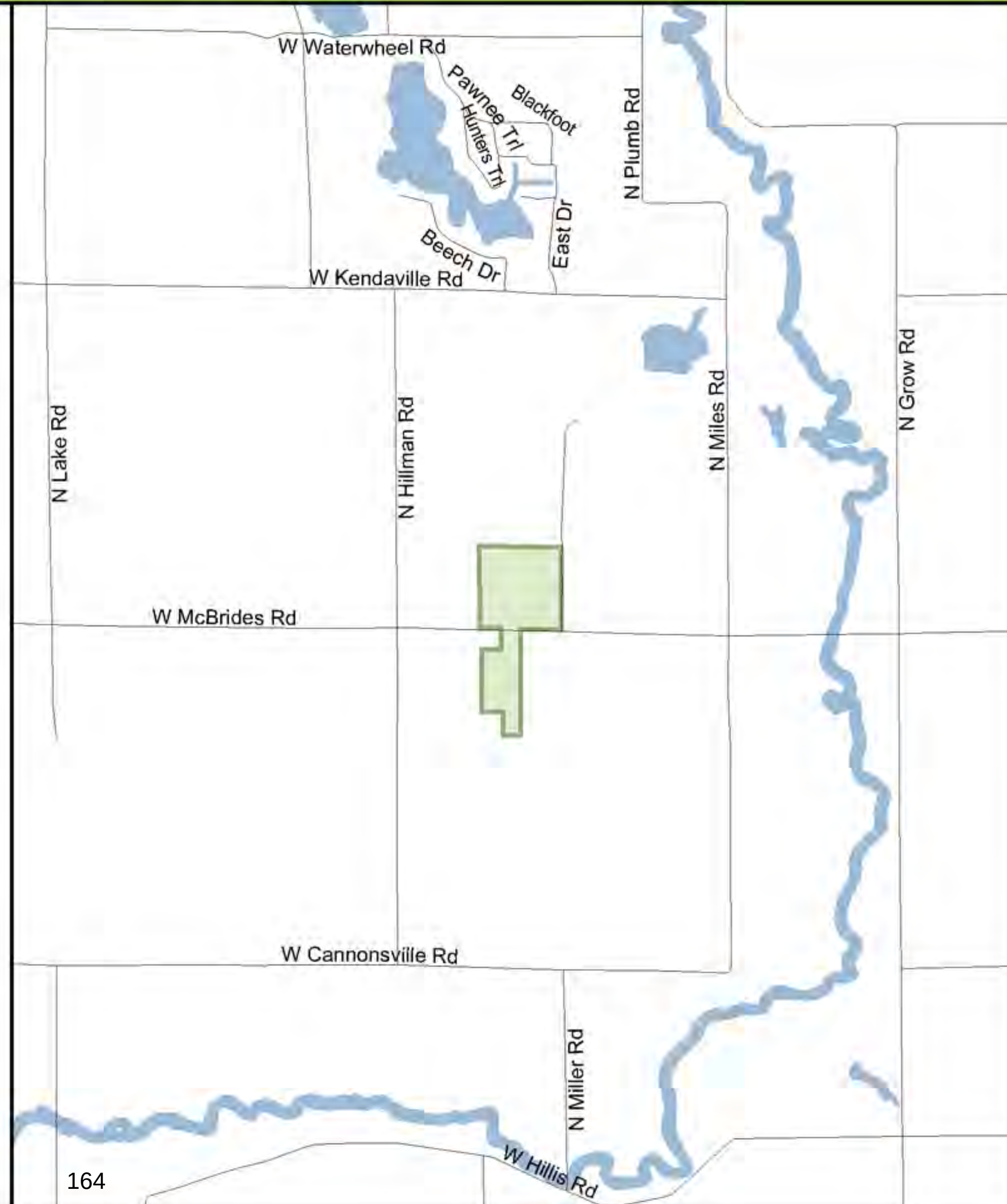


Montcalm Experimental Farm

Douglass Township, Sections 8 and 17

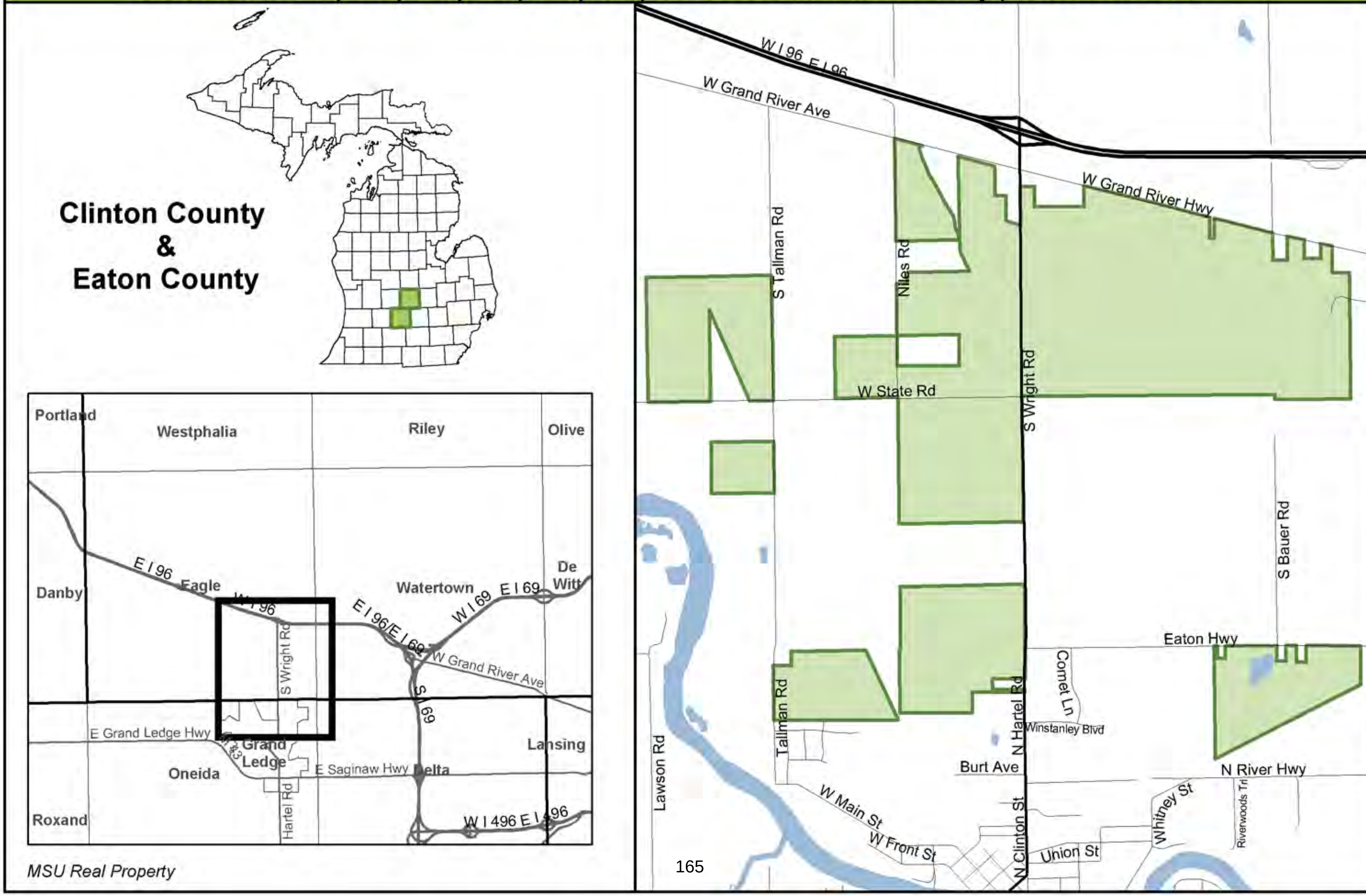
Montcalm County





Morris Property

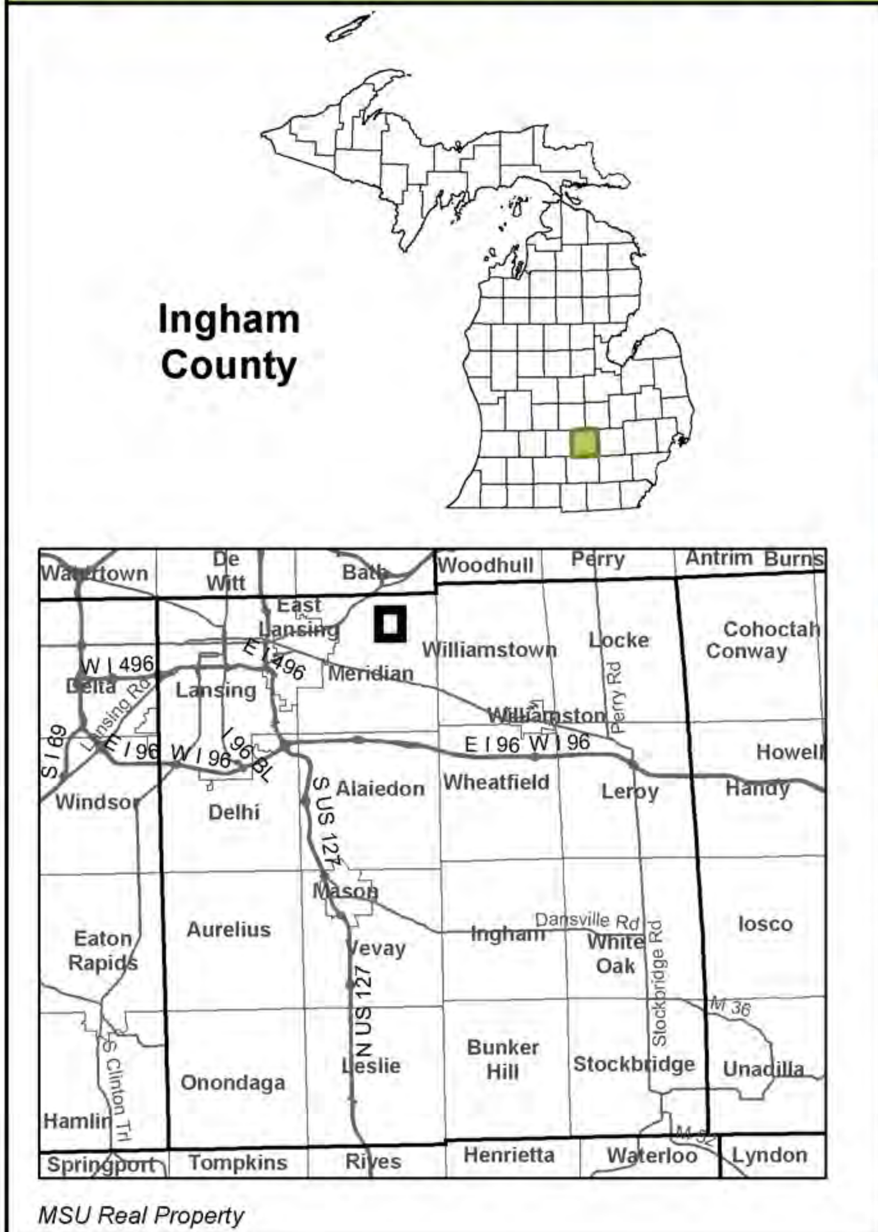
Oneida Twp, Sections 1 and 2; Delta Twp, Section 6; Eagle Twp, Sections 23, 25, 26, 27, 34, 35; and Watertown Twp, Section 30



