Central Minnesota Sustainable Development Plan

MAPPING THE PROCESS

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Outline:

1. **Problem description**
   Geographic Information Systems (GIS) was used for two discrete purposes in the project: presentation and analysis. For the former, a series of maps was created to visualize aspects of sustainability planning, especially when several scenarios were compared. For the latter, various geographic data was obtained and analysis performed to derive results on key sustainability issues identified.

2. **Investigation**
   - **a.** Modeling process (Scenarios, Working Groups; 22 Key Issues; model – variables, change/scenario, relationships, weighting)
   - **b.** Testing model: challenges (generalization and simplification, discarding complex maps (expert group, preparing for public presentation, realizing it is **too complex**, deriving 9 key issues spread across working groups (with help of experts, Kathy, core consultant group).
   - **c.** Key issues described: (software, data, calculations, output)

Identification of key issues and Development of Four Scenarios

The project was formed to address sustainability planning around four working groups composed of experts and community members which were created to guide the modeling process as it relates to land use, housing, economic development and transportation. In early stages, these groups consolidated a list of 27 key issues to be addressed (appendix A, “Region Five Sustainability Project Key Issues Overview”)[1]. The issues identified covered a very wide aspect of planning domains with a significant degree of interrelation, for example infrastructure, employment, public transit and affordable housing.

[1] Key Issues 3

With the object of envisioning the region in 2035, a scenario approach was adopted. Four scenarios were developed, with a narrative description characterizing each: abundance, bootstrap, current trends and doomsday (conveniently referred to as A, B, C and D) (appendix B). Scenario planning is a technique used by businesses, communities, and the military which focuses on using today's decisions to reach a desired, plausible future. By adopting this planning strategy community members were able to choose their preferred future, incorporating land use, economic, demographic, natural resource, transportation, and housing aspects. The envisioning process, to be driven by community members, was to be done through presenting all key issues under each of the scenarios so that community members may opt for the best fitting planning scenario.

After creating a profile of the region based on current trends, the work groups/consortium described the following four scenarios:

The abundance scenario is characterized by a healthy natural environment, diverse cost- and energy-efficient transportation options, increased government revenue without increasing taxes, and well-funded education. The region benefits from a strong, diversified economy, employment opportunities, excellent medical care, and many affordable housing options.

The bootstrap scenario envisions a strong, self-reliant, and efficient region. The economy focuses on producing and keeping resources—food, energy, etc.—in the region, and governments are forced to collaborate due to decreased funding. The health care system is competitive, the transportation system is effective and efficient, and neighborhoods are mixed-use and multigenerational. The region lives within its means but still meets the needs of its residents and manages to grow sustainably.

The third scenario is current trends and focuses on what happens if the region continues on the path it is on. The economy is slightly more diversified, with a growing health care sector to accommodate the growing number of retirees. The transportation system is maintained but does not expand, and water quality continues to deteriorate because land use regulations have not changed. Schools are forced to consolidate and energy costs are inconsistent, but on the rise.

The final scenario, doomsday, is reminiscent of the Great Depression of the 1930s. An extreme dustbowl-like climate has settled over Minnesota, drying up the region's lakes and wetlands. Government resources are virtually non-existent and population has plummeted. Fuel is rationed and people must rely on their survival skills.

An initial attempt to model all key issues under the four scenarios, including the interrelations between the issues, took place early in the year. A meeting of experts was called, in which the project aimed to develop model parameters such as appropriate variables for each key issue, a change factor per variable for each of the scenarios, identification of other issues that impact the variable, and determination of their impact weight (see figure 1).

Key Issue	Change details	Scenario Change Factor				Variable	Type	Timeframe	Current Value
		A	B	C	D				
LU5a. Healthy lakes	Chang in water quality	0.5	0.8	1	1.2	Impaired waters (Sq. Km)	Internal: dependent (Outcome)	Long	910.3
Impacting variable:									
ED3b.Sewer and water	Funds for maintenance/replacement (water and sewerage)	2	1.1	1	0.3	% properties served	Internal: independent	long	

Impact weight	Weighted Value			
	A	B	C	D
-0.2	**364.1**	**713.7**	**910.3**	**1245.3**

Figure 1 : Sample parameters for the key issue of aging population[2]

[2] In this example, the variable of "impaired waters (area)" is determined for the key issue of healthy lakes (land use working group). The current extent of impaired water in the region is 910.3 sq. Km, which informs the change factor of "1" for scenario C (current trends) (assuming no change for this scenario). Change factors are determined for the other scenarios: 0.5 for A (abundance), 0.8 for B (bootstrap) and 1.2 for D (doomsday).[2] This variable is considered internal, i.e. dependent on regional policy choices, with a long timeframe. Subsequently, an impacting variable is determined: percentage of properties served by sewer. (This variable, too, has its own change factor per scenario). It is assigned the impact weight of negative 0.2 reflecting the expected improvement in water impairment with increased wastewater treatment.
The final, weighted value of the variable is calculated as:
([Current Value] * [Scenario Change Factor]) + ([Current Value] * [Scenario Change Factor]) * [Scenario Change Factor for Impacting Variable] * [Impact Weight]

The outcome of the experts meeting made clear, however, that this modeling approach is overly complicated. The group was unable to provide effective input on most of the variables, and discussions led to an increased level of complexity and detail rather than the desired generalizations. The concern was not only that the groups would be unable to provide the parameters needed for the envisioned model, but also that the resulting complexity would burden the community consultation process and deprive the project of its main tenet.

In consultation with the core team of experts, core group of consultants and project director, a limited set of key issues was selected to be addressed. It includes the following:

1. Population and aging
2. Housing – affordability
3. Health care
4. Education
5. Natural resources (water and public space)
6. Economy – livable wage / Poverty rate
7. Land use – growth patterns
8. Transportation - mobility
9. Broadband

With this more manageable list of key issues, the project proceeded to prepare planning scenarios for the community consultation process. A variable was defined for each key issue (for example, the variable of "percent of the population over 65" describes the key issue of aging population). Further, for every key issue, a change factor was derived in consultation with the core team of consultants for each scenario. Each of the (final) key issues was illustrated conveying expected changes per scenario for the community consultation process. Participants were required to select the 2035 reality they choose to plan for by voting for a scenario for each key issue.

Scenarios per key issues were created and illustrated using GIS software (Esri ArcMAP suite) as well as Microsoft Excel. While some key issues required simple calculations and graphic representations of alternative scenario outcomes, others required more extensive geographic analysis. Initially, maps were produced showing variations by county or lower units of analysis such as census blocks. For simplification purposes, however, most of the maps that were shared with the public presented the entire five-county region as a single unit for quantitative data, showing variation across scenarios but not within the region.

Process and data sources for each key issue are outlined below, including:

- Variable used to describe changes in key issue
- Data and data source
- Mapping methodology
- Change factor per scenario
- Results

Below is a description of the mapping process for each key issue.

1. Population and aging

Variable: Percentage of the population over 65.

Mapping methodology: A time enabled map was created using ArcMAP 10, showing the variable using color gradation in 5-year intervals per scenario. The extent of the aging process predicted (generally) in the US is effectively presented in a time series map, though that requires computer presentation. Only the 2035 map was presented to the community, in comparison with the 2010 data.

Data sources: A table produced by the Minnesota State Demographic Center, titled "ProjectionsAgeGender2005-2035".[3] This is a population projection based on data prior to the 2010 census, so the 2010 population figures diverge somewhat from most accurate data available. This was not corrected however because the entire projection was based on that data and a more recent projection is not available at the time of writing.

