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The Danger of Sprawl: Planning for the Protection and Extraction of Construction Aggregates Utilizing Open Space Planning and Design Principles and Techniques

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Executive Summary

The Problem of Future Scarcity of Subsurface Mineral Deposits

There is a problem looming on the horizon that could have very significant impacts on the way we live our every day lives. This problem, if left unsolved, could have reaching implications for generations to come. This problem is the increasing loss of subsurface minerals to development. While not as headline grabbing as toxic waste, poisoning our water supplies, or global warming changing the earth's climate; the loss of these subsurface resources may have unforeseen and profound impacts on our economy and how we continue to grow as a society.

Subsurface minerals are essential to nearly every facet of modern society. From the cars we drive, the buildings we live and work in, and the consumer products we use every day, all are derived in some fashion from mined materials. Historically, in the United States, access to these materials has been readily available with regards to the population centers they were serving. Today however, circumstances are quickly changing with our ever growing population and demand for these resources. While the United States is currently a nation of approximately 293 million people per the United States Bureau of the Census website, societal demand of subsurface minerals, such as sand and gravel deposits, has steadily increased to meet this growing population's consumption (U.S Census Bureau, 2004).[1] The danger looming on the horizon is in how our society is growing not only in population, but in our patterns of land use.
The growth patterns associated with current land use polices and practices point to a disturbing trend of increasing land coverage at an alarming rate, that if continued unchanged will increase the rate of loss of subsurface materials before they can be mined

and utilized. The net effect of which will be shortages of needed materials and rising costs of goods derived form these resources.

To slow this type of unsustainable growth, Michigan and the nation need to learn new approaches to growing society without utilizing land at rates greater than their populations need; wasting resources we cannot replace. Open Space Planning and Design processes and techniques are tools to help manage growth in a more sustainable way, while at the same time offering unique opportunities to shape land and create new natural resources and habitats. These new resources can then be protected in the post mining land use in harmony with new development.

Legal changes are necessary to accomplish this task, namely the rewriting of Michigan Land Division acts and new legislature to protect the aggregate materials and provide for a statewide inventory and analysis of resource locations. Promotion of regional planning efforts is vital in order to help in resolution of multi-jurisdictional land use comprehensive planning and zoning efforts. The public and mining companies need to be aware of the problem and realize that they both have a role to play in making a sustainable future for the State of Michigan.

Introduction

What is Sprawl?

Sprawl is a word that is hard to specifically define, as it has evolved to mean many types of development and development activity to different people. Some may describe "sprawl" to mean strip development along major arterial roads, with characteristic "big box" chain stores that have rapidly expanded across the country in the last twenty years. Others may describe it as expanding suburban development accelerated by the American love of the automobile. While both of these definitions certainly are valid examples of sprawling development patterns, they are incomplete in defining what sprawl truly is and what it encompasses. William Fulton, Rolf Pendall, Mai Nguyen, and Alicia Harrison, in their article *"Who Sprawls Most? How Growth Patterns Differ Across the U.S."*, have put a quantifying measure on the definition of sprawl. They state: *"If land is being consumed at a faster rate than population growth, then a metropolitan area can be characterized as "sprawling". If population is growing more rapidly than land is being consumed for urbanization, then a metropolitan area can be characterized as "densifying".*[2]

This definition, while not perfect as the authors themselves state, does provide a measuring line for evaluating sprawl, because it places a quantitative measure on land use versus population growth rates. The ability to define sprawl in this manner is crucial for evaluating and recognizing land use patterns that threaten natural resources. It is also important however, to understand the historical origins of sprawl in order to form a more complete picture of the influence and effect of sprawl over time.

Origins of Sprawl

While the exact moment sprawl was born is impossible to determine, since there is no perfect definition of sprawl, it can be said that the governmental policies just prior to and following the Second World War had a profound effect on land use patterns in the decades to follow. The New Deal programs under President Franklin Delano Roosevelt were designed to revitalize the American economy and major portions of the programs had direct influence on land use patterns. Two of the most significant programs that influence sprawl were policies on housing and highways.

Housing starts were near an all time low following the stock market crash of 1929. In order to prevent further economic loss, as Peters Hall states in his book Cities of Tomorrow, *"It was an early New Deal experiment - the Home Owners Loan Corporation (HOLC), introduced as an emergency measure of April 1933 to stem farm foreclosures – that introduced into America the long-term, self amortizing mortgage."*[3] Prior to this period the American public was limited to loans that were ranging from 6-7 percent and were limited in term from 5-10 years. The creation of the Federal Housing Administration (FHA) in 1934 opened the door to new financing options for the middle income American. For the first time a 30 year mortgage, with a 3-4 percent interest rate became available. This was because private lenders became backed by the FHA (Hall, 1988).[4] With subsequent additional programs such as: the Federal National Mortgage Association (Fannie Mae), the Government National Mortgage Association (Ginnie Mae), the Federal Home Loan Corporation (Freddie Mac), and the Veteran Administration, the amount of middle and lower income Americans who could qualify for a home mortgage greatly increased (Squires, 2002).[5]

The governmental policies related to the automobile in America, have worked hand in hand with the governmental home and business financing programs to generate the explosion of suburban expansion over the last sixty years. In 1956 the Federal-Aid Highway Act opened the central cities to automobile commuters and for the first time made living outside the central city, while working in the central city, a viable option for middle and upper class citizens. While previous acts had provided federal subsidy for commerce expansion through improvements to highways and county road networks, they avoided connections to the central city core. The 1956 Interstate Highway Act fully endorsed and provided for the access to the central city as a means to expand commerce and drive urban renewal. This was a monumental endeavor encompassing over 41,000 miles of new roads at a cost of approximately $41 billion dollars (Hall, 1988).[6]

Armed with this new federal initiative for infrastructure and a financial mechanism for funding new home ownership, suburban expansion was a mere matter of time. For the right entrepreneurs, who could see the future potential of these programs, it was a proverbial pot of gold at the end of a development rainbow. One such entrepreneur who became infamous during this time was Abraham Levitt. He and his sons founded a small development company in Long Island, New York in 1929 (Hall, 1988).[7] In a few short years the Levitt company had learned to create fast large scale developments that appealed to the middle and upper class, almost exclusively Caucasian, citizens and returning World War II veterans who wished to escape the real or perceived negative lifestyle of the central city. Vainly named Levittowns, they appeared in New York, Pennsylvania, and New Jersey, and were quickly bought by an eager citizenry, making Levitt a very wealthy man in a short period of time.

To those who benefited from the availability of low cost suburban housing, namely the home owners and municipalities who saw there tax coffers increase from the increase in economic activities; Levitt could be considered a saint. To many urban and regional planners, architects, landscape architects, and environmental scientists, who have seen the social and environmental results of this style of massive suburban development, he may be considered a villain. In either case, his profound influence on suburban development has been mimicked by his peers and set in motion carbon copies of like developments all over the United States.

While federal programs had a profound influence on the creation of sprawl, it is not the only factor in why sprawl has occurred in the United States. Social change occurring at the same time as the federal programs greatly added to the exodus from the central cities to the fringe communities and beyond. One fundamental social change was within the dynamics of the American family. Prior to the Second World War, it was not unusual for several generations of families to reside within the same household, or at the least to remain in close proximity to one another. In the central city this would often be within the same apartment building or within the same neighborhood. Economics often played an important role in this dynamic, as extended family was often necessary in order to pay for housing and day-to-day living expenses. In addition, child-rearing would be shared among generational relatives as extended family often worked different shifts. Ethnic groups also were segregated together in the central city neighborhoods, often by choice, as they shared a common background and cultural social framework.

The move out to the suburban fringe following the Second World War took these social norms and promptly discarded many of them. The cheaper mortgage rates and

long-term loans allowed access to homes to the nuclear family. No longer was it a necessity for the newly married couples to reside with the parents, brothers, or other extended family in order to economically survive. There was a sense of independence in breaking away from this paradigm and having ones own home and private yard, no matter what size. The Federal programs to expand and improve existing highways allowed access to the central city for work, while allowing this independence. A new paradigm was forming and it was quickly gaining momentum.

Those that were economically able to leave the central cities for these new suburban areas did so in increasing numbers during the 1950s and 1960s. This was almost exclusively middle and upper income whites. As a result central cities and the suburban fringe became very racially and economically segregated during this period. Fear of increased crime and an increasingly deteriorating central city made the suburbs more and more attractive for those that could leave. The civil rights clashes and racial riots of the 1950s and 1960s further motivated this exodus, which came to be known as 'white flight' (Fox, 1985).[8] These changing American social paradigms and the federal programs initiated during this period were a perfect catalyst for sprawl.

Growth of Sprawl

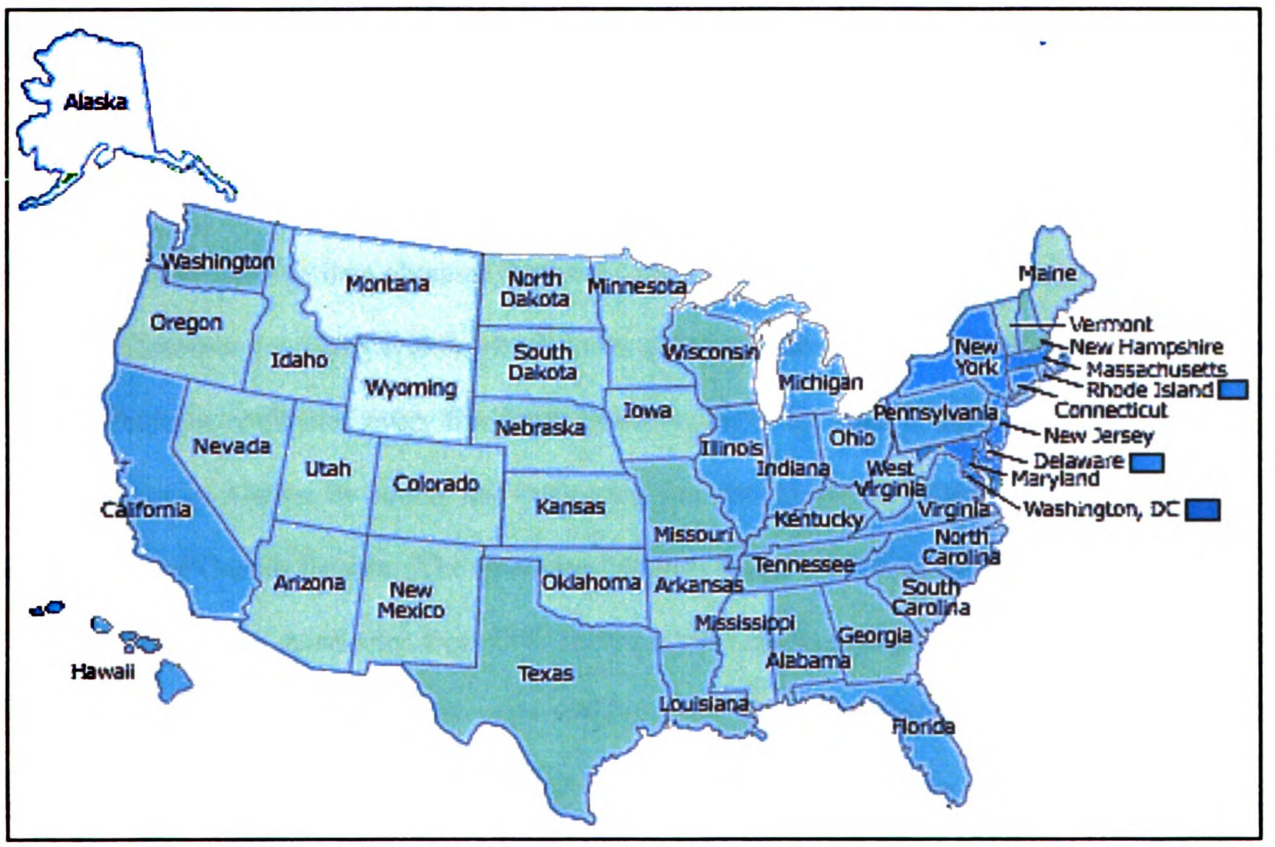
United States 2000 Census and Land Consumption

With the factors which encouraged the creation of sprawling land use strongly in place, it is important to evaluate how much land use change has occurred. A first step in this process is to look at the current population density in the United States to establish a baseline. According to the United States Bureau of the Census, the United States' population for the year 2000 Census was 281million people.[9] A statistical summary

breakdown of the United States 2000 census is presented in Appendix A. The following graphic (Figure 1) shows a representation of the Census 2000 population density per square mile data broken down by state.

Figure 1

United States 2000 Census - Population per Square Mile



Persons per square mile

- 3,000 to 66,940.0
- 300.0 to 2,999.9
- 160.0 to 299.9
- 79.6 to 159.9
- 7 to 79.5
- 1.0 to 6.9
- 0.0 to 0.9

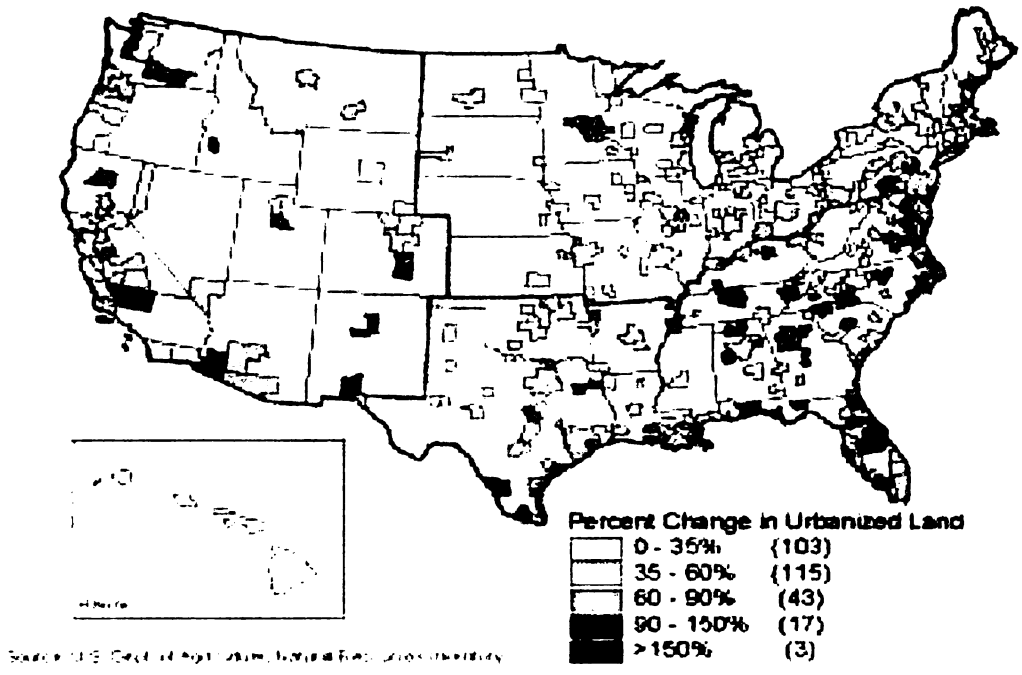
Source: U.S. Census Bureau, data file from Geography Division based on the TIGER/Geographic Identification Code Scheme (TIGER/GICS) computer file. Land area updated every 10 years. http://www.census.gov/mp/www/rom/msrom12d.html or http://factfinder.census.gov.

As can be seen from the previous graphic interpretation of the census data, the bulk of the U.S. population is located along the coastlines as would be historically expected, with the center of the country maintaining lowest density levels on average. While this does provide an indication of where sprawl might be occurring it does not adequately express the nature of sprawl as land consumed at a faster rate than population growth. To evaluate this it is necessary to look at a different data set.

Fulton, Pendall, Nguyen, and Harrison, in their article: *"Who Sprawls Most? How Growth Patterns Differ Across the U.S.,"* published by the Brookings Institute, have presented an analysis of data obtained from the U.S. Department of Agriculture's National Resource Inventory (NRI), which looks at the urbanization of land over time. The inventory is conducted every five years by surveying every state in the union, with the exception of Alaska, by county and evaluating this data by metropolitan areas as defined by the Census Bureau. The Brooking Institute's aggregation of the data collected from the inventories, conducted from 1982 through 1997, yielded some very significant findings. They found, *"between the years 1982 to 1997, the amount of urbanized land in the United States increased by 47 percent, from approximately 51 million acres in 1982 to approximately 76 million acres in 1997. During this same period, the nation's population grew by only 17 percent."*[10] The bulk of this change occurred in the period of 1992 to 1997, when the nation added 11 million new acres of urbanized land (Fulton, Pendall, Nguyen, and Harrison, 2001).[11] The following graphics (Figure 2 and 3) are reproduced from the Brookings report, illustrating the nature of this change.

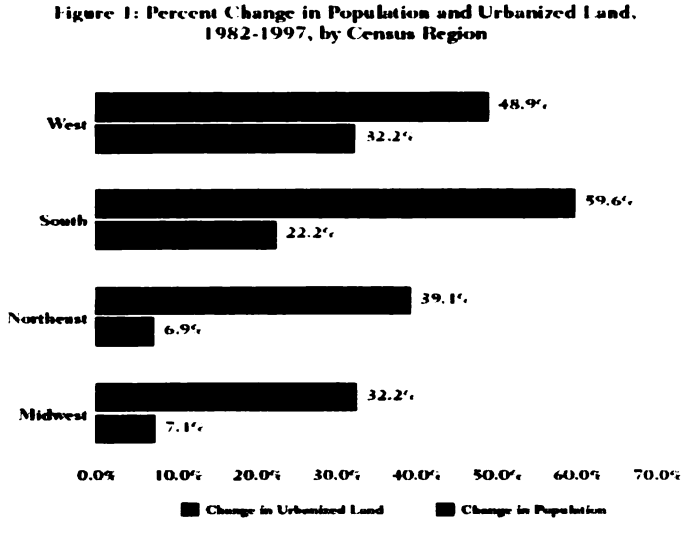
Figure 2

Percent Change in Urbanized Land, MSAs and CMSAs, 1982–1997



Source: Fulton, William, Rolf Pendall, Mai Nguyen, and Alicia Harrison. Center on Urban & Metropolitan Policy, Who Sprawls Most? How Growth Patterns Differ Across the U.S. July 2001. 3 <http://www.brookings.edu/index/reports.htm>.

Figure 3



Source: Fulton, William, Rolf Pendall, Mai Nguyen, and Alicia Harrison. Center on Urban & Metropolitan Policy, Who Sprawls Most? How Growth Patterns Differ Across the U.S. July 2001. 9 <http://www.brookings.edu/index/reports.htm>.

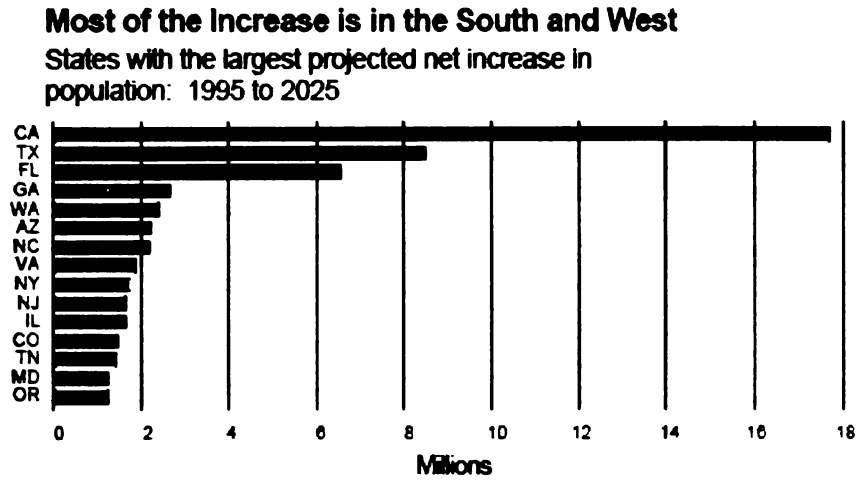
From the data analysis we can see that the West was the most efficient in managing growth, as it relates to minimizing sprawl, achieving an average density of 3.59 persons per acre. The Brookings report indicated there are several factors which likely have had an influence on why they are much better than the rest of the country at maintaining a higher density ratio. A significant amount of the areas that can support intense development are surrounded by mountainous terrain. In addition, the western states have a heavier reliance on public water and sewer infrastructure and generally have a more stringent master planning requirement which encourages more dense development.

Contrarily, the Midwest was the worst in terms of land use consumption vs. population growth. During this period the Midwest consumed 4.5 million acres of land to urbanization while the population only increased by 4.1 million people. This equates to a density level of only 0.91 persons per acre (Fulton, Pendall, Nguyen, and Harrison, 2001).[12] From the data, we have a clearer picture of the current amount of sprawling land use in the Unites States, but what can we expect in the future?

Future Growth Needs

While it is crucial to have an understanding of the current status of sprawl, it is even more important to determine as best as possible the anticipated growth of population and land use. This is necessary in order to estimate what areas of the country are most at risk from further land urbanization. The United States Bureau of the Census in their Report, *"Population Projections: states, 1995-2025"*, has estimated that the greatest growth will occur in California and the southern states of Texas and Florida; see Figure 4 (Campbell, 1997).[13]

Figure 4



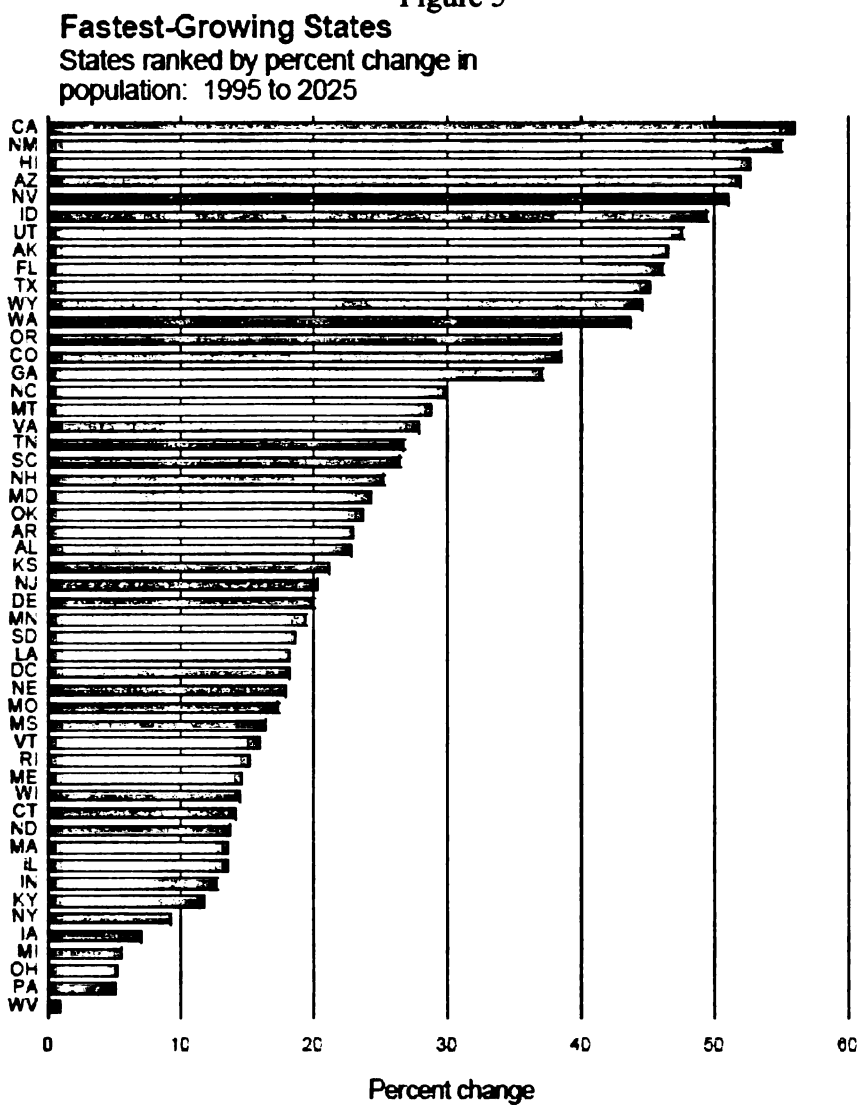
Source: Campbell, Paul. "Population Projections: States, 1995-2025." Current Population Reports. Census Bureau P25-1131. May 1997. 1
< http://www.census.gov/prod/www/abs/popula.html>.