MSU Real Property

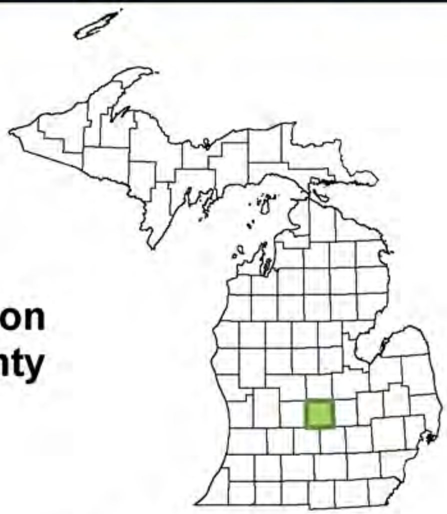
MSU Sailing Club

Meridian Township, Section 11

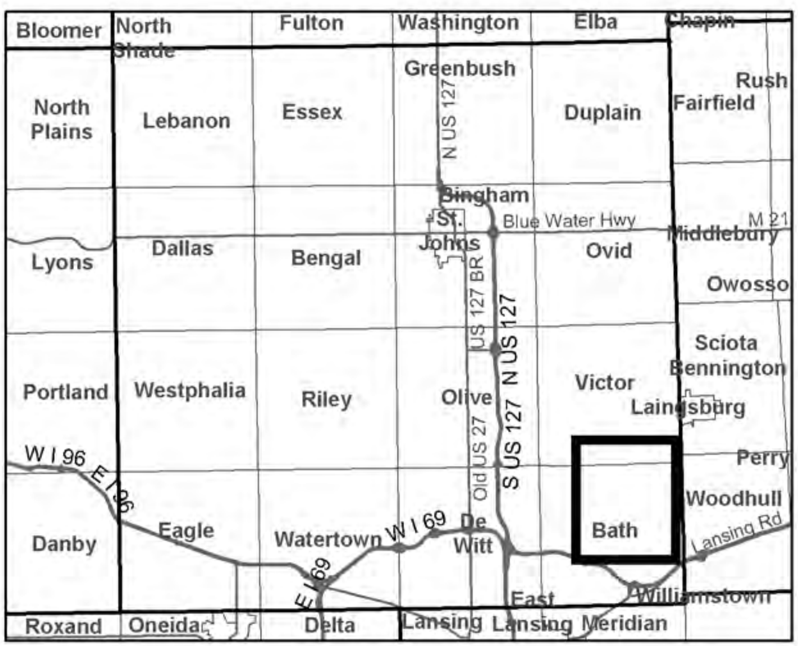


Muck Soils Research Farm

Bath Township, Sections 4, 5, 11, 12, 13, and 14

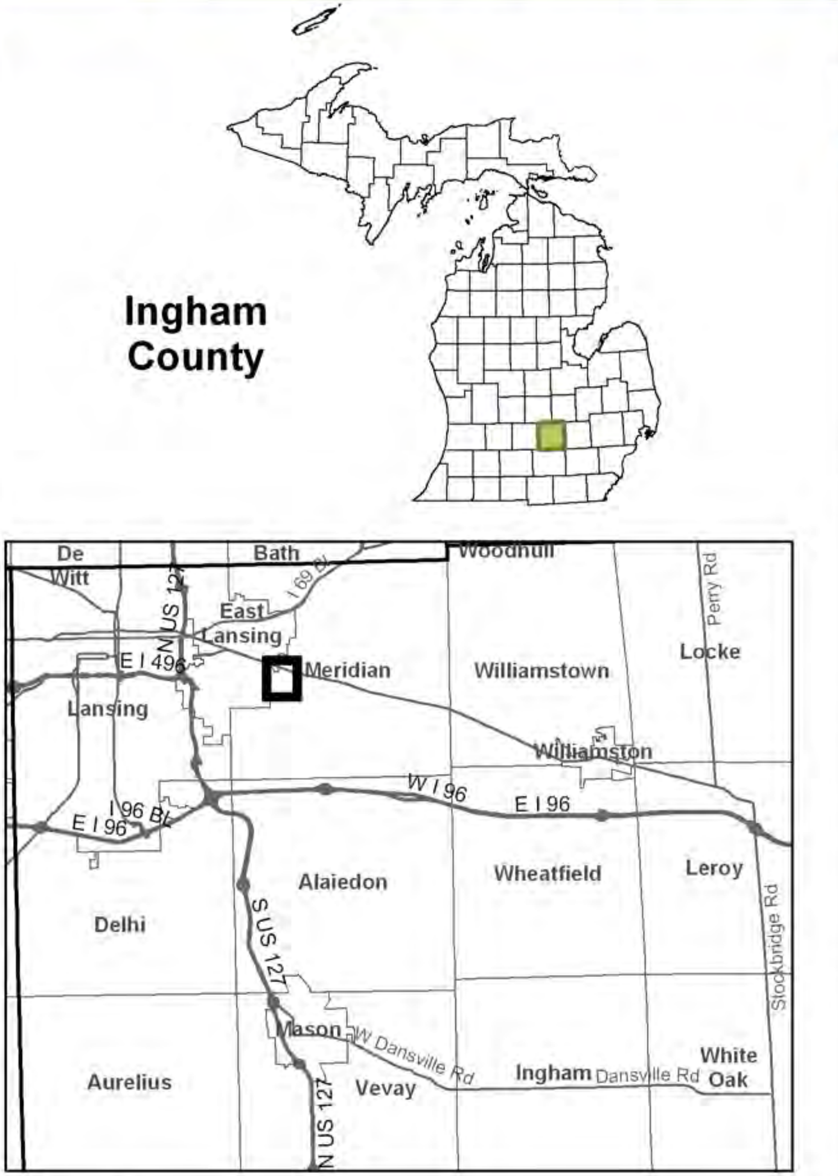


Clinton County



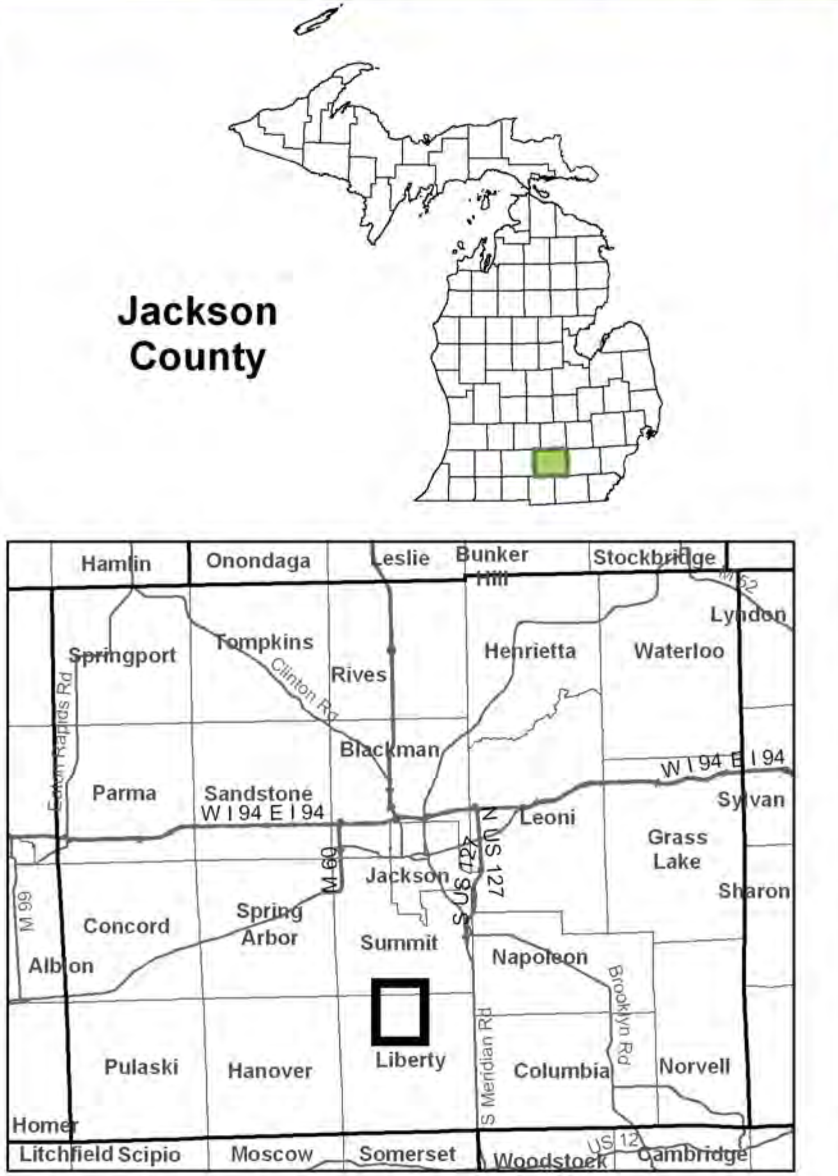
River Terrace Property

Meridian Township, Section 20



Rogers Reserve

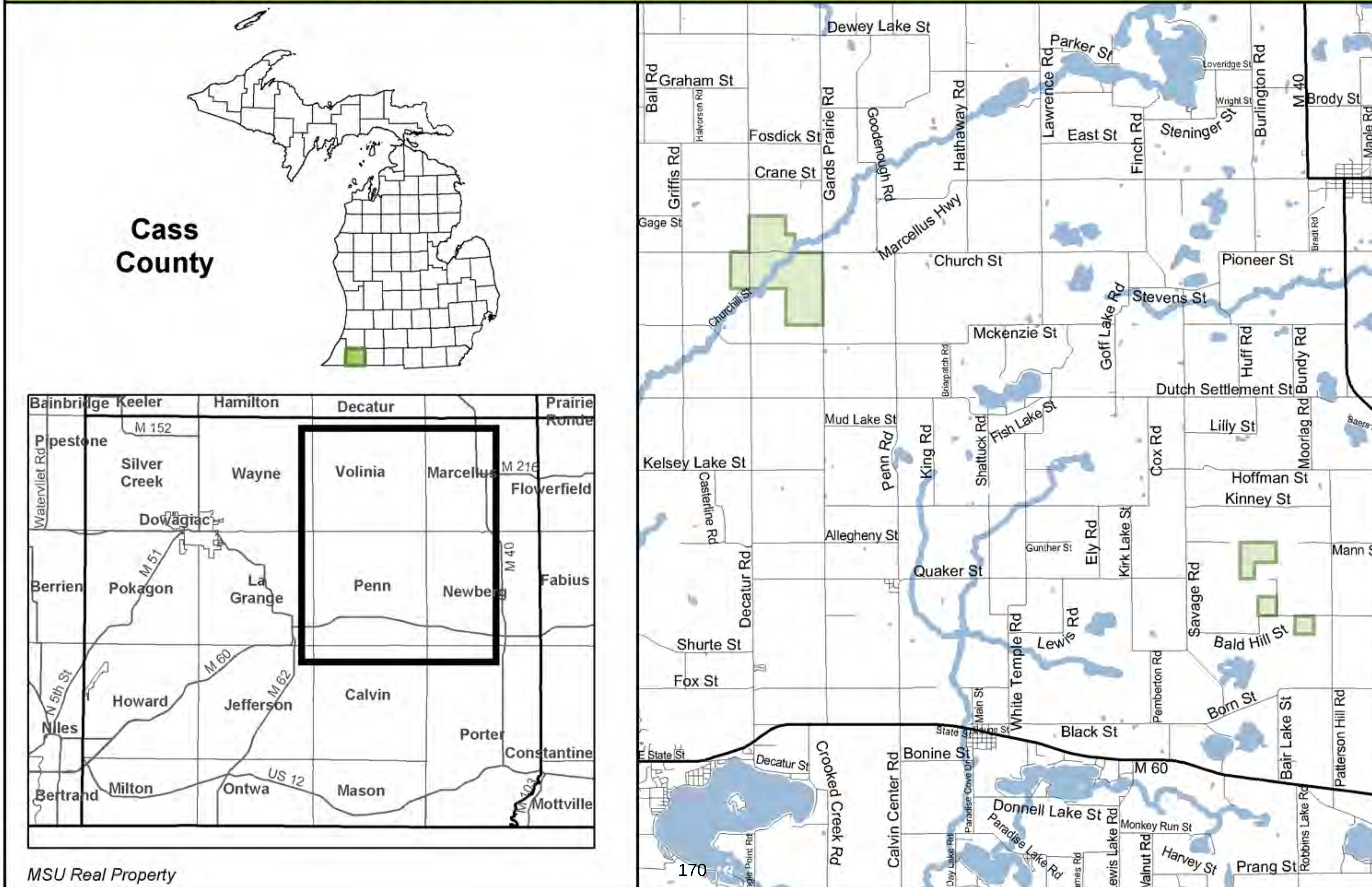
Liberty Township, Section 4



MSU Real Property

Russ Forest Experiment Station

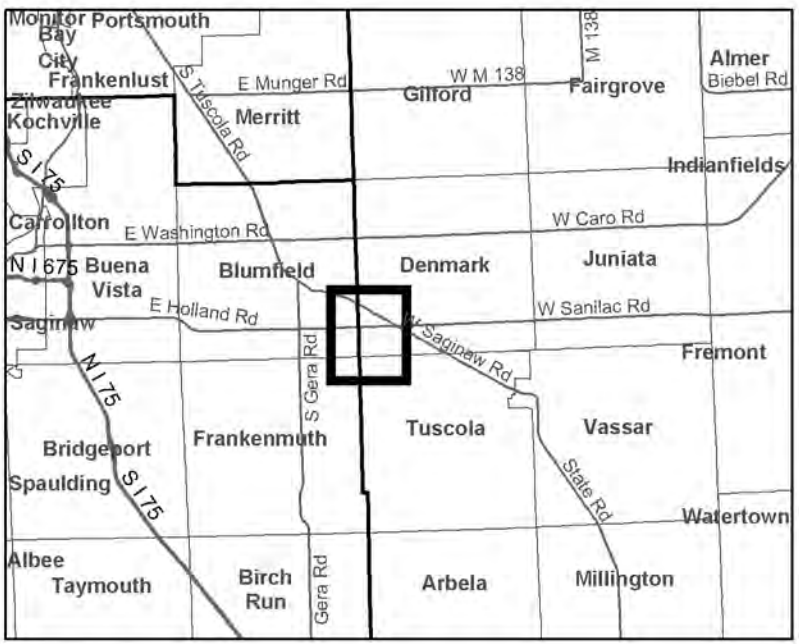
Cass County, Volinia Township, Sections 20, 29 and 30; Newberg Township, Sections 16, 17, and 21



Saginaw Valley Research and Extension Center

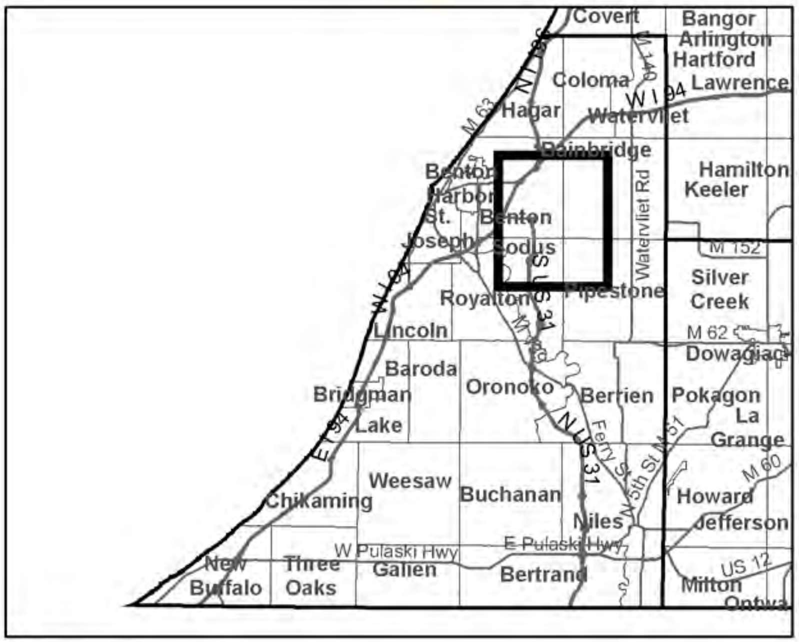
Blumfield Township, Section 25; Denmark Township, Section 31

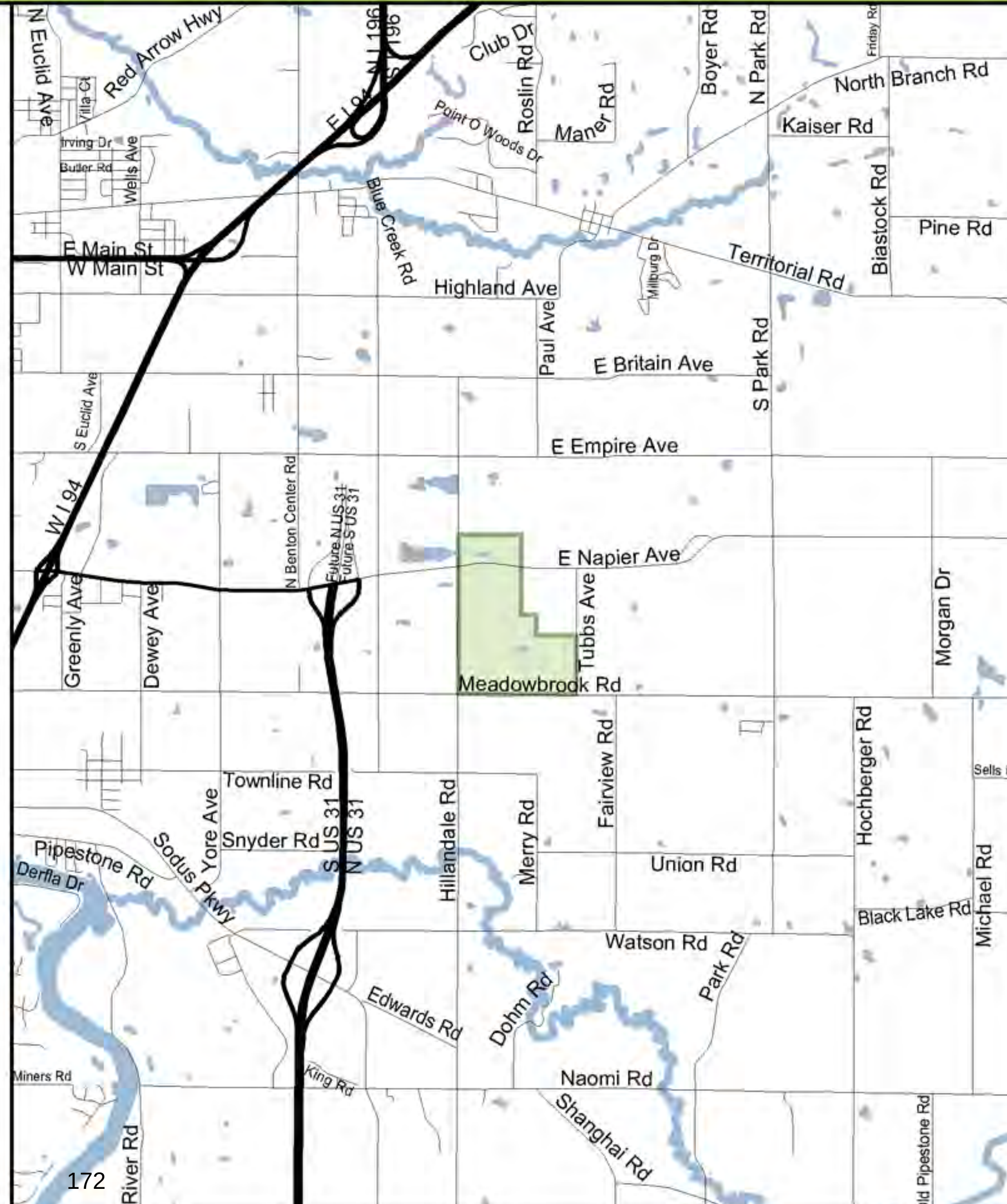
Saginaw County & Tuscola County



Southwest Michigan Research and Extension Center

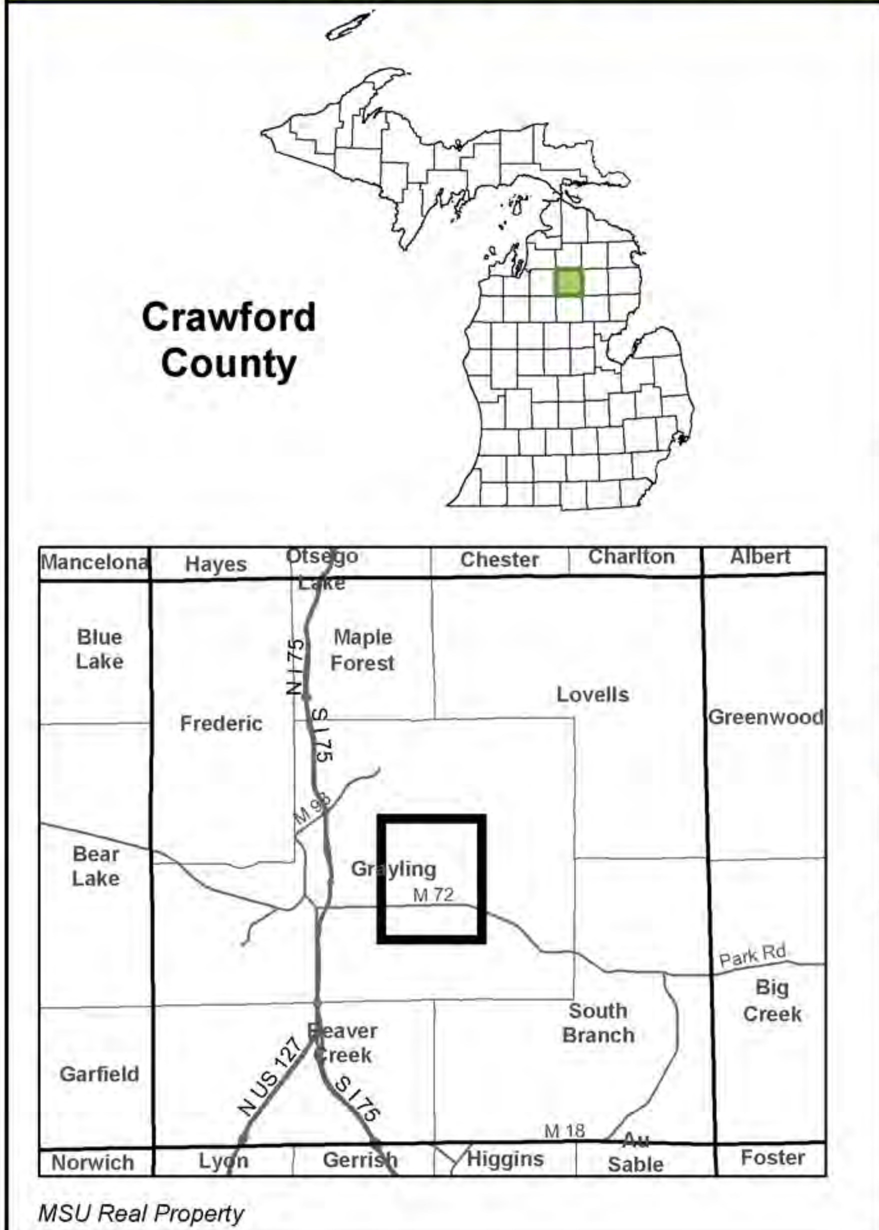
Benton Township, Sections 25 and 36





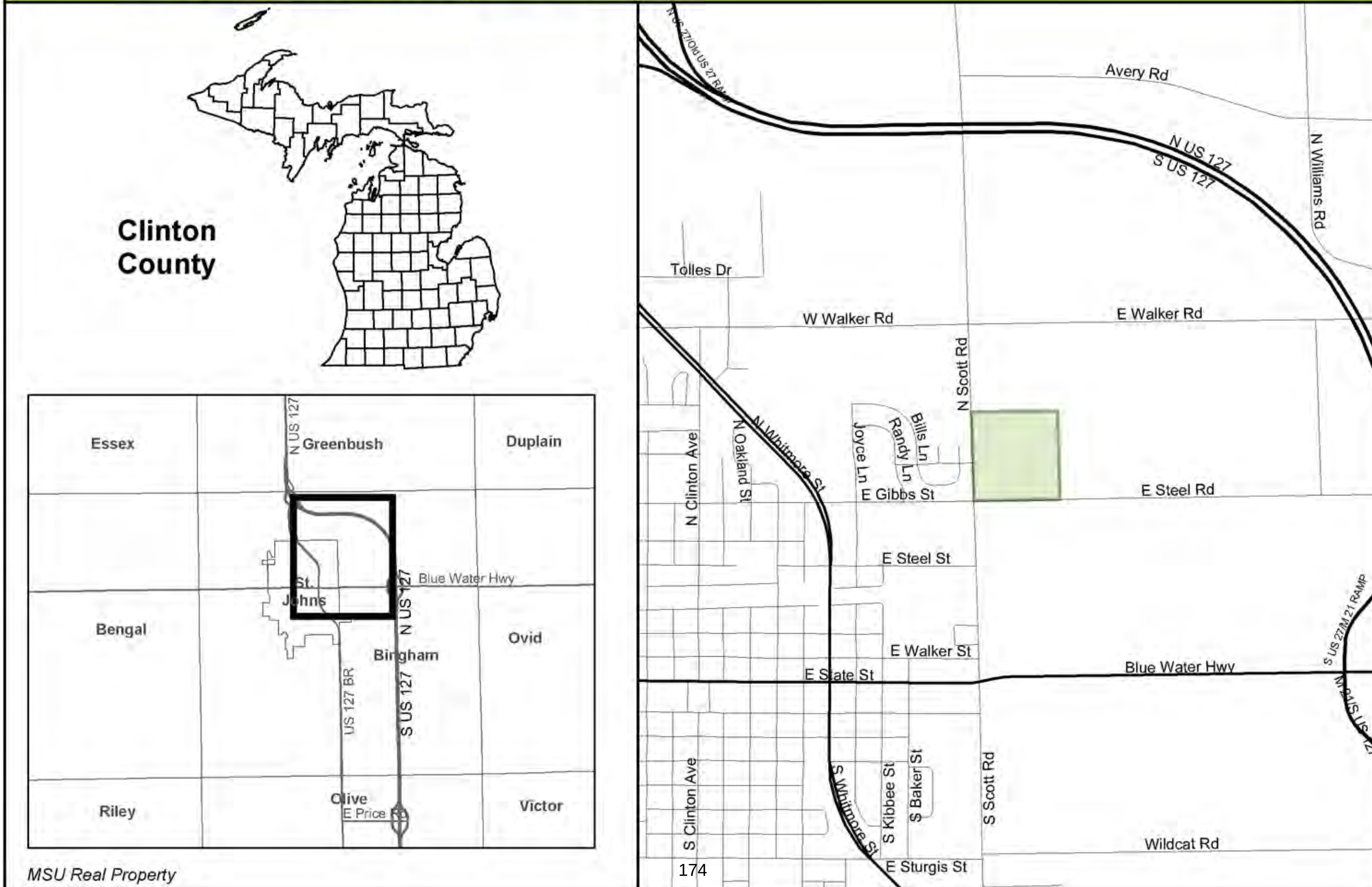
Stranahan-Bell Property (Wa Wa Sum)