Scenario change factor: The table below shows the projected percentage for each county for 2010 and for 2035 (under C value[4]). Change factor per scenario reflects outmigration of working age population from the region for scenario D, and a slightly increased retention of such age population under scenario B with no change in scenario A. Percentage was multiplied with projected population per county and the weighted percentage for the entire region presented in the map “Central Minnesota: Aging Population 2035” (appendix C).

Figure 2

		A value	B value	C value	D value
Change factor:	2010	**1**	**0.9**	**1**	**1.5**
Cass County	18.7%	30.33%	27.30%	30.33%	45.49%
Crow Wing County	17.0%	28.93%	26.04%	28.93%	43.40%
Morrison County	15.2%	26.50%	23.85%	26.50%	39.75%
Todd County	16.3%	26.33%	23.70%	26.33%	39.50%
Wadena County	21.7%	35.30%	31.77%	35.30%	52.95%

[3] http://www.demography.state.mn.us/resource.html?Id=19169
[4] C = ”Current Trends”

2. Housing (affordability)

The project's work on housing affordability was extensive. As a base, the extent of regional need for affordable housing was mapped with the variable of "percentage of lower-income households spending 30% or more of income on Housing". In subsequent analysis and modeling, additional variables were used including commute time, employment, population and existing housing. These are detailed in the affordability modeling description.

A. Need for affordable housing

Variable: Percentage of Lower-Income Households Spending 30% or More of Income on Housing

Mapping methodology: The 2011 Affordable Housing Need map represents the data in the table based using a graduate color scheme whereby darker colors stand for higher need (i.e. a greater percentage of the population spending 30% or more of income on housing). Note that areal units are census tracts and not counties, unlike most other datasets used for the project. This created some challenges for analysis when combined with other variables, see discussion on housing affordability modeling.

Data sources: That data, which was available at a census tract unit, represents the "Percentage of Lower-Income Households Spending 30% or More of Income on Housing".[5] The option of including commute cost in the base data on housing affordability was considered, but rejected as that variable was included in other ways in the affordability modeling process.

Scenario change factor: The table below shows the projected percentage of lower-income households spending 30% or more of income on Housing for each county for 2011 and for 2035 under each scenario (a mean value was derived for census tracts in each county). Current trends scenario retained 2011 values, the abundance scenario saw the need declined in half, bootstrap scenario saw need declined to 70 percent, whereby doomsday scenario saw the need for affordable housing double.

Figure 3

		A value	B value	C value	D value
Change factor:	2011	0.5	0.7	1	2
Cass County	43.9%	21.96%	30.75%	43.92%	87.85%
Crow Wing County	50.2%	25.09%	35.13%	50.19%	100.00%
Morrison County	48.7%	24.37%	34.12%	48.75%	97.50%
Todd County	47.0%	23.51%	32.92%	47.03%	94.05%
Wadena County	45.5%	22.75%	31.85%	45.50%	91.01%

[5] Data: table in file mhfa_010999_MNHousingData, attribute: "COSTBALL".

B. Location-allocation model

A model process was derived using ArcGIS Model Builder to assist decision makers in determining where to prioritize development of affordable housing units in the region. The model takes data on need for affordable housing, commute times, employment, population and available affordable housing units, along with data on the number of affordable housing units desired for the region. Bringing together the variables of need and of jobs, it ranks each of the communities in the region that has a population higher than 500, multiplies its rank by the population size and provides the number of housing units desired for that community.

Some useful features of this model are its determination of employment opportunities for each community, based on the number of jobs within a 20-minute commute, and its flexibility in allowing the user to decide the importance of each variable in relation to the other by specifying "weights" for both need and jobs variables. This provides different results that depend on policy preferences.

A detailed description of the model is presented in appendix D.

3. Health Care

Variable: Number of Licensed Physicians and Nurse Practitioners (primary care practitioners) per 1,000 people.

Mapping methodology: Two maps were produced for the health care component of the project. The first, a graduated color choropleth map, represents the level of health care services available to residents of the region according to a calculation of the number of primary care physicians per 1,000 people, and the second depicts existing hospitals and clinics in the region.

Data sources: Data on the number of those was obtained by personal communication with Angie Sechler, research analyst at the Minnesota Office of Rural Health & Primary Care, in October 2011.

Scenario change factor: The table below shows the projected number of primary care practitioners per 1,000 people for each county, per scenario. It also shows the total number for the whole region. Assumptions for scenario change were as follows: an increase of 20 percent from current trends for the abundance scenario, an increase of 10 percent for the bootstrap scenario, and a 50 percent decline for the doomsday scenario.

Figure 4

	A value	B value	C value	D value
Change factor:	1.2	1.1	1	0.5
Cass County	1.05	0.96	0.88	0.44
Crow Wing County	3.26	2.99	2.72	1.36
Morrison County	1.01	0.93	0.84	0.42
Todd County	1.16	1.06	0.96	0.48
Wadena County	1.47	1.35	1.23	0.61
Total average:	**1.94**	**1.78**	**1.62**	**0.81**

Including Nurse Practitioners, weighted for population.

4. Education

Variable: Percentage persons 25 years and over with bachelor's degree or higher 2005-2009

Data: U.S. Census Bureau-American Community Survey, 2005-09

Mapping methodology: A graduated color choropleth map representing the percentage of persons 25 years and over with bachelor's degree or higher for the time period available. Change factors per scenario were applied, resulting in four maps for comparison.

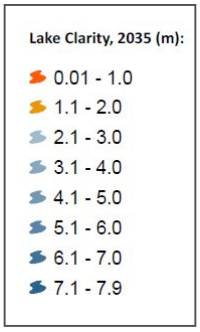
Figure 5

		A value	B value	C value	D value
Change factor:	2005-09	2	1.2	1	0.5
Cass County	21.3	42.6	25.6	21.3	10.7
Crow Wing County	21.9	43.8	26.3	21.9	11.0
Morrison County	14.1	28.2	16.9	14.1	7.1
Todd County	12.0	24	14.4	12	6
Wadena County	15.1	30.2	18.1	15.1	7.6

Comments: "Current trends" projections are not expected to be different than today.

5. Natural resources (water)

Variable: Lake Clarity. Initially, the variable of *Impaired Waters* was considered, but it proved less useful for representation of lake health for several reasons. First, only about 40% of lakes in Minnesota are tested for impairment. Second, impairment is often due to factors that cannot be substantially altered in the timeframe of this projection, for example mercury concentrations in lakes, and is thus a less useful parameter for scenario projection. Further, it is difficult to define gradation in the extent of impairment. Another variable that was considered invasive species, but it was considered not sufficiently representative of lake health.



The availability of time series data on lake clarity across Minnesota, which is based on satellite imagery classification, provided very large coverage with data on most lakes in the region. Lake clarity is an intuitive representation of lake health, and the data further allows for trend analysis which was useful for the purpose of scenario development.

Data source: Data was provided by Prof. Marvin Bauer from the University of Minnesota, and is the result of a long term study by the University's Remote Sensing and Geospatial Analysis Laboratory. It includes a dataset that covers the entire region from 1975 through 2008, using late summer Landsat images. [6]

Mapping methodology: Five maps were produced – one for current state (based on 2005/2008 data), and one for each scenario. All lakes were represented with a color scheme ranging from red through light to dark blue for lake clarity in meters.

[6] Background information and documentation for Landsat monitoring of lake water clarity can be accessed at www.water.umn.edu, and is described in "A 20-year Landsat Water Clarity Census of Minnesota's 10,000 Lakes."

Analysis:

Current trends calculation:

a. 1985[7] values are subtracted from 2008 values
b. Result is divided by 23 to obtain annual change
c. 2035 values are projected as the sum of : 2008 value + (annual change * 27[8])
d. (For lakes that have no 2008 value, a corresponding analysis was performed based on 2005 values. Lakes that had neither, or had no 1985 value were omitted).
e. Lakes that resulted in a negative value (suggesting unrealistic projection, scoring badly on clarity) were manually changed to 0.1.
f. Similarly, some very high clarity values also suggest unrealistic projection. Given the maximum clarity value of 8 meters in 2005-8, all higher values were manually set to 7.9.