In relation to total land conversion to an urbanized use the *"TCRP Report 74,"* research conducted by Rutgers University, has studied current land use trends and evaluates and projects future land use consumption. Their research is based upon population projections and current trends of what they call 'Uncontrolled-Growth' land use scenario for the period of 2000 to 2025. They found that under this scenario the United States could expect to urbanize approximately 18.83 million acres of land. This breaks down in the following manner: 7.09 million acres in agricultural land, 7.04 million acres in environmentally sensitive land, and 4.7 million acres in other lands (barren, unproductive agriculturally, or awaiting development); (TCRP, 2002).[14]

As in the case of the U.S. Census population projections for the same period, the TCRP Report 74 found the bulk of the land consumption is anticipated to occur in the south, accounting for 53 percent of the growth. The Midwest is expected to grow by only 17.5 percent and convert approximately 2.8 million acres of land to urbanized use.[15] Both research findings show the highest and most significant increase is in the South

region. Looking at the individual state data (Figure 5) by the U.S. Bureau of the Census, the projected trend also generally agrees with the TCRP findings (Campbell, 1997).[16]

Figure 5



Source: Campbell, Paul. "Population Projections: States, 1995-2025." Current Population Reports. Census Bureau P25-1131. May 1997. 1 < http://www.census.gov/prod/www/abs/popula.html>.

From this we see the Midwest states are last in rate of growth. This is in contrast to the TCRP Report 74 projections which indicate the Northeast states will grow the least. According to the TCRP Report 74, the Northeast region will consume 1.46 million acres of land, with a growth rate of 9 percent (TCRP, 2002).[17] So while there is some

discrepancies in the specific regions the overall projected trends remain consistent. The nation will continue to sprawl as it grows. In order to gain a better understanding of what this projected trend of sprawling land use means to the State of Michigan, it is necessary to examine some more Michigan specific data.

Michigan's Growth

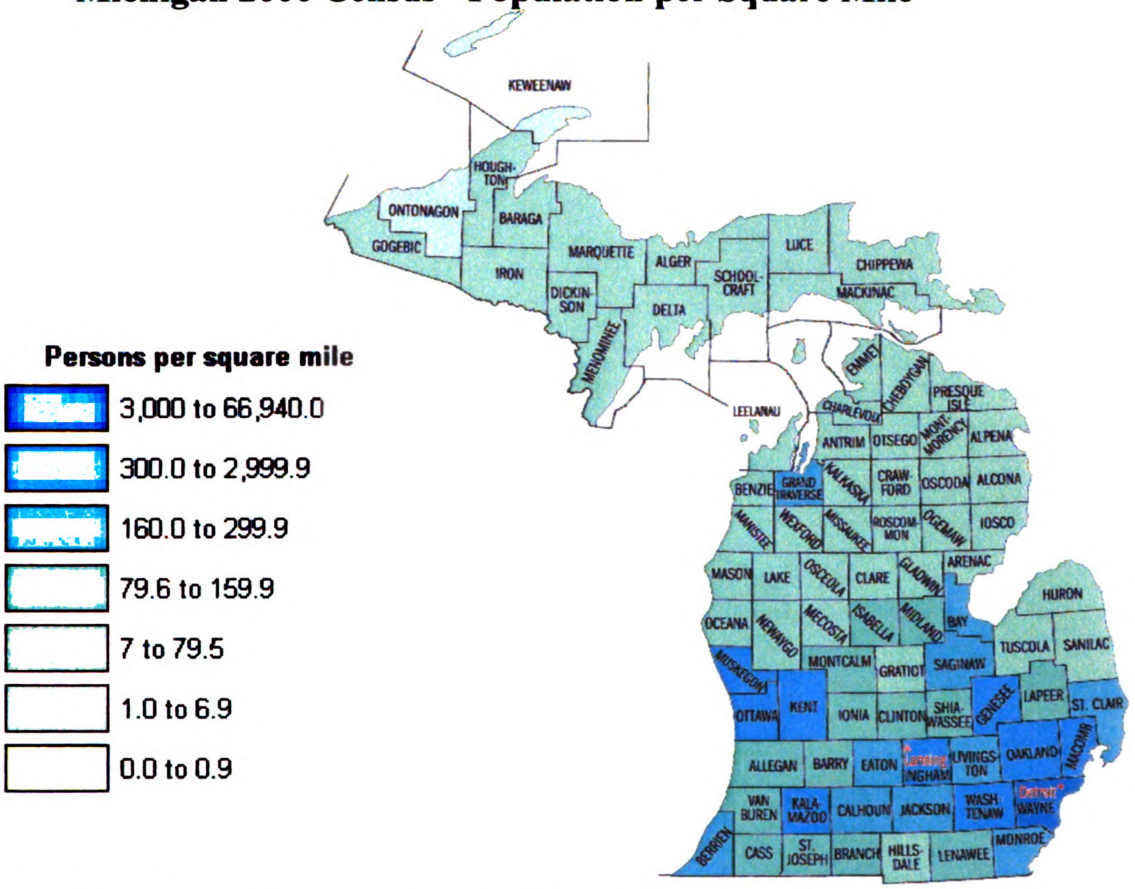
The State of Michigan is a very unique place. Comprising approximately 37 million acres of land area, the state is also the home to 95 percent of the world's fresh surface water. In addition, Michiganders enjoy over 11,000 inland lakes, 36,000 miles of inland streams, 19.3 million acres of timberland, and 75,000 acres of sand dunes (PSC, 2001).[18] Michigan is also home to over 3.3 million acres of inland wetlands. An additional 207,898 acres are located in coastal and offshore wetland vegetated areas (U.S. Department of Interior, 1994).[19]

The 2000 U.S. Census has shown Michigan's population to be approximately 9.94 million people. The density of the state's population is illustrated in Figure 6 (Pg.25). A summary of the state census is provided in Appendix B. As can be seen from the data in Figure 6, the bulk of the population density is in the Southeastern Lower Peninsula of the state. This also shows the sprawling land use that has, and continues, to occur in the areas surrounding the major metro areas of Detroit, Lansing, Grand Rapids, and Kalamazoo. Michigan, over time, is anticipated to continue sprawling. To understand how this can influence land use, it is important to examine projection studies that have been completed.

Public Sector Consultants, Inc., a public policy consultant agency, prepared in 2001, a study on Michigan land use titled "Michigan Land Resource Project" and with

Figure 6

Michigan 2000 Census - Population per Square Mile

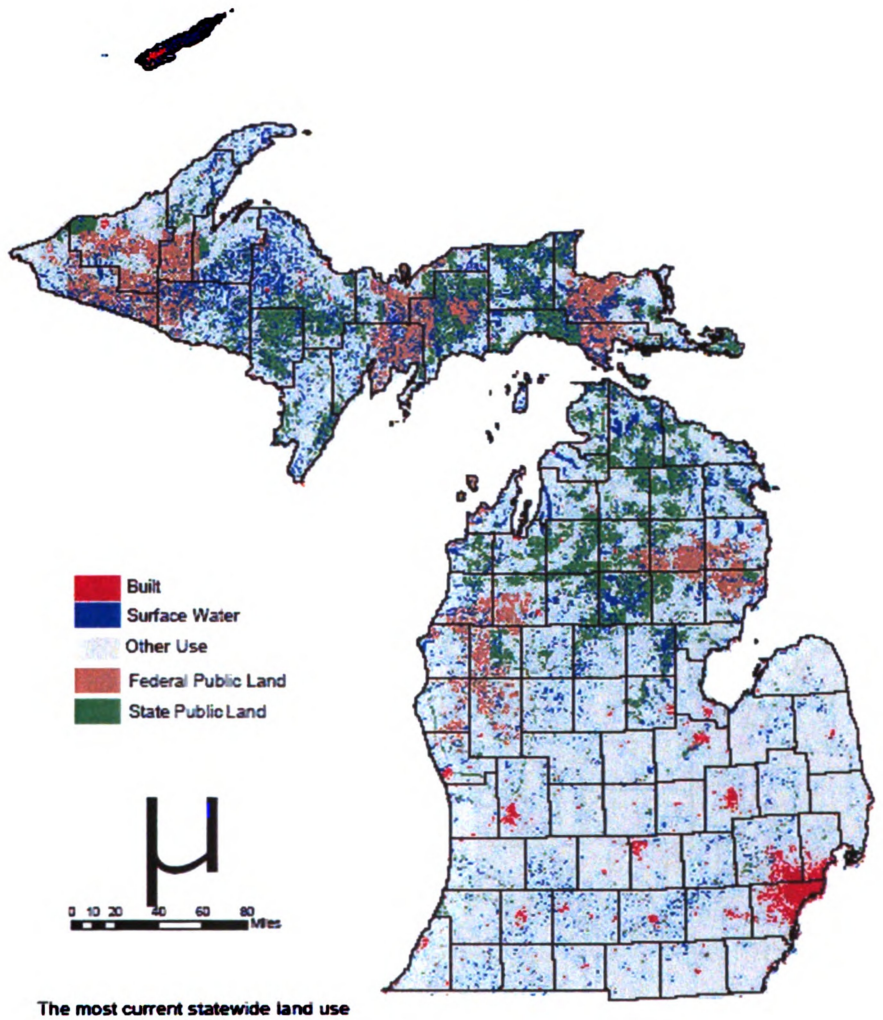


Source: U.S. Census Bureau, data file from Geography Division based on the TIGER/Geographic Identification Code Scheme (TIGER/GICS) computer file. Land area updated every 10 years. http://www.census.gov/mp/www/rom/msrom12d.html or http://factfinder.census.gov.

assistance from Michigan State University completed a series of land use projections based upon current land use trends. Michigan State University utilized Geographical Information Systems (GIS) in conjunction with remote sensing to create the Land Transformation Model (LTM). The model was built upon the *Michigan base* data provided by the Michigan Department of Natural Resources. This model shows how land use will change over time from the years 1980 to 2040. The graphical results of this study are reproduced on the successive pages in Figures 7- 9 (PSC, 2001).[20]

Figure 7

1980 Built



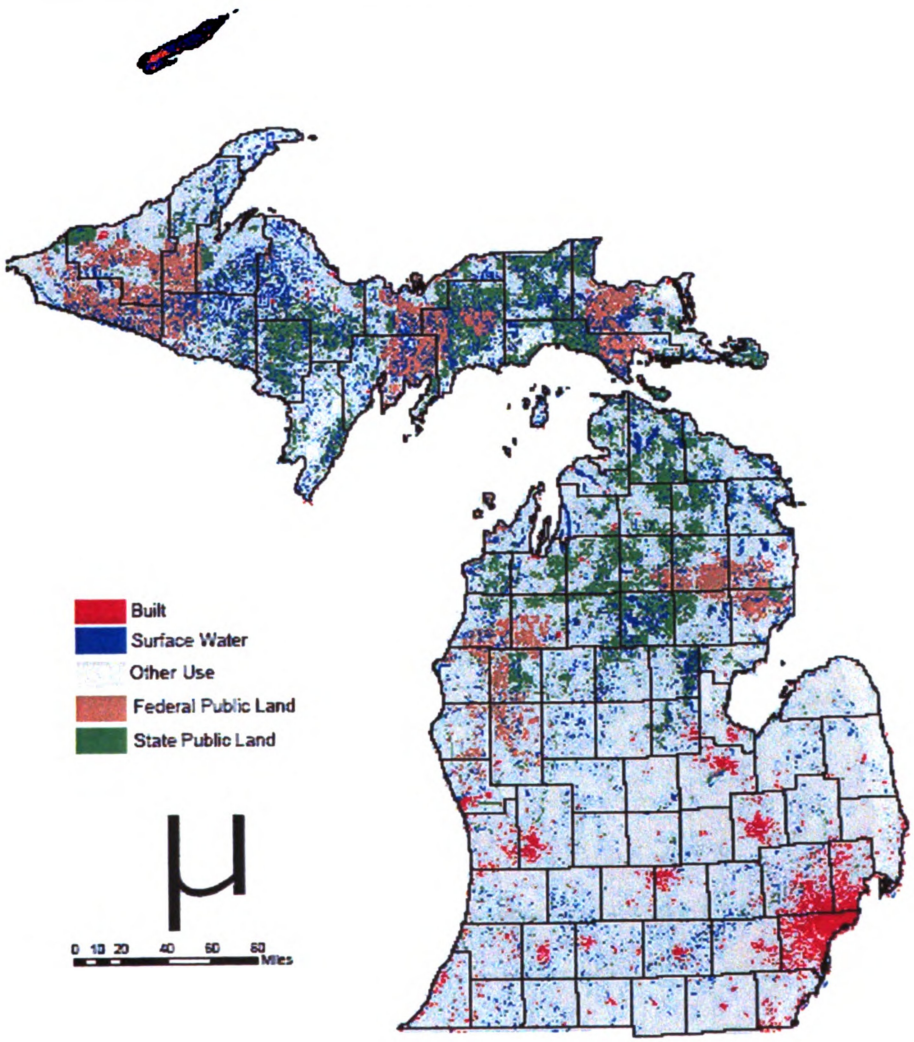
The most current statewide land use assessment was conducted by the MDNR in 1980. This statewide land use database is referred to as the Michigan Resource Information System (MIRIS).

SOURCE: LTM.

Source: Public Sector Consultants. Michigan Land Resource Project. 20 June 2004. November 2001. 13 <http://www.pscinc.com/Documents/Ibilu/index.htm>

Figure 8

2020 Built



Future built estimated for the year 2020 based on the Land Transformation Model projections.

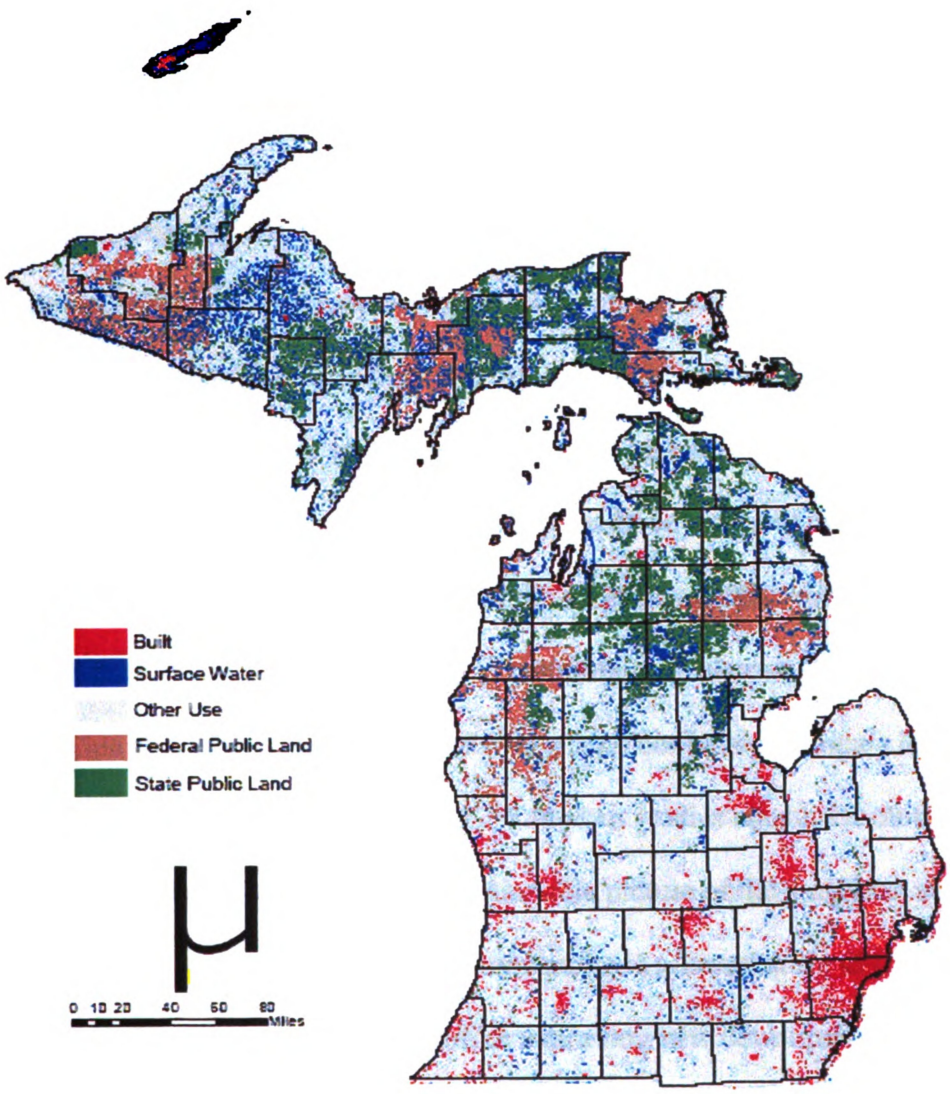
The scenario is based on the urbanization to population growth trends that occurred during the 1980 to mid/late-1990s.

SOURCE: LTM.

Source: Public Sector Consultants. Michigan Land Resource Project. 20 June 2004. November 2001. 14 <http://www.pscinc.com/Documents/Ibilu/index.htm>

Figure 9

2040 Built



Future built estimated for the year 2040 based on the Land Transformation Model projections.

The scenario is based on the urbanization to population growth trends that occurred during the 1980 to mid/late-1990s.

SOURCE: LTM.

Source: Public Sector Consultants. Michigan Land Resource Project. 20 June 2004. November 2001. 15 <http://www.pscinc.com/Documents/Ibilu/index.htm>

Results of the LTM projections indicated that land use in Michigan will increase at a rate of approximately 8:1. This means that the state will utilize 8 percent more land for every 1 percent increase in population. The net result of which will be an increase of built areas of 178% by the year 2040 (PSC, 2001).[21]

Effects of Sprawl

The questions that often get asked by politicians, citizens, and sometimes even by planners are, 'What is wrong with sprawl? Shouldn't market forces decide how land use should be used within the bounds of legal zoning?' The answer is complex and highly debatable with both positive and negative elements on both sides. When the phenomenon of sprawl was in its infancy, sprawl could very easily be seen as a minor issue or simply the desire of the American public to live in the way they wished. However, now having lived with sprawl and seen its expansion continuing at an alarming rate over the last fifty years, we have a better understanding of why it may not be in America's long-range interest to continue this way of land use. Numerous studies conducted on the subject of sprawl over the last ten years paint a questionable picture of the long term sustainability of sprawl. In particular several areas of concern have arisen that should be carefully studied by land use decision makers before approving new development. These areas are: Transportation, Social and Human Welfare, Environmental and Natural Resources. It is important to note that these areas are not mutually exclusive of one another. They are intrinsically linked and can have dramatic influence on one another. However, to expand upon them all in their entirety is beyond the scope of this research. Only one area will be expanded upon, subsurface natural resources, as this area has been the most neglected in relation to sprawling land use. Therefore, a brief look at the major negative

factors related to these issues will be examined in order to understand how they interrelate to one another and to subsurface resources.

Transportation

As has been discussed the Federal highway programs have had significant influence on the creation of sprawl. However the cost of highway expansion is only one piece of a much larger transportation pie. Local communities face huge challenges both fiscally and politically with the expansion of local road systems. The Transit Cooperative Research Program Report 74, completed for the year 2000, had found that in order to meet anticipated demand over the next 25 years, under current uncontrolled growth rate scenarios, the United States would need to spend $927 billion dollars to provide a necessary 2 million additional lane miles of infrastructure (TCRP, 2002).[22]

The expansion of the suburbs increases automobile use and dependence. A study conducted by Amy Helling, published in the book Urban Sprawl, looked at the rise of suburban automobile use and found that in 1995 the average household consisted of 2.65 persons and owned 1.78 vehicles. Of all household related trips taken, over 86% were taken with their privately owned transportation. A more significant note is that of those trips taken, 33.1 percent were for a distance of only 1 to 5 miles. 19.5 percent of the total trips were a distance of less than a mile (Squire, 2002).[23] The dependence and/or desire to utilize private over public transportation and walking are directly related to the social and human welfare effects of sprawl.

Social and Human Welfare

As automobile dependence and use has increased so have the emissions of greenhouse gases. Motor vehicles are the leading cause of air pollution and a major

contributor to the creation of ozone (greenhouse) gasses in the country approximately 26% of the total greenhouse gas emissions (Frumkin, 2002).[24] These gas emissions in turn have had a direct link to an increase in the rates of respiratory diseases such as asthma, resulting in more visits to medical professionals and loss of time at work and school. The elderly and children are most at risk from the increased levels of pollution (Frumkin, 2002).[25] In addition, the sedentary nature of Americans has increased as well, and is having a deleterious effect on our health as a people.