Grayling Township, Sections 1, 6, and 12



Stuckman Property

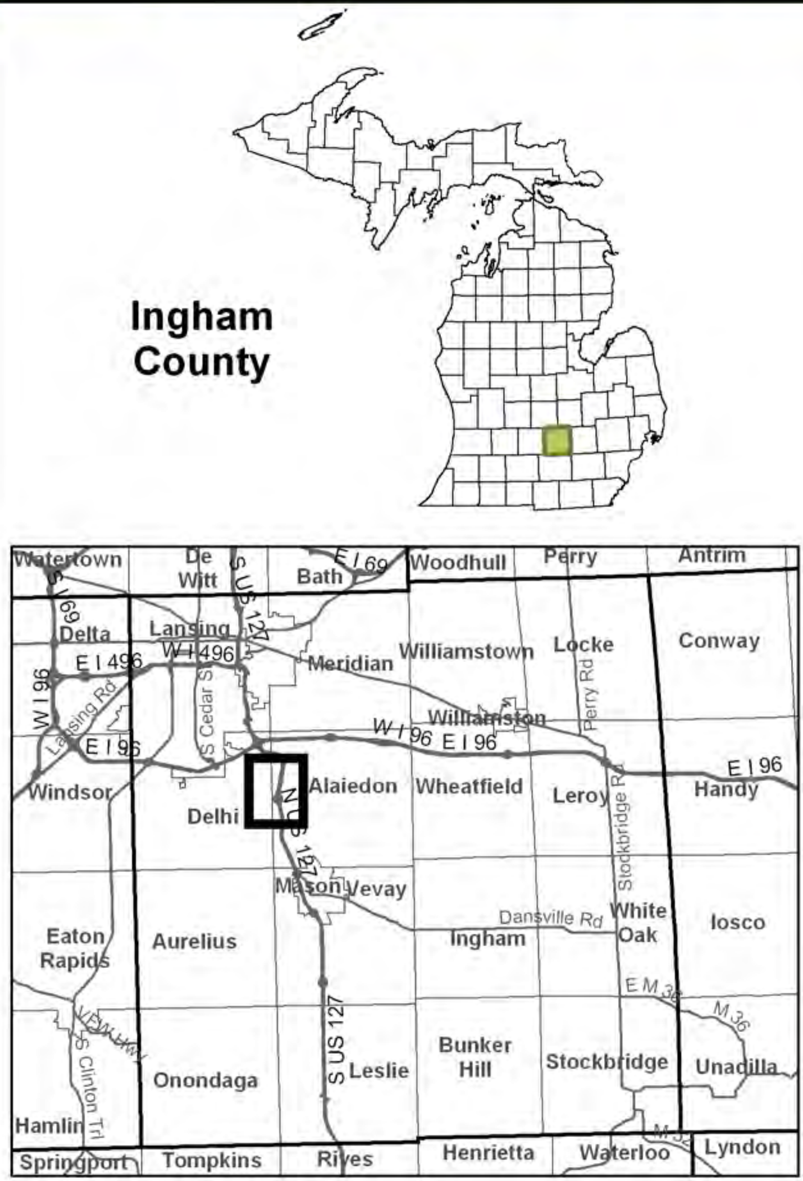
Bingham Township, Section 10

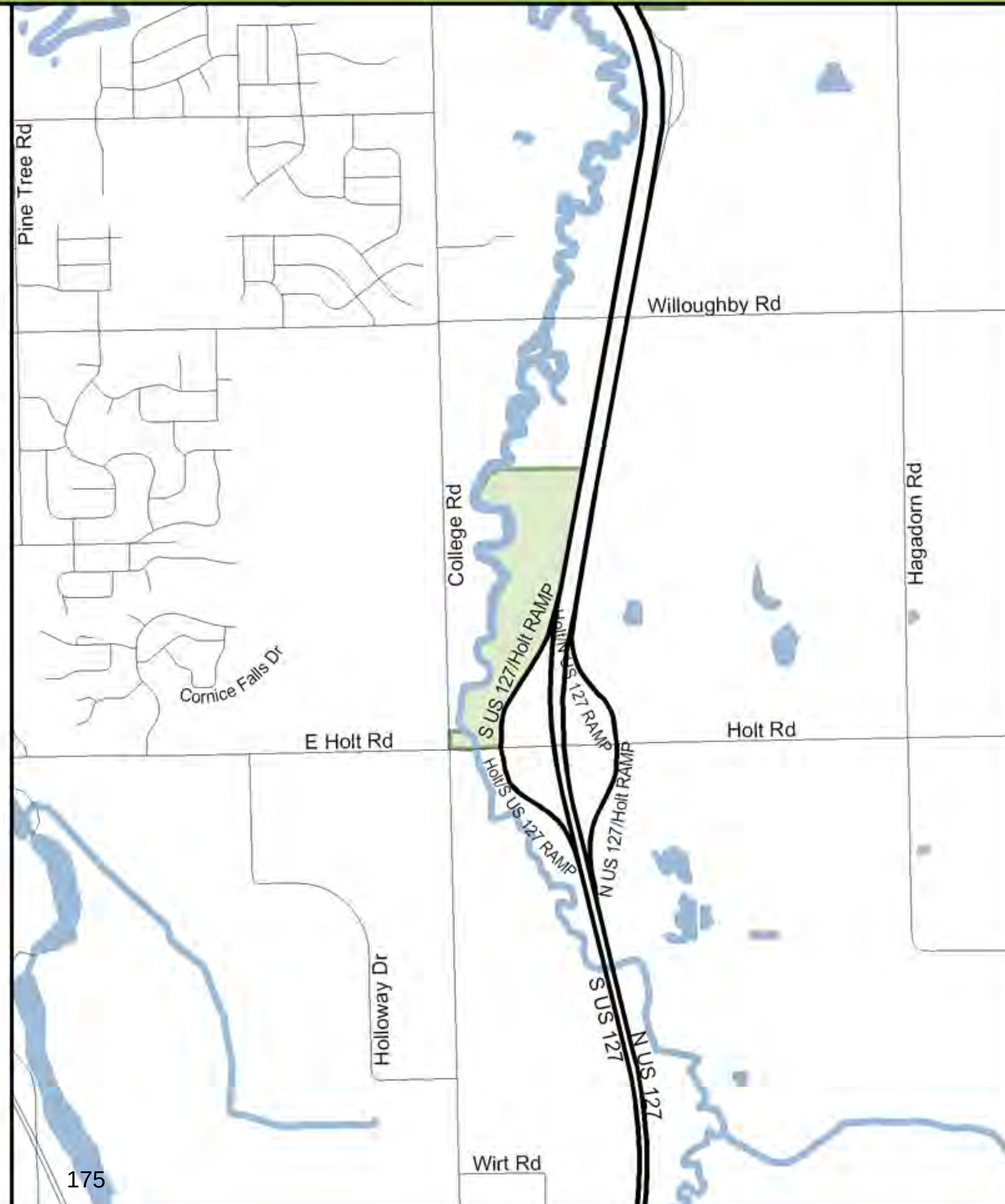


MSU Real Property

Sycamore Creek Property

Alaiedon Township, Section 18

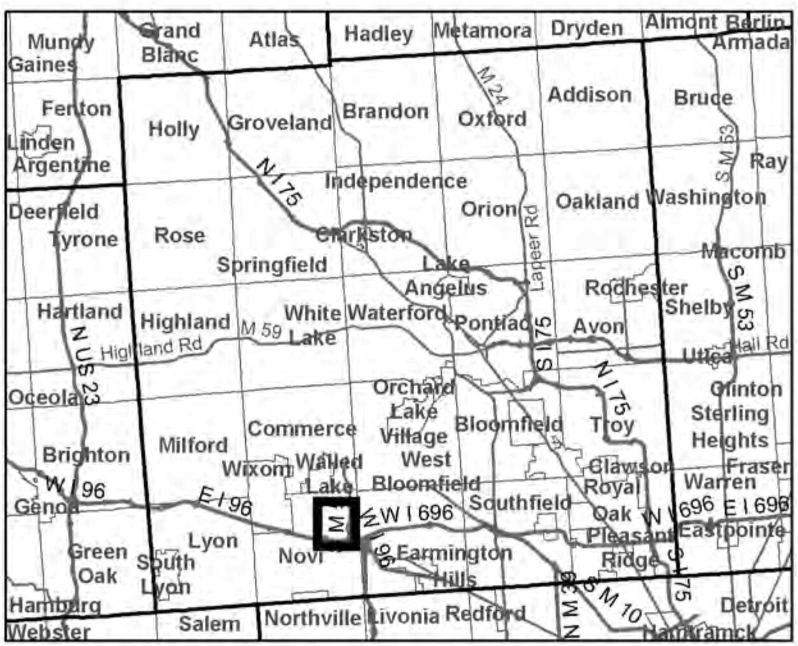




MSU Real Property

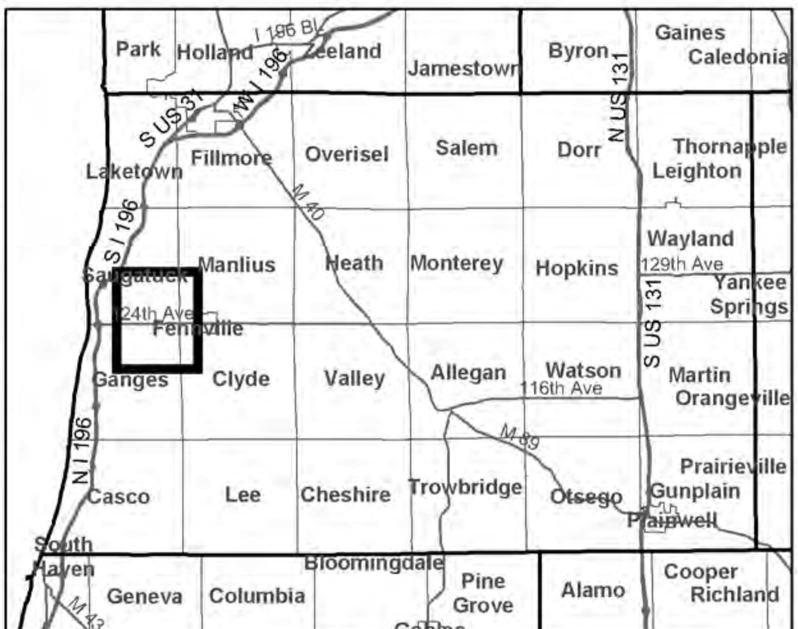
Tollgate Education Center and Americana Foundation Property