Scenario change factor:

Change factor of lake clarity per scenario is somewhat complex. Current trends was derived according to the calculation above. Scenario D shows substantial improvement in lake clarity given spread of population centers and low levels of polluting activity overall. Scenario A has a change factor of 1.1, reflecting greater investment in pollution prevention infrastructure, and scenario B is divided: lakes located close to population centers, or ones designated as "general development" or "Recreational development" by the MN DNR, fare worse (0.7), but all other lakes fare better (1.3). Determination of proximity to population centers is a 5-mile buffer around centers with population greater than 1,000.

In addition, based on a determination by the project's core group, results were modified so that:

a. In scenario B, 60% of the lakes that show declining values were set to no change from today's values; and
b. In scenario A, 75% of the lakes that show declining values were set to no change from today's values.

In each case, projected values for lakes with the least projected decline relative to current values were manually set to current values. The following table shows results as change trend in lake clarity for all lakes in the region:

Figure 6

	A value	B value	C value	D value
Decline	132	306	665	368
Increase	736	492	591	895
No change	395	465	7	0

[7] According to data providers, 1975 values are less reliable than those of 1985.
[8] 2035-2008=27

6. Economy – livable wage

Variable: Poverty percent, all ages

Data source: U.S. Census Bureau, Small Area Estimates Branch; 2009 Poverty and Median Income Estimates – Counties

Mapping methodology: A graduated color choropleth map representing poverty percentage for the time period available. Change factors per scenario were applied, resulting in four maps for comparison.

Figure 7

		A value	B value	C value	D value
Change factor:	2009	0.5	0.9	1	2
Cass County	14.0%	7.00%	12.60%	14.00%	28.00%
Crow Wing County	14.3%	7.15%	12.87%	14.30%	28.60%
Morrison County	13.7%	6.85%	12.33%	13.70%	27.40%
Todd County	14.7%	7.35%	13.23%	14.70%	29.40%
Wadena County	16.0%	8.00%	14.40%	16.00%	32.00%

Comment: "Current trends" projections are not expected to be different than today.

7. Land use – growth patterns

An initial attempt was made to derive an accurate map of current distribution of population based on counties' parcel data. Unfortunately, not all counties had such data in GIS format and an alternative way was sought. Current distribution of population was mapped using 2010 census figures, using a dot density map per census block whereby each dot stands for 10 persons. However, creating a scenario representation of divergent growth patterns required particular creativity. This work aimed to provide the audience with a sense of what things might look like in each scenario, rather than data derived calculations.

Data source: The current extent of large population centers was manually digitized based on Bing aerial image. Polygons were created for population centers larger than 1,000. MN DoT roads layer was also used.

Mapping methodology: Manually created and edited polygons for centers of population to represent growth patterns for each of the scenarios.

Scenario change factors:

Abundance: Growth concentrates around lakes, in particular ones classified for "general development" by the MN DNR. Points were digitized around such lakes representing development. In addition, large and small communities were buffered to represent growth compared with today's extent of development.

Bootstrap: Growth concentrates in large centers of population at the expense of smaller ones. Population centers larger than 1,000 were left in-tact, whereas communities with a population of 500-1,000 were symbolized with a point and smaller communities were not symbolized at all. The road network was highlighted to represent strong interdependence and trade.

Current trends: Growth continues along the line of current development. Population centers over 1,000 were buffered by 250 meters; communities with population between 500-1,000 are represented with a point, which was buffered by 1,000 meters while communities with population of 100-500 were buffered by 500 meters and ones with population under 100 were buffered by 300 meters.

Doomsday: This scenario is characterized by a declining roads network and dispersion of population from large communities to many isolated settlements. Small communities that are dispersed throughout the area, especially in agricultural areas, were represented by points that were digitized manually in the region.

8. Transportation - mobility

Variable: Extent and significance of roads and public transit.

Data: MN DoT, 2002 (roads network); MN DoT, Office of Transit, 2011 (existing transit)

Mapping methodology: Manipulated graphic representation of existing roads network was used to indicate the relative importance of different transportation alternatives. Segments of roads and transit routes were manually deleted or digitized to represent future scenarios.

Scenario change factors:

Abundance: All roads are maintained, with new transit routes available.

Bootstrap: Highways are highlighted at the expense of county roads representing the relative importance of trade routes and strapped financing for local infrastructure. Transit routes are expanded however.

Current trends: Several county roads are decommissioned, transit routes remain limited.

Doomsday: Many county roads are decommissioned but the network of local roads is more dominant than that of state and federal highways representing relative little mobility. No transit routes are available.

9. Broadband

Variable: Percentage of households served, number of unserved households and investment gap per county

Data source: National Telecommunications and Information Administration (NTIA), 2011.

Mapping methodology: A graduated color choropleth map representing the percentage of households served by broadband per county, and textual reference to other variables

Scenario change: This key issue was not discussed in terms of scenario change for 2035, given the uncertainty about the relevance of broadband technology in this time frame.

Appendices:

Appendix A: Region Five Sustainability Project Key Issues Overview

Appendix B: Narrative Scenarios

Appendix C: Central Minnesota: Aging Population 2035 (includes the following maps)

Central Minnesota: Aging Population 2005 – 2035 (full region)

Central Minnesota: Aging Population 2035 (Scenario comparisons with county variations)

Central Minnesota: Aging Population 2035 (Scenario comparisons without county variations)

Appendix D: Affordable Housing Location – Allocation Model for Central Minnesota

Appendix E: Data Catalog

Other thematic maps

Credits

Appendix A

Region Five Sustainability Project Key Issues Overview

The following are the Key Issues that the workgroups will be forming recommendations around. As these Key Issues are addressed we will need to keep in mind that our basic goal is to balance the need for both the protection of the environment and for increasing economic vitality. The impact of the following facts and trends on the region need to be considered as well;

- **An aging population;** the age of our population impacts every area that we will be planning for. It will affect the housing, transportation, land use and the workforce we will have and need for the future.
- **Energy costs and sources;** the costs of transportation and fuel for both residences and businesses has a great impact on rural areas due to the decentralized nature of our region. At this point we import almost all of our energy, could that change utilizing more local sources?
- **Health issues that affect the population;** The availability of a healthy workforce and the lower costs and higher productivity that it provides along with the accessibility and sustainability of healthcare services for our residents will be important to our future success.
- **Education;** The importance of a well educated future workforce cannot be overstated. Both in terms of wages earned and having the kind of workforce that can attract and retain businesses.
- **Population demographics;** As our future workforce shrinks and ages it is important that every citizen possible has the skills necessary to be a productive and valued member of society rather than being dependent on society. Ethnic diversity will continue to grow and expand from existing clusters that are now mostly associated with areas with food processing jobs and will be an important source of future workforce growth.
- **Geographic differences;** While our five counties have much in common we need to realize that not every recommendation we make will have a direct affect on every county. One example of differences is that Cass and Crow Wing County have a stronger tourism and forest products oriented economy and Morrison, Todd and Wadena Counties have a more agricultural oriented economy.
- **Tighter Resources:** Both public and private institutions are squeezed and trying to do more with less. Solutions will need to take into account new ways to get things done that are not dependent on increased spending from traditional sources.

Transportation

1. **Public Transit (types and availability, costs)**
   How can regional public transit be an alternative to cars for commuters, for both the young and elderly? What opportunities are there for transit partnerships? Where does it make sense to focus on public transit? In what ways might the private sector be involved in this as the need grows?