Land use decisions and design requirements have also had an influential role in the change to a more sedentary lifestyle. Many of the new developments being designed in Michigan and across the nation do not have pedestrian access or the available access is designed in such a way as to be undesirable or impossible to use by pedestrians. This includes physical barriers such as crosswalks and crossing points that do not line up with adjacent properties, narrow sidewalks adjacent to very busy arterial streets, and local neighborhoods with no sidewalks at all. Lack of coordination with adjacent communities also is a hindrance to pedestrian access and mobility. This includes bike paths and jogging trails that abruptly end at jurisdictional boundaries, differing requirements for levels of pedestrian access between jurisdictional boundaries, and inadequate public transportation routes to service the communities. Given these limitations and obstacles to accessing the community, it is not surprising that many choose to use their cars to travel from location to location; even when the destination may be less than a mile. The unfortunate net result as Frumkin illustrates is that Americans are becoming more and more overweight. From 1960 to 1990 the percentage of overweight Americans rose from 24% to 33% (Frumkin, 2002).[26]

Environmental and Natural Resources

The environment is a sensitive and often politically volatile topic for planners, politicians and the public. Often environmentalists and environmental concerns are viewed as a barrier to growth and economic expansion. However the irony of the debate is that development and environmentalism do not have to be at polarized ends of the land use dilemma. If sustainable development is to occur then they must be mutually interlinked. To date however, current non-sustainable sprawling land use in Michigan has had a very deleterious effect on environmentally sensitive lands. Critical forest lands, wetlands, water resources, species habitats and subsurface resources have all been impacted by the spread of sprawl.

Forestlands in Michigan are a major economic industry in the state bringing an estimated $9 billion dollars annually and providing 150,000 jobs (PSC, 2001).[27] Good managing practices in the state have maintained a positive sustainable balance of timber production. The problem of the future however, is the continuing fragmentation of productive forestland by sprawling land use. Currently 45 percent (8.4 million acres) of the total quality timberland in the state (18.6 million acres) is held in private ownership by over 353,000 different entities (PSC, 2001).[28] The concern is over the next few decades the current trends of sprawl will place these owners in close proximity to urbanized land uses that will directly influence their market value. Many are likely to sell all or pieces of their properties, resulting in a fragmented pattern of land use.

This problem of fragmented land use also has influenced wetland and water resources. To date the state of Michigan had lost over 50% of the total wetlands that

existed at the time the first European settlers came to the state (Michigan Legislature, 2001).[29] These wetlands serve critical functions in maintaining and rejuvenating our environment. Pollutants natural and man-made are filtered out by wetland systems. Wetlands also provide erosion and flood control by absorbing excess storm run-off and by trapping soil particles before they can erode away (Michigan Legislature, 2001).[30] Despite these advantages to the ecosystem, Michigan and the nation have continued to destroy and or negatively impact wetlands on a monumental scale. Fragmentation of the landscape from sprawling land use decisions has created small pockets of wetlands from what were once large contiguous systems. This fragmentation has in effect short-circuited the filtration capacities of the wetlands, overloading them with pollutants and destroying native endangered and threatened species as well as habitat for water fowl and other aquatic species.

While legislation exists at both the state and national level to protect wetlands and more particularly endangered species of flora and fauna, many of these wetland pockets are too small to be under the protection of the environmental laws. For example, in Michigan, local municipalities have jurisdiction over wetlands of 5 acres or less in size. In more rural townships that do not have environmental ordinances to regulate development impacts on wetlands, these smaller fragments are left at risk.

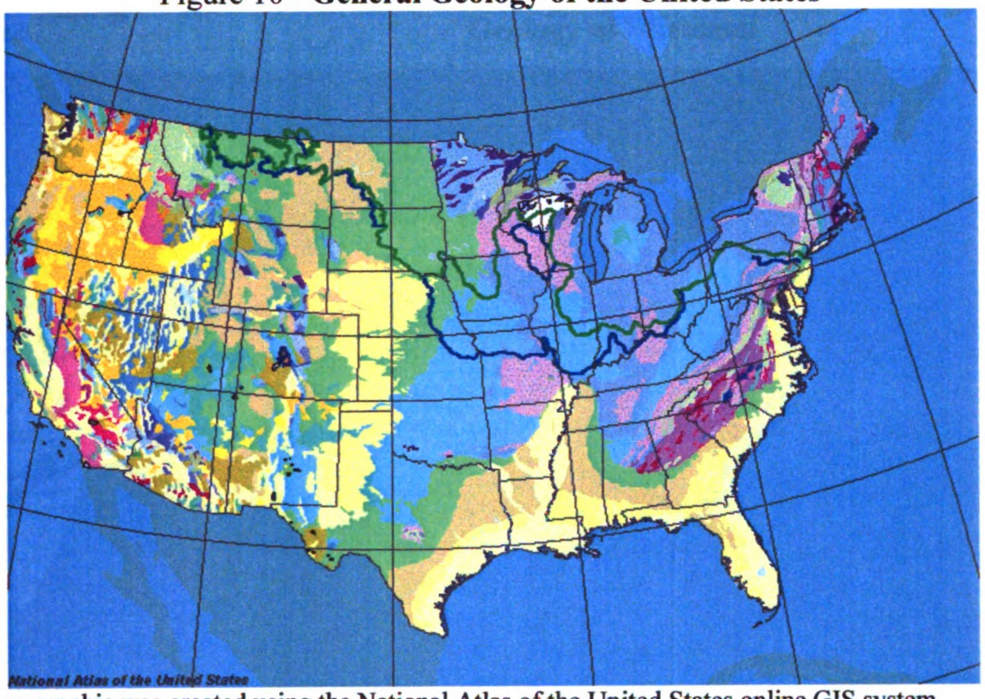
Water resources both above and below ground have also been negatively influenced by sprawling land use. Increase in impervious surfaces have created excessive run-off from storm water on downstream residents in watershed areas, as well as causing concentrated points of water born pollution from metropolitan areas. In addition, the expansion of the suburban developments across the country has created draw-downs on

ground water aquifer levels. In other areas, contamination of water supplies from industrial wastes and land fills has reduced the availability of clean groundwater, placing additional pressure on municipal systems to service the public. One of the key dangers to ground and surface water resources is the expansion of suburban sprawl which exposes more and more ground and surface water resources to pollution sources. Given that 40 percent of Michigan residents obtain their drinking and other water uses from groundwater wells, and that Michigan with its Great Lakes comprise 95 percent of world's surface water, the concern of endangering this critical resource is understandable (Michigan Legislature, 2001).[31] One area that has been largely ignored in comparison to the other aforementioned environmental concerns is the threat to subsurface natural resources. Construction aggregate deposits are crucial to maintaining our societies' infrastructure and are as endangered as the other natural resources we depend upon for sustaining us.

Threat to Subsurface Construction Aggregate Resources

Every person in the country utilizes subsurface minerals in every day of their lives. Over the course of a lifetime the average American will use 1,750 tons of minerals. 23 tons are used per person in the average year. Of these totals 85 percent consists of sand and gravel resources (PSC, 2001).[32] Annually the average Michigan resident will consume 11 tons of aggregate sand and gravel and the average suburban home, in a new subdivision, will consume 400 tons of aggregate materials (Michigan Aggregates Association, 2001).[33] To appreciate the scope of the threat that sprawling land use poses to subsurface natural resources, it is necessary to examine the geology of the country and State of Michigan to understand how they were created.

Figure 10 - **General Geology of the United States**



The above graphic was created using the National Atlas of the United States online GIS system.
Source: National Atlas of the United States. 25 July 2004.
<http://nationalatlas.gov/natlas/NatlasStart.asp>

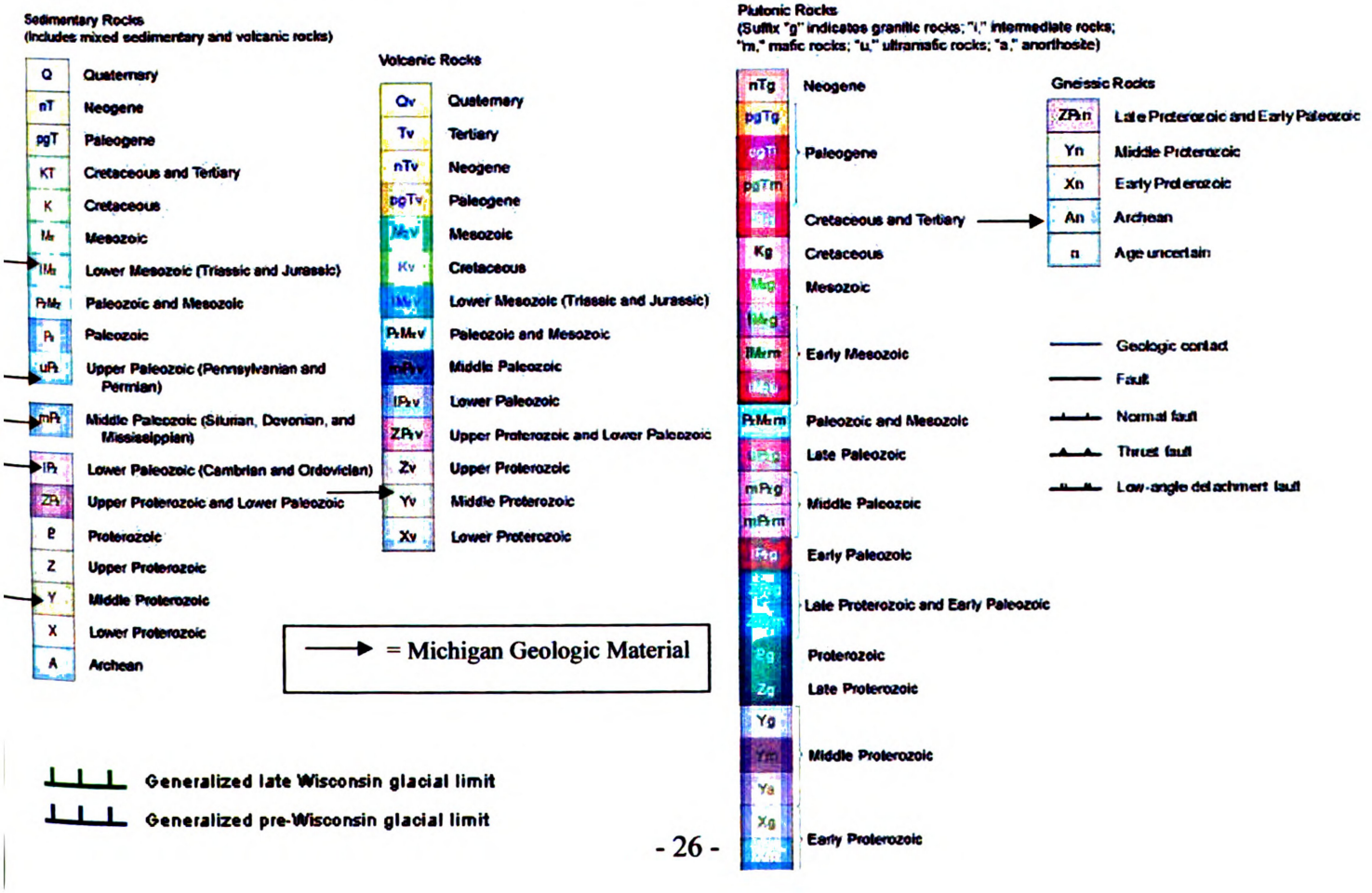
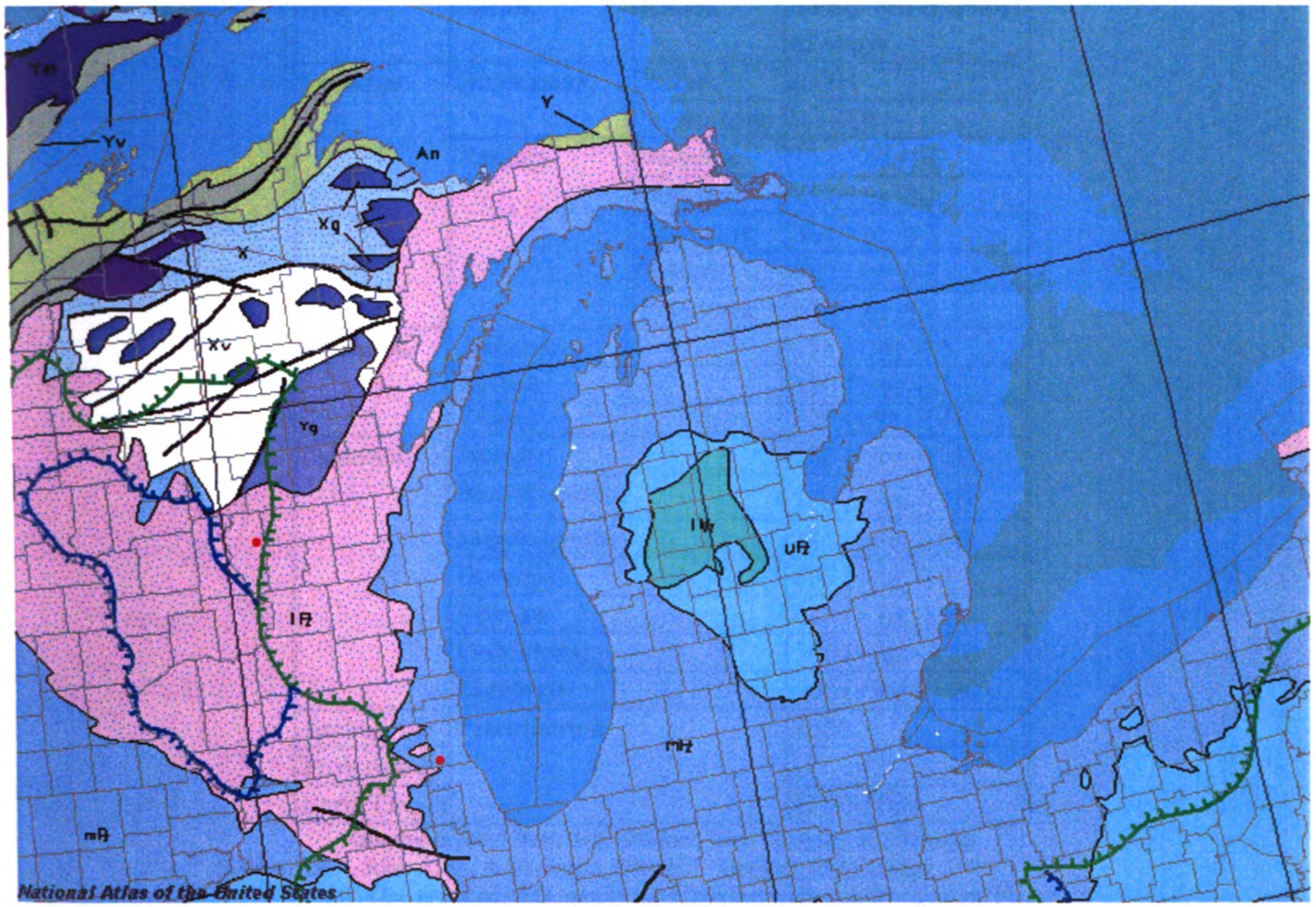


Figure 11
General Geology of Michigan



The above graphic was created using the National Atlas of the United States online GIS system.
Source: National Atlas of the United States. 25 July 2004.
<http://nationalatlas.gov/natlas/NatlasStart.asp>

Geology of Michigan and the Nation

The eras indicated in the Legend on page 35 for both the United States and Michigan show the geologic record as it is currently known to date. Figure 12 on the following page illustrates the span of geologic time in relation to the various geologic periods indicated in the graphics (Dorr and Eschman, 1970/1996).[34]

Figure 12

Era	Period	Epoch	Time – In millions of years
Cenozoic	Quarternary	Recent	0.004
		Pleistocene	0.5-2.0
	Tertiary	Pliocene	13 (+ or -) 1
		Miocene	25 (+ or -) 1
		Oligocene	36 (+ or -) 2
		Eocene	58 (+ or -) 2
		Paleocene	63 (+ or -) 2
Mesozoic	Cretaceous		135 (+ or -) 5
	Jurassic		180 (+ or -) 5
	Triassic		220 (+ or -) 10
Paleozoic	Permian		280 (+ or -) 10
	Pennsylvanian		310 (+ or -) 10
	Mississippian		345 (+ or -) 10
	Devonian		405 (+ or -) 10
	Silurian		425 (+ or -) 10
	Ordovician		500 (+ or -) 10
	Cambrian		600 (+ or -) 20
Archeozoic	Precambrian		3500
Proterozoic			
Earth Origin			4500-5000

Graphic created from data obtained from Geology of Michigan
Source: Dorr, John A. Jr., & Eschman, Donald F. Geology of Michigan. 1996 USA: University of Michigan Press. (Original work published in 1970)

From the above table the geologic age of Michigan's bedrock material is shown to be some of the oldest in the country. The value of the state's subsurface resources is immense due to the process of glaciations which occurred at least four and possibly as much as six times during the Pleistocene period (Michigan Legislature, 2001).[35] These glaciers, which reached thousands of feet high above terra firma dragged with them base material from what geologists refer to as the Canadian Shield. These glaciers pushed with tremendous force across the surface of the earth pulling up additional base materials

and grounding them up in the process of their forward expansion. The actions of these surging and retreating glaciers created the Great Lakes, which in turn, through wave action and outwash processes created the dunes and lake shore bluffs that we enjoy today. These are valuable in industrial capacities for such consumer goods as automobile manufacturing. The material dropped from the glaciers, as they retreated, formed the moraines, drumlins, and outwash stream beds that contain the valuable sources of construction aggregate deposits we depend upon to build our society's infrastructure and is in danger of loss from development (Dawson, 1992).[36]

Value of Construction Aggregates

What exactly are construction aggregates? Construction aggregates are glacial sand, gravel and crushed rock mixtures that can be washed and mixed to meet specifications for construction materials which are used in road and highway construction, concrete mixtures, and other building materials. The United States is mostly self sufficient in the production of these resources. Figure 13 on page 39 shows the first quarter of 2004 domestic national production of these materials as tabulated by the United States Geological Survey (USGS). Appendix C shows that Michigan ranked third in 2003 for total sand and gravel sold or used by producers and is already 6 percent higher in the first quarter's total for 2004 (USGS, 2004).[37] Construction aggregates, in particular sand and gravel, are an integral part of the Michigan economy equaling over $242 million annually, the fourth most valuable resource mined in the state (PSC, 2001).[38] It is on the rise in value in relation to other mined minerals in the state, up 83 percent over the last 10 years (PSC, 2001).[39] This is reflective nationally as well, due to

Figure 13

AGGREGATES SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY DIVISION[1]

(Thousand metric tons and thousand dollars)

Region/Division	2003 Quantity 1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	Total[2]	Value total[2]	2004 Quantity 1st qtr.	Per-cent change[3]	Percent cover-age	Number of cos.[3]
Northeast:										
New England	6,890	23,700	28,500	24,300	83,300	515,000	7,180	4.2	42	22
Middle Atlantic	26,000	66,200	77,700	65,200	235,000	1,430,000	30,000	15.4	52	33
Midwest:										
East North Central	53,100	138,000	163,000	136,000	491,000	2,250,000	64,000	20.6	55	52
West North Central	35,400	78,700	89,700	65,400	269,000	1,260,000	39,100	10.6	44	50
South:										
South Atlantic	86,800	117,000	125,000	112,000	441,000	2,730,000	101,000	16.6	81	43
East South Central	36,200	51,300	57,500	50,400	195,000	1,150,000	41,200	13.9	63	25
West South Central	63,900	80,000	80,500	71,400	296,000	1,450,000	63,800	-0.1	64	28
West:										
Mountain	50,900	76,200	77,800	61,900	267,000	1,340,000	65,400	28.5	40	30
Pacific[4]	63,600	87,800	89,800	72,200	313,000	2,060,000	62,900	-1.0	55	34
Total[2]	423,000	719,000	789,000	659,000	2,620,000 [6]	14,300,000 [6]	475,000	12.4	XX	XX

XX Not applicable.

[1]Quarterly totals shown are estimates based on a sample survey. Estimated quantities for prior quarters have been recalculated.

[2]Data may not add to totals shown because of independent rounding and differences between projected totals by States and by divisions.

[3]Number of companies reporting for the quarterly survey.

[4]Does not include Alaska and Hawaii.

[5]Includes Alaska, Hawaii, and "Other" totals; see table 6, footnote 7.

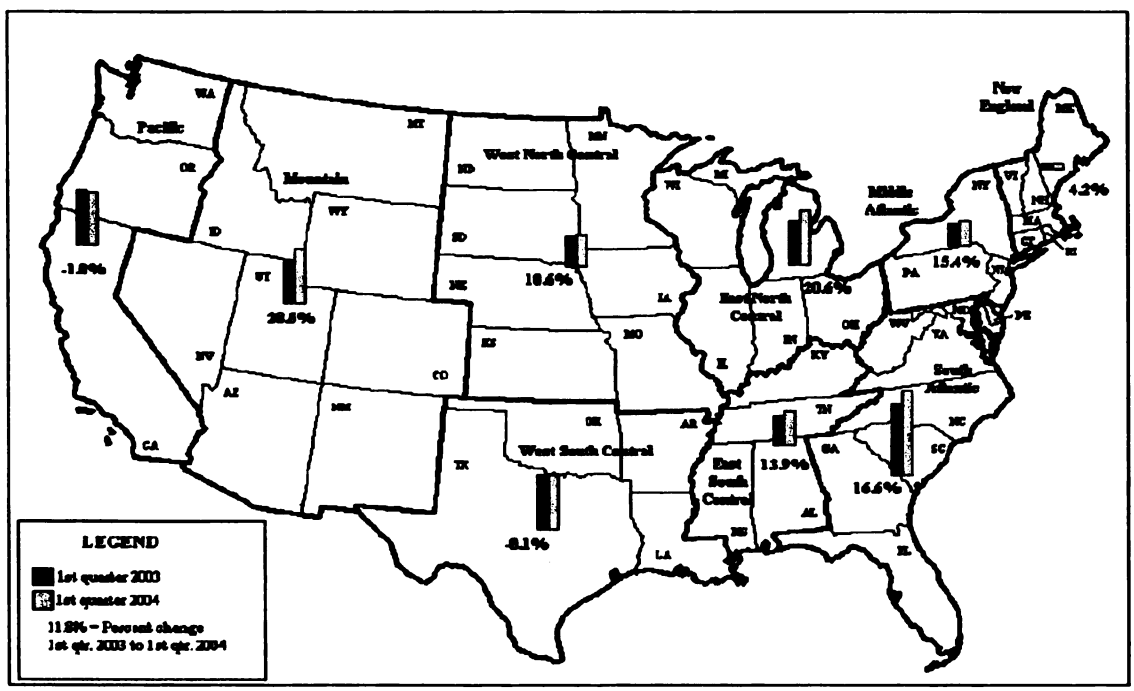


Figure 3 - First quarter aggregates production by geographic division

Source: USGS. "USGS Minerals Information-Crushed Stone and Sand and Gravel" 10 July 2004.
<http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/csmis1q04.pdf>

the tremendous building boom of the 1990s. In Michigan, aggregate material is produced from 325 major surface mining operations, with some form of mining taking place in every county of the state. Many of the operations are family owned with 20 or less employees, with the average operation having a life span of 25 years (Michigan Aggregates Association, 2001).[40] Smaller operations are often not included in the statistical information that is presented and collected by governmental and industry tracking organizations.