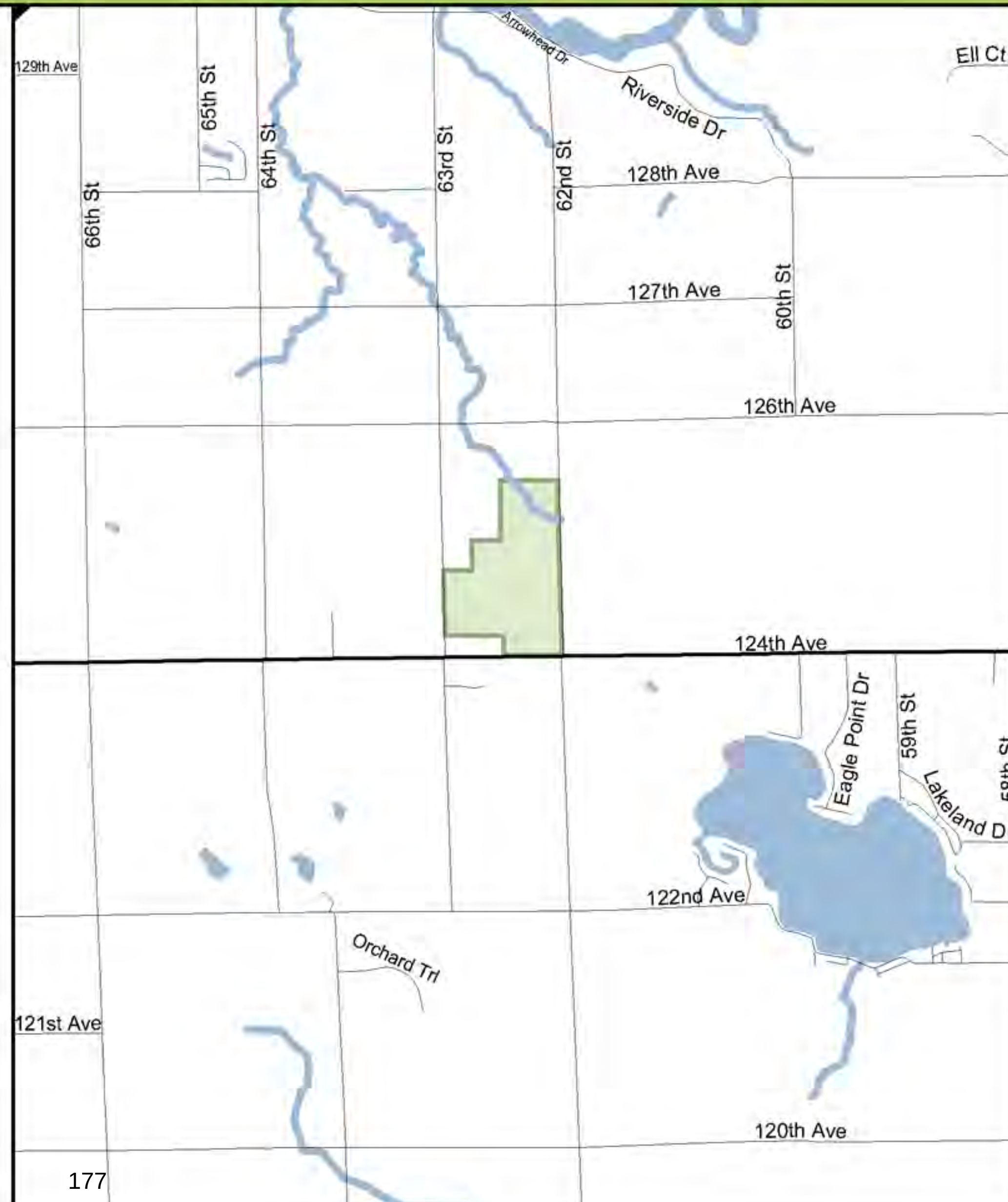
City of Novi, Section 11



Trevor Nichols Research Complex

Saugatuck Township, Section 35

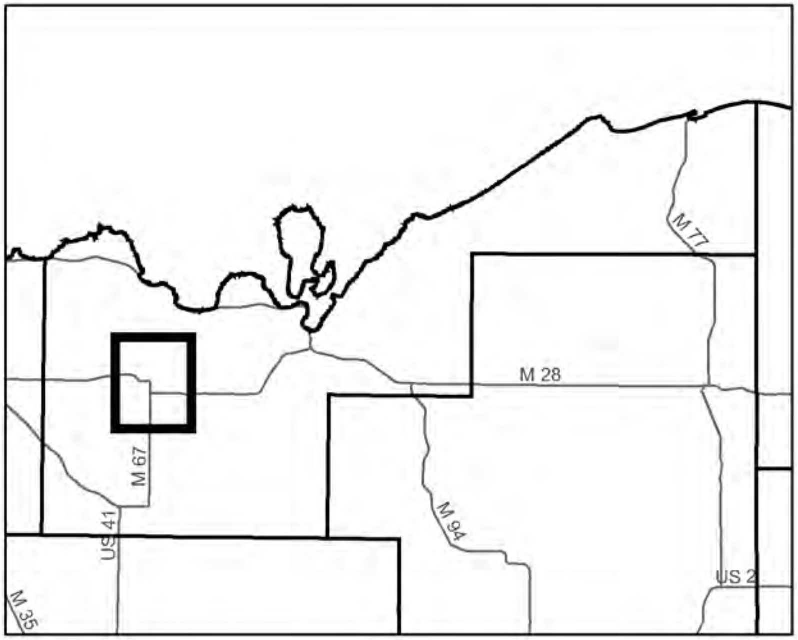




MSU Real Property

Upper Peninsula Experiment Station

City of Chatham and Rock River Township, Sections 24, 25, 27, 28, and 34



MSU Real Property

Van Hoosen Property

Avon Township, Section 1

MSU Real Property

BioEconomy Research and Development Center

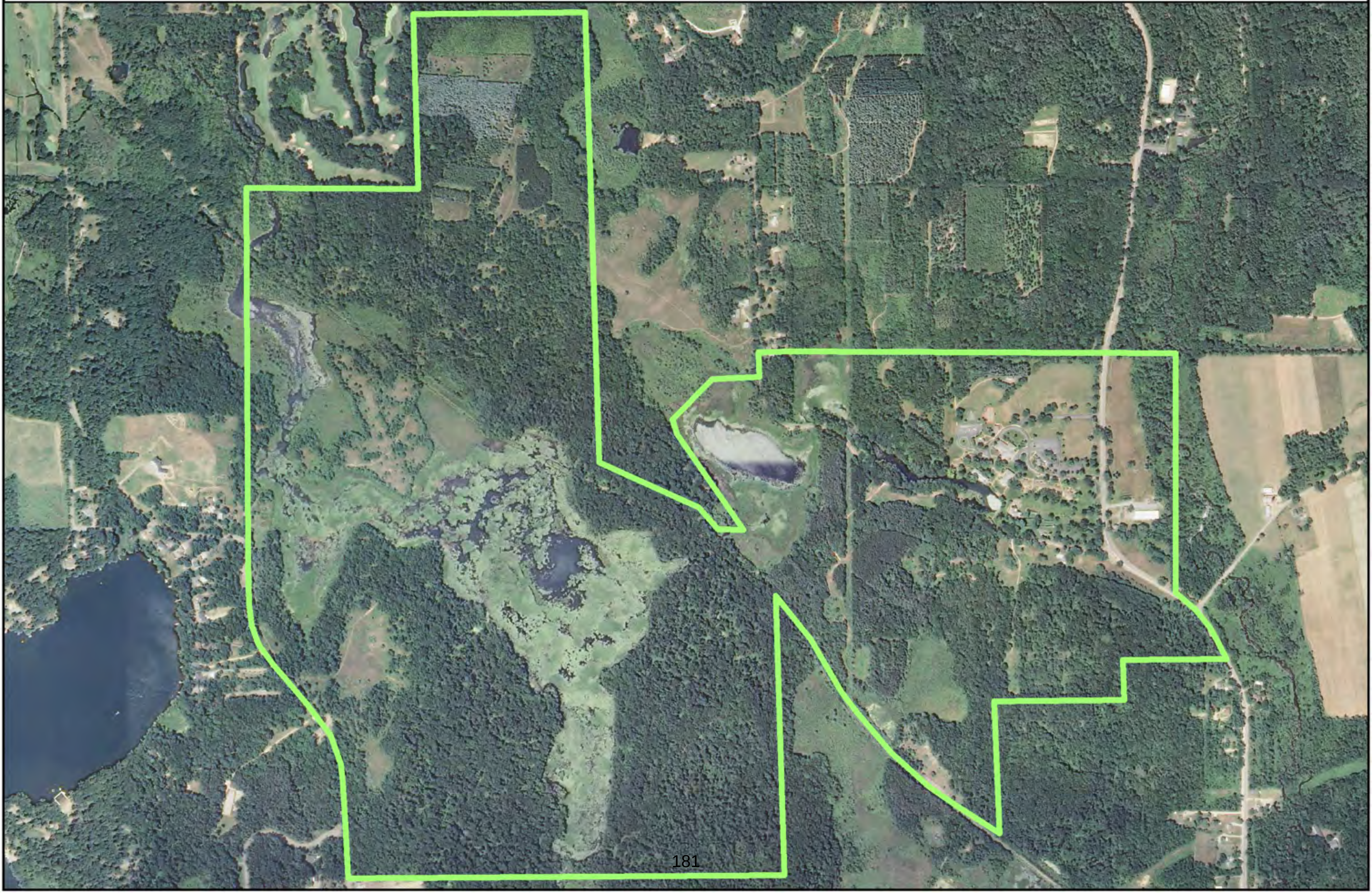
Ottawa County, Holland Township, Section 19

Image Year: 2009

Brook Lodge

Kalamazoo County, Ross Township, Section 21, 27, 28, and 29

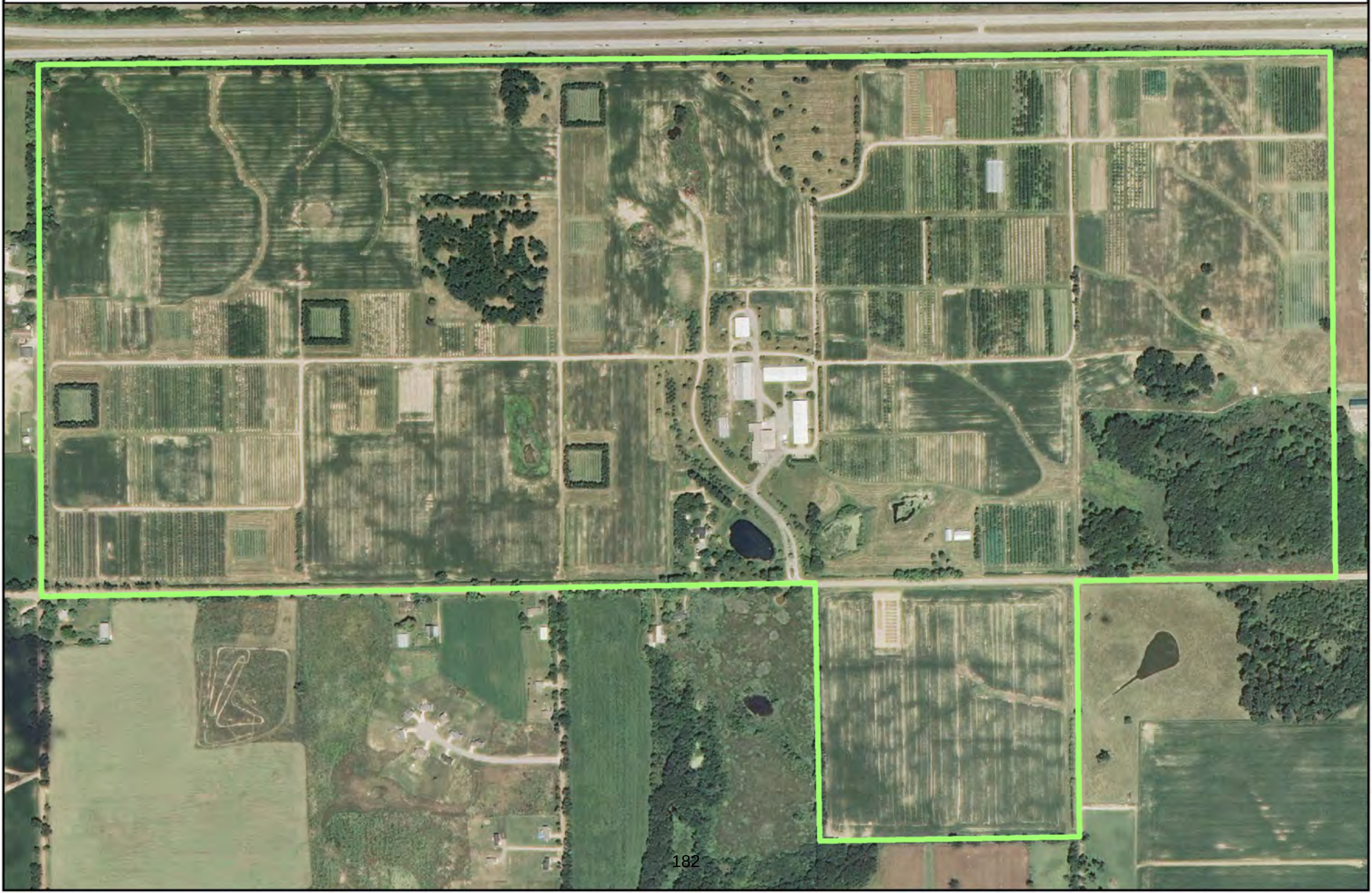
Image Year: 2009



Clarksville Horticultural Experiment Station

Ionia County, Boston Township, Sections 27, 28, and 33

Image Year: 2009



Dobie Road Property

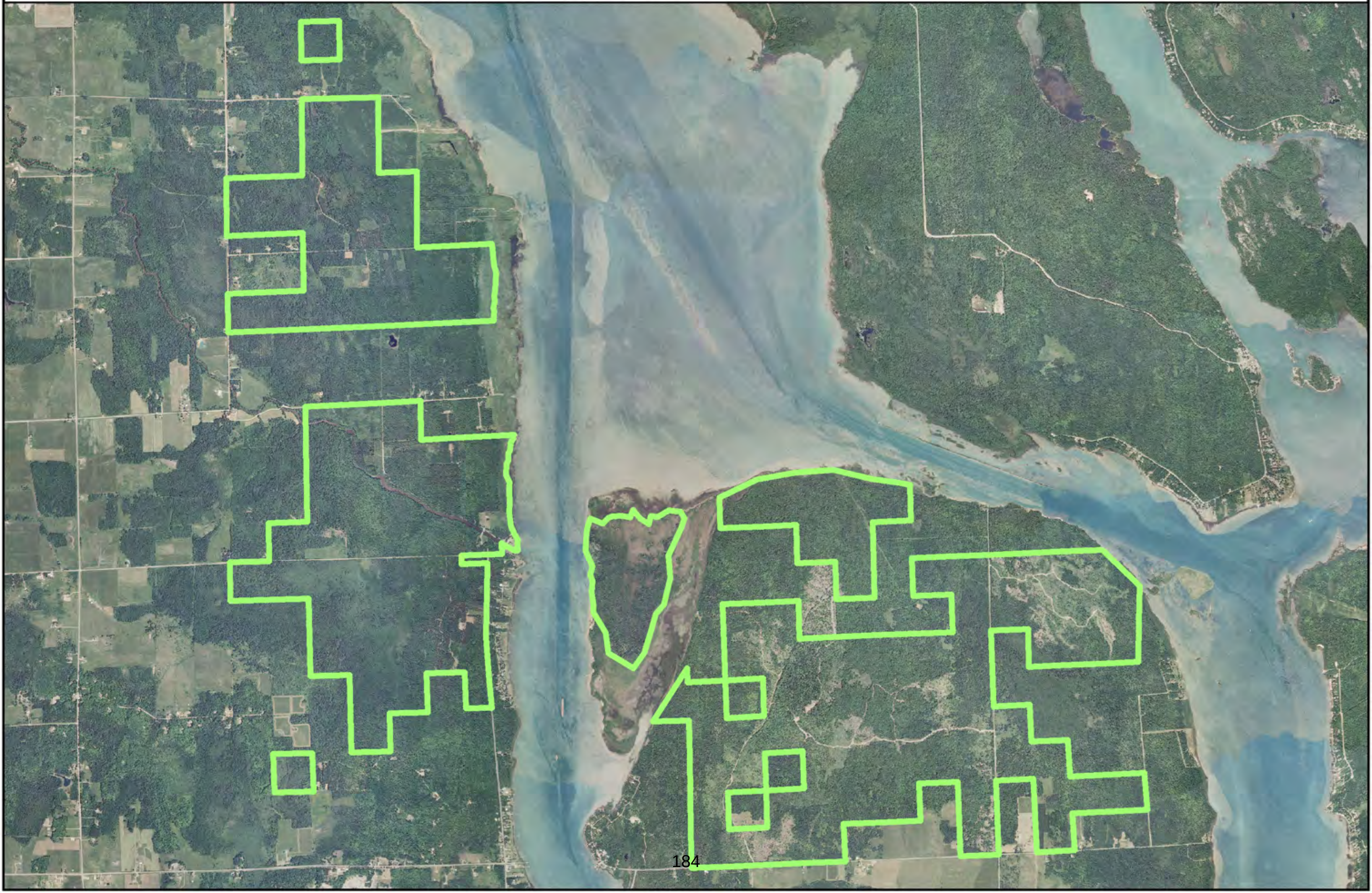
Ingham County, Meridian Township, Section 27

Image Year: 2009

Dunbar Forest Experiment Station

Chippewa County, Soo Township, Sections 3, 4, 5, 8, 9, 10, 11, 14, 15, and 16;
Bruce Township, Sections 1, 6, 7, 12, 13, 24, 25, 30, 31, and 36

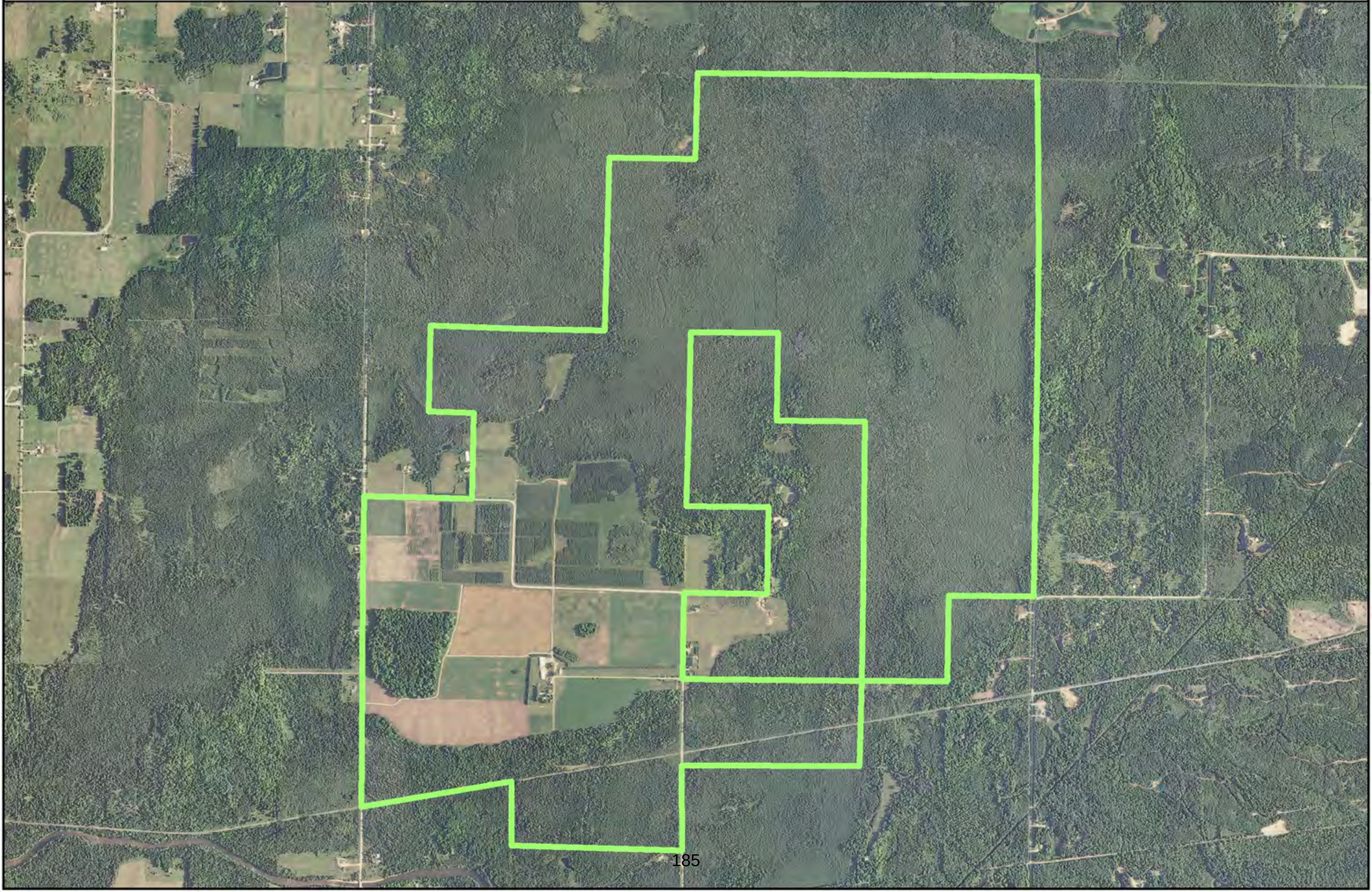
Image Year: 2009



Forest Biomass Innovation Center

Delta County, Wells Township, Sections 8, 17, 18, 19, and 20

Image Year: 2009



Gantos Property

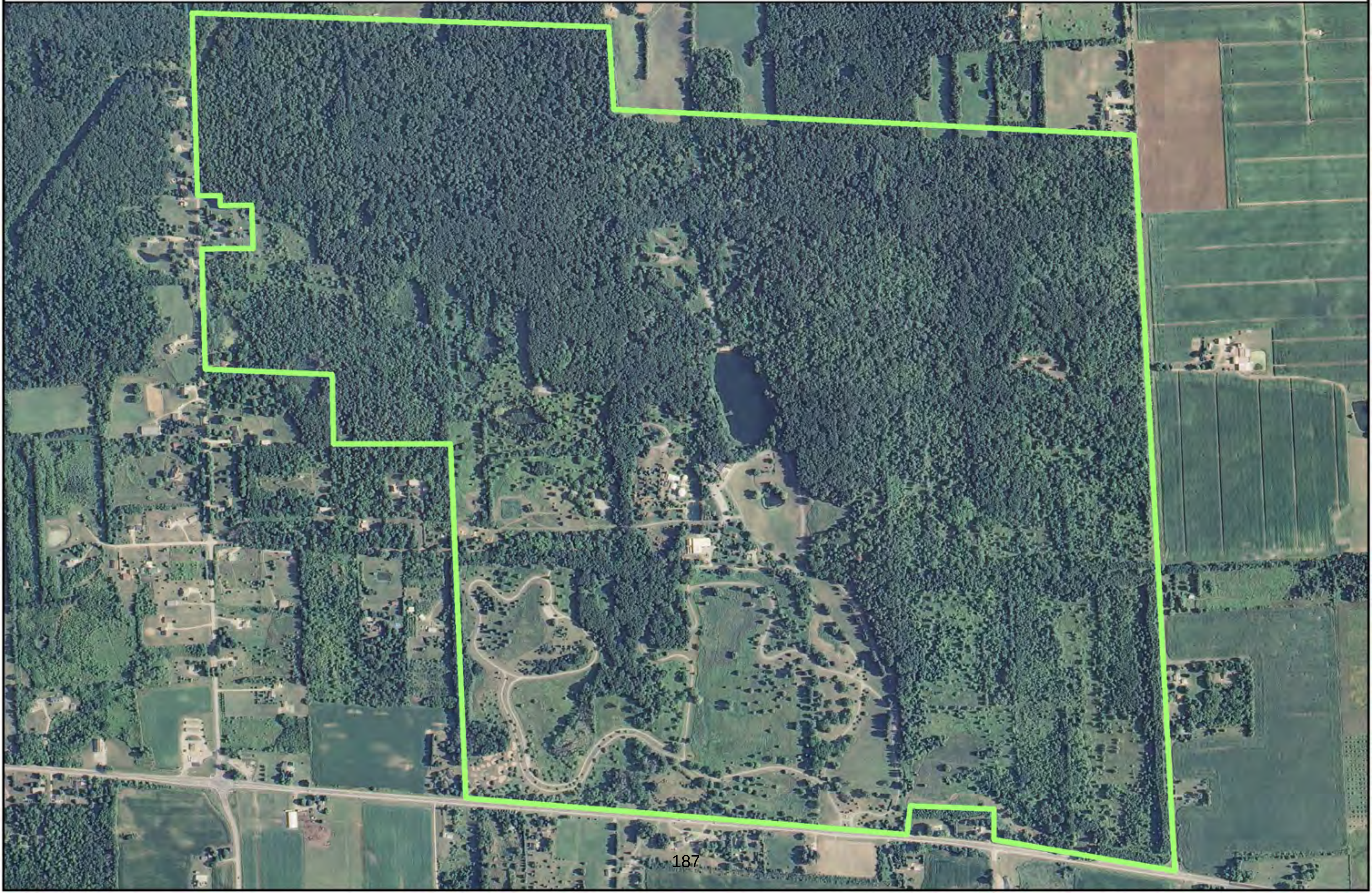
Kent County, Kentwood Township, Section 23