2. **Highways (quality, maintenance, improvements)**
   How can our highway system and corridors serve the regions' mobility, land use, and economic development needs in a safe manner while linking the other pieces of transportation system.

3. **Alternative Transportation (telecommuting, alternative energy, broadband)**
   Increasing broadband access throughout the region would increase the opportunity for telecommute and provide an economic benefit for businesses. How do we best plan for alternative transportation technologies, including alternative fueled vehicles, which are closer or further from reality so they serve our regions needs to provide efficiency, safety, cost savings, and economic development?

4. **Walking and Biking (trails sidewalks, bike lanes)**
   Adopting and implementing complete streets to promote walking, biking, trail use as a transportation option while increasing health and wellness. Developing bike lanes and routes on existing roads where appropriate would encourage biking. Can the Region build/invest in a walk able/bike able system that promotes and addresses health needs while acting as an economic development driver all while enhancing our regional transportation system?

Economic Development

1. **Work Force**
   This key issue has many different facets, including understanding the demographic and skill makeup of people in the region's major employment sectors. It is also important that skill sets of high growth industries be evaluated to determine what incumbent workforce sectors may be more easily transitioned into higher growth industries and away from the "legacy" industries that are in decline. Other key components of this issue include: how to keep young workers in the region, how to attract & retain talent, and how to best utilize an older workforce.

2. **Technological Advances (Energy and more)**
   Not all of the jobs that were lost in the past ten years were to developing countries with lax regulatory oversight and low wages, many jobs were lost to advancements in technology and related productivity gains. Furthermore, as the region has many companies that are working within energy related fields, developing breakthrough technology in energy production will be critical for advancing the industry cluster and the region.

3. **Infrastructure**
   Availability of suitable infrastructure is critical for communities and businesses alike. While dependence on certain types of infrastructure vary greatly from industry to industry, availability of transportation systems is vital for movement of goods and workforce. In many parts of the region, traditional infrastructure is nearly the end of its useful life with many towns facing the financial burden of replacing sewer & water lines and/or having to replace wastewater treatment facilities. In addition to traditional infrastructure needs and as the global economy continues to grow, one piece of infrastructure is emerging that will be critical for businesses to remain competitive in the future: availability of broadband access.

4. **Natural and Social Environments**
   Natural and Social Environments is an all encompassing issue as it relates to the region's past, current and future economic growth patterns and opportunities. The region is uniquely positioned in the state as such that three different biomes encroach on the five county area: the south and west portion of the region is primarily utilized for agricultural purposes, whereas the most of Cass and Crow Wing counties rely on the heavily wooded areas and abundant lakes as economic drivers for the tourism industry. While many of these areas are not well suited for bulk agribusiness new opportunities such as the local Foods movement and energy crops that can be raised on marginal land may bring new opportunities. The unique arts and culture environment in our communities is also a potential economic driver, and like the forest types varies by county and sometimes by community, and is also subject to ongoing change in ethnic diversity. How the region chooses to preserve its land and cultural traditions and utilize those assets in the future will have a direct impact on its economic vitality

5. **Financing**
   This issue involves the availability of capital to new and expanding businesses in the region. In today's credit market, accessing capital can be a big challenge for businesses, especially for entrepreneurs and companies in research & development stages. Alternative financing mechanisms should be created to fill this void, such as microenterprise loan funds or local venture capital financing.

Housing

1. **Affordable Housing**
   This key issue includes rental and single-family housing, the needed physical development of affordable rental housing and the need for single-family housing that is affordable due to price and/or financing, along with mechanisms to bring those goals about. Building design and green technology need to play a role in affordable housing. Also, homeless emergency shelters are thought of when discussing affordable housing. There is a need for a homeless emergency shelter to cover Region 5. Senior housing, with an aging population, needs to be offered as well as built to be affordable.

2. **Rehabilitation**
   Rehabilitation of housing focuses on the current housing stock. Seniors with a fixed income may find it to be very costly to rehabilitate their home when it is needed. A Continuum of Care model should be followed when referring to seniors and their housing. There is also a fairly large housing stock of foreclosed homes, which should go through rehabilitation and be sold to homebuyers at an affordable price with affordable financing. Green technology as to housing methods needs to play a role in this key issue.

3. **Employment**
   This key issue is mainly in regards to the financial aspects of housing. First of all, livable-wage employment needs to be available and secondly, the location of the employment is a large factor. Affordable housing will need to be produced near employment centers. A household should not have to drive an hour each way to and from their job.

4. **Infrastructure**
   The key issue of infrastructure deals with a variety of issues. It includes the critical role of central sewer and water systems in the development of housing, the availability of broadband internet connectivity in housing and economic development and the importance of road connectors to market and service centers within Greater Minnesota. In addition, it deals with the issue of responsive and available public transportation systems, such as on-demand systems, like dial-a-ride, in smaller towns and rural areas.

5. **Building Standards**
   The key issue of building standards is a broad one covering issues that are associated with general government controls as well as technical guidelines. As with other issues, building standards entails recognition of green criteria, including green building standards and the Minnesota Green Criteria Overlay. Education of the community, especially architects and contractors in the attributes and best practices of green construction techniques, is a sub-issue of this key issue. The issue also seeks to acknowledge the importance of local agriculture, the preservation of small farms and community-supported agriculture (CSA) as it concerns policies such as zoning, agriculture-appropriate real estate taxation and development.

Land-Use

1. **Land-use plans based on a balance of environmental and economic needs in the long term**
   We need to promote a regional land-use plan that promotes contraction rather than sprawl, and addresses and respects the potential long-term financial burdens placed on local taxpayers (for maintenance and replacement of infrastructure), as well as addresses and respects the potential long-term impacts of a development on the environment. The region needs to define the term, "sustainable land-use" and then adopt a method for measuring if it is attained or not.

2. **An effective land-use decision process that works better than the current system**
   The current Euclidian model of zoning, which doesn't allow for much flexibility, doesn't work. We need a process that incentivizes sustainable development and standardizes terms and definitions throughout the region. Performance-based zoning, or outcome-based zoning, or form-based zoning might promote sustainability better than Euclidian zoning.

3. **Scale up good processes/practices that are already working elsewhere**
   There are a number of land-use sustainability practices that are already working in the region and elsewhere. We need to aggressively promote these throughout the entire region. They include Green Step Cities, Conservation Design, the Micropolitan Planning Project, Low Impact Development (LID), Minimal Impact Development Standards (MIDS), Smart Growth Principles, Active Living by Design, DNR revised shoreland ordinances, conservation easements, Design Review Teams (DRTs), etc.

4. **Land-use policies that create affordable, intergenerational, active living housing opportunities**
   We need "life-cycle housing" that is close to natural areas and promotes walkability, and health and wellness – not just for our growing ranks of seniors, but for every generation living and working in the region.

5. **Protect our water (surface and subsurface) and provide better public access to public waters**
   Clean water defines our region and it is the economic driver (tourism and high lakeshore property values). Healthy lakes equal a healthy economy. Therefore, we need to promote and implement a regional land-use plan that, above all, protects water quality. In this region, there are few public beaches that allow non-lakeshore owners to access public waters, and this is viewed as unfair.

6. **Protect our region's agricultural heritage and support smaller-scale efforts like CSAs (Community Supported Agriculture)**
   We need a land-use plan that keeps our prime farmlands in production, rather than chopping them up (fragmenting) and turning them into subdivisions. We need to promote local agriculture for affordable local food production. CSAs and local farmers markets offer solutions to the problem that here in Minnesota; we currently import two-thirds of the food we eat. With fuel costs rising, food costs will rise, too. Those costs will be more manageable if we are able to produce food locally.