The Cost of Doing Business and Conflicting Land Use

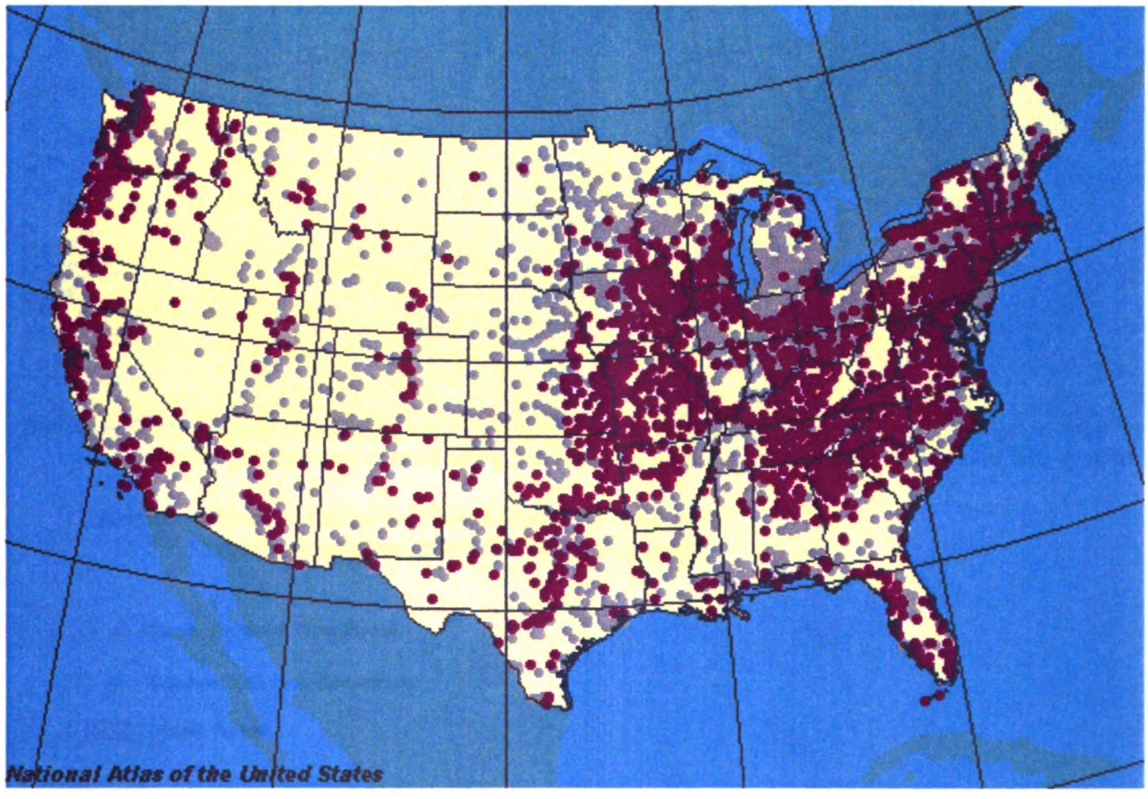
What makes construction aggregate mining unique, in particular sand and gravel, to other mining operations is its marketability which is directly tied to the proximity of the operation to its consumer base. Since 90 percent of all aggregate material must be trucked to its market, there is a finite point of economic return on profitability of the material. Material costs 10-15 cents per ton mile. For every 20-30 miles (depending on market fluctuations) material is hauled, the base cost doubles. At forty plus miles it becomes uneconomical to mine the material (PSC, 2001).[41] These limitations put aggregate operations in direct conflict with other land uses, in particular sprawl. As suburban developments become closer and closer to mining operations the value of the mining land and other surrounding properties increases greatly, making it difficult for smaller companies to compete on bidding for properties to continue mining. In addition many of the smaller mining operators feel compelled to sell out to real estate developers as the money offered is beyond what they hope to obtain from the mining.

The net result is construction aggregate materials are covered by development and lost. The irony of the whole situation is that sprawl could not exist nor continue very

much longer without construction aggregates, as the cost of construction would continue to rise dramatically and bring sprawling land use activity to a crawl. Conversely, mining cannot exist without a close market for its product or it too is eliminated; yet both are dependent on the same land for continued existence. The following figures indicate where current aggregate operations are taking place and where urbanized areas come in conflict with them.

Figure 14

Current National Construction Aggregate Operations

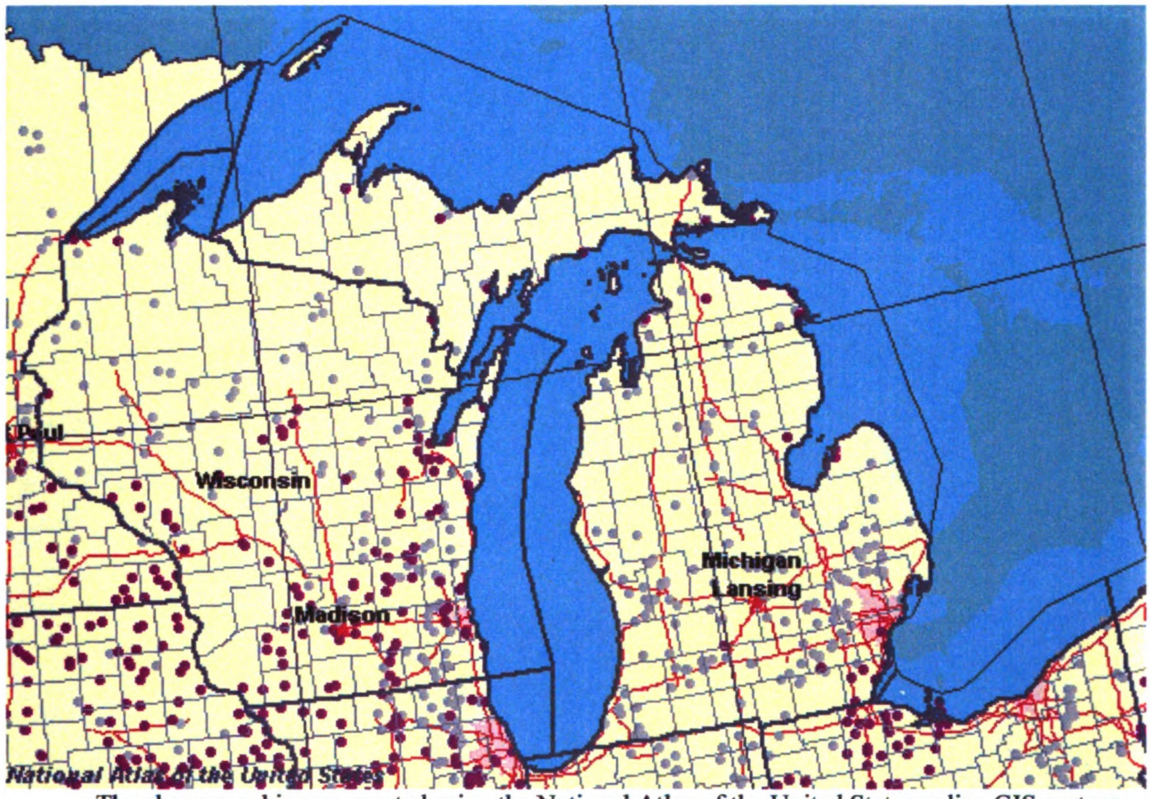


The above graphic was created using the National Atlas of the United States online GIS system.
Source: National Atlas of the United States. 24 June 2004.
<http://nationalatlas.gov/natlas/NatlasStart.asp>

- Stone, Crushed Operations
- Sand and Gravel Operations

Figure 15

Current Michigan Construction Aggregate Operations



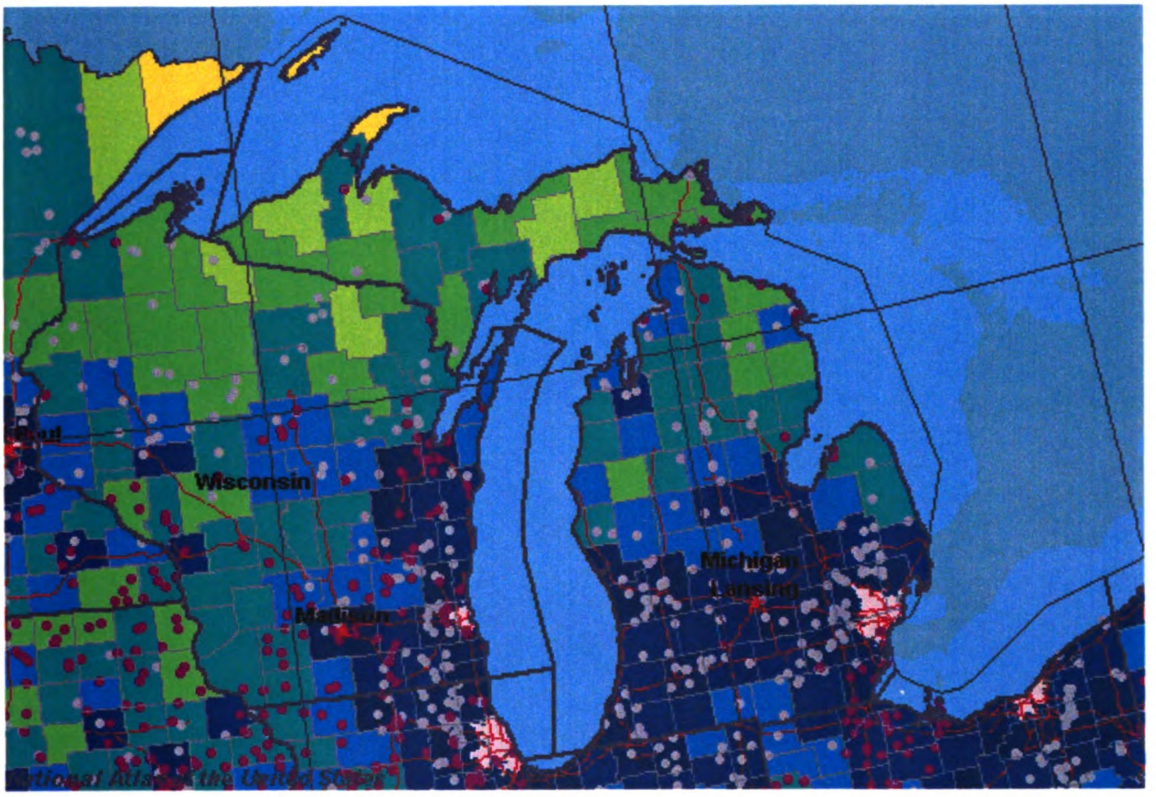
The above graphic was created using the National Atlas of the United States online GIS system.

Source: National Atlas of the United States. 24 June 2004.
<http://nationalatlas.gov/natlas/NatlasStart.asp>

- Stone, Crushed Operations
- Sand and Gravel Operations
- Urban Areas

Figure 16

Current Michigan Construction Aggregate Operations with Census 2000 Density Per Square Mile



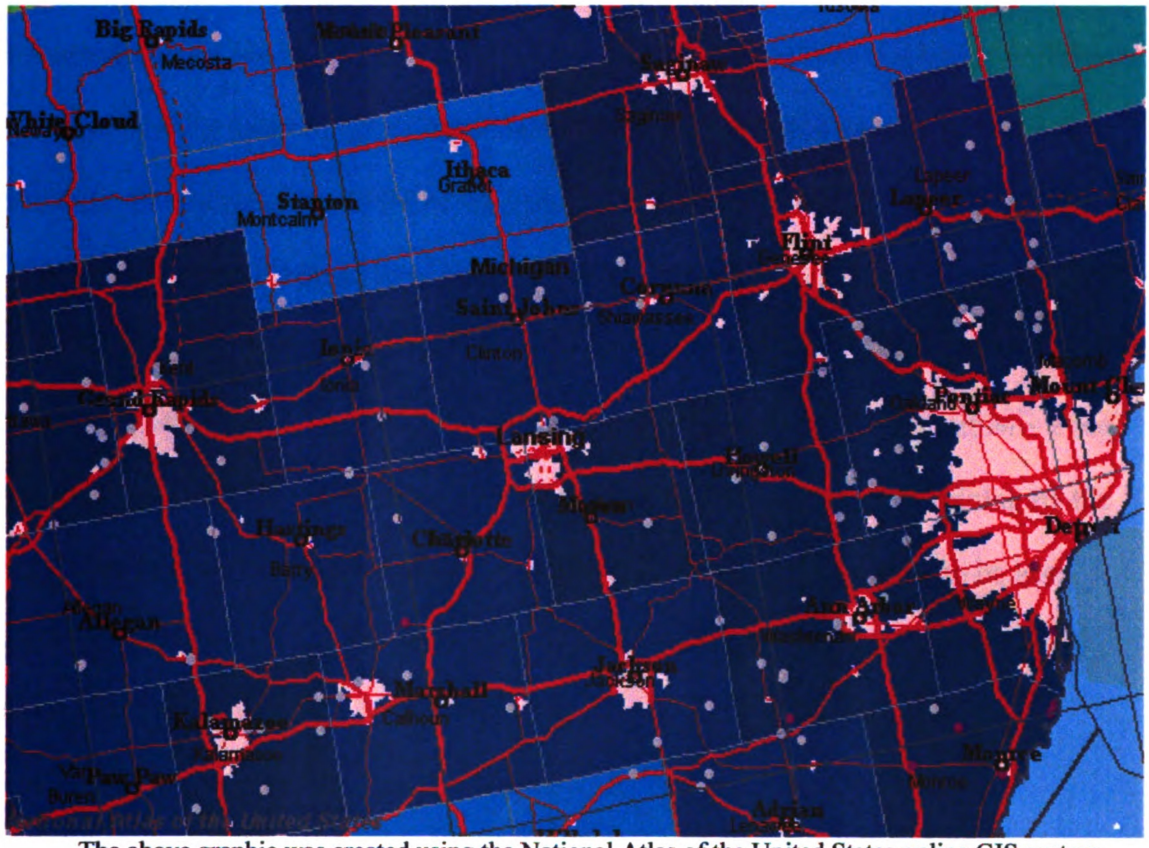
The above graphic was created using the National Atlas of the United States online GIS system.
Source: National Atlas of the United States. 24 June 2004.
<http://nationalatlas.gov/natlas/NatlasStart.asp>

- Stone, Crushed Operations
- Sand and Gravel Operations
- Urban Areas

Number of people per square mile
- 250 - 66935
- 100 - 249
- 50 - 99
- 25 - 49
- 10 - 24
- 5 - 9
- 1 - 4
- Less than 1

Figure 17

Current Michigan Construction Aggregate Operations with Census 2000 Density Per Square Mile



The above graphic was created using the National Atlas of the United States online GIS system.
Source: National Atlas of the United States. 24 June 2004.
<http://nationalatlas.gov/natlas/NatlasStart.asp>

- Stone, Crushed Operations
- Sand and Gravel Operations

Limited Access
Principal Highway
Through Highway
Other Roads
Ferry

Urban Areas

Number of people per square mile
250 - 66935
100 - 249
50 - 99
25 - 49
10 - 24
5 - 9
1 - 4
Less than 1

As shown on the previous figures, construction aggregate mining operations are nearest (on average) to the urbanized areas they serve as discussed. Southeast Michigan has already seen a large loss of material in counties such as: Oakland, Washtenaw, and Livingston. There are no hard fixed numbers on the volume of material lost to date, as there is not a fully mapped out resource inventory of construction aggregate reserves statewide. In addition, the nature of sand and gravel deposition varies considerably with some shallow deposits spread over larger sections of land and deeper, narrower deposits in larger glacial formations such as moraines. Given the average life of most mines is 20 to 30 years and averages over 50 acres in size for even a small operation; virtually every major metropolitan area in the state is threatening construction aggregate mining by the very nature of sprawl. If current trends remain, the material will continue to be lost. When figures 9 and 10 are compared to figures 16 and 17, the conflict points become clearer.

Conflicts Over Mining

So why is there such a conflict between suburban growth and mining? The answer lies in historical mining practices. Prior to the environmental movement and subsequent laws, the mining industry did plenty of damage to the environment and viewsheds across the country. For example, gold mining practices of the past did tremendous damage to the water resources of the west by adding large amounts of toxic materials. To put this in perspective, Michele Olsen in her article "Gold Rush's toxic legacy" for SN&R Newsreview.com, stated, *"That old fever thermometer in your medicine cabinet contains half a gram of mercury, enough to render all fish in a 25-acre*

lake unsafe to eat. In contrast, Gold Rush Era miners used over 26 million pounds of mercury in Nevada County alone, depositing as much as 8 million pounds into the watershed" (Oslen, 2001).[42] Understandably, with the average person's knowledge of environmental damage greatly increased in modern times, this type of mining practice should give anybody trepidation about having an operation anywhere near them and their family. Today, however, even with new and stringent environmental protection laws aimed at curbing this type of mining damage, residents are still anti-mining.

Arizona citizens have been battling a Canadian copper mining company from opening an 885 acre operation 75 miles north of Phoenix. The issue is over the amount of water the mining operation would utilize, enough for a town of 6,000 people per day. Residents in the area have managed to tie the opening of the operation up in the courts and reviewing agencies for over five years. In the interim, the mining companies stock had dropped from $15 dollars a share to $2 (Brady, 03/13/2000)[43] This tactic in preventing a mining operation from opening however, will likely not work in the long run as the copper source is too valuable. In time it is probable that another company will want to try again if Cambior, Inc. decides not to pursue the operation. This tactic would be very effective against a construction aggregate operation because of the relative low cost of the material per ton and the likelihood of real estate market values enticing an operator to sell the land, versus continuing to incur overhead legal and operating expenses fighting back.

Conflicts with Crushed Stone Aggregate Operations

For crushed stone construction aggregate operations the main objections stem from water use, and blasting of limestone. In some instances they are legitimate concerns

as in the case of Chewacla State Park in Alabama, where the Chewacla Creek began running dry due to sinkhole formation. Martin Marietta, which had purchased the quarry from a previous operator, settled a law suit and agreed to fix all sink holes caused by the operation. It is interesting to note however that the quarry in question had been in operation for over 20 years before the pubic fight over the operation began. Residents admit the neighborhoods affected by the operation and state park issue did grow nearer to the quarry, however they claim that the operation had increased in scope. Going from small trucks to large 18 wheelers and increased blasting. Alabama currently has no legislation for monitoring the operations of the aggregate industry. Continued conflicts between operators and residents with the growth of suburban development will likely entice legislators to sponsor some in the future (Associated Press, 12/30/2002).[44]

Michigan operations and residents face the same conflictive problems as other states, as companies and residents come in closer proximity to one another. In Trenton, the Sibley Quarry, a limestone operation, had been in existence for over 150 years and had gone through several owners, one of which used the limestone to produce the Arm & Hammer brand of baking soda. The limestone from the quarry also went to construction materials that built many of the buildings in Detroit. Detroit Edison, the major utility company in the region who currently owns the quarry, will not renew the lease to the Michigan Foundation (current operator). The reasons for non-renewal were complaints from nearby residents about the blasting damaging their homes and causing other disturbances in their neighborhoods (Woodards, 10/18/2000).[45] Again, growth of the community brought about much of the problem, as there were not many homes near the site when the operations first began.

Sand and Gravel Operation Conflicts

For sand and gravel operations the main concerns seem to trend toward truck traffic noise, dust, and water resource depletion and contamination. Sand and gravel operations do require washing of the mined material in order to sift and size it properly. The crushing process for gravel and subsequent washing is done to bring materials into size specifications for market use and to remove extraneous material that would lower the quality of the final products. In addition many operations must dig below the water table in order to reach the resources. This has spurred concerns over contamination of water well sources and degradation of lakes, streams and wetlands.

In the state of Maryland for example, the citizens of Charles County, which has 40 percent of the states sand and gravel resources, gained passage of a bill that would allow citizens to appeal to the county commissioners (elected officials) any operations permit decision made by the Charles County Board of Appeals (Conservation Report V. 24, n.9,1998).[46] Prior to this legislative revision, citizens needed to appeal to the circuit court any disagreement they had with the Board of Appeals decisions (Maryland Code ARTICLE 66B, 2000).[47] This whole push for legislative change originated from a small township that was concerned over water quality and well water drying up.

In Lenox Township, Macomb County Michigan residents are concerned about the same issue arising in their neighborhood from a proposed gravel operation on a 113 acres site. Residential concerns raised are the drying up of their well water supplies, and the nuisance of having the operation close to them. As stated from a 60 year long resident of the township, "I just don't like the neighborhood getting all crowded up, and I like it the way it is-nice and quiet." (Wowk, 12/24 2000)[48] In Tyrone Township, Livingston

County, Michigan the concern is over truck traffic, noise and dust from the operations of an 80 acre operation which was given the right to expand its work week; in exchange for granting the township ownership of the property following the closure of the mining operation. As one retiree, who lived near the site said, "We're not going to get very much peace around her for the next eight years." (Locker, 09/21/2003).[49] The gravel operation has changed hands twice in its over 20 year history of being in existence (Locker, 09/21/2003)[50]

These typical complaints are not exclusive to the states mentioned, nor are they isolated incidents. They are examples of a more and more common problem which results when community suburban growth runs into existing mining operations. The solutions to these growing problems are not easy to find. There is not one all encompassing panacea for this land use conflict. However, one area has been emerging which does offer methods for addressing and mitigating potential problems before they reach this level. This area of land use planning is Smart Growth.

Smart Growth and Open Space Planning and Design

Within the last decade a new wave of community activism has grown around the dangers that sprawl presents to American land use. Local and national organizations have worked together to disseminate information, share stories and concerns, and most beneficially lend technical support and guidance in how to slow the growth of sprawl and conserve our natural resources. The explosion of the World Wide Web and the ease in which it is now possible to share information and communicate with one another has greatly enhanced this effort, not only within the state and nation, but internationally. The topic of discussion in most internet interest group related chat rooms, websites, and

planning seminars of how to best deal with the problems of sprawl is what has been termed "Smart Growth."

Smart Growth

So what is "Smart Growth"? The answer is somewhat simple in definition but very complex in what it encompasses as a land use planning technique. Smart Growth as defined by the Smart Growth Network, an organization made up of numerous private and public entities, non-profit organizations, state governments, and government agencies, is: "*development that serves the economy, community, and the environment. It provides a framework for communities to make informed decisions about how and where they grow*" (SGN, 2002).[51] A simple definition, although vague in scope, the SGN has stated that Smart Growth can be further defined as adhering to ten basic principles: a mix of land uses; compact building design (where possible); range of housing choice and opportunity; walkable communities; distinctive communities with a strong sense of place; preserve open space, farmland, and critical environmental areas; strengthen and direct development towards existing communities; provide a variety of transportation choices; make development decisions fair, predictable, and cost effective; and encourage stakeholder and community involvement in development decisions (SGN, 2002).[52] These principles, form the over arching mission to create more sustainable communities.