Image Year: 2009

Hidden Lake Gardens

Lenawee County, Franklin Township, Sections 17, 18, 19, and 20

Image Year: 2009



Hulett Road Engineering

Ingham County, Alaiedon Township, Section 5

Image Year: 2009

College of Human Medicine

Kent County, Grand Rapids Township, Section 19

Image Year: 2009

Jolly Road Engineering and Civil Infrastructure Lab

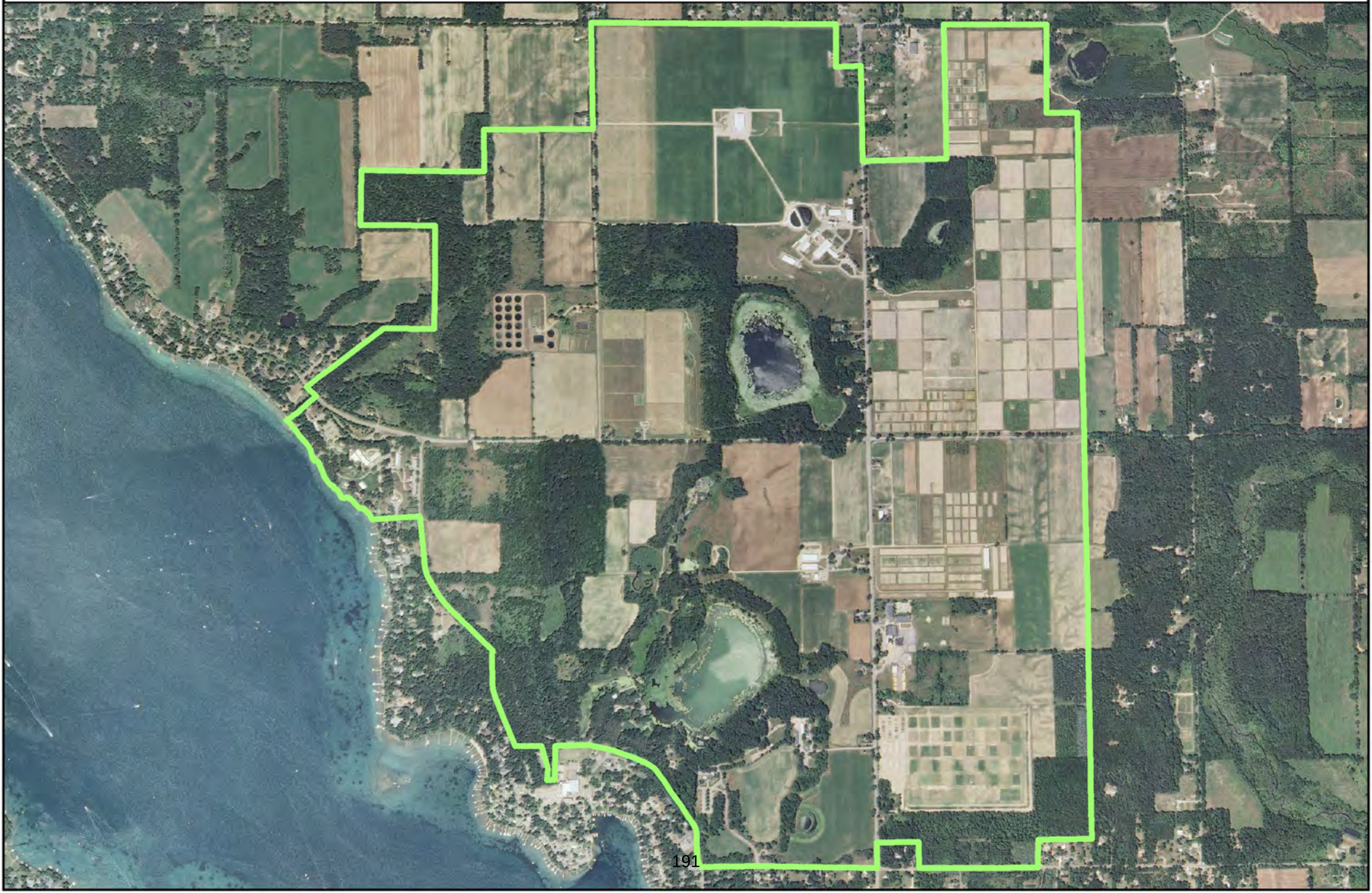
Ingham County, Alaiedon Township, Section 5

Image Year: 2009

W.K. Kellogg Biological Station, Bird Sanctuary, and Farm

Kalamazoo County, City of South Gull Lake and Ross Township, Sections 4, 5, 6, 8, and 9

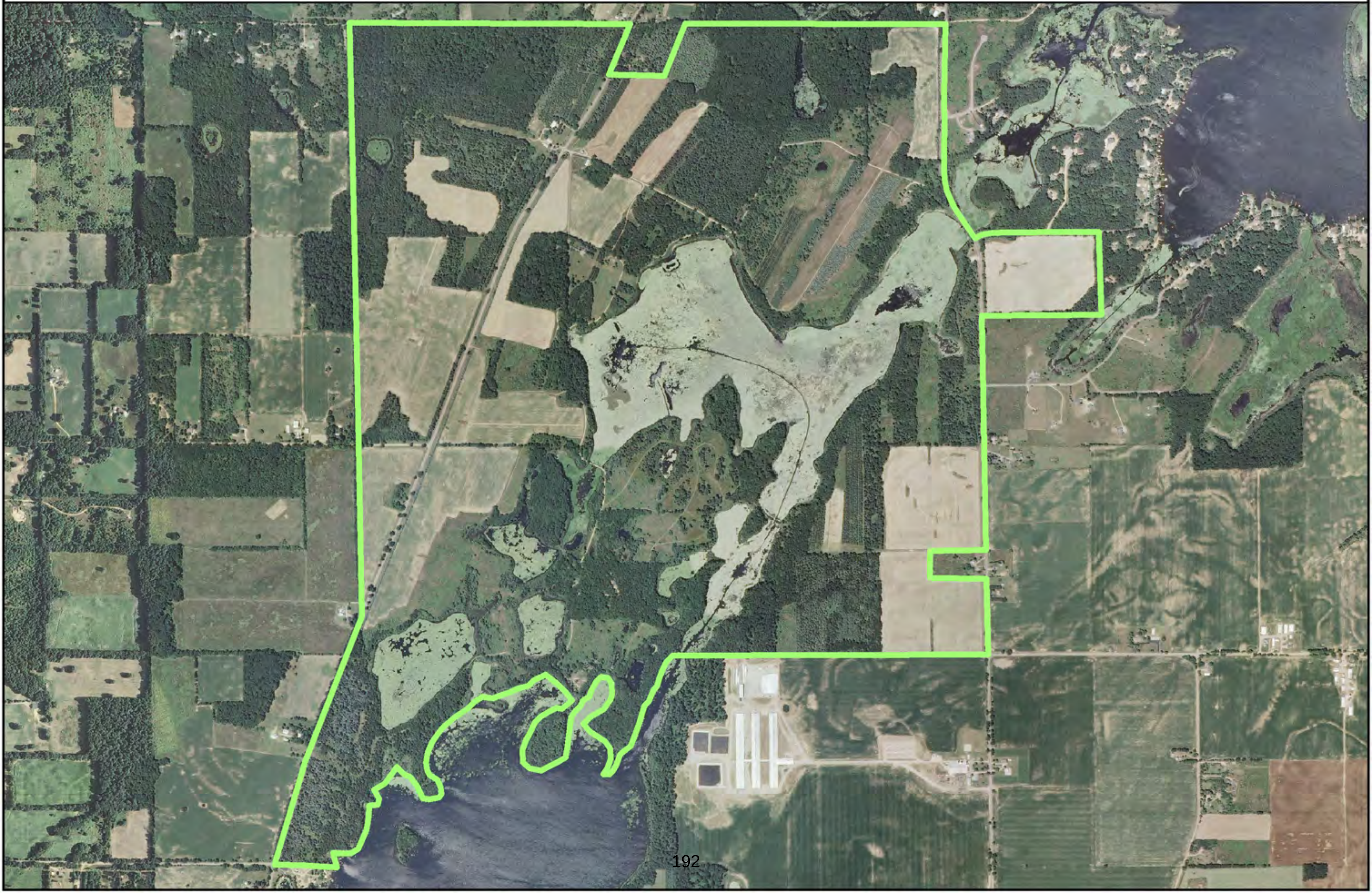
Image Year: 2009



W.K. Kellogg Biological Station (Lux Arbor Reserve)