Appendix B

Central Minnesota Sustainable Development Plan
DRAFT Scenario Narratives
Workgroup Meeting - August 23, 2011

SCENARIO A: Abundance

The discovery of a cheap and abundant energy source in 2015 led to a strong national recovery and the reestablishment of the United States as the dominant world economy. In 2035 politicians exercise reason and base legislation on the results of intelligent, respectful debate. Due to the strong economy, government has seen significant increases in revenue and is able to meet not only the needs, but many of the desires, of their citizens while keeping taxes from increasing.

Central Minnesota residents enjoy a high quality of life and are keenly aware that their actions, and to a great degree their economy, directly relate to their natural surroundings. They have taken firm action and made significant investments in improving the natural environment. Because of those actions and investments, the region has healthy natural systems that provide abundant clean air and water, and support opportunities for growth of a green economy.

Transportation options are diverse, cost-effective, non-polluting, and easily accessible to all. Options include roads, buses, bike trails, walking and rail. Transportation infrastructure is well maintained and supports the movement of people and products throughout the region. Everyone has broadband connections and the whole region has wireless access at low cost.

Education is valued so it is well-funded, flexible, lifelong and affordable. The education system trains a strong workforce in the skills they need to be competitive in a productive economy where innovation and entrepreneurship are prized. There is full employment for all people that fits their abilities and pays a living wage for full-time work. The region's diverse economy provides for local needs and exports to the nation and the world. The economy is open to new ideas and new immigrant populations that strengthen the region's global impact.

Because of cheap and abundant energy sources, housing is affordable and operation costs are low. The housing market is strong due to healthy in-migration and the recognized high quality of life. Diverse housing options exist so that as people's needs change due to age, lifestyle or family situation they can remain in the community.

Healthy, locally produced foods meet the needs of the region and beyond. Food production does not degrade the natural environment and provides a living wage and positive return on investment for growers.

People of all ages and classes are attracted and retained by the high quality of life, local arts and culture, excellent medical care, and opportunities to contribute to the broader community and live in an area with great natural beauty.

SCENARIO B: Bootstrap to a Stronger Region

After the safety net of state support was withdrawn in the early 2010s, Central Minnesota struck out on a path of self-reliance to build a strong, efficient region that uses external relationships to strengthen the region. In 2035 we think first about investing in efficiency to keep more resources here. We then think about what we can export in order to bring dollars in to the region. We use what we have first, before looking outside the region.

Counties, cities, townships, schools, and other institutions collaborate for economic efficiency due to decreased funding for public education and governmental entities. Schools are a combination of on-line, charter, home school and traditional education programs. The Regional Sheriff patrols roads and the Central Minnesota Fire Department responds from outposts evenly spread through the region. Joint purchasing and sharing staff is the norm for government. There are now only three counties in the region and several smaller towns have un-incorporated.

Businesses strive to employ community residents in well-paying jobs that create products that other countries want – modular housing, solar panels, etc. We do not rely on California for our produce, we grow it here. Local farmers grow food for us first and commodity crops for export second. Manufacturers use the web to market their products globally. We connect globally for local gain. Electronic and virtual communication is universal and used to support new types of jobs that in the past were bound to a certain geographic place, but can now be in our region.

Workers live near jobs. Houses, businesses, and cars are energy efficient so dollars not spent on energy can be spent on other goods and services produced locally. Energy is produced locally (solar, wind) and distributed locally. We are not dependent on power lines bringing in energy. Residents and businesses boast how they spend most of their dollars locally instead of buying goods and services from outside the region.

Our region works diligently and cooperatively to create a transportation system that efficiently gives people access to jobs, takes our exports to markets, and brings in tourists to spend their dollars here. While the road infrastructure may not mimic 2010 standards, preservation of major corridors is the priority focus. Some roads have been abandoned and some that were paved are now gravel.

Our natural resources are assets we maintain and improve for local benefit. Clean water means we don't spend money on cleaning up our drinking water. Access to parks and open space keep us healthy and happy. Natural resources keep the tourist dollars coming into the region.

Social and civic institutions support our local strength. People have strong connections to friends and neighbors in the region developed through schools, churches, arts organizations, coffee shops, etc. People love to live here because of the beauty of the built and natural environments. There are many political parties represented in elected office. The polarized, uncollaborative two-party system no longer exists. Party affiliations are not listed on election ballots. Our education system works to strengthen social ties and train people for jobs here in the region. Our competitive health care system keeps us healthy in place and attracts retirees to the area. The population grows sustainably because people have good jobs, good community, and good services. People grow in place. Life is good here.

SCENARIO C: Current Trends

After the recession of the 2010s, the national economy moderately revived, and in 2035 the economy is no longer as completely dependent on consumption of imported goods and housing construction for growth. In our region we now have a more diverse economy that still includes tourism and forestry, but also includes a more significant industrial sector specializing in "green" industries that export products out of the region and country. Health care jobs have also increased because of the number of "baby boomer" retirees that settled in the region attracted because of the region's beautiful natural resources. "Hidden companies" are growing, including data storage and other high-tech businesses, although lending and capitalization can still be a challenge. Commodity agriculture continues with some niche local food production.

Housing values stabilized after the recession, but never returned to the inflated values of the 2000s. Because values moderated, counties and cities still struggle to provide services with decreased revenues from property taxes. Public services have been reduced or are delivered jointly by counties and cities. Transportation systems are maintained, not expanded. Some local roads have been abandoned because of limited transportation money and some roads went back to gravel. Expectations for what services government will provide have decreased. Because of the challenge of doing more with less, political gridlock still rears its head regularly.

The upside of lower housing values has been that first time buyers are able to purchase homes which brings younger people back in to the area – people who vacationed here want to live here, adults with children who want to live in rural community settle here, also young people who grew up here and went away now move back (we call them "boomerangs.") It is sometimes hard to find good jobs, but there are some expanded opportunities due to good broadband connections in cities and the growing trend of working in virtual offices. Minority communities have expanded because of the attractions of a small town and rural lifestyle and agricultural and health care job opportunities.

Schools continue to consolidate in fewer locations in larger towns because of limited public funding. Because of increased travel distances to schools, rural students turn increasingly to homeschooling and on-line schools. The combined effect of lowered governmental services, schools closing, and jobs locating in larger towns causes small towns to decline and larger centers to thrive.

Water continues to be increasingly impaired because land use regulations really haven't changed and enforcement has declined because of decreased local government staffing. We are happy to have development so we are not placing more regulatory burdens on the development. Invasive species in our lakes and rivers, and in our forests are still increasing. Resorts have declined in general and small family-owned resorts are practically gone.

Energy and fuel prices fluctuate, but have risen significantly over time. We are still mostly dependent on fossil fuel for heating, electricity and transportation. Alternative energy sources have increased, but slowly and incrementally.

SCENARIO D: Doomsday/Collapse

"*On its simplest level, the Great Depression was an economic crisis. Between 1929 and 1933, the average family in the United States saw its income drop by more than one third. The national jobless rate, which stood at about 3% in October of 1929, reached at least 25% less than four years later. The numbers in Minnesota were comparable, although residents in some parts of the state—the Iron Range, for example, where the unemployment rate hit 70%—suffered more than others. Children did not always understand the larger economic forces that were swirling around them, but they could tell something was wrong. Their fathers came home with news of pay cuts and layoffs. Their mothers struggled to make a few days' food last an entire week.*
*Illnesses went untreated. Clothes wore out and were seldom replaced. Many kids scavenged for food. Others took low-paying jobs to help their families survive. Even those whose families weathered the crisis reasonably well felt less secure than they ever had before. All around them they saw evidence of an economy in shambles, and the adults they depended on were helpless to do anything about it."*The Depression. Retrieved 6/14/11 http://stories.mnhs.org/stories/mgg/depression.do?eraID=2

The Greater Depression of 2014-2024 has left Central Minnesota of 2035 in a state very like the Great Depression of the 1930s. Population has plummeted. There is a predominance of ailing seniors who remain. They are without resources and are a major drain on neighbors and the faith community because government support was disbanded in the year 2015 and their adult children do not live in the region. Those who remain pine for the good old days.