Smart Growth has been mistaken at times to mean a specific type of development, usually referred to as "New Town". This style is characteristic of turn of the 20th century community design. It traditionally involved a grid street pattern with narrow lanes, sidewalks, and buildings that were located nearer to the street, with parking typically located behind the commercial businesses, and residential districts that were typically on

smaller lots. A town center would be designed with connecting pedestrian paths and community parks. The development in general would be compact and designed for moderate to high density. This is in direct contrast to much of the type of development that has happened in the last 40 years. American suburban development, as has been stated, is often designed to have wide streets (that encourage higher rates of speed), large lot residential, and commercial strip development, often without pedestrian access. This contrast is likely one of the main reasons that New Town development has become more popular in recent years, because it is (and was) a more compact, walkable community that usually was located just outside a more metropolitan area, and can been viewed as an alternative to typical suburban sprawl development.

While the New Town concept does embrace many of the 10 principles as listed by the Smart Growth Network, it is not in and of itself what Smart Growth is about. Smart Growth is a guiding method for making land use decisions, not a design concept for community development. Smart Growth is intended to provide a "check list" of ideals and issues to be considered in planning for community growth. In this way it proposes to limit the negative after effects of what has become "traditional" land use planning. Smart Growth can and should be included in the formation of a community's Comprehensive Plan. The power of the Smart Growth principles is in guiding this document and subsequent ordinances that should promote the long-range plan. This aspect of Smart Growth principles is critical, especially as it refers to guiding principle number 6 preserving open space, farmland, and critical environmental areas.

Open Space Planning and Design

Open Space Planning has often become synonymous with Smart Growth; however it is only one of the principles in the Smart Growth movement. It is often referred to as Conservation Planning and Design, and this may actually be a better definitional name for it, because it emphasizes the primary goal of the planning nature of the technique-conservation of resources. Simply put, Open Space (Conservation) Planning and Design are processes and techniques for land use planning which help promote the maximum sustainable use of land and natural resources.

These processes and techniques have traditionally been implemented to foster conservation of natural systems and viewsheds, and not subsurface natural resources other than water related ones such as aquifers. This is an immense oversight given the importance of construction aggregates to the sustainability of our society, and the critical problem we now face of the loss of these resources. Open Space Planning processes and Design techniques can achieve a great deal in the successful conservation and planned extraction of these critical resources within the traditional role it has been intended to play; that of creating sustainable land use. To accomplish this feat, a two stage approach is necessary: a macro scale planning effort, and a micro scale design effort, utilizing site specific design and operational techniques.

Open Space Planning Process-Regional Inventory and Analysis

The first stage step in the process is a regional inventory and analysis of the municipalities' resources. This is definitely the longer process of the two because it involves potentially many organizational entities and cooperation amongst them in order to accomplish it successfully. Failure to coordinate efforts with different agencies of

jurisdiction and expertise, and utilizing the proper professionals (planners, landscape architects, engineers, soil scientists, hydrologists, etc.) to collect the data, will likely result in "holes or poor data" in the final analysis which could lead to poor decision making by those in charge of land use development approvals. The analysis should encompass all areas of environmental resource concerns. This should include, but not be limited to, the following areas: hydrology (lakes, streams, rivers, wetlands, etc.), existing flora and fauna, endangered species present, habitats, agricultural lands, forest and commercial quality timberlands, soils and geological resources.

Most communities in Michigan at this time have addressed these items in some way in preparation of previous comprehensive plans, zoning and other municipal ordinances. The geology portion very likely has not been greatly researched by many Michigan municipalities because of lack of perceived need at the time, lack of dependable data, or available financial resources to obtain information. The advent of the internet, continued increase in personal computing power, and Geographical Information Systems (GIS) is making this an easier task to complete. Much of the needed data is likely already in the possession of the State of Michigan, and county and township agencies across the state. For example, The Michigan Center for Geographic Information, a division of the Department of Information Technology, has tremendous GIS resource files free for download. Data such as the Michigan Framework which is available in version 3b (at the time of this writing) has many data sets from which to select information (CGI, 2004).[53] The data complied by the State of Michigan has county level geological files that can be readily utilized in desktop GIS applications. These

applications once prohibitively expensive are now very reasonably priced with the budgets of most municipalities and/or consultant's budgets.

What also is necessary to obtain for the Inventory and Analysis step is the quantity of available construction aggregate material. This can be obtained from well digging logs. When wells are dug the contractor is usually required to maintain a log of material the drill is passing through and the depths associated with each layer. While usually not scientific in their explanation of material, they usually are sufficient to provide enough information on the general type of material (sand, fine sands, sand and gravel, silt, etc.). From these logs GIS can be used to map the well locations and develop a depth of material layer. In time as these are refined with additional log information, a rough picture will develop, that will clarify estimations of material reserves available for an area. Obtaining cooperation from mining companies will also help in this endeavor as they must do these types of logs on their own in order to assess whether a piece of property is worth purchasing or not. This may be more difficult to accomplish as some mining companies consider this proprietary information they do not wish to share with competitors. However, if the goal is explained (protection and planned future extraction of the resource) and that the end result will go to protecting their industry for years to come, operators may be more willing to share the information they have to the municipality knowing in the end they will have access to a much larger database than they currently have available.

Once the Inventory is complete, the various layers of data can be put together for analysis of all resources and types (i.e. timber, water, construction aggregates, etc.) in a GIS system. The Analysis should be able to paint a good picture of: where subsurface

resources are located; the quality and depth of subsurface resources; areas of concern that must be protected for endangered species habitat; critical farmlands; wetlands, lakes, and streams, etc.; timber and forestlands; and current land use coverage. This is not an exhaustive list, just an example of the types of information that should be mapped and analyzed together in order to understand a more complete picture. The most logical level to coordinate this task at is the county level as they already have relationships with their cities, villages, and townships. When the data is combined from the various local sources, it may be easier to determine where conflict points in land uses and resources are between jurisdictional boundaries at all levels.

Identifying Stakeholders and Assessing Community Goals and Needs

The next step in the process is to determine who are the stakeholders and assess community goals and needs. Mining operators should be already involved, if possible, as data providers and expert consultants in their field. Other stakeholders include: commercial entities, civic groups, governmental representatives, home owner associations, and the general public. Once all stakeholders are identified, a series of "informational seminars" and "question and answer" sessions should be held to fully explain the process and what the data collected to date means. This should be done for all stakeholder groups, as different groups have different understanding and priorities of what is most important to them. While it is not likely to be possible to obtain input from these constituencies at the same time, they must be given the opportunity to participate in the process. This is number 10 in the Smart Growth Network's list of principles and critical for this step in the Open Space Planning process (SGN, 2002)[54]. Failure to obtain input from the effected stakeholders, will likely ground the effort to a crawl as opposition

resources are located; the quality and depth of subsurface resources; areas of concern that must be protected for endangered species habitat; critical farmlands; wetlands, lakes, and streams, etc.; timber and forestlands; and current land use coverage. This is not an exhaustive list, just an example of the types of information that should be mapped and analyzed together in order to understand a more complete picture. The most logical level to coordinate this task at is the county level as they already have relationships with their cities, villages, and townships. When the data is combined from the various local sources, it may be easier to determine where conflict points in land uses and resources are between jurisdictional boundaries at all levels.

Identifying Stakeholders and Assessing Community Goals and Needs

The next step in the process is to determine who are the stakeholders and assess community goals and needs. Mining operators should be already involved, if possible, as data providers and expert consultants in their field. Other stakeholders include: commercial entities, civic groups, governmental representatives, home owner associations, and the general public. Once all stakeholders are identified, a series of "informational seminars" and "question and answer" sessions should be held to fully explain the process and what the data collected to date means. This should be done for all stakeholder groups, as different groups have different understanding and priorities of what is most important to them. While it is not likely to be possible to obtain input from these constituencies at the same time, they must be given the opportunity to participate in the process. This is number 10 in the Smart Growth Network's list of principles and critical for this step in the Open Space Planning process (SGN, 2002)[54]. Failure to obtain input from the effected stakeholders, will likely ground the effort to a crawl as opposition

will grow. It is not possible to please everyone, or address every group's or individual's concerns; nor should a municipality try to do this as they must act for the greater good of the community and long-term sustainability. However, failure to include them in the process, and legitimately listen and take into account their input; breeds resentment and feelings of disenfranchisement. Inclusion can be accomplished in numerous ways, open "town hall" discussions, questionnaires or surveys, and planning charettes for a more "hands on" approach where participants problem solve and "brainstorm" in smaller discussion groups and present their ideas. This data from the various stakeholders should then be analyzed and a list of priorities established based upon the responses.

Once the initial input is received from these sessions the prioritization of areas of concern and natural resource conservation can be implemented. What this involves is taking the community input and the analyzed physical inventory data and seeing where opportunities and constraints are in relation to land use in order to develop a regional long-range land use plan. For example, if responses list priorities as: maintaining rural character, more medium income housing, more open space, recreation opportunities, and saving wetlands; there may be an area of county, township, etc. where all three and more are possible in long-range planning. The goal of this step is to maximize the use of available resources, whether they are renewable such as: commercial timber and other forestlands, agricultural lands, etc.; or non-renewable such as: construction aggregates, oil and gas resources; so there is no wasted capacity without good cause.

Regional Long-Range Land Use Plan

Once these priorities are aligned with compatible land use areas a preliminary regional land use land could be put together by professional planners, landscape

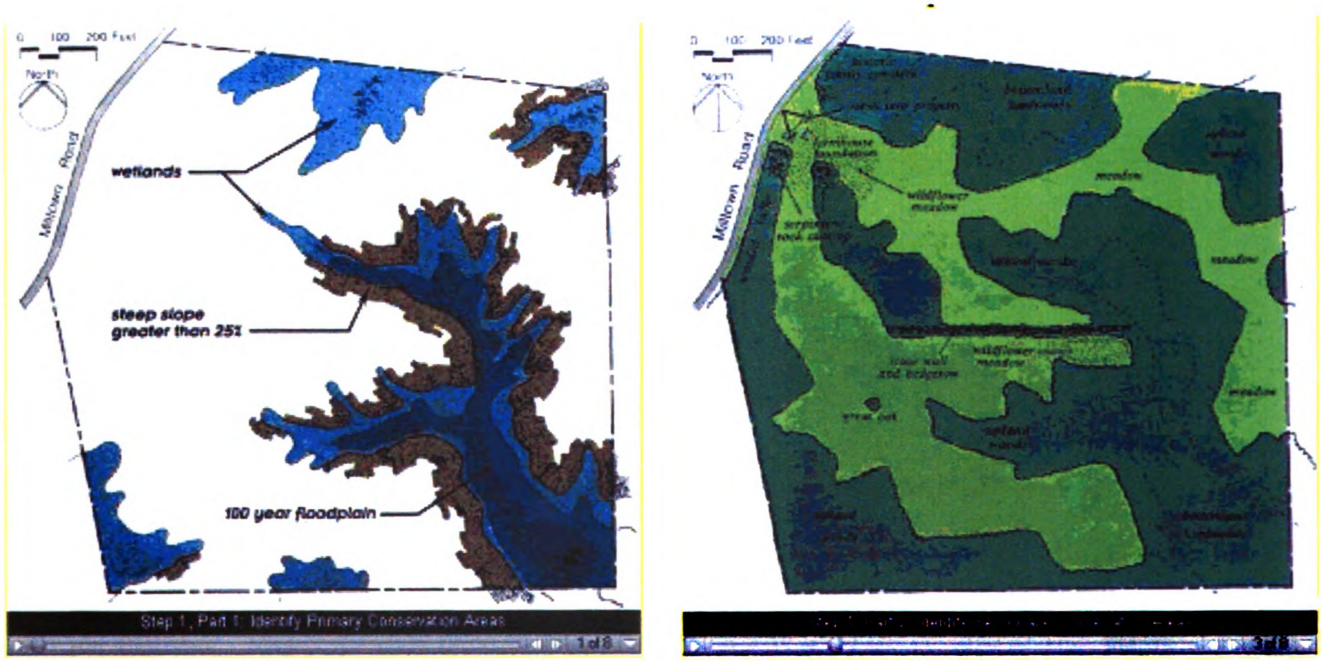
subdivisions and planned unit developments. Special use permits are perhaps the most critical change, as these are typically used to regulate activities such as construction aggregate mining. These may require new legal language to bring them in line with other revised ordinances and development standards. The important factor is that the subsurface resources present on a site proposed for development, become a factor in the decision of how that site is developed. All these revisions would allow for the second step in Open Space Planning and Design; site specific design and operation techniques to be used for site development.

Site Specific Design and Operational Techniques

The first step in this process is very similar to what is done at the macro or regional scale; an Inventory and Analysis is conducted on the site in question. This is done within the confines of the site specific area and immediate surroundings. As in many site plan submittal processes, environmental factors, access points, traffic issues, and adjacent land uses are all required to be researched by the applicant as part of the submittal package for approval. In addition to these traditional items to be researched an applicant would also need to provide research on the subsurface resource conditions to determine if there are critical resources that would be lost or compromised by the proposed development. Figures 18 and 19 show two examples of how this Inventory and Analysis could be graphically depicted for a proposal package submittal. Figure 18 is from Growing Greener Ordinance Language CD-ROM and depicts traditional considerations in Inventory and Analysis (GGOL, 2001).[55] Figure 19 is from a submittal to the 1993 National Stone Association (NSA) and American Society of Landscape Architects student design competition for Aggregate Operations, which shows an

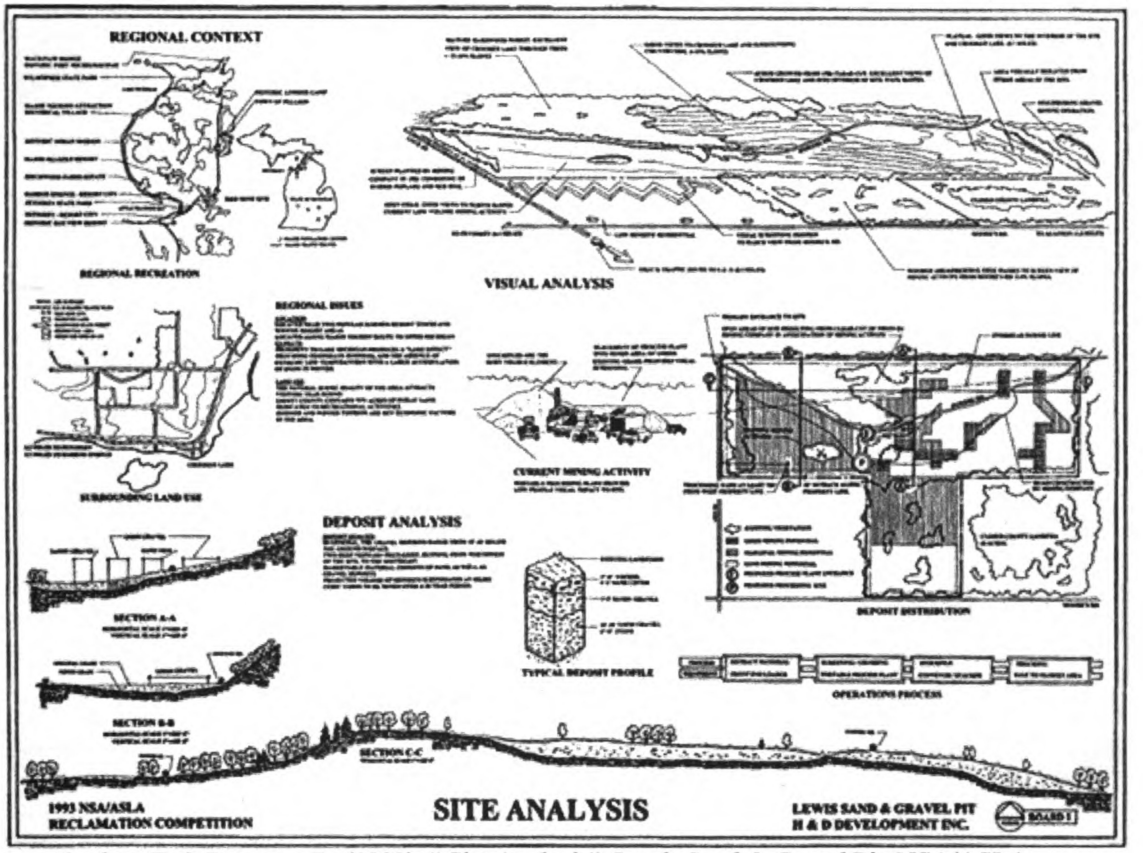
Inventory and Analysis for a proposed sand and gravel operation (Lesher and Peterson, 1993).[56] The sand and gravel operation information indicates the depth and areas of material present. This data was provided by the aggregate mining company, however if a regional Inventory and Analysis was completed ideally this would be available from the township and/or county.

Figure 18



Source: Growing Greener Ordinance Language Visually Enhanced Zoning and Subdivision Models (2001). [CD-ROM]

Figure 19

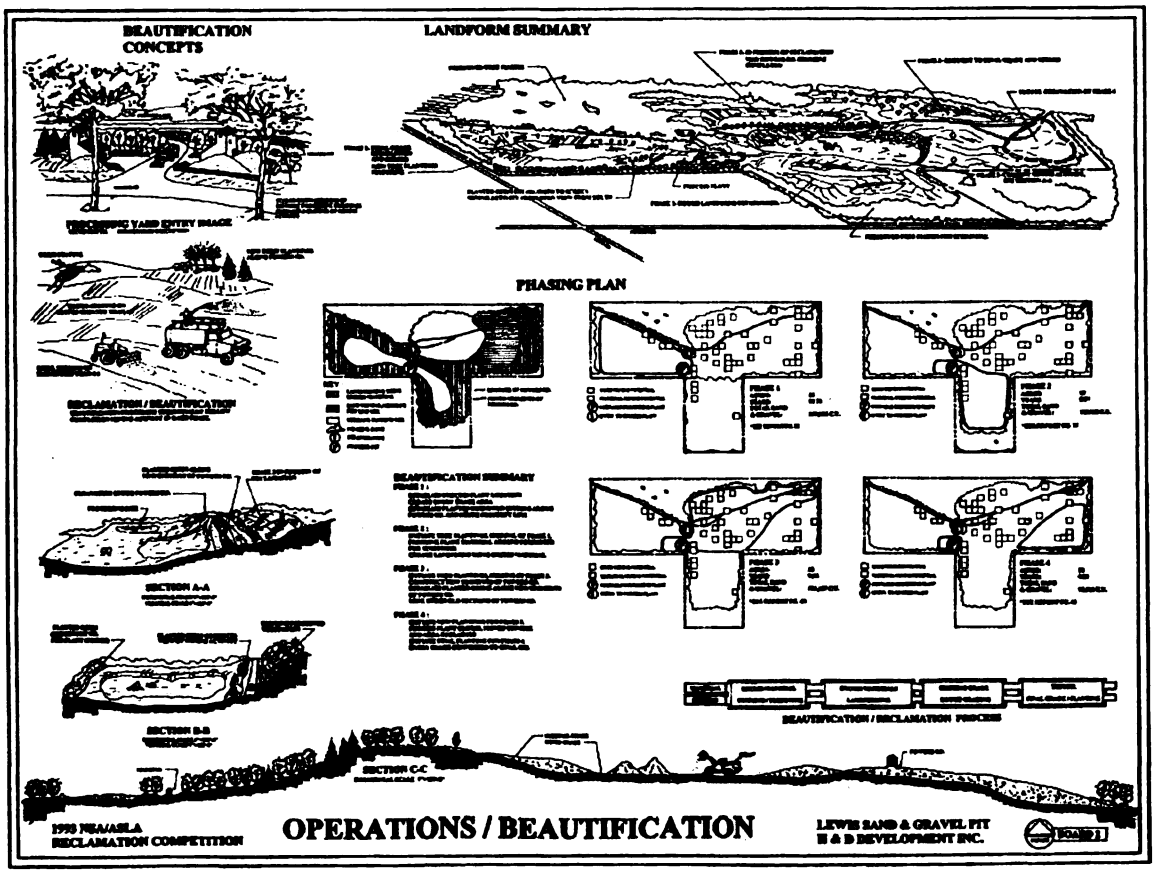


Source: Lesher, T.,& Peterson, B. (1993). " Site Analysis". Lewis Sand & Gravel Pit. NSA/ASLA Reclamation Competition.

For aggregate operations, information provided on the Site Analysis should include the expected amount of material to be mined and a time frame for the extraction of the material. Municipalities need to understand that any time frame provided is going to be an estimate only. Market forces, size of the operation, and weather conditions play a large role in how quickly a site will deplete its resources.

At this point, if the proposal is for an aggregate operation, an "Operations and Beautification Plan" should be provided. This indicates how the material will be mined, types of equipment that will be used, hours of operation, a phasing plan on how the site will be mined, any stockpiling or processing of material on site, trucking routes, and any

Figure 20



Source: Lesher, T.,& Peterson, B. (1993). " Operations/Beautification". Lewis Sand & Gravel Pit. NSA/ASLA Reclamation Competition.

Post mining land uses can be developed under current traditional zoning methods and ordinances. For example, a post mining subdivision site development and lot count could be handled the same as it would be under a conventional zoning. However, this is little different than the type of sprawling land development current taking place. The only difference is that the aggregate material was not lost first. While this is an improvement over what is currently taking place, there is still a better option for developing a post mining subdivision. Open Space Design can allow a more efficient and less sprawling

land use for the post mined site. However there is confusion by many who make and propose land use development as to what Open Space Design means.

Misconceptions of Open Space Design and the Protections of Traditional Zoning

Just as Smart Growth has been confused to mean 'New Town" development, Open Space Design is often misunderstood by the public and government officials to mean multi-family units clustered together on a smaller portion of a site with private parkland (Livingston County Department of Planning, 1996).[58] While multi-family units can be part of an open space community, they are not by any means exclusively this way. Single family residential units can easily be part of open space communities. Mixed use development is also a possibility. The open space conserved is used not only for potential recreational opportunities, but also to protect such environmental concerns such as: wetlands, lakes, streams, sensitive habitat, and endangered species.

On social needs it can be used to provide active and passive recreation, maintain positive viewsheds, and maintain the rural setting feel that is quickly being lost in counties across the state. The misconception held by much of the public and, unfortunately some municipal planning boards, is that zoning already provides for this protection of rural setting by limiting density in agricultural areas; and can further set density controls in others if it feels the need. Others go even further to say that allowing overlay districts for cluster development and open space is only giving developers a "free ride" to increase density where the municipality does not want it. The truth is that traditional zoning, which we have used for over 50 years now in much of the country, is a recipe for sprawl. It is sprawl which is destroying the rural character our small cities and townships wish to maintain, not density. The density may be less under traditional

zoning, especially in agriculturally zoned areas (for example 1 single family home per 5 acre lot), but this is what is causing the problem not the solution. This single family home is utilizing far more land and resources than necessary.