Barry County, Prairieville Township, Sections 10, 11, 14, and 15

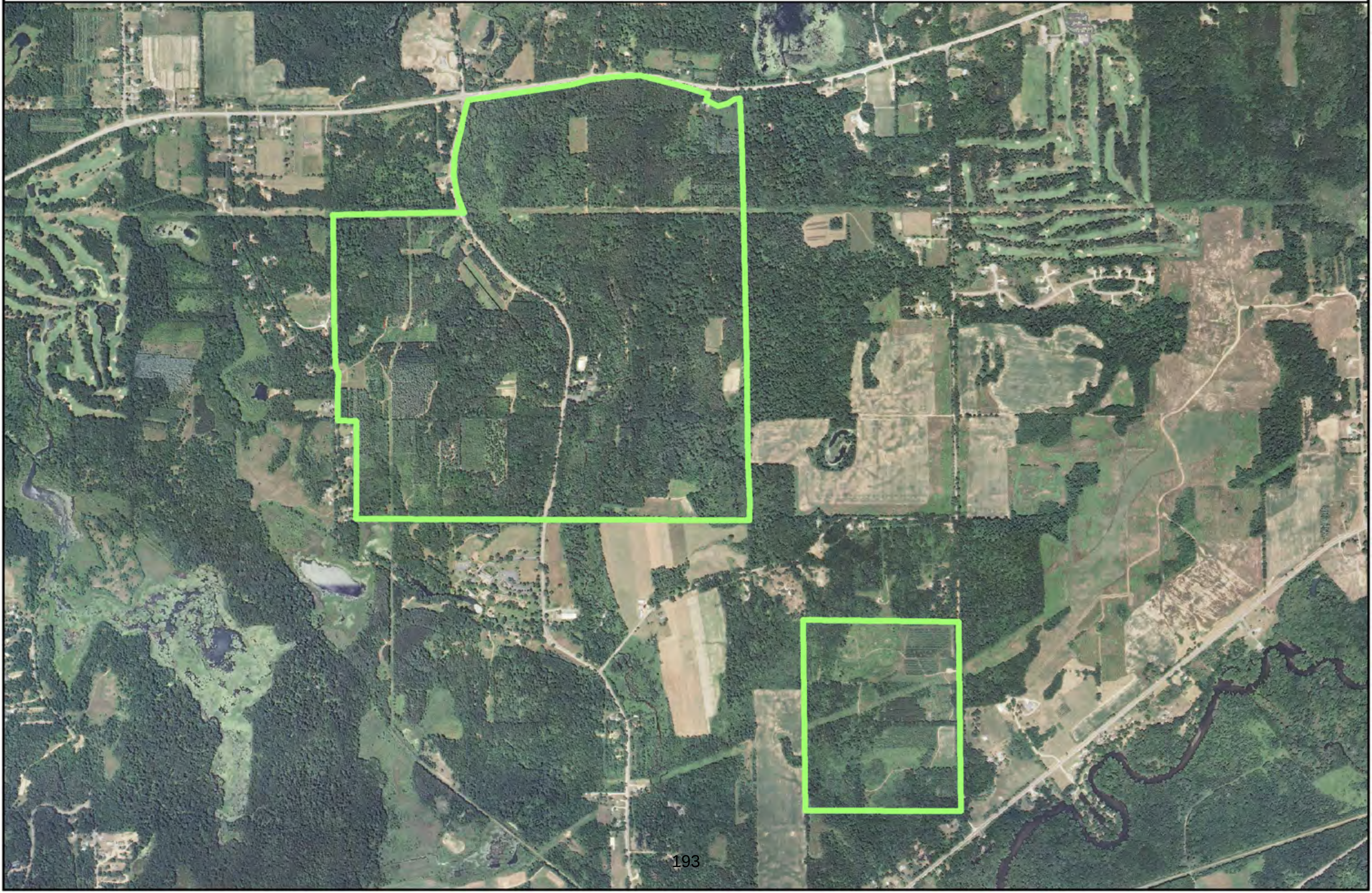
Image Year: 2009



W.K. Kellogg Experimental Forest

Kalamazoo County, Ross Township, Sections 21, 22, 27, and 28

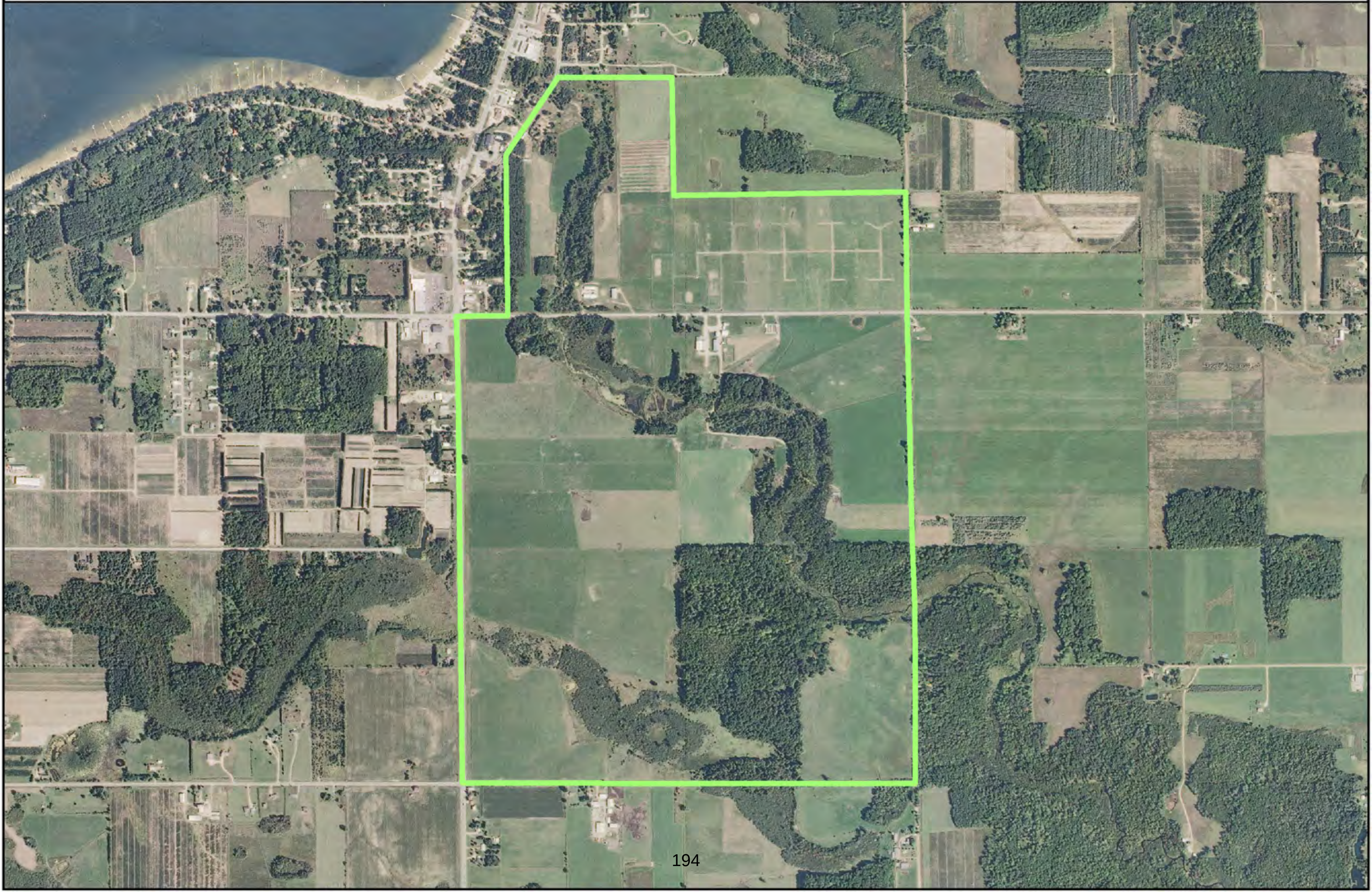
Image Year: 2009



Lake City Experiment Station

Missaukee County, Reeder Township, Sections 7 and 18

Image Year: 2009



Leland Property

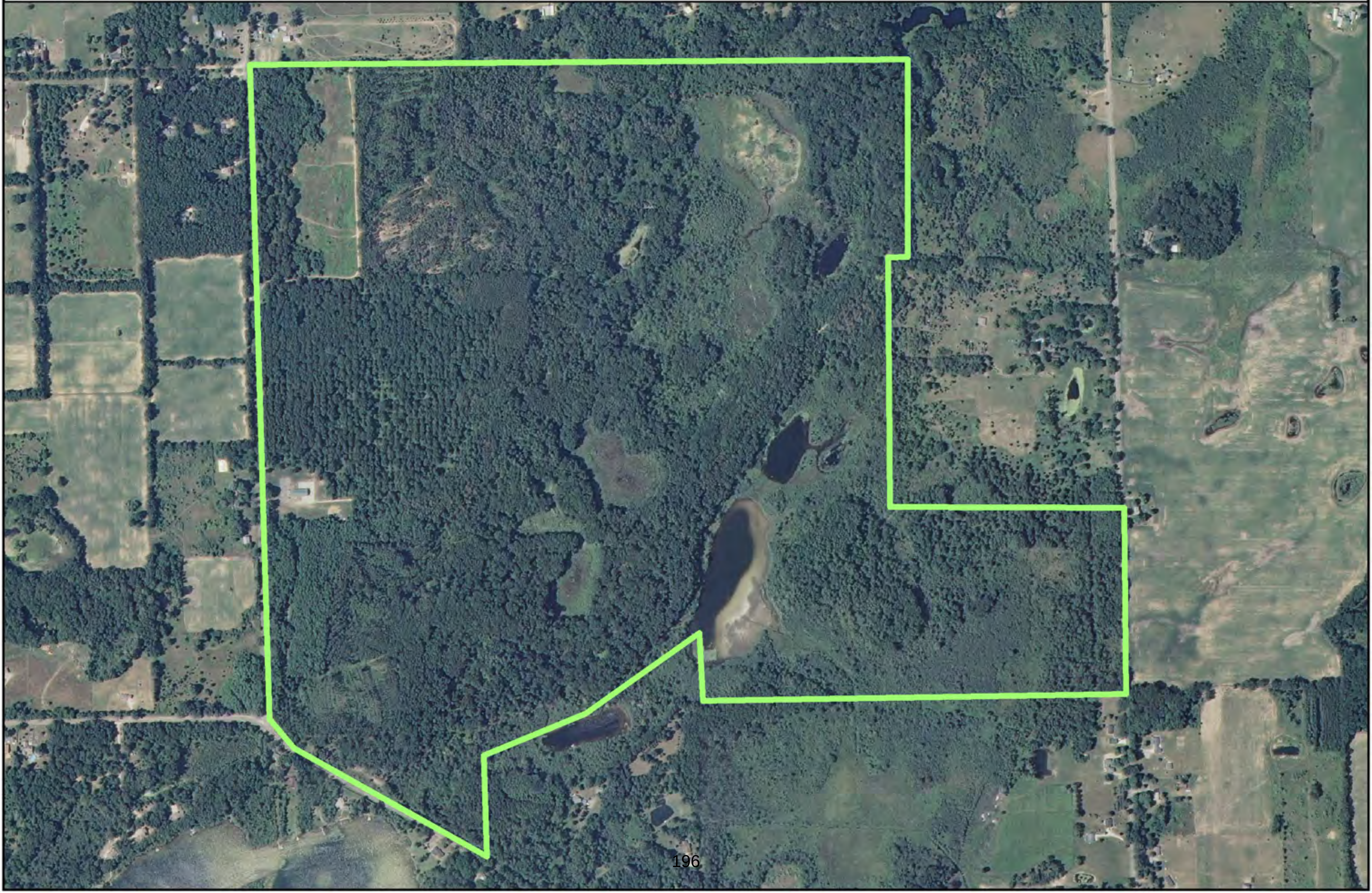
Leelanau County, Leland Township, Section 9

Image Year: 2009

MacCready Forest and Wildlife Reserve

Jackson County, Liberty Township, Sections 11 and 14

Image Year: 2009



Management Education Center, Troy

Oakland County, City of Troy, Section 9

Image Year: 2009

Martin Property (Rose-Dell Seed Orchard)

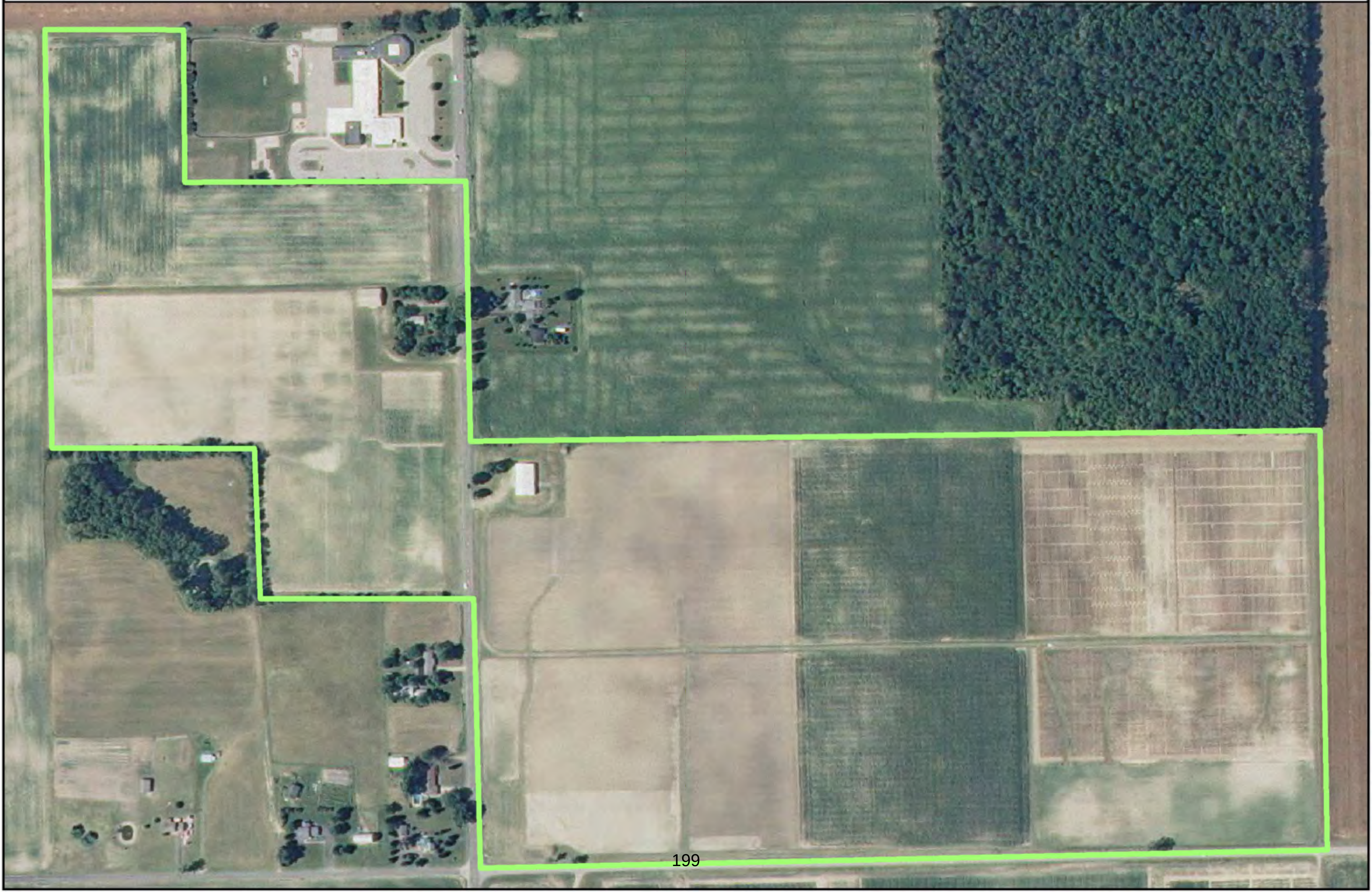
Calhoun County, Albion Township, Sections 23 and 24

Image Year: 2009

Mason Research Farm

Ingham County, Alaiedon Township, Section 21

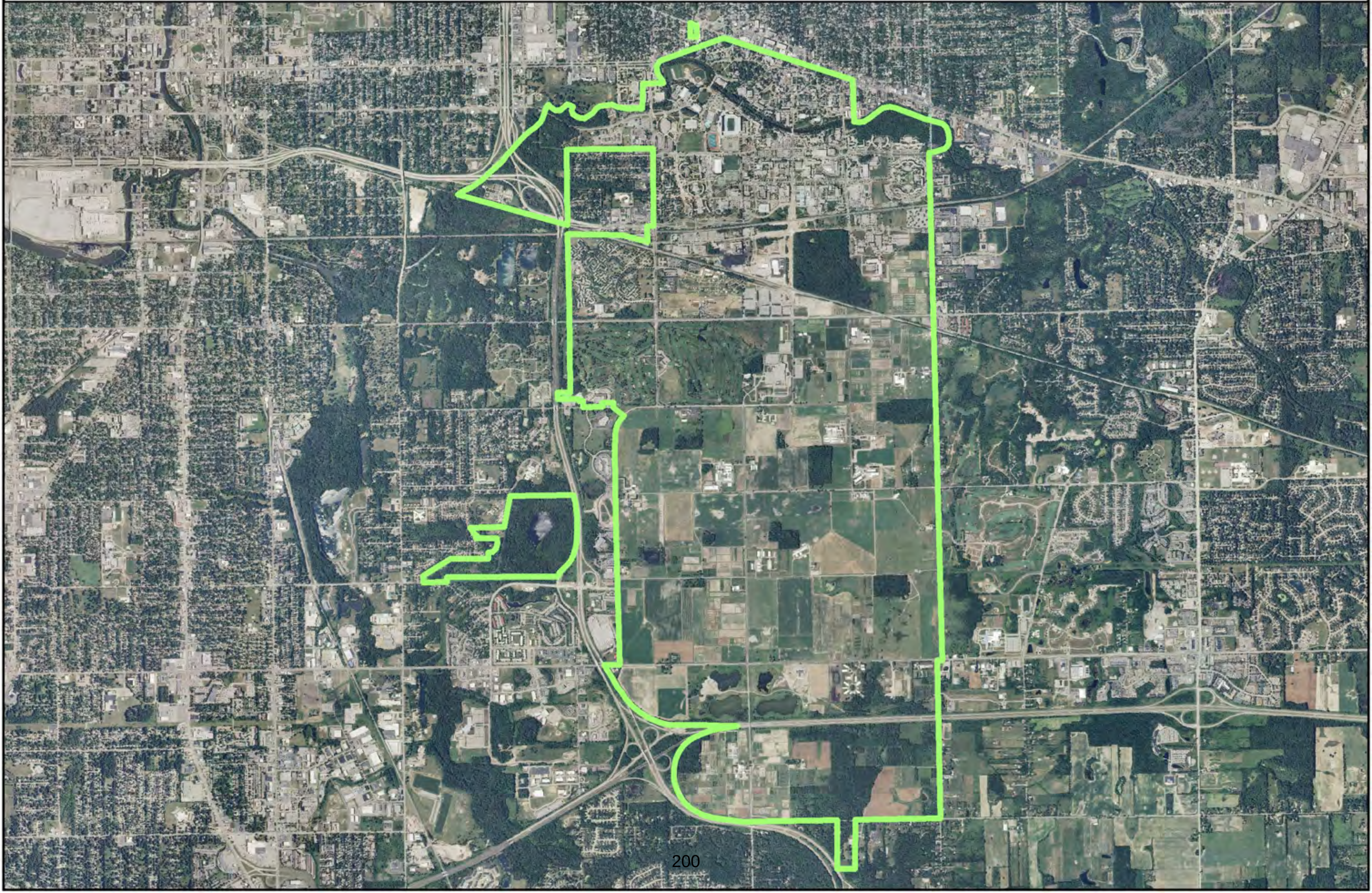
Image Year: 2009



Michigan State University Campus, East Lansing

Ingham County, Alaiedon, Delhi, Lansing, and Meridian Townships

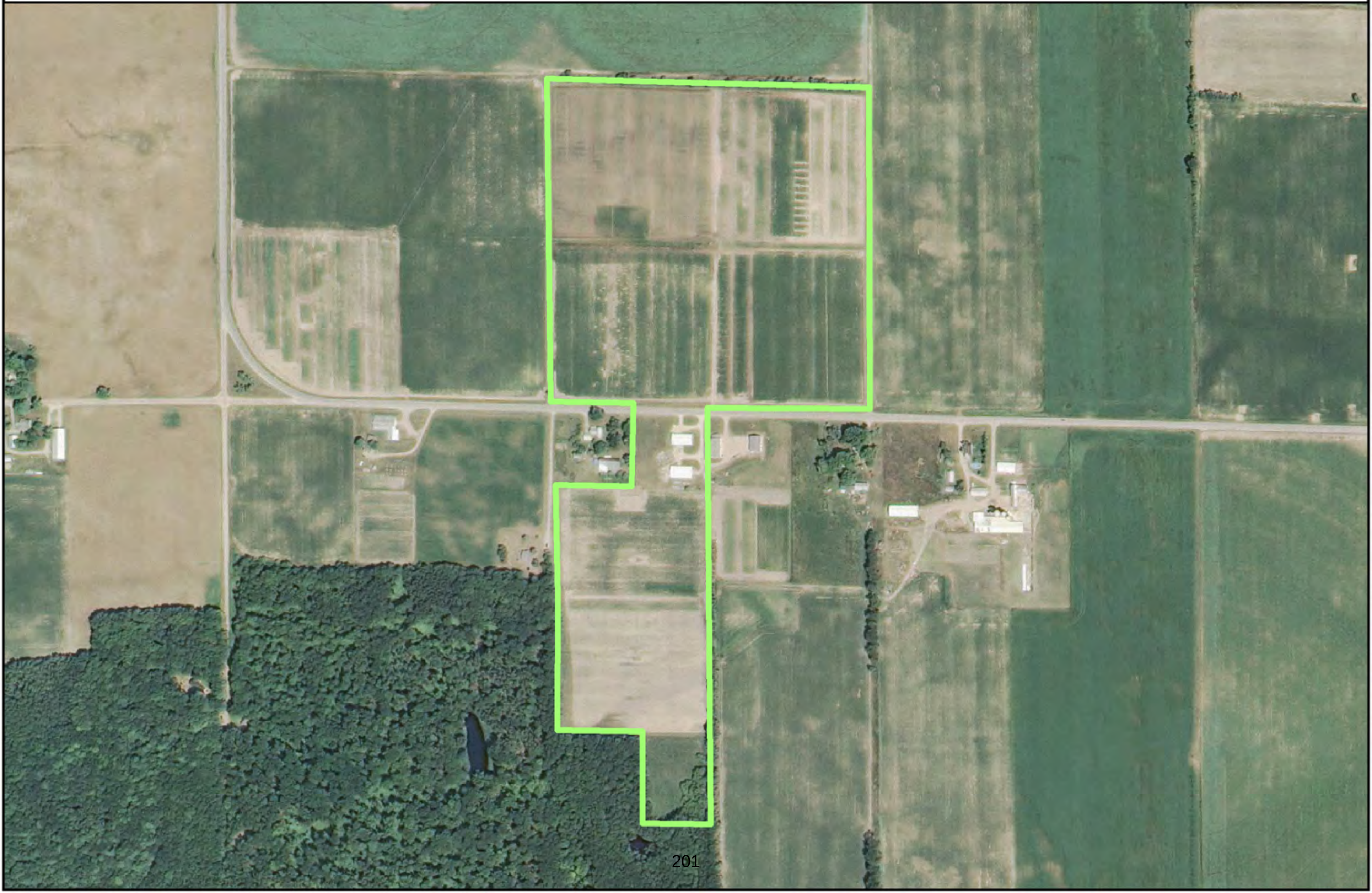
Image Year: 2009



Montcalm Experimental Farm

Montcalm County, Douglass Township, Sections 8 and 17

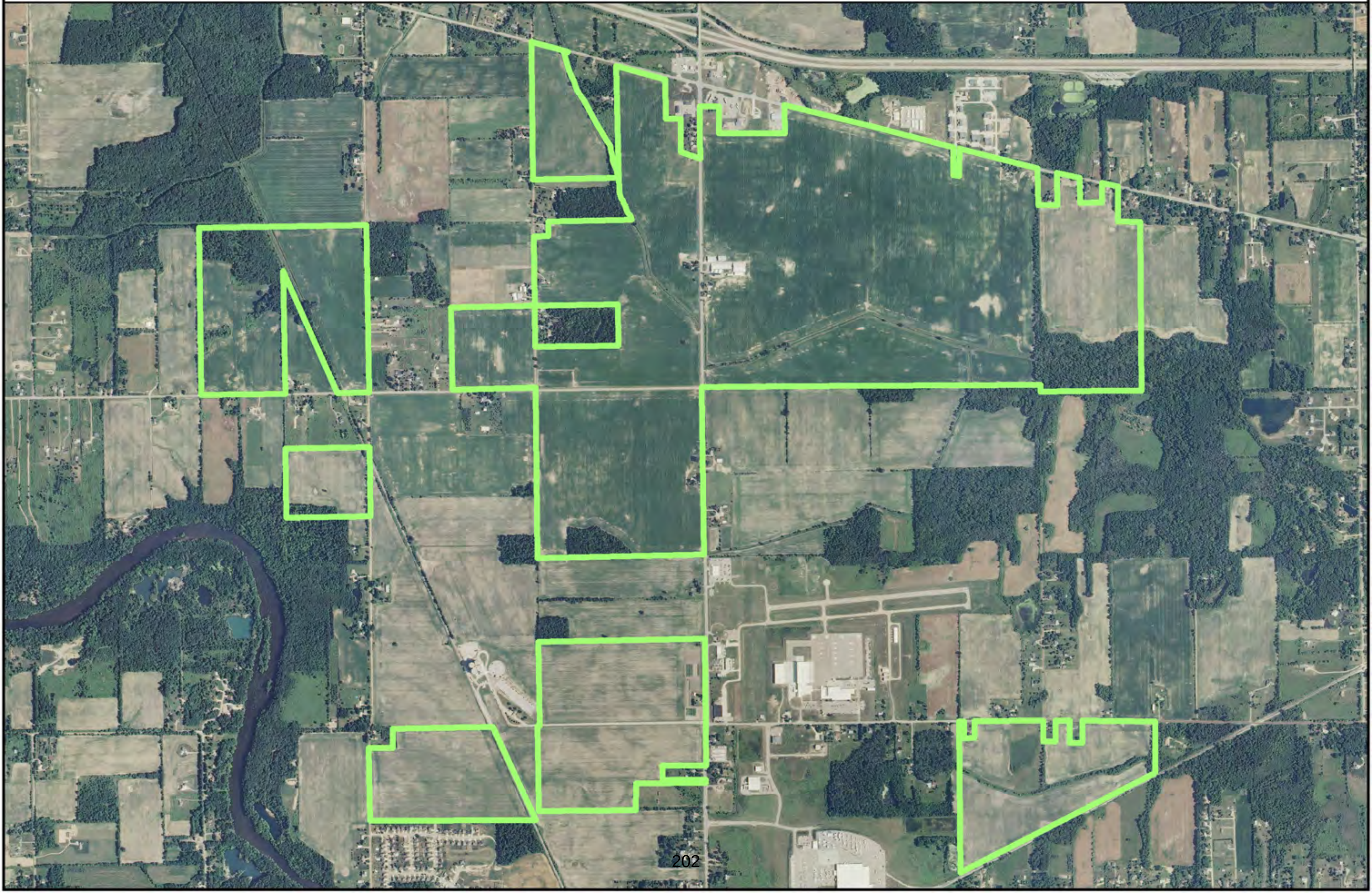
Image Year: 2009



Morris Property

Clinton & Eaton Counties, Oneida Twp, Sections 1 and 2; Delta Twp, Section 6; Eagle Twp, Sections 23, 25, 26, 27, 34, 35; and Watertown Twp, Section 30