The area is no longer viewed as a single region. There is significant isolation between local areas with some open hostility as scarce public resources are fought over. Some communities have done relatively well and there is more division between the haves and have-nots. Communities that are doing well attract people fleeing the large metropolitan areas who are looking for decent shelter and food.

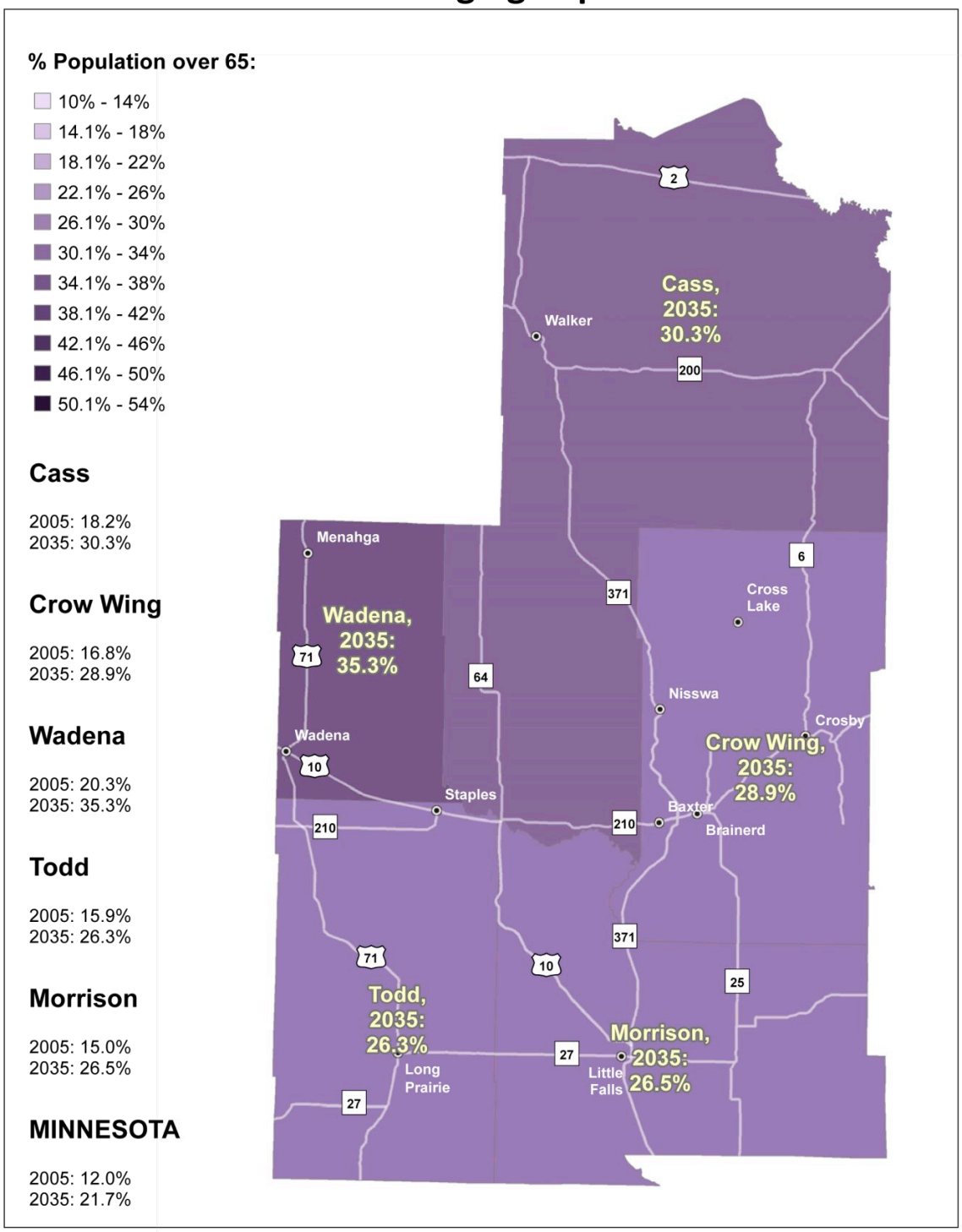
Weather swings are more severe with more draughts and massive food shortages. Dust bowl days return to southern Minnesota and will move northward as climate change means lakes and wetland dry up and forests burn. Air quality is checked each day instead of the rain forecast. Fisheries are depleted because people ignored regulations and over-fished the streams to feed their families. Invasive species made lakes sterile. Wildlife is diminished because of overharvesting for food. Forests have been cut down for heating fuel.

People live in multi-generational housing for survival. Houses are smaller and focused on an interior room to conserve heat. Many houses are in small compounds surrounded by walls to keep others out. Life expectancy has decreased significantly because of food shortages, poor sanitation, and disease.

People have re-learned survival skills - the ability to plant, care for, harvest, and preserve food they grow from seeds. Fuel is rationed and few people own automobiles. There is little publically maintained infrastructure. The internet and other technologies are gone because they were too complex to maintain and recreate. People with jobs are generally employed by companies run by foreign governments. The ruling class, such as it is, is mainly old-money families trying to protect their wealth.

Appendix C (Map 1)

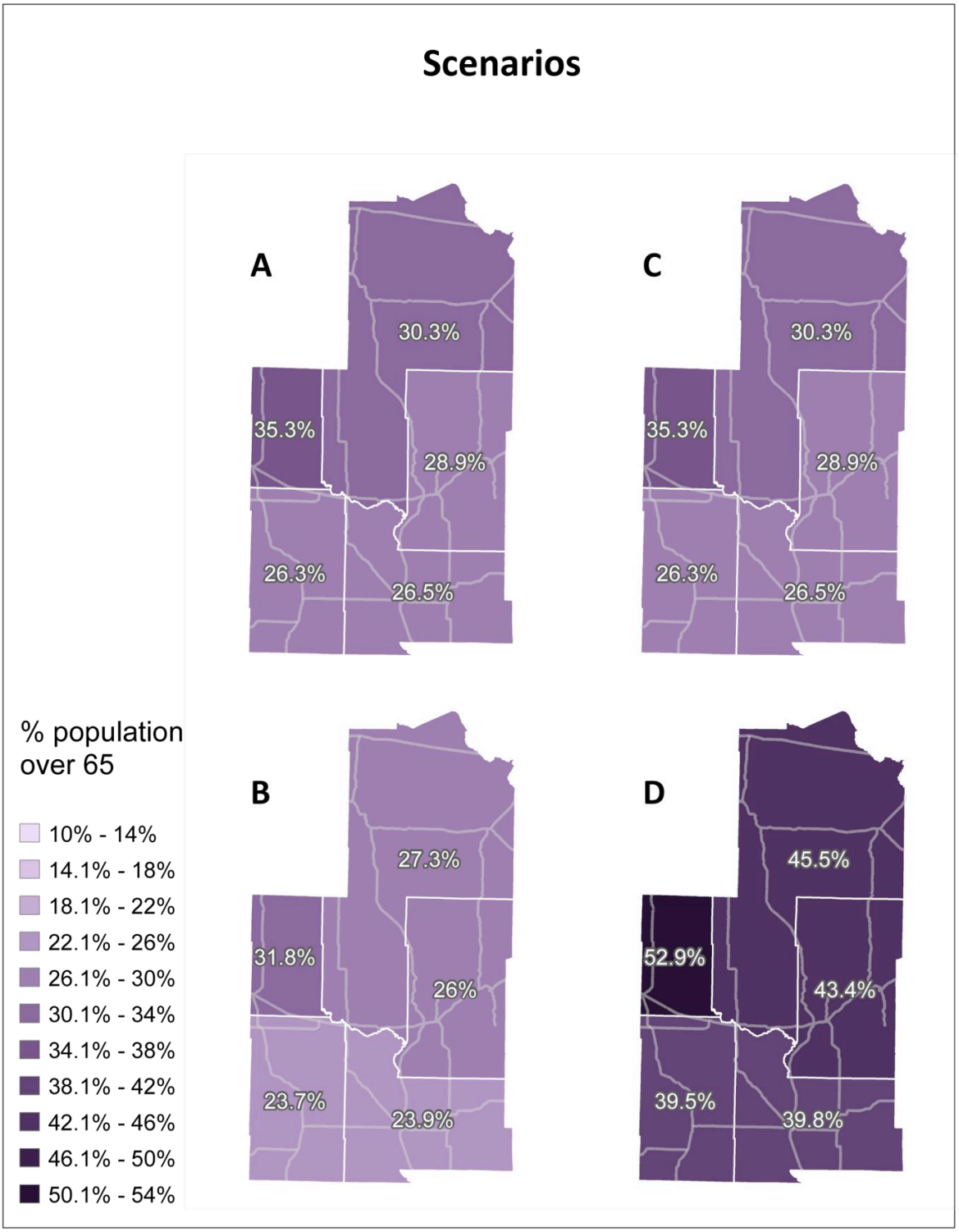
Central Minnesota: Aging Population 2005-2035