Very few people actually build a small home and maintain a moderate, open yard in most instances, especially if they are not involved in agricultural activities. The typical situation is the owner fences off his or her property and seeds the entire yard. Often the home is set way back on the parcel, in addition to this yard size, requiring municipal services to reach further out to serve the area. This degrades not only the rural character but the environmental integrity of the land.

Native species of grasses, wildflowers, etc, are replaced by non-native species of grasses for lawns. Fertilizers are added to enhance growth and to "green" the new lawns, which inundates the watertable with nitrates. Surface run-off takes still more to the wetland systems, streams, and lakes. This in turn results in an explosion of algae which chokes the lakes and wetlands and kills off fish and other species.

The fencing of these huge lots interferes with wildlife migration patterns and results in cutting them off from other area food sources and proper breeding. The result is a loss in biodiversity for the area as species begin to inbreed. This causes a loss in the species abilities to fight off new diseases as they arise and can also result in genetic disorders over extended periods of time.

This may seem like "the pebble-size snowball that starts the avalanche" and it is, when added to instance after instance of this land use across a region or a state. It is becoming abundantly clear each year as more studies are conducted, that traditionally

zoned land use that encourages sprawl is inherently unsustainable. So how can Open Space Design techniques stop this downward spiral?

Benefits of Open Space Design

As stated earlier there is no pure panacea for environmental and social land use ills. As long as our population continues to grow faster than our available housing stock and support industries, there will always be a need to expand outward. To make matters worse the more environmental degradation we cause, the fewer "safe" areas that remain available for expansion. Open Space Design techniques help deal with this problem by limiting the fast expansive nature of human land use on a site by site basis. When used in conjunction with Open Space Planning processes and Smart Growth principles on a regional scale it can change in how we grow as a society. Open Space Design benefits each site it is applied to in both economic and environmental ways.

Economic Benefits

The economic advantages of Open Space Design are numerous and benefit both the municipality and the developer. For example, open space communities typically enjoy lower infrastructure construction costs. By shortening road lengths and widths the developer reduces his cost for both the road but also utilities that are normally placed in the road right-of-way or just outside in an easement. Depending on the configuration of the parcel of land the savings can be very significant. Stormwater control structure costs are also reduced by shorter road lengths and decreased individual lot size. This is because the amount of impervious surfaces is reduced parcel wide and is mitigated more easily on-site. The municipality gains under these design techniques because, if the roads are public, maintenance costs are reduced for the county road commissions. Ambulance,

fire and police services do not have to travel as far to reach those in need and likely are closer to municipal support services they may need to do their jobs effectively (i.e. watermains for firetrucks, regional dispatch towers for police, area hospitals and main arterial roads for ambulances). Reduced impervious surfaces, reduces the amount of potential problems to residents located downstream in the watershed. Typically homeowners call municipalities when excessive flooding occurs in their area. Locally owned and maintained infrastructure is therefore compromised in these areas and must be expanded and/or replaced as necessary to mitigate the problem. These costs become the burden of the municipality and ultimately the local tax payers.

Another advantage is the number of wetland crossings is generally reduced under an Open Space designed community. As home lots are reduced in size, the need to cross wetland areas is reduced, as it is no longer necessary to cross them in order to obtain the same lot count for the parcel under traditional zoning maximums for the category. The cost of crossings can be both expensive in terms of construction and time. A wetland crossing application can be a multi-month process from start to finish without a guarantee to the developer that he or she will be allowed the crossing. Municipalities gain in this instance from additional land area to handle stormwater run-off and mitigate pollutants.

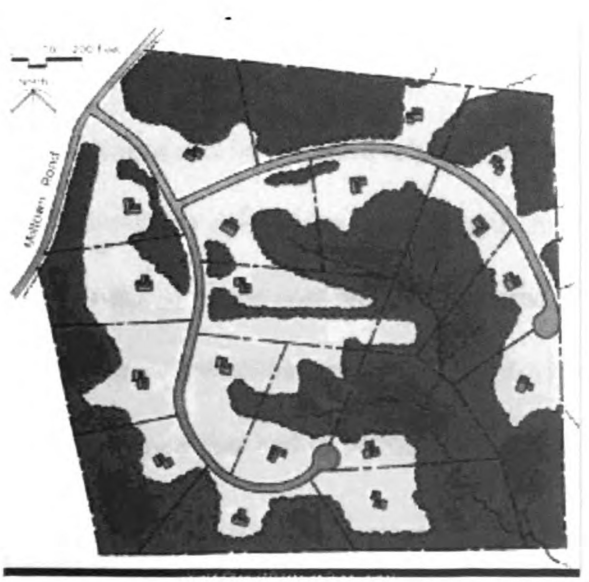
A third advantage is in marketing and sales. Studies by Randall Arendt, a planner and proponent of Open Space Planning and Design, have shown that properly marketed Open Space Designed communities sell out faster, and appreciate faster than larger lot home subdivisions developed under traditional zoning. This is because the open space conserved provides a unique and value added resource to their lot, even though their lot is

smaller than under traditional zoning. The municipality gains from the increased amount of open space, reduces the demand on public recreational services (Arendt, 1996).[59]

Ecological Benefits

Ecologically Open Space Design techniques can help mitigate degradation of environmentally sensitive areas. For example negative impacts to wetlands can be avoided by limiting the exposure of pollutants carried from roads and yards by designing these areas away from wetlands on the site, and using detention and retention stormwater basins to filter out pollutants before they reach the wetlands. If designed correctly these can be an added amenity to the site itself. Other areas such as woodlands, and sensitive prairie lands can be handled in the same manner, by careful design of the road systems and home sites to minimize disturbance, and by creating walking trails that allow for pedestrian traffic to view and enjoy the resources, provide linkages to other regional pedestrian trail systems, but to also discourage traffic in sensitive areas to reduce damage to the resource. Figures 21 and 22 show a conventionally designed subdivision which impacts the whole parcel, and an Open Space Designed example that minimizes the impacts and provides added value in conserved resources.

Figure 21



Source: Growing Greener Ordinance Language Visually Enhanced Zoning and Subdivision Models (2001). [CD-ROM]

Figure 22

Source: Growing Greener Ordinance Language Visually Enhanced Zoning and Subdivision Models (2001). [CD-ROM]

As can be seen in Figure 22, existing tree stands can be utilized to screen the view of houses from adjacent properties, as well as provide privacy for the homeowner. If the development in question is for a post mining land use, Open Space Design techniques can serve an even greater purpose because of the unique opportunities the mining operation lends to the post mined land use. Aggregate could be removed and the land geomorphed to obtain desired screening, to enhance views for home sites, create active and passive recreational areas, and construct new lakes and wetlands. The cost of doing these without mining can be prohibitively expensive for the developer. Fortunately they are part of the necessary operations for aggregate mining; therefore the cost to do them in this case is minimal as the cost would be carried by the operation anyway. These options may change the attitude of some operators who may have seen reclamation requirements as a nuisance that had to be tolerated as a cost of doing business, doing only what is necessary

to meet government regulatory mandates, and barely enough to keep local citizens form complaining. The opportunity to plan and design an end use that can serve multiple purposes and create additional profit in the long run could be very appealing; especially when many small operations are run very close to profit margins and risk going out of business.

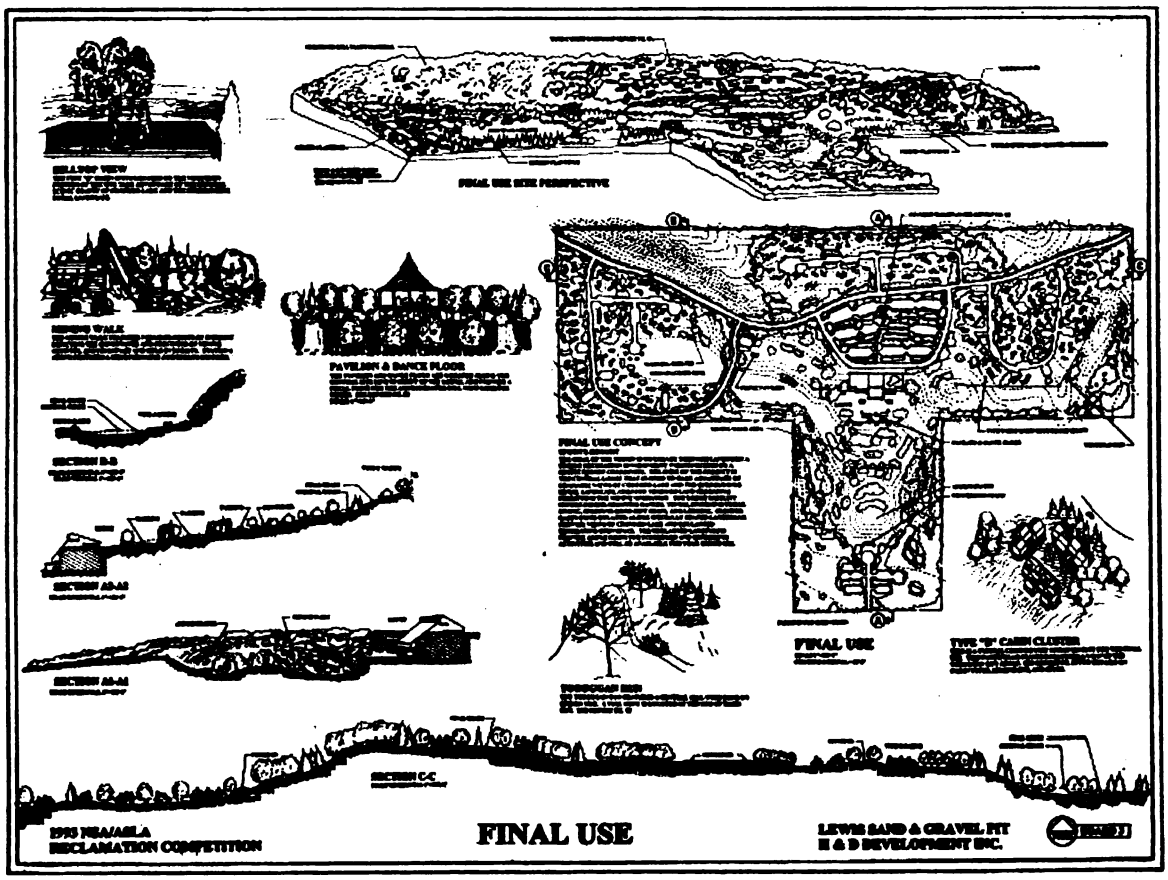
Success Stories of Reclamation Efforts

In addition to single-family residential Open Space Design, depleted aggregate operations can be reclamated and designed to meet other regional land uses goals. For example in Stevensville, Michigan a 40 acre mine site will be added to the Grand Mere State Park. Reclamation of the site has included the restoring of the landscape with over 50,000 individual plants and over 100 species, to blend it into the existing park's flora and fauna. The Michigan Department of Natural Resources and local children have made the reclamation process into a community project, restoring habitat for endangered species, and waterfowl. The mining company plans to turn the property over to the park system once reclamation is finished in 2005 (Associated Press, 10/15/2003).[60]

Mixed-use developments are also possible and work well with aggregate operations. In Edina, Minnesota, a $300 million reclamation project is in progress to create an 87 acre mixed-use development that will include: low-rise condominiums, apartment complexes, office space, a hotel, and an 8 screen movie theatre. The site will include a lake and 25 acres of park space for the development. The development is located in an active real estate market and is expected to fill up quickly (Pit & Quarry, 05/02/2002).[61] Figure 23 shows a proposed post mining use for an open space recreation center that would serve the community and access the state's snowmobile trail system on

the northern property line, and provide green space (ice rink in winter), toboggan runs, community amphitheater, and rustic cabins.

Figure 23



Source: Lesher, T.,& Peterson, B. (1993). " Operations/Beautification". Lewis Sand & Gravel Pit. NSA/ASLA Reclamation Competition.

Implementing Open Space Planning and Design

Currently Open Space Design can be implemented through a zoning ordinance modification. The most common way this is done in Michigan is through the creation of an open space overlay zoning district which can be allowed as a permitted use under the zoning ordinance. This allows an open space zoning ordinance to in effect 'supercede' the underlying zoning within the confines of the open space ordinance restrictions.

Allowable density can be determined in numerous ways such as simply setting maximum number of lots per acre restriction. Many however have the developer create what is called a Parallel Plan to help determine allowable density.

The Parallel Plan is drawn up to show the maximum amount of possible units a developer would be allowed to show on a Proposed Plan Site Plan. The Parallel Plan is never actually built it is merely to create an agreed upon lot count for the Site Plan. Areas such as wetlands, lakes, streams etc. are generally removed from being shown as part of a buildable window on a lot. To encourage the use of the Open Space ordinance the municipality would generally lower the lot sizes shown on the Parallel Plan. This grants a density bonus to the developer in most circumstances. This is a point of contention among those that believe in controlling density via the zoning ordinance; however the number of units granted as a bonus is usually very minor and varies by the underlying zoning requirement. Hamburg Township, Michigan is recognized as a leader in Open Space conservation efforts. Figure 24 shows a table from the Hamburg Township Open Space Ordinance that lists the lots size for the Parallel Plan based upon the underlying zoning district (Hamburg Township, 1996).[62] In this way the overlay

Figure 24

Underlying Zoning District	Parallel Plan Minimum Lot Size (square feet)
RAA	60,000
RA	30,000
RB	7,000*
NR	30,000
WFR	30,000
VR	10,000*

Source: Hamburg Township, Livingston County, Michgan (1996 September 13 amended). Zoning Ordinance Article 14.00 Open Space Community (Planned Unit Development). 8 May 2004. < http://www.hamburg.mi.us/lawroom/PDFS/ZONING%20ORDINANCE/Article%2014.00.pdf>

district does not simply grant a huge density increase as some people fear, but does provide an incentive to pursue an open space community development option. Once the number of lots is approved, the Site Plan can be designed showing the approved amount of lots.

The way the open space is conserved from development is a concern voiced by most people when discussing open space ordinances. The prevention of future development on the conserved open space is critical for the success of reducing sprawling land use. Therefore the remaining open space, usually established in the ordinance to be between 40-60 percent of the total site, must be legally protected from development. This can be accomplished through some form of legal restriction on land development. Land covenants, purchasing developing rights, transfer of development rights and master deed and by-law restrictions on site condominium developments are just a few of the ways this has historically been accomplished. It is important to note however that Michigan does not legally have a mechanism in place for allowing Transfer of Development rights (TDR). The main legislation must come from revisions to Michigan Statutes that govern land use.

A sample Open Space ordinance developed by the Livingston County Planning Department has been reprinted in Appendix E. Revisions to this "boiler plate" ordinance are intended to show what areas would be necessary to append in order for the ordinance to function for the protection and planned extraction of construction aggregate materials (Livingston County Planning Department, 1996).[63]

Mining and Michigan Land Use Regulation Reform

If a regional process for protection and planned extraction of construction aggregate is ever going to come to fruition, it is critical that revisions be made to Michigan's statutes that regulate land use. Current land use legislation encourages sprawling land use behavior by municipalities. In order to curb this behavior, encourage more sustainable land use practices, and protect aggregate resources; changes or additions need to be the following areas of Michigan's land use regulation: construction aggregate resource protection, define sprawl and initiate regional planning, state land division and planning acts, incentive zoning options and training for planning commissions and zoning boards of appeal.

Protecting and Regulating Mining Operations and Resources

Currently Michigan does not have a legal way to protect construction aggregate resources from loss by development. To date little has been done to even recognize the problem exists. Aggregate mining in Michigan to date has been regulated primarily by the townships and/or counties who allow the operations under a special use permit. State regulation of aggregate mining is limited in scope to environmental and reclamation statutes. Figure 25 shows a list of the current Michigan laws which regulate mining as listed by the Michigan Department of Environmental Quality – Geologic and Land Management Division (MDEQ-GLMD, 2004).[64] It is important to note that not all laws will necessarily be applicable to aggregate mining operations in every instance. For example a permit under Air Pollution Control may not be necessary if aggregate processing is not conducted on-site. To date the state and federal environmental laws have done an adequate job of policing the industry from doing major environmental

Figure 25

Michigan Laws Applicable for Mining Activity

Part 31, Water Resources Protection	**Discharge to surface water or groundwater, storm water control, construction in a floodplain**
Part 55, Air Pollution Control	**Air emissions**
Part 91, Soil Erosion and Sedimentation Control	**Earth-moving activity disturbing more than one acre or within 500 feet of water**
Part 111, Hazardous Waste Management	**Handling and disposal of hazardous waste**
Part 115, Solid Waste Management	**Handling and disposal of solid waste, excluding waste rock stockpiles and tailings basins**
Part 201, Environmental Remediation	**Cleanup and remediation of contamination and prevention of migration or exacerbation**
Part 301, Inland Lakes and Streams	**Dredging or depositing fill in a lake or stream**
Part 303, Wetlands Protection	**Disturbance of a wetland**
Part 625, Mineral Wells	**Drilling of test wells or disposal wells**
Part 631, Reclamation of Mining Lands	**Reclamation of surface mines and associated operations**

Source: Maki,J., Michigan Department of Environmental Quality-Geologic and Land Management Division. (2004, January 31). "Exploration and Mining in the Northern Peninsula of Michigan". 15 June 2004. <http://www.deq.state.mi.us/documents/deq-gsd-land-metallicmining-mining.ppt>

damage to sensitive areas, however it has left it to the counties, cities, and townships to decide where mining operations will be allowed outside of these statutes.

The state needs to be a leader and take a proactive role if construction aggregates are to be protected. They must be given the same or similar priority as other natural resources such as forestry, wetlands, lakes, and streams. This would require a state statute that would recognize the importance of construction aggregates, mandate a statewide inventory of available reserves, and require municipalities to plan for and allow subsurface resources protection and extraction where appropriate in their comprehensive

plans and zoning ordinances. Other states and countries have taken this first step and can be a guide for any legislation that Michigan initiates. Three good examples of such efforts are the states of California and Minnesota and the province of Ontario, Canada.

California has pioneered the protection and planning for subsurface resources in the Unites States with the Surface Mining and Reclamation Act of 1975 (SMARA). California's mining industry was endangered by the exceptional fast growth rate of its population and the even faster expansion of its suburban communities. Industry analysts had predicted that without adequate protective measures taken the state was going to face a significant short fall in meeting its aggregate demand. The creation of SMARA marked the first effort to recognize subsurface resources as an integral part of a state's economy and necessary for its continued growth. As the SMARA Article I General Provisions states:"*§ 2711. (a) The Legislature hereby finds and declares that the extraction of minerals is essential to the continued economic well-being of the state and to the needs of the society, and that the reclamation of mined lands is necessary to prevent or minimize adverse effects on the environment and to protect the public health and safety"* (SMARA, 1975).[65] The other critical action that SMARA authorized was the creation of a planning effort to delineate areas of resource significance to the state, thereby placing these areas under protection of state law. Doing this ensured that any planned development in these areas would have to justify coverage of the subsurface resources, if proposed to be constructed before extraction had occurred on the site in question.

In a similar measure the State of Minnesota in 1984 enacted the Aggregate Planning and Protection Minnesota Statute 84.94. This effectively did the same for Minnesota, as SMARA did for California. It created a legal entity for authorization to

plan for construction aggregate protection and an initiative to take inventory of available aggregate reserves (Ad Hoc Aggregate Committee, 1998).[66] The problem with the Minnesota effort is that it only requires that municipalities consider the data in their land use decisions. Given the general lack of understanding of the total problem and the common view of aggregate mining operations as a nuisance land use, it is not surprising that little has been changed in how land use decisions are being conducted in the state. Minnesota is still facing the same problem of development out pacing extraction of resources.

In Canada the province of Ontario enacted in 1990 the Aggregate Resources Act. The purposes of this act are: "*to provide for the management of the aggregate resources of Ontario;to control and regulate aggregate operations on Crown and private lands; to require the rehabilitation of land from which aggregate has been excavated; and to minimize adverse impact on the environment in respect of aggregate operations*". (Chapter A8, Aggregate Resource Act R.S.O, 1990).[67] The difference of the Canadian Act over the Minnesota and California stautes is that the provincial government adminsters mining permits and activities. The local control has been limited. This has the advantage of reducing local objections against mining operations from biasing land use approvals.

While the system of land use rights in Michigan likely would not allow for removing review rights from local control, it may be possible to create a state appeals board with legal powers to overide the local decision if it can be proven as biased; not fact driven. This would be an important improvement in protecting aggregate resources. In any case Michigan needs a legislative act like SMARA to recognize and give state

authority to inventory reserves and mandate that subsurface resources are seriously considered in land use decisions.

Define Sprawl and Initiate Regional Planning

One area that would help to put land use decision making on equal footing would be for the State of Michigan to define sprawl. In particular, place a quantitative measure to the term so an evaluation can be made that is not subjective. The current problem is that there is no clear definition of sprawl and therefore some areas may not realize they are sprawling or may think they are sprawling when in reality they are not. A quantative measure for a definition would also provide a non-biased way of measurement since there is a lot of personal bias as to what types of land use constitute sprawl. Making land use decisions based upon personal interpretations of sprawl will put some applicants at a disadvantage over others. A quantative measure for sprawling land use "levels the playing field" for all sides and can be easily determined by calculation.

In relation to defining sprawl and protection of construction aggregates, the state needs to mandate a regional inventory of aggregate resources and categorize areas of primary concern. A quantative measure of sprawling land use would help indentify these areas. Linked to a quality of material inventory and reserve amounts, priorities could be determined as to what counties, townships, etc. were most at risk from developing over there reserves. The state needs to legislatively strengthen Metropolitan Planning Organizations so they can play a larger role in helping townships and counties to make compatible regional land use plans. To date there is not any legislation to grant real authority to MPOs to plan and there are not that many organizations; however the need

for them to help mitigate potential land use conflicts between counties and townships is crucial to a successful regional land use plan formulation.