Image Year: 2009



MSU Sailing Club

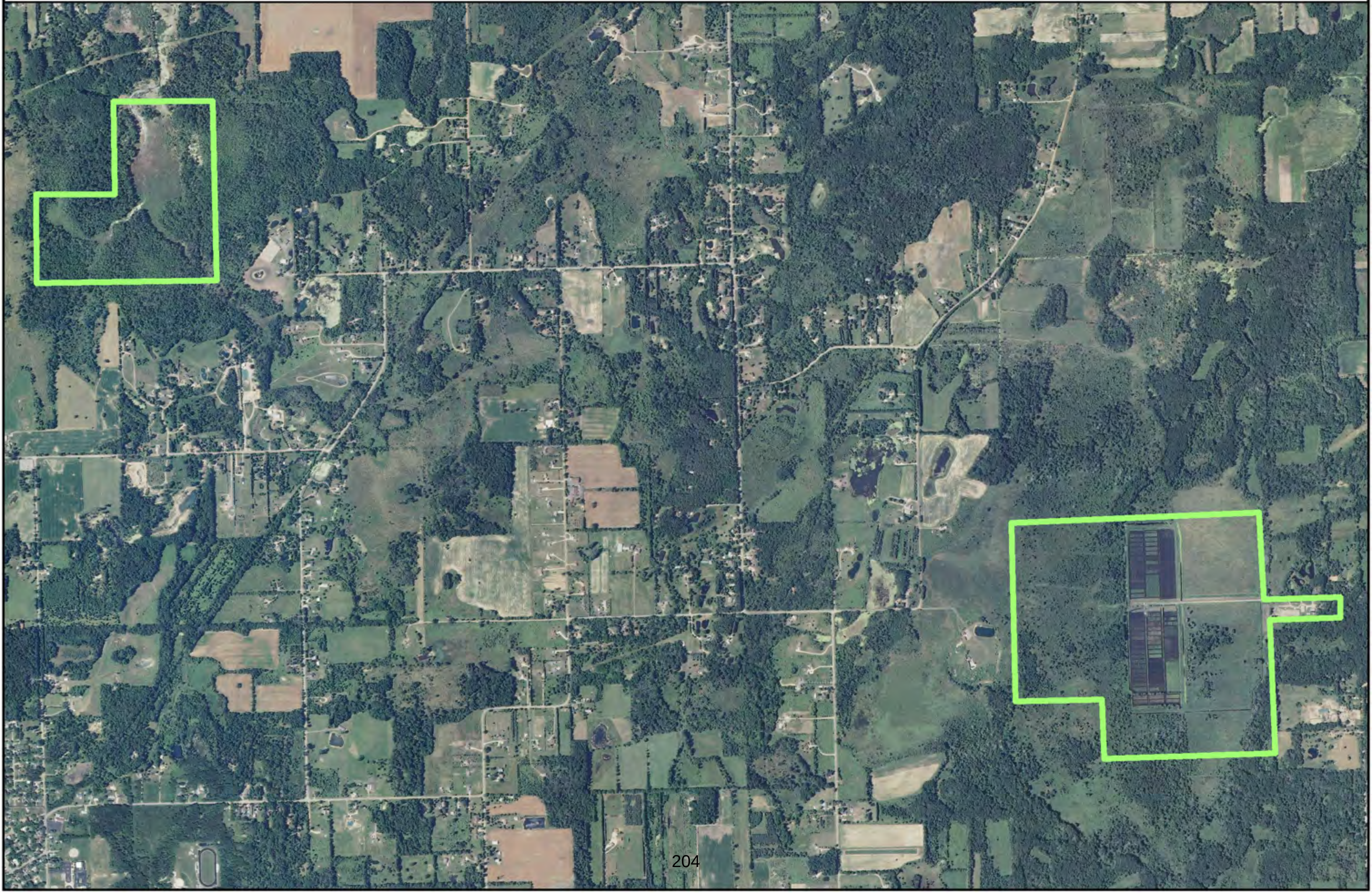
Ingham County, Meridian Township, Section 11

Image Year: 2009

Muck Soils Research Farm

Clinton County, Bath Township, Sections 4, 5, 11, 12, 13, and 14

Image Year: 2009



River Terrace Property

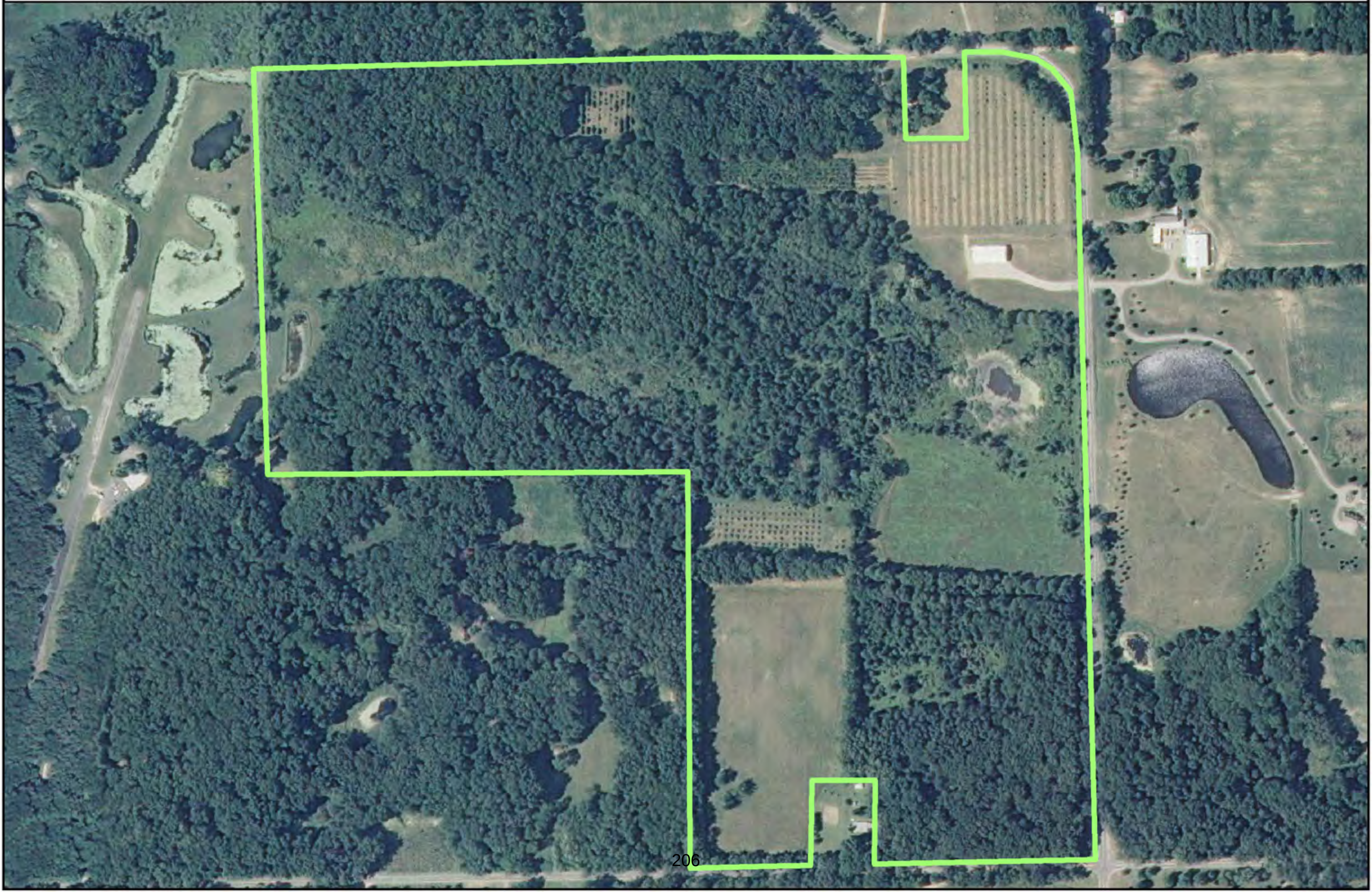
Ingham County, Meridian Township, Section 20

Image Year: 2009

Rogers Reserve

Jackson County, Liberty Township, Section 4

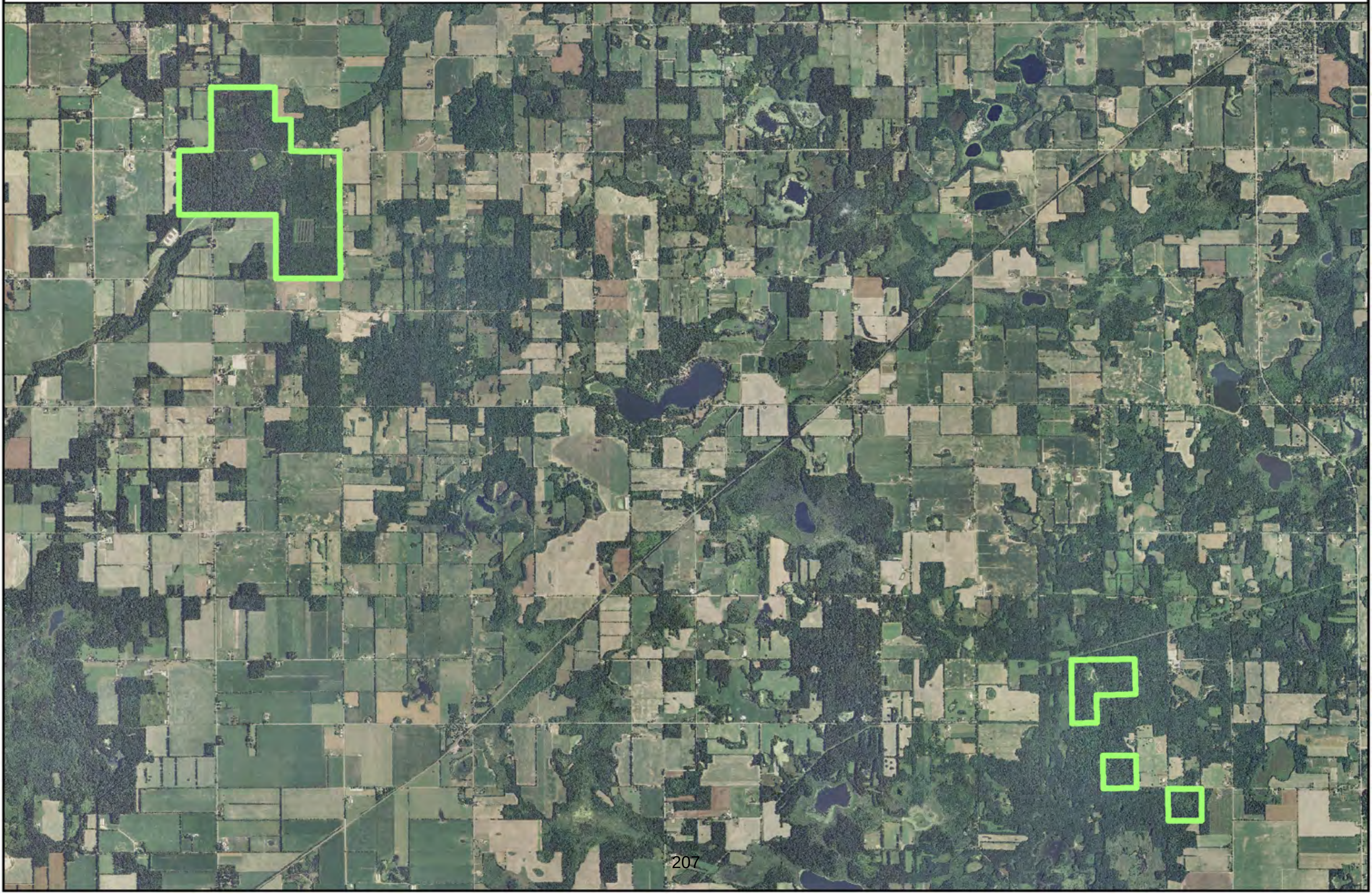
Image Year: 2009



Russ Forest Experiment Station

Cass County, Volinia Township, Sections 20, 29 and 30;
Newberg Township, Sections 16, 17, and 21

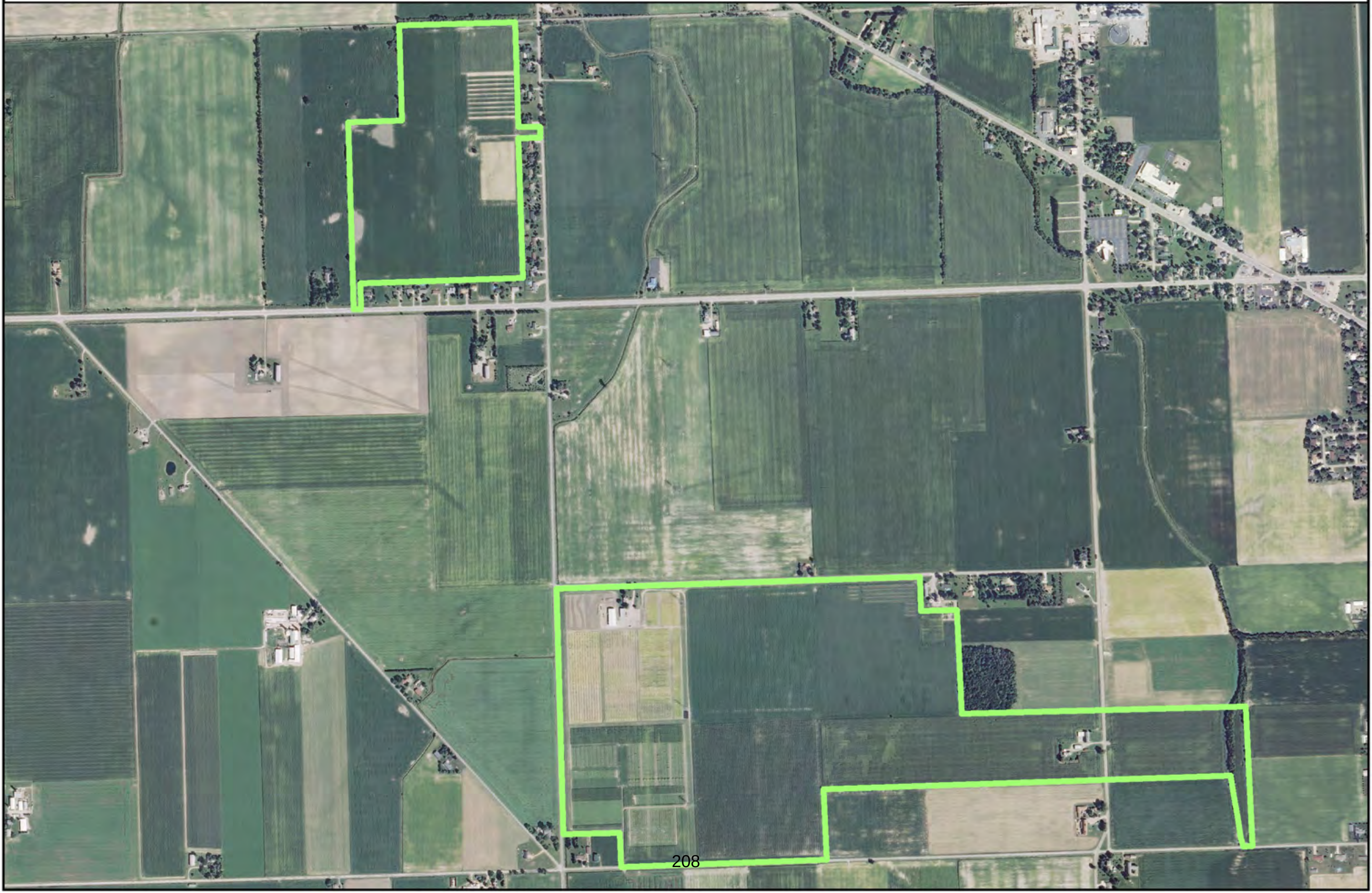
Image Year: 2009



Saginaw Valley Research and Extension Center

Saginaw County, Blumfield Township, Section 25; Tuscola County, Denmark Township, Section 31