Source: Minnesota State Demographic Center
Map production: Z. Tagar, October 16, 2011

Appendix C (Map 2)

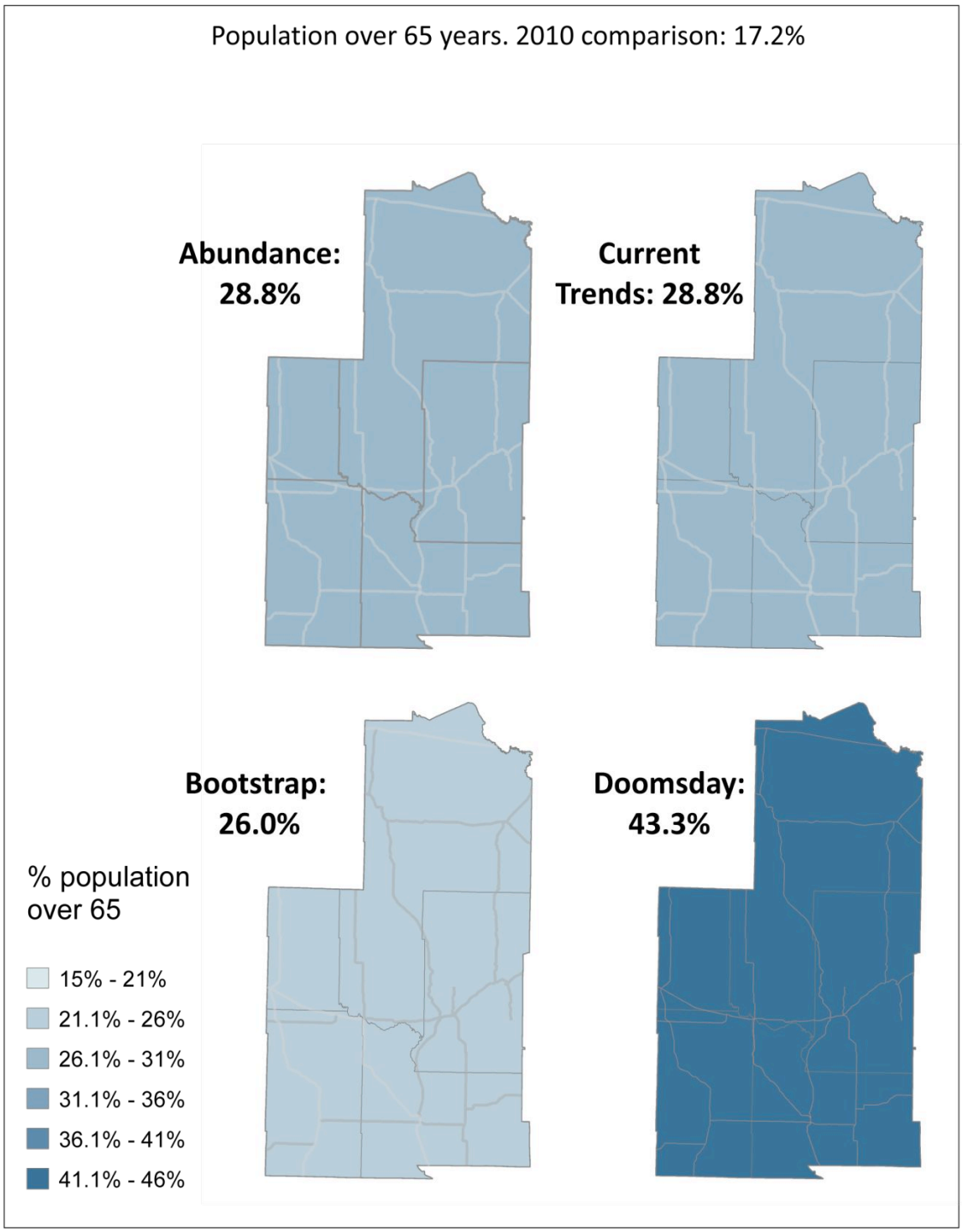
Central Minnesota: Aging Population 2035



Source: U.S. Census Bureau-American Community Survey, 2005-2009
Map production: Z. Tagar, October 16, 2011

Appendix C (Map 3)

Central Minnesota: Aging Population 2035



Source: Minnesota State Demographic Center, April 2007
ProjectionsAgeGender2005-2035
Map production: Z. Tagar, December 2, 2011

Appendix D

Affordable Housing Location-Allocation Model for Central Minnesota

Zach Tagar
April 2012

Introduction

The Department of Housing and Urban Development (HUD) set goals for affordable housing in Region 5: of the existing housing units (100,021), a certain percentage needs to be available for rent at 30%, 50% and 80% of area median income (AMI) respectively. While these goals easily translate into number of housing units, the distribution of these units throughout the region is not defined by HUD. That decision is left to local agencies, including non-profit organizations. While these organizations have ample knowledge of local conditions, they expressed a need for decision support in determining resource allocation for affordable housing between communities in the region. It is this need that the model seeks to answer.