State Land Division and Planning Acts

Revisions are desperately needed to change the way the state handles land division. Currently there are several legislative acts that have a say in how land is subdivided. The Michigan Society of Planning has recognized this issue in the numerous studies and comments obtained from planners and land use decision makers across the state. In their report, "New Directions: Recommendations for Planning, Zoning, and Subdivision Law in Michigan", they indicate that the following needs to be clarified and revised to Michigan's Land Division statutes:

> *"Completely rewrite the Land Division Act and consolidate related provisions from the planning acts. Without a doubt, provisions for division of land and subdivision in the Michigan statutes are in need of a major rewriting; study after study has asserted this and all of the interviews confirmed it. The current statutory framework spreads the authority for subdivision review over several code sections. A separate statute deals with land division and subdivision (MCL 560.101 et seq.). Language related to subdivision control, however, appears in both the municipal planning act (MCL 125.43-.45) and the township planning act (MCL 125.332). In addition, cities and villages have the authority to adopt official maps, which control the location of major public improvements on land undergoing subdivision (MCL 125.51 et seq.). A set of complex provisions, enacted in 1997 as a substitute for a clearly written overhaul of the statute, deals with division of land without formal subdivision (MCL 560.108). It appears that, over time, the land division procedure can produce what is in reality a multiple-lot subdivision"* (MSP, 2004).[68]

Currently, these statutes are encouraging sprawl in an unintentional way; the length of time for approvals under certain acts makes choosing the 1997 Land Division Act the

most likely to be used. This is because it is the easiest and quickest statute for the developer to utilize. The problem is this act has been criticized for encouraging land fragmentation and sprawl as it allows for up to ten parcel splits from the parent parcel. The process is easy to do under traditional zoning, and fast for the developer, but the result is sprawl. This is detrimental for resource protection efforts and for maintaining high-yield farmlands. The length of time to do a traditional plat or site condominium makes these far less likely to be used as they can take over a year to receive final approval from every state and local agency that must review and approve the plans. These statutes should be rescinded and a new legislation written which clearly defines development options available and agencies to be involved with the approval process. A change should be made to allow the local municipality to act as the lead agency for collection of plans and applications, so that an acceptable time table can be presented and explained to applicants for land division projects.

Incentive Zoning Options and Training

Two areas that also must be changed in relation to this problem are incentive zoning options for developers and training for planning commissioners and zoning board of appeals members. The complexity or lack of development options to do open space planning or planned unit developments severely limits the ability to slow sprawling land use. The state needs to officially allow for, and endorse the use of these development options; in particular the use of these districts as they apply to resource protection efforts. While townships have been using these districts with some successes, there needs to be a clear state statute and allowance for bonus densities grantable by the municipality for exceptional design that furthers the comprehensive plan goals. The comprehensive plan

itself should be a legally enforceable document. Currently, courts do not recognize any binding enforcement of the comprehensive plan, instead defaulting to zoning, because there is no clear statute giving it standing in Michigan.

Finally, training is crucial for those that are making land use decisions for the state. Currently, legislation does not require any formalized training for those who are responsible for guiding the state land use course. Many of those sitting on planning commissions and zoning boards of appeals have no formal planning training. They are unfamiliar with even the most basic planning terminology and are uneasy about embracing any new planning and design techniques beyond the standard zoning ordinance. This is especially true for more rural areas where the need to protect resources is most crucial. The state should mandate that those who are on these commissions and boards receive proper training on the basics of land use planning and encourage further training opportunities (MSP, 2004).[69]

Conclusions

Need To Recognize the Critical Situation We Face

The problem of sprawl was not created overnight and it will not be solved overnight; however efforts must be made to address its effects on our land use if we are going to continue to be able to grow as a society. The hand that feeds sprawl, construction aggregates, is in danger of being lost to the very same phenomena it helped create. Michigan citizens must snap out of their complacency and realize that current land use practices are not sustainable in the long-term and are counter productive to conserving critical natural resources that we must have to function. Increasing construction costs from the loss of construction aggregates will in time slow growth on its

own, but not before a tremendous amount of resources are buried below new shopping centers and subdivisions.

Implement Legislation and Corrective Actions

To forestall this dim future for our state we must implement legislation to protect these resources and mandate a regional inventory of remaining reserves and critical areas where loss of high quality reserves is imminent. We must correct confusing and sprawl encouraging land division statutes and streamline the process so it is easier for all to understand and follow. Use of Open Space Planning and Design processes and techniques can play a valuable role in fostering this effort and for planning the protection, extraction and end use creation for post mined sites. They have the added advantage of allowing new landforms and habitats to be created at minimal costs as part of the mining operation and can be an unobtrusive neighbor when operations are planned and phased carefully to minimize disturbances.

Improve Education of Both the Public and Mining Operators

To accomplish protection of these resources and the promotion of Open Space Planning and Design, the public needs to understand that aggregate materials are a finite resource; and while we currently have vast supplies, we are going to lose them if we don't change our growth paradigm. The public and land use decision makers need to realize the implication of land use changes they approve, with the knowledge that these resources do not follow jurisdictional boundaries and that we must protect them where we find them, as we would any other critical resource. They are not necessarily more important than other natural systems or resources, but they should be considered equally in land use policy and practice.

Mining operators need to be more proactive in the advocating of construction aggregate resource protection as their continued livelihood is in question. Education must continue with operators on the consequences of short term business decisions that can create public opposition. Human nature is unfortunately fast to forget the years of being a "good neighbor" and remember the one time operations inconvenienced them. Going the "extra mile" to maintain positive public relations will pay off in the long run for the operators. Both groups need to see the full impact of current practices and learn about alternative land use options to address this problem, working together to solve the problem as both can benefit in the long run with a sustainable community for everyone to enjoy.

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Appendices

Appendix A

People QuickFacts	**USA**
Population, 2002 estimate	288,368,698
Population, percent change, April 1, 2000 to July 1, 2002	2.5%
Population, 2000	281,421,906
Population, percent change, 1990 to 2000	13.1%
Persons under 5 years old, percent, 2000	6.8%
Persons under 18 years old, percent, 2000	25.7%
Persons 65 years old and over, percent, 2000	12.4%
Female persons, percent, 2000	50.9%
White persons, percent, 2000 (a)	75.1%
Black or African American persons, percent, 2000 (a)	12.3%
American Indian and Alaska Native persons, percent, 2000 (a)	0.9%
Asian persons, percent, 2000 (a)	3.6%
Native Hawaiian and Other Pacific Islander, percent, 2000 (a)	0.1%
Persons reporting some other race, percent, 2000 (a)	5.5%
People QuickFacts	**USA**
Persons reporting two or more races, percent, 2000	2.4%
Persons of Hispanic or Latino origin, percent, 2000 (b)	12.5%
White persons, not of Hispanic/Latino origin, percent, 2000	69.1%
Living in same house in 1995 and 2000', pct age 5+, 2000	54.1%
Foreign born persons, percent, 2000	11.1%
Language other than English spoken at home, pct age 5+, 2000	17.9%
High school graduates, percent of persons age 25+, 2000	80.4%
Bachelor's degree or higher, pct of persons age 25+, 2000	24.4%
Persons with a disability, age 5+, 2000	49,746,248
Mean travel time to work (minutes), workers age 16+, 2000	25.5
Housing units, 2002	119,302,132
Homeownership rate, 2000	66.2%
Housing units in multi-unit structures, percent, 2000	26.4%
Median value of owner-occupied housing units, 2000	$119,600
Households, 2000	105,480,101
Persons per household, 2000	2.59
Median household income, 1999	$41,994
Per capita money income, 1999	$21,587
Persons below poverty, percent, 1999	12.4%
Business QuickFacts	**USA**
Private nonfarm establishments with paid employees, 2001	7,095,302
Private nonfarm employment, 2001	115,061,184
Private nonfarm employment, percent change 2000-2001	0.9%
Nonemployer establishments, 2000	16,529,955
Manufacturers shipments, 1997 ($1000)	3,842,061,405
Retail sales, 1997 ($1000)	2,460,886,012

Retail sales per capita, 1997	$9,190
Minority-owned firms, percent of total, 1997	14.6%
Women-owned firms, percent of total, 1997	26.0%
Housing units authorized by building permits, 2002	1,747,678
Federal funds and grants, 2002 ($1000)	1,901,247,889

Geography QuickFacts	**USA**
Land area, 2000 (square miles)	3,537,438
Persons per square mile, 2000	79.6
FIPS Code	

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.
FN: Footnote on this item for this area in place of data
NA: Not available
D: Suppressed to avoid disclosure of confidential information
X: Not applicable
S: Suppressed; does not meet publication standards
Z: Value greater than zero but less than half unit of measure shown
F: Fewer than 100 firms
Source: US Census Bureau State & County QuickFacts

Appendix B

People QuickFacts	**Michigan**
Population, 2003 estimate	10,079,985
Population, percent change, April 1, 2000 to July 1, 2003	1.4%
Population, 2000	9,938,444
Population, percent change, 1990 to 2000	6.9%
Persons under 5 years old, percent, 2000	6.8%
Persons under 18 years old, percent, 2000	26.1%
Persons 65 years old and over, percent, 2000	12.3%
Female persons, percent, 2000	51.0%
White persons, percent, 2000 (a)	80.2%
Black or African American persons, percent, 2000 (a)	14.2%
American Indian and Alaska Native persons, percent, 2000 (a)	0.6%
Asian persons, percent, 2000 (a)	1.8%
Native Hawaiian and Other Pacific Islander, percent, 2000 (a)	Z
Persons reporting some other race, percent, 2000 (a)	1.3%
Persons reporting two or more races, percent, 2000	1.9%
Persons of Hispanic or Latino origin, percent, 2000 (b)	3.3%
White persons, not of Hispanic/Latino origin, percent, 2000	78.6%
Living in same house in 1995 and 2000', pct age 5+, 2000	57.3%
Foreign born persons, percent, 2000	5.3%
Language other than English spoken at home, pct age 5+, 2000	8.4%
High school graduates, percent of persons age 25+, 2000	83.4%
Bachelor's degree or higher, pct of persons age 25+, 2000	21.8%
Persons with a disability, age 5+, 2000	1,711,231

People QuickFacts	**Michigan**
Mean travel time to work (minutes), workers age 16+, 2000	24.1
Housing units, 2002	4,331,986
Homeownership rate, 2000	73.8%
Housing units in multi-unit structures, percent, 2000	18.8%
Median value of owner-occupied housing units, 2000	$115,600
Households, 2000	3,785,661
Persons per household, 2000	2.56
Median household income, 1999	$44,667
Per capita money income, 1999	$22,168
Persons below poverty, percent, 1999	10.5%

Business QuickFacts	**Michigan**
Private nonfarm establishments with paid employees, 2001	236,711
Private nonfarm employment, 2001	4,008,572
Private nonfarm employment, percent change 2000-2001	-1.6%
Nonemployer establishments, 2000	526,958
Manufacturers shipments, 1997 ($1000)	214,900,655
Retail sales, 1997 ($1000)	93,706,078
Retail sales per capita, 1997	$9,576
Minority-owned firms, percent of total, 1997	7.6%
Women-owned firms, percent of total, 1997	27.2%
Housing units authorized by building permits, 2002	49,9681
Federal funds and grants, 2002 ($1000)	55,909,012

Geography QuickFacts	**Michigan**
Land area, 2000 (square miles)	56,804
Persons per square mile, 2000	175
FIPS Code	26

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.
FN: Footnote on this item for this area in place of data
NA: Not available
D: Suppressed to avoid disclosure of confidential information
X: Not applicable
S: Suppressed; does not meet publication standards
Z: Value greater than zero but less than half unit of measure shown
F: Fewer than 100 firms
Source: US Census Bureau State & County QuickFacts

Appendix C

SAND AND GRAVEL SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE[1]

(Thousand metric tons and thousand dollars)

State	2003 Quantity 1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	Total[2]	2003 Value total[2]	2004 Quantity 1st qtr.	Per-cent change[3]	Percent cover-age	Number of cos[4]
Alabama	2,440	3,040	2,930	2,790	11,200	51,500	2,260	-7.6	40	7
Alaska	(5)	(5)	(5)	(5)	16,300	93,700	(5)	(5)	(5)	(5)
Arizona	13,100	15,200	15,400	14,400	58,000	319,000	21,700	65.8	66	8
Arkansas	1,640	2,390	3,000	2,070	9,100	47,300	1,850	12.9	60	3
California	31,500	47,700	44,900	33,900	158,000	1,160,000	33,300	5.5	63	15
Colorado	5,610	12,700	11,500	7,170	37,000	204,000	5,970	6.4	34	7
Connecticut	562	2,340	3,290	2,710	8,900	53,800	668	18.8	32	5
Delaware	(6)	(6)	(6)	(6)	2,000	15,900	(6)	(6)	(6)	(6)
Florida	6,780	7,840	7,290	7,100	29,000	125,000	7,120	5.0	66	8
Georgia	1,460	1,930	1,990	1,720	7,100	29,500	2,190	49.6	51	6
Hawaii	(5)	(5)	(5)	(5)	600	6,900	(5)	(5)	(5)	(5)
Idaho	2,210	4,890	3,590	4,310	15,000	55,500	1,670	-24.4	22	3
Illinois	3,550	9,610	11,200	8,850	33,200	153,000	3,480	-2.1	35	7
Indiana	5,350	8,380	7,290	6,080	27,100	121,000	5,110	-4.5	47	6
Iowa	1,060	4,080	5,140	3,730	14,000	60,200	1,200	13.5	49	6
Kansas	1,760	3,040	3,090	2,310	10,200	31,100	1,780	1.4	21	3
Kentucky	972	2,480	2,610	2,740	8,800	35,200	2,350	142.0	13	3
Louisiana	4,250	5,380	5,310	4,760	19,700	107,000	3,970	-6.5	37	3
Maine	575	2,440	3,960	2,330	9,300	39,100	605	5.3	16	4
Maryland	2,050	3,070	3,150	3,130	11,400	78,100	2,410	17.4	40	4
Massachusetts	1,730	2,620	3,760	3,300	11,400	70,700	1,780	3.2	13	5
Michigan	4,930	23,200	24,600	17,300	70,000	245,000	5,240	6.3	41	10
Minnesota	1,070	13,200	19,900	12,900	47,000	188,000	1,030	-3.2	41	9
Mississippi	2,330	3,300	3,920	3,250	12,800	69,100	2,570	10.1	49	5
Missouri	1,380	3,060	3,660	2,100	10,200	43,400	1,820	32.0	48	4
Montana	2,480	6,190	6,230	3,100	18,000	81,900	1,690	-31.9	38	3
Nebraska	1,740	4,020	3,840	2,610	12,200	42,100	1,770	2.0	23	5
Nevada	8,450	8,700	11,200	9,700	38,000	173,000	7,720	-8.6	20	5
New Hampshire	715	2,470	3,280	2,640	9,100	44,100	923	29.1	28	4
New Jersey	2,720	3,780	3,860	4,850	15,200	92,000	2,990	10.1	31	5
New Mexico	3,110	4,000	3,930	2,970	14,000	68,600	3,010	-3.1	36	5
New York	3,900	8,910	11,900	7,320	32,000	171,000	3,310	-15.1	22	9
North Carolina	2,030	2,300	2,600	2,180	9,100	46,000	2,180	7.5	28	4
North Dakota	(5)	(5)	(5)	(5)	10,600	28,100	(5)	(5)	(5)	(5)
Ohio	5,320	12,700	16,100	12,800	47,000	242,000	6,180	16.1	48	13
Oklahoma	2,140	2,740	2,640	2,280	9,800	39,700	2,080	-2.8	47	6
Oregon	3,350	4,200	6,420	5,030	19,000	113,000	3,380	0.9	41	5
Pennsylvania	2,120	4,830	6,060	5,000	18,000	115,000	2,980	40.7	38	8
Rhode Island	(6)	(6)	(6)	(6)	1,680	13,500	(6)	(6)	(6)	(6)
South Carolina	2,170	2,970	2,770	2,400	10,300	36,100	2,270	4.6	41	4
South Dakota	654	4,110	5,110	3,120	13,000	52,600	916	40.0	12	5
Tennessee	1,450	2,530	3,150	2,570	9,700	54,800	1,780	22.6	36	5
Texas	17,200	22,000	20,200	18,700	78,000	394,000	17,400	0.9	37	9
Utah	4,040	6,760	8,850	6,850	26,500	101,000	4,200	3.9	31	3
Vermont	434	1,390	1,540	1,330	4,700	21,200	309	-28.7	21	4
Virginia	2,130	2,940	3,170	2,860	11,100	63,800	2,490	17.0	62	7
Washington	7,690	10,300	13,700	10,400	42,000	218,000	7,130	-7.3	39	7
West Virginia	343	495	478	284	1,600	8,000	153	-55.3	48	3
Wisconsin	4,170	11,300	13,400	10,200	39,100	156,000	4,300	3.3	20	8
Wyoming	580	2,270	3,320	1,330	7,500	31,500	965	66.4	15	3
Total	XX	XX	XX	XX	1,130,000	5,810,000	XX	XX	XX	XX

XX Not applicable.

[1]Quarterly totals shown are estimates based on a sample survey. Estimated quantities for prior quarters have been recalculated.

[2]Data may not add to totals shown because of independent rounding and differences between projected totals by States.

[3]Compared with the same period of the previous year, all percentage changes are calculated using unrounded totals.

[4]Number of companies reporting for the quarterly survey.

[5]State not included in quarterly survey.

[6]Owing to a low number of reporting companies, no production estimates by quarters were generated.

AGGREGATES SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE[1]

(Thousand metric tons and thousand dollars)

State	2003						2004			
	Quantity					Value	Quantity	Per-cent	Percent cover-age	Number of cos.[4]
	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	Total[2]	total[2]	1st qtr.	change[3]		
Alabama	11,800	14,600	15,900	13,900	56,200	327,000	13,200	11.6	72	15
Alaska	(5)	(5)	(5)	(5)	17,600	101,000	(5)	(5)	(5)	(5)
Arizona	15,200	17,500	17,800	16,700	67,200	377,000	24,800	63.4	59	8
Arkansas	6,720	10,200	12,200	9,440	38,600	200,000	8,340	24.0	62	10
California	45,100	64,200	61,300	49,600	220,000	1,560,000	45,700	1.3	60	21
Colorado	8,140	17,400	15,500	9,550	50,600	292,000	8,100	-0.6	42	9
Connecticut	1,350	5,380	6,510	5,960	19,200	141,000	1,360	1.2	60	7
Delaware	(6)	(6)	(6)	(6)	2,000	15,900	(6)	(6)	(6)	(6)
Florida	30,500	34,600	33,700	28,500	127,000	714,000	33,400	9.7	67	10
Georgia[7]	16,400	20,200	22,000	19,900	78,600	509,000	19,700	20.0	99	9
Hawaii	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Idaho	2,550	6,040	4,190	5,120	17,900	69,000	2,850	11.7	26	4
Illinois[7]	11,200	28,300	35,400	31,000	106,000	574,000	12,600	12.7	57	13
Indiana	11,800	22,900	24,100	21,800	80,600	383,000	13,400	13.8	71	12
Iowa	4,850	15,200	16,200	12,400	48,700	247,000	5,670	16.8	51	8
Kansas	5,790	8,590	8,540	7,880	30,800	134,000	6,170	6.5	49	11
Kentucky	9,880	16,200	18,300	16,300	60,700	352,000	11,900	20.7	47	10
Louisiana	4,360	5,210	5,390	4,740	19,700	107,000	3,090	-29.2	65	3
Maine	1,390	2,990	5,740	3,580	13,700	65,100	1,450	4.3	30	4
Maryland[7]	5,000	9,160	9,290	9,750	33,200	216,000	6,300	25.9	92	10
Massachusetts	2,360	7,040	8,120	7,080	24,600	175,000	2,510	6.2	46	7
Michigan[7]	7,700	34,600	39,600	29,300	111,000	418,000	9,280	20.5	52	13
Minnesota	1,560	16,400	24,000	14,900	56,800	245,000	1,430	-8.2	43	12
Mississippi	2,870	3,930	4,760	3,750	15,300	95,900	2,990	4.0	47	5
Missouri	16,200	23,400	25,200	18,700	83,500	424,000	18,800	15.6	46	16
Montana	2,980	6,920	6,980	3,620	20,500	92,700	2,160	-27.5	36	4
Nebraska	3,330	5,700	5,600	4,470	19,100	93,200	3,090	-7.2	47	9
Nevada	10,100	11,200	13,300	12,000	46,700	219,000	10,600	4.2	22	7
New Hampshire[7]	1,030	3,920	4,100	3,850	12,900	63,500	1,110	7.8	41	4
New Jersey	5,170	9,910	11,300	11,300	37,700	234,000	5,070	-1.8	52	7
New Mexico	3,970	5,000	5,050	3,880	17,900	93,800	3,820	-3.8	38	7
New York	6,990	24,100	31,700	20,700	83,500	529,000	6,950	-0.6	53	14
North Carolina	13,100	18,900	21,700	18,900	72,600	506,000	14,500	11.4	92	12
North Dakota	(5,7)	(5,7)	(5,7)	(5,7)	10,600	28,100	(5,7)	(5,7)	(5,7)	(5,7)
Ohio	13,000	31,200	38,400	33,200	116,000	552,000	17,600	34.9	69	17
Oklahoma	11,800	14,900	15,700	13,300	55,600	242,000	13,100	11.0	63	12
Oregon	7,690	8,710	11,900	9,450	37,800	210,000	6,900	-10.3	49	12
Pennsylvania	13,900	32,200	34,700	33,200	114,000	662,000	18,100	30.1	52	18
Rhode Island	(6)	(6)	(6)	(6)	3,580	25,800	(6)	(6)	(6)	(6)
South Carolina	7,880	9,560	9,980	9,190	36,600	207,000	8,890	12.9	70	8
South Dakota	1,770	6,360	7,280	4,290	19,700	86,100	1,950	10.4	35	7
Tennessee	11,200	16,600	18,800	16,500	63,200	376,000	12,800	14.2	73	10
Texas	41,000	49,700	47,300	44,000	182,000	898,000	39,300	-4.0	64	15
Utah	5,420	8,930	11,500	8,640	34,500	141,000	6,120	12.9	36	6
Vermont	608	3,400	3,050	2,250	9,300	44,000	527	-13.4	21	4
Virginia	12,300	20,000	22,200	19,600	74,100	492,000	16,000	29.7	77	14
Washington	10,500	14,000	17,300	13,700	55,400	297,000	9,630	-8.1	38	9
West Virginia	2,240	4,180	5,190	4,800	16,400	73,900	2,580	15.3	65	9
Wisconsin	7,830	22,100	27,700	19,400	77,100	318,000	8,450	8.0	20	12
Wyoming	1,550	3,330	3,960	2,670	11,500	122,000	1,750	12.9	41	7
Other	XX	XX	XX	XX	11,500	90,300	XX	XX	XX	XX
Total	XX	XX	XX	XX	2,620,000	14,300,000	XX	XX	XX	XX

XX Not applicable.

[1]Quarterly totals shown are estimates based on a sample survey. Estimated quantities for prior quarters have been recalculated.

[2]Data may not add to totals shown because of independent rounding and differences between projected totals by States.

[3]Compared with the same period of the previous year, all percentage changes are calculated using unrounded totals.

[4]Number of companies reporting for the quarterly survey.

[5]State not included in quarterly survey.