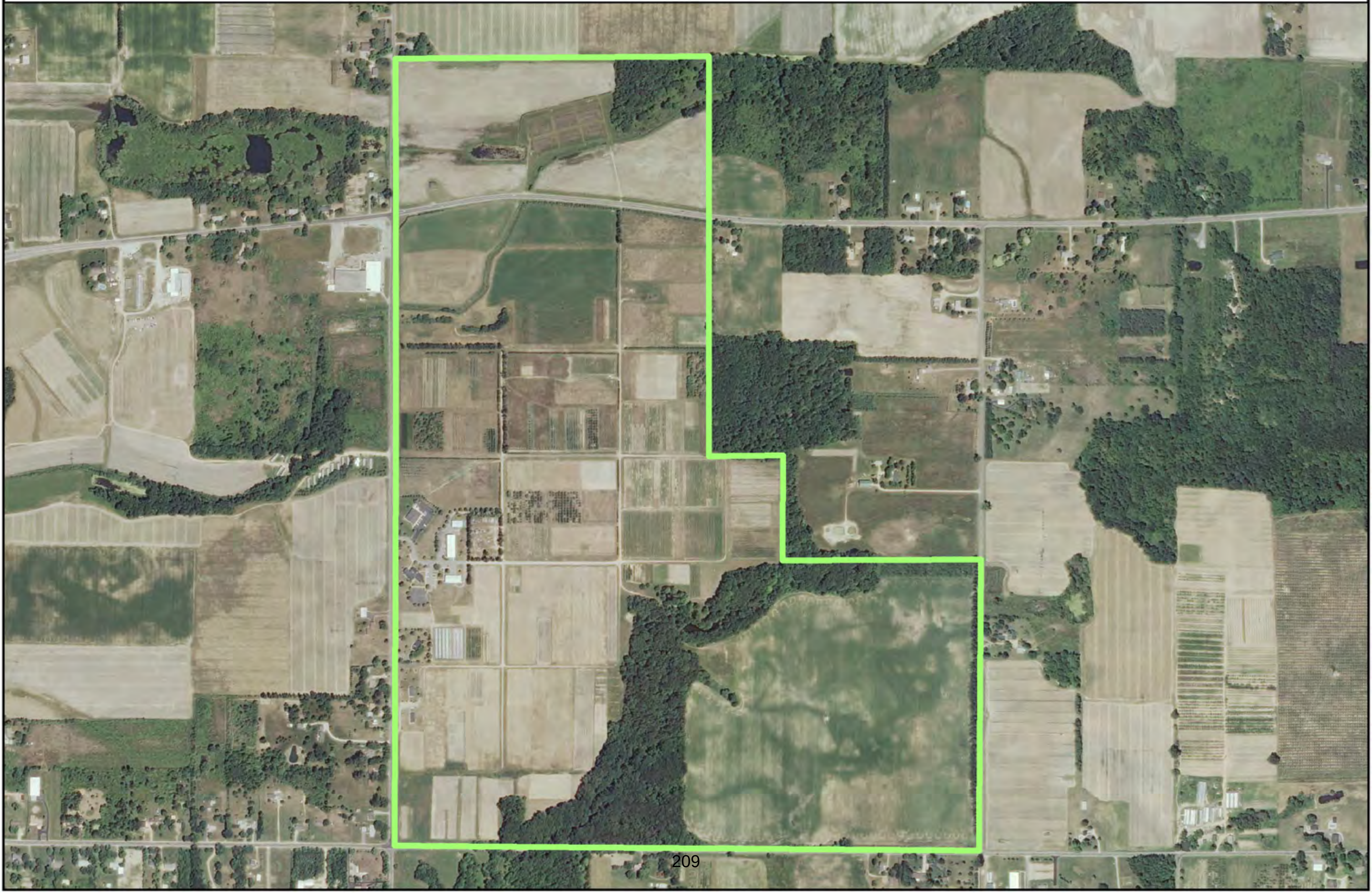
Image Year: 2009



Southwest Michigan Research and Extension Center

Berrien County, Benton Township, Sections 25 and 36

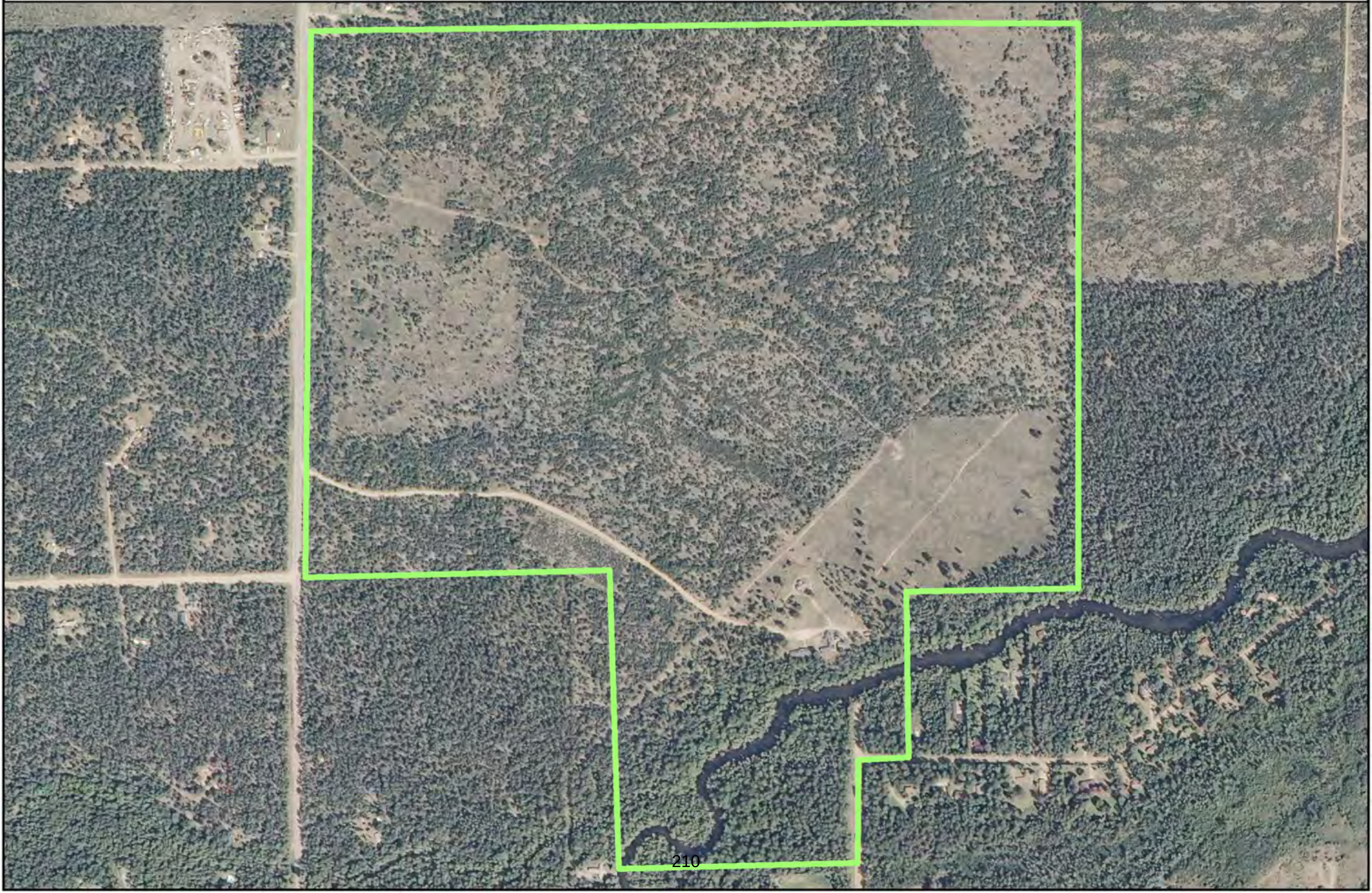
Image Year: 2009



Stranahan-Bell Property (Wa Wa Sum)

Crawford County, Grayling Township, Sections 1, 6, and 12

Image Year: 2009



Stuckman Property

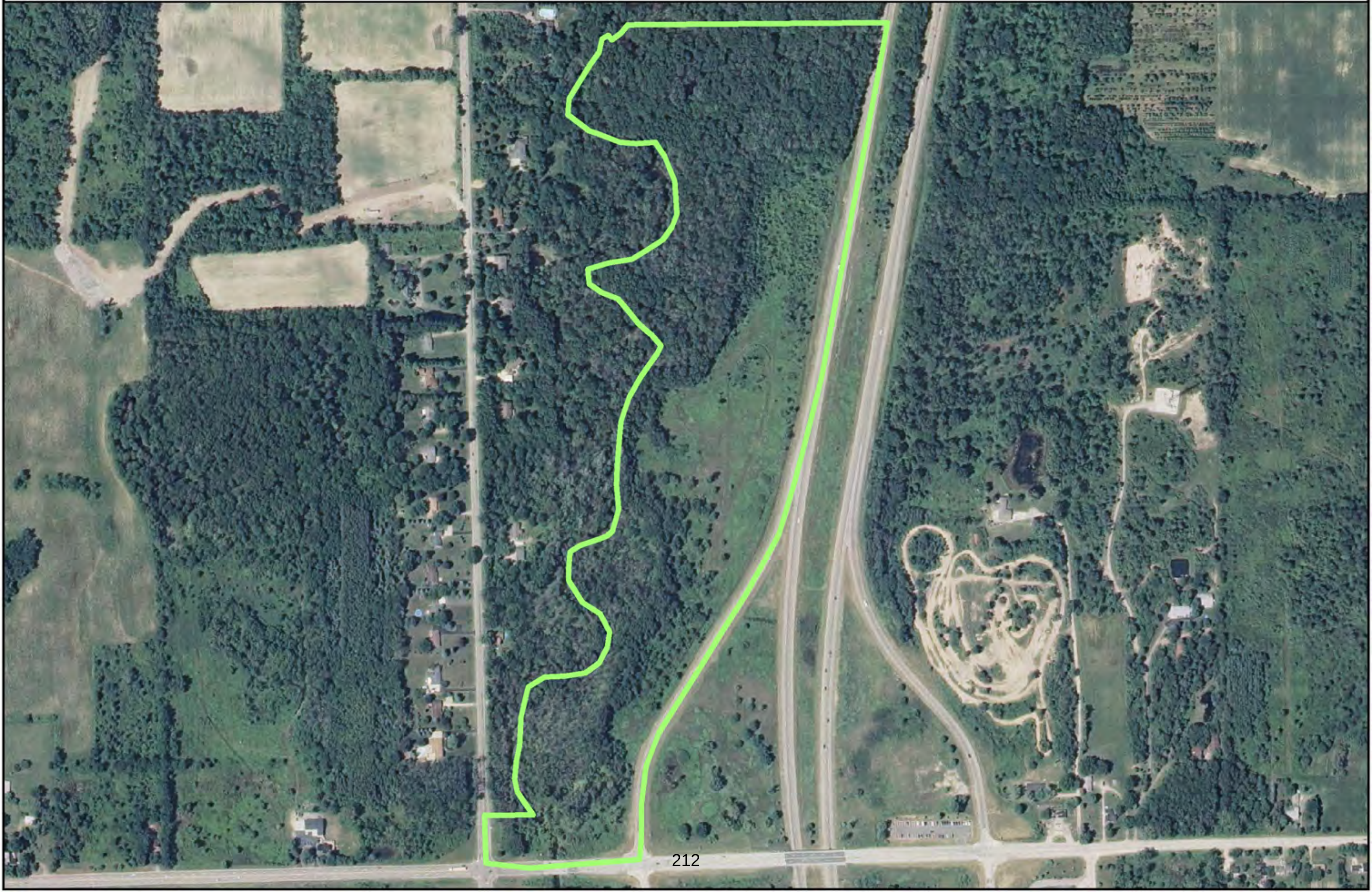
Clinton County, Bingham Township, Section 10

Image Year: 2009

Sycamore Creek Property

Ingham County, Alaiedon Township, Section 18

Image Year: 2009



Tollgate Education Center and Americana Foundation Property

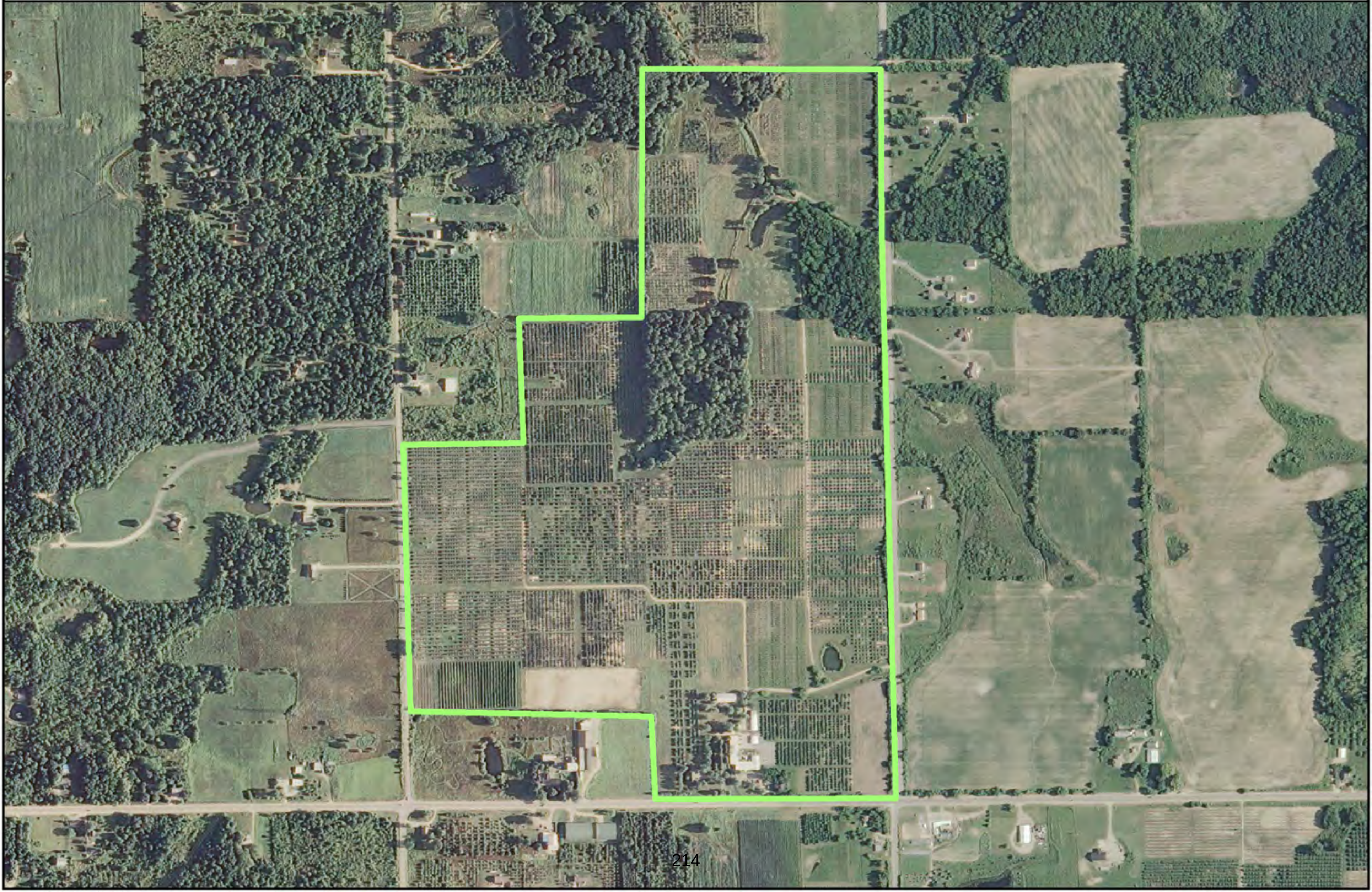
Oakland County, City of Novi, Section 11

Image Year: 2009

Trevor Nichols Research Complex

Allegan County, Saugatuck Township, Section 35

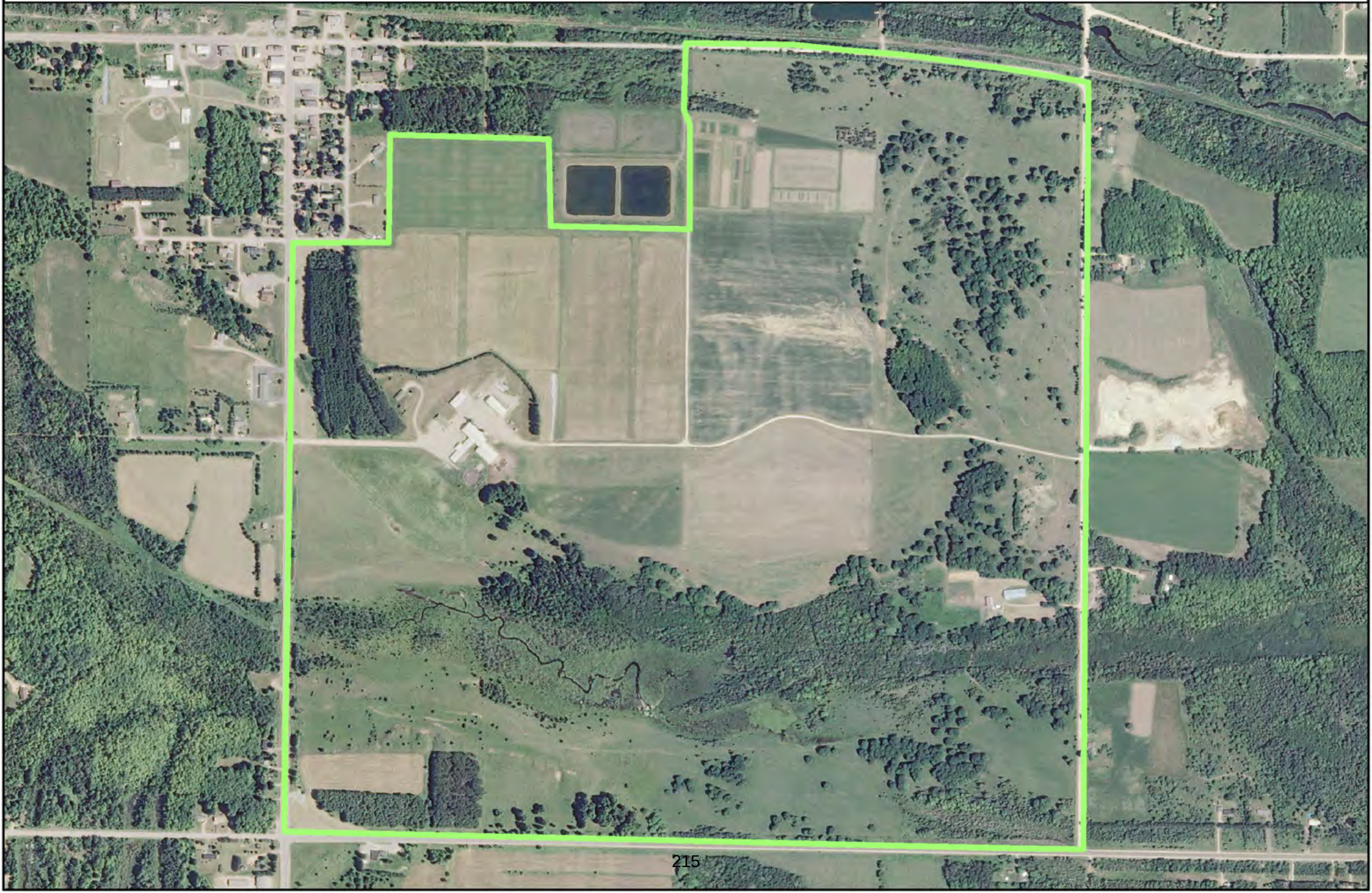
Image Year: 2009



Upper Peninsula Experiment Station

Alger County, City of Chatham and Rock River Township, Sections 24, 25, 27, 28, and 34

Image Year: 2009



Van Hoosen Property

Oakland County, Avon Township, Section 1

Image Year: 2009