[6]Owing to a low number of reporting companies, no production estimates by quarters were generated.

[7]To avoid disclosing proprietary data, certain State totals do not include all kinds of stone produced within the State;the portion not shown has been included with other.

Source: USGS. "USGS Minerals Information-Crushed Stone and Sand and Gravel" 10 July 2004. <http://minerals.usgs.gov/minerals/pubs/commodity/stone_crushed/csmis1q04.xls>

Appendix D

SAND AND GRAVEL (CONSTRUCTION) STATISTICS
By Kenneth E. Porter and Wallace P. Bolen
[All values in metric tons (t) unless otherwise noted]
Last modification: January 6, 2004

Year	Primary production	Imports	Exports	Apparent consumption	Unit value ($/t)	Unit value (98$/t)	World production
1900							
1901							
1902	452,000			452,000	0.71	13.30	
1903	747,000			747,000	0.80	14.50	
1904	5,280,000			5,280,000	0.47	8.50	
1905	16,400,000			16,400,000	0.45	8.14	
1906	24,400,000			24,400,000	0.35	6.33	
1907	32,100,000			32,100,000	0.31	5.41	
1908	30,000,000			30,000,000	0.34	6.15	
1909	49,000,000			49,000,000	0.30	5.42	
1910	56,900,000			56,900,000	0.29	5.06	
1911	53,700,000			53,700,000	0.30	5.24	
1912	53,800,000			53,800,000	0.33	5.56	
1913	65,100,000			65,100,000	0.29	4.77	
1914	65,500,000			65,500,000	0.29	4.71	
1915	61,800,000			61,800,000	0.30	4.82	
1916	71,800,000			71,800,000	0.32	4.78	
1917	60,400,000			60,400,000	0.42	5.34	
1918	47,000,000	503,000		47,500,000	0.54	5.84	
1919	56,300,000	542,000		56,900,000	0.62	5.84	
1920	64,800,000	1,110,000		65,900,000	0.76	6.18	
1921	67,300,000	823,000		68,100,000	0.73	6.65	
1922	78,100,000	409,000	162,000	78,300,000	0.68	6.61	
1923	117,000,000	431,000	250,000	117,000,000	0.65	6.21	
1924	132,000,000	630,000	142,000	133,000,000	0.64	6.10	
1925	145,000,000	481,000	193,000	146,000,000	0.65	6.05	
1926	155,000,000	852,000	193,000	156,000,000	0.63	5.81	
1927	169,000,000	658,000	191,000	169,000,000	0.61	5.73	
1928	179,000,000	675,000	334,000	180,000,000	0.58	5.52	
1929	190,000,000	1,510,000	221,000	191,000,000	0.62	5.90	
1930	171,000,000	1,640,000	147,000	173,000,000	0.62	6.05	
1931	134,000,000	350,000	98,800	134,000,000	0.60	6.42	
1932	105,000,000	169,000	43,600	105,000,000	0.51	6.09	
1933	93,000,000	85,500	37,400	93,100,000	0.51	6.42	
1934	100,000,000	100,000	15,200	100,000,000	0.54	6.58	
1935	106,000,000	114,000	17,000	106,000,000	0.50	5.94	
1936	153,000,000	295,000	22,600	154,000,000	0.52	6.12	
1937	162,000,000	438,000	30,500	163,000,000	0.52	5.90	
1938	159,000,000	605,000	16,100	159,000,000	0.50	5.79	
1939	197,000,000	229,000	12,600	197,000,000	0.49	5.75	
1940	207,000,000	399,000		207,000,000	0.47	5.47	
1941	249,000,000	388,000		249,000,000	0.52	5.76	
1942	262,000,000	503,000		262,000,000	0.64	6.41	
1943	197,000,000	348,000		197,000,000	0.66	6.22	
1944	161,000,000	251,000		161,000,000	0.63	5.84	
1945	163,000,000	253,000		163,000,000	0.66	5.98	
1946	216,000,000	314,000		216,000,000	0.68	5.68	
1947	245,000,000	431,000		245,000,000	0.77	5.62	
1948	274,000,000	385,000		275,000,000	0.82	5.55	
1949	277,000,000	383,000		277,000,000	0.80	5.47	
1950	320,000,000	396,000		321,000,000	0.82	5.55	
1951	346,000,000	426,000		347,000,000	0.85	5.34	
1952	379,000,000	367,000		380,000,000	0.84	5.16	
1953	383,000,000	363,000		383,000,000	0.87	5.30	
1954	490,000,000	248,000		490,000,000	0.94	5.70	
1955	519,000,000	290,000		519,000,000	0.94	5.72	
1956	548,000,000	301,000		549,000,000	0.98	5.88	
1957	556,000,000	277,000		556,000,000	0.98	5.68	
1958	607,000,000	295,000		607,000,000	1.00	5.64	
1959	645,000,000	409,000		645,000,000	1.04	5.82	
1960	627,000,000	347,000		628,000,000	1.06	5.83	
1961	666,000,000	343,000		666,000,000	1.04	5.67	
1962	686,000,000	306,000		687,000,000	1.06	5.71	
1963	726,000,000	306,000	907,000	726,000,000	1.07	5.70	
1964	767,000,000	402,000	1,250,000	766,000,000	1.07	5.62	
1965	801,000,000	615,000	1,360,000	800,000,000	1.09	5.63	
1966	824,000,000	572,000	2,110,000	824,000,000	1.09	5.47	
1967	800,000,000	534,000	2,170,000	798,000,000	1.12	5.47	
1968	808,000,000	661,000	2,130,000	806,000,000	1.15	5.39	6,090,000,000

Sand and Gravel (Construction) Worksheet Notes

Data Sources

The sources of data for the construction sand and gravel worksheet are the mineral statistics publications of the U.S. Bureau of Mines and the U.S. Geological Survey—Minerals Yearbook (MYB) and its predecessor, Mineral Resources of the United States (MR), and Mineral Commodity Summaries (MCS) and its predecessor, Commodity Data Summaries (CDS). The years of publication and corresponding years of data coverage are listed in the References section below. Blank cells in the worksheet indicate that data were not available.

Primary Production

U.S. production data collection and reporting did not start for construction sand and gravel until 1902. Before 1902, sand was included with stone and included only silica sand for glass making. Construction and industrial sand and gravel production were reported together in the salient statistics table in the MR and the MYB through 1958, and were split between "commercial" and "government" (State, county, municipalities, and Federal). Categories were split between construction and industrial according to the following guidelines: Construction sand included building, paving, railroad ballast, and other (excluding ground sand). The reporting of gravel production prior to 1959 did not indicate any industrial applications, therefore the assumption is made that all gravel production data were for construction applications. After 1958, some gravel was used for industrial applications, such as filtration, ferrosilicon, and nonmetallic flux for sulfur production. Industrial sand includes sand for glass, molding, grinding and polishing (also blast sand), fire or furnace, engine, and filter (ground sand is included in the "other" category and is separated out for inclusion with industrial). Construction and industrial sand and gravel statistics were reported separately in a combined chapter starting with the 1959 MYB and later in separate chapters starting with the 1988 MYB.

Imports

U.S. import data for construction sand and gravel were reported in tables starting with the 1922 MR and continue to be reported in the MYB and the MCS.

Exports

Export data for combined sand and gravel (construction) and sand and gravel (industrial) were reported in the foreign trade section text starting with the 1922 MR and continuing in the MYB through 1939. Construction and industrial sand and gravel export data were split 50:50 for the years 1922–39 based on the average for the years 1971–2001 when more complete export data were available.

Sand and gravel (construction) export data were not available for the years 1940–62.

Export data for the years 1963–2001 are from the CDS, the MCS, and the MYB.

Apparent Consumption

Apparent consumption is defined as follows:

APPARENT CONSUMPTION = PRIMARY PRODUCTION + IMPORTS – EXPORTS.

Export data are not available for the years 1940–62 and are not included for the purpose of estimating apparent consumption. Import and export data have very little effect on apparent consumption because of their relative insignificance compared to primary production. The net imports account for less than 0.2% of primary production for the years 1940–2001.

Unit Value ($/t)

Unit values were estimated by summing the values for different types of sand and gravel (construction) and dividing by total primary production quantity. Imports and exports were not considered in determining unit value because quantities are insignificant compared to primary production and values were not available. Data for quantities and values from which unit values are estimated are from the MR and the MYB.

Unit Value (98$/t)

The Consumer Price Index conversion factor, with 1998 as the base year, is used to adjust unit value in current U.S. dollars to the unit value in constant 1998 U.S. dollars.

World Production

World production data for sand and gravel (construction) are not available for most of the period from 1900 through 2001 owing to the lack of data collection by many of the producing countries. World production data are available for the years 1969–72, 1974, and 1975 from the MCS.

References

U.S. Bureau of Mines, 1927–34, Mineral Resources of the United States, 1924–31.

U.S. Bureau of Mines, 1933–96, Minerals Yearbook, 1932–94.

U.S. Bureau of Mines, 1962–77, Commodity Data Summaries, 1962–77.

U.S. Bureau of Mines, 1978–95, Mineral Commodity Summaries, 1978–95.

U.S. Geological Survey, 1901–27, Mineral Resources of the United States, 1900–23.

U.S. Geological Survey, 1997–2003, Mineral Commodity Summaries, 1997–2003.

U.S. Geological Survey, 1997–2003, Minerals Yearbook, v. I, 1995–2001.

U.S. Geological Survey and U.S. Bureau of Mines, 1996, Mineral Commodity Summaries, 1996.

Source: Porter, Kenneth E., and Bolen, Wallace P., USGS. "Mineral Statistics and Information from the USGS". 9 April, 2004 <http://minerals.usgs.gov/minerals/pubs/of01-006/sandandgravelcon.xls>

Appendix E

Source: Livingston County Department of Planning. (1996). Open Space Planning. Livingston County Department of Planning.

Article 0.0
Open Space Community District

Definition

The grouping of single family homes onto part of a parcel, with the remaining acreage preserved as open lands. Open space developments emphasize the preservation of natural environment as a basis for grouping of dwellings. Homes are separated from adjacent property or other groupings of dwellings by the substantial open space that is permanently protected from development.

Section .001 Purpose

The intent of the Open Space Community Overlay District is to permit residential development that results in an enhanced living environment through the preservation of agriculture, environment, and rural landscape. The provisions set forth encourage innovative and liveable housing environments within residential districts through both permanent dedication of open space and a planned reduction of individual lot area requirements. The overall density remains the same as would be found in a traditional development in the underlying zone.

Increasing suburban development of rural areas has produced a need for more environmentally sensitive and cost efficient single family development. The Open Space Community Overlay District meets this need as dwelling units are grouped onto part of the parcel so the remaining acreage can be preserved as open lands.

The following provisions are intended to result in residential development which is consistent with zoning ordinance standards, yet allows for modifications from the general standards to insure appropriate, fair and consistent decision making.

Section .002 Objectives

The following objectives shall be considered in the review of any application for an Open Space Community Zoning District development.

A. To provide a more environmentally sensitive residential environment by preserving the natural character of open fields, stands of trees, ponds, streams, hills and similar natural features.

B. To preserve the rural landscape and protect environmentally sensitive lands from the disruptive effects of traditional subdivision developments.

C. To provide a more efficient and aesthetic use of open space by allowing developers to reduce lot sizes while maintaining the residential density required in the underlying zoning district.

D. To allow a more flexible and economical residential layout and street design.

E. To assure the permanent preservation of open space, rural lands and natural resources.

Recommended Revisions

Section 002 Objectives

A. Change "*preserving*" to "**conserving**" – Natural systems cannot be preserved. They are constantly changing systems and infinitely complex. Conservation is the term which would apply best, managed care with minimized impacts.

B. Change "preserve" to "**conserve**"

F. (Add objective) – **Recognize that construction aggregate materials are essential for societal sustainability and therefore plan and allow for future extraction of construction aggregate resources when doing so would not compromise or degrade other critical natural resources.**

Section .003. Establishment of Overlay District

The Open Space Community Districts are herein established as overlay districts. The Open Space Community Districts are described on the Township zoning map as open space protection districts within the single family residential zones. This district includes open space lands of state and local significance. Determination of open space significance is based upon a combination of factors including soil type, topography, existing vegetation and habitat, historic use of land, size of parcel, use of land for agricultural purposes and character of the surrounding area.

Section .004 Principal Permitted Uses

A. All types of attached and detached single family residential dwellings are permitted. Attached dwellings shall number no more than twenty five (25) percent of the total number of dwellings and shall not exceed four (4) dwelling units in one building.

B. Agriculture, horticulture or floriculture excluding farm based agribusiness and intensive livestock raising operations, stables, or veterinary hospitals or clinics.

C. Accessory uses and buildings incidental to the principal permitted uses including recreational activities which are passive and occur on common open space lands only.

Section .005. Site Location Principles

The following general principles shall be utilized to evaluate the proposed location of any open space community development within a permitted district. These principles shall be applied by the Planning Commission as a general guideline to help assess the impact of the development.

A. Protecting Natural Features. The purpose of an open space community is to maintain the rural, natural and scenic qualities of the Township. Toward this end, all open space community developments shall be designed to promote the preservation of natural features. Significant wildlife habitats, sensitive environmental lands and scenic vistas are to be protected.

B. Single Ownership Control. The proposed development in the Open Space Community District shall be under single ownership or control, such that a single person or entity has proprietary responsibility for the completion of the development. The applicant shall provide documentation of ownership or control in the form of agreements, contracts, covenants and/or deed restrictions that indicate the development will be completed as proposed.

C. Access to Public Roadway. Open space community developments shall have one property line abutting a public roadway. All entrances and exits shall be directly onto or from said roadway.

Recommended Revisions

Section 003 Establishment of Overlay District
(Text revision) – Determination of open space significance is based upon a combination of factors including soil type, **geology**, topography, existing vegetation and habitat, historic use of land, size of parcel, use of land for agricultural purposes, **use of land for aggregate mining**, and character of the surrounding area.

Section 005 Site Location Principles

A. Change *"preservation"* to "**conservation**" and add *"..natural features*, **planned extraction of aggregate resources where possible**, significant wildlife habitats.."

Section 006 Development Requirements

A. Density Standards

1. The total number of dwelling units permitted in an open space community development shall be determined by submittal of a conventional subdivision plan identifying the lots and buildable lands. After Planning Commission review of the conventional subdivision plan, the maximum number of lots for the open space community development will be determined. In no case shall the maximum residential density specified for the zoning district in which the development is located be increased.

2. Lots not served by a public or common sanitary sewer shall be at least 30,000 square feet in area. Lots served by public or common sanitary sewers or served by a common public water well system shall have a minimum lot area of 15,000 square feet.

3. Lots may vary in size but in no case shall they consume, on average, more than two (2) acres per dwelling including roads.

4. Dwelling units shall be grouped so that open space within a development is at least fifty (50) percent of the total area of buildable land. (May require revision if alternative approaches for density standards or wetland credits are adopted.)

5. No more than ten (10) dwelling units per cluster shall be permitted within a development.

B. Open Space Standards

1. Areas Not Considered Open Space. The following areas shall not be calculated as dedicated open space:

a. Open space shall not include areas devoted to public or private streets or rights-of-way or any land that has been or is to be conveyed to a public agency.

b. Any area devoted to natural or improved flood control channels, or those areas encumbered by floodway or county drain easements.

c. All area in surface water bodies or wetlands shall not be considered dedicated open space.

2. Calculating Open Space. Except as noted above, any undeveloped land area within the boundaries of the parcel may be included as required open space.

C. Use Of Open Space. All land within a development that is not devoted to a residential unit, an accessory use, vehicle access, vehicle parking, a roadway, an approved land improvement, or is not considered open space as defined above shall be considered dedicated open space and shall be set aside as common land for recreation, conservation, agricultural uses, or preserved in an undeveloped state. Further subdivision of open space lands, or their use for other than recreation, conservation or agriculture shall be prohibited.

D. Preservation Of Open Space. Open space shall be set aside by the developer through an irrevocable conveyance that is acceptable to the Planning Commission. Forms of dedicating open space may include:

1. A recorded deed restriction,

Recommended Revisions

B. Open Space Standards

1.

c. Change "*All area*" to "**75% of area, 50% of (if created)** " in surface water…

Not allowing any consideration of submerged areas devalues them. This is especially true if an aggregate operation proposes creation of lakes or wetlands as part of their plan.

2. Covenants that run perpetually with the land, or

3. A conservation easement established per Public Act 197 of 1980, as amended.

Such conveyance shall assure that the open space will be protected from all forms of development, except as shown on an approved site plan, and shall never be changed to another use. Such conveyance shall:

1. Indicate the proposed allowable use(s) of the dedicated open space.

2. Require that the dedicated open space be maintained by parties who have an ownership interest in the open space.

3. Provide standards for scheduled maintenance of the open space.

4. Provide for maintenance to be undertaken by the Township in the event that the dedicated open space is inadequately maintained, or is determined by the Township to a public nuisance, with the assessment of cost upon the property owners.

E. Structures Built in Open Space Areas. Any structure(s) or building(s) accessory to recreation, conservation or agriculture may be erected within the dedicated open space, subject to the approved open space plan. These accessory structure(s) or buildings shall not exceed, in the aggregate, one (1) percent of the required open space area.

F. Access To Open Space. Open space intended for recreation or use by the residents shall be easily accessible to pedestrians. Accessibility shall meet the needs of the handicapped and older citizens.

Section 007 Design Standards

A. Location of Lots

1. Residential lots shall be laid out, to the greatest extent feasible, to achieve the following objectives:

a. On the most suitable soils for subsurface septic disposal.

b. Within a woodland contained in the parcel or along the far edge of open fields adjacent to any woodland.

c. In locations least likely to block or interrupt scenic vistas, as seen from public roadway(s).

B. Setbacks. The following design parameters will be used to establish setbacks.

1. Front, rear and side yard setbacks may be staggered to provide for maximum variety in the size of such yards.

2. The minimum distance between dwellings shall be sixty (60) feet.

3. Maximum possible rear yards onto open space shall be provided.

4. Dwelling placement shall be as far as possible from open space.

Recommended Revisions

None needed.

C. Lot Width. Eighty (80) feet as measured from the front building line.

D. Open Space Between Clusters. Open spaces between clusters, including those spaces used as recreation areas, shall be at least one hundred (100) feet wide and shall be protected with an irrevocable conveyance that is found acceptable to the Planning Commission.

E. Landscaping and Buffering.

1. Buffer zones at least one hundred (100) feet in width shall be required between residential and agricultural areas and shall be planted with fast growing native shrubs and trees to create an effective barrier separating yards from fields and pastures.

2. Landscaped or natural vegetative cover shall provide a screened buffer between dwellings and neighboring properties.

F. Dwelling Placement. Dwelling units shall be carefully located and designed in accordance with community plans, inventories and mapping in order to avoid conflicts with neighboring land uses. Dwelling placement shall be planned to screen homes from off-site vantage points, away from environmentally sensitive areas, existing agricultural uses, sites suitable for open space and upwind from areas subject to land management practices that will cause dust, noise, smoke, odors or similar problems.

G. Natural Features Preservation. The development shall be designed to promote the preservation of natural features. Individual lots, buildings, streets and parking areas shall be designed and situated to minimize alteration of the natural environment.

H. Compatibility With Adjacent Land Uses. Individual lots, buildings, and units shall be arranged and situated to relate to surrounding properties, to improve the view from public roadways and to blend into the existing natural landscape.

I. Preserving Rural Character. The design of open space should show consideration for the character of the open space reserve. Wildlife habitats shall be preserved by leaving open space in single blocks of land. Prime agriculture and woodlands shall be preserved in such a way to ensure continuing feasibility of agriculture and forestry.

J. Vehicular and Open Space Access. Cluster home sites shall provide vehicular access from an interior common area. The interior common area shall be connected to the common open space system by an open space corridor.

K. Waterway and Wetlands Buffering. All dwellings, accessory structures and roadways shall be no less than one hundred (100) feet from lakes, ponds, streams and wetlands. The one hundred (100) foot area shall be part of the dedicated open space and shall not be in private ownership.

L. Preserving Roadway Frontage. All dwellings and accessory structures shall be no less than one hundred (100) feet from the edge of the major arterial and that one hundred (100) foot area shall be maintained in native plants and trees so as to create a buffer between the roadway and the development.

Recommended Revisions

E. Landscaping and Buffering

3. **Landscaped Berms should be required between any active aggregate mining operation and proposed dwellings on-site and neighboring properties to screen the operation and provide a noise buffer. A minimum distance of 100 should be maintained from active mining and the berms.**

G. Change "*Preservation*" to "**Conservation**" as needed.

I. Change "*Preserving*" to "**Conserving**" and "*preserved* "to "**conserved**" as needed.

Section . 008 . Roadway Standards

A. Access. Open space community developments shall have direct access to a public roadway. Any entrance or exit drive shall be located no closer than two hundred (200) feet from any existing street or road intersection as measured from the nearest right-of-way line.

B. Internal Roads.

1. Construction of private roads or private access drives as a means of providing access and circulation is encouraged. Private roadways within an open space community are exempted from the design requirements of the Township Private Road Ordinance, if the following findings are made by the Planning Commission.

a. A deed restriction is placed on the project site that perpetually vests fee simple of the land area in the parties adjoining the road and prohibits future transfer to the public, prohibits future lot splits; and

b. A maintenance plan, including a means of guaranteeing maintenance assessments from the affected property owners, is reviewed and approved by the Township Planning Commission.

Section . 009 . Open Space Community Standards

In considering any application for approval of an Open Space Community site plan, the Planning Commission shall make their determination on the basis of the standards for site plan approval set forth in Article ___, as well as the following standards and requirements.

A. The overall design and land use proposed in connection with the open space community development shall be consistent with the Open Space Community District objectives in Section 2, as well as with specific development requirements and standards set forth herein.

B. An open space community site plan shall set forth in detail specifications with respect to height, setback, density, parking, circulation, landscaping, views and other design features that illustrate the relationship of the proposed development to surrounding properties, the character of the parcel, and the land uses. In determining whether this requirement has been met, consideration shall be given to:

1. The bulk and placement of proposed structures.

2. Vehicular and pedestrian circulation.

3. Location and screening of proposed dwelling units from neighboring property.

4. Provision of landscaping and other site amenities.

C. The usefulness of open space intended for recreation, conservation or agricultural purposes shall be determined by the size, shape, topographic and location requirements of the particular purpose proposed for the parcel.

D. Open space shall include irreplaceable natural features located on the parcel, such as but not limited to stream beds, significant stands of trees, and individual trees of significant size.

E. The suitability of open space intended for scenic value purposes shall be determined by its visibility from a significant number of units or buildings.

F. Diversity and originality in lot layout and individual building design shall be encouraged to achieve the best possible relationship between development and the land.

Recommended Revisions
None required.