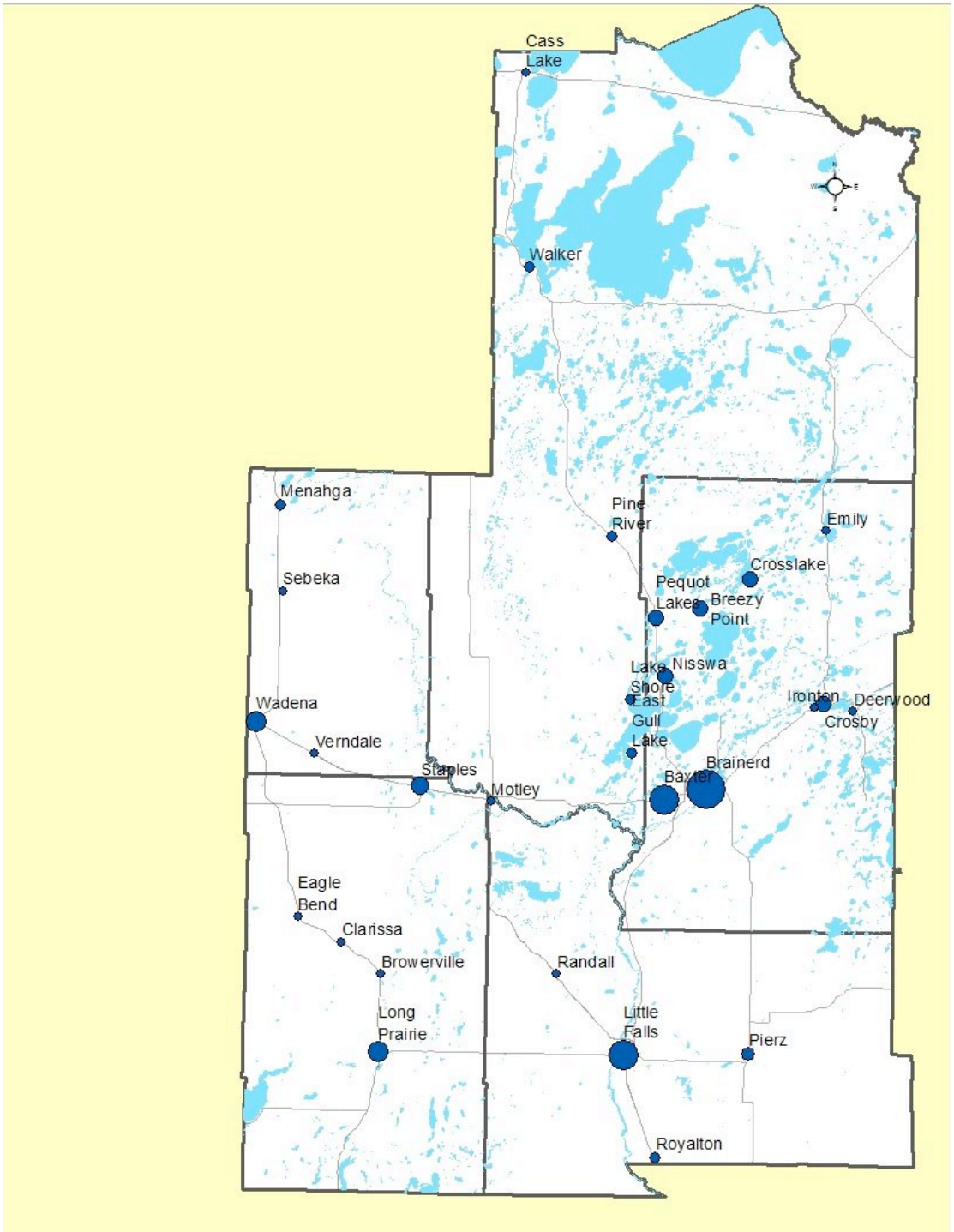
Project objective

The project aims to create a model for iterative use, which provides the number of affordable housing units needed in each of the municipalities examined. The model is to be based on parameters of need, jobs, commute and population, and provide weighting functionality given policy preference of decision makers. A model approach is ideally suited for such a problem, as it allows the users to experiment with different weighting options.

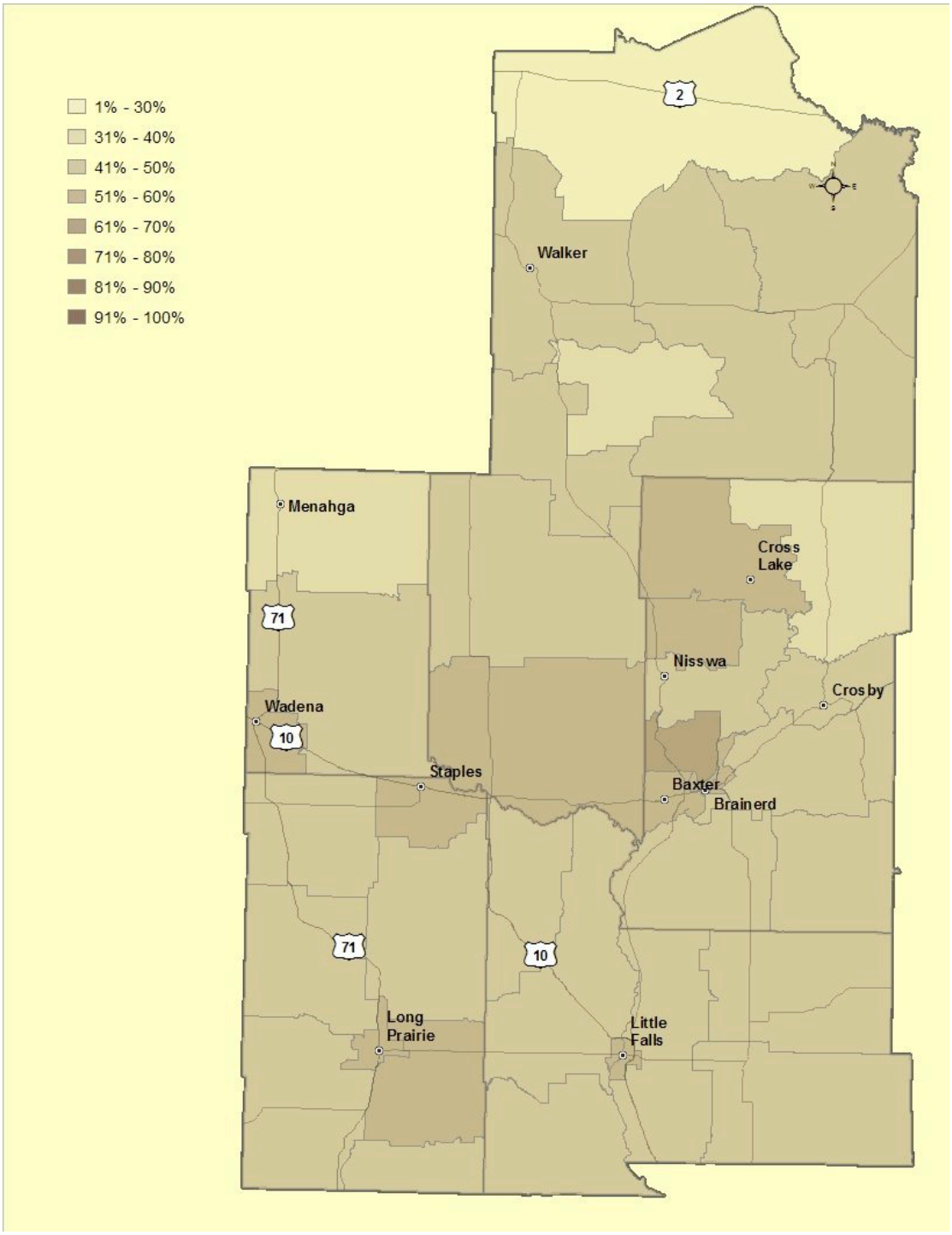
Data sources

The analysis relies on the following data sources:

- Populated places in Minnesota (Minnesota Department of Natural Resources)
- Population figures (Census 2010)
- Transportation network (Minnesota Department of Transportation)
- Census tracts (Census 2010)
- Municipal boundaries (Minnesota Department of Natural Resources)
- Table: “percentage of low income housing units paying 30% or more of their income on housing” (by census tract) (Minnesota Housing)
- Table: “number of wage earners in 2010” (by Minor Civil Division) (Minnesota Department of Employment and Economic Development)
- Table: “existing rental affordable housing units at 30%, 50% and 80% of area median income” (US Department of Housing and Urban Development)



Map 2: Municipalities with population greater than 500. Symbol size is proportional to population size.



Map 3: Census tracts representation of affordable housing needs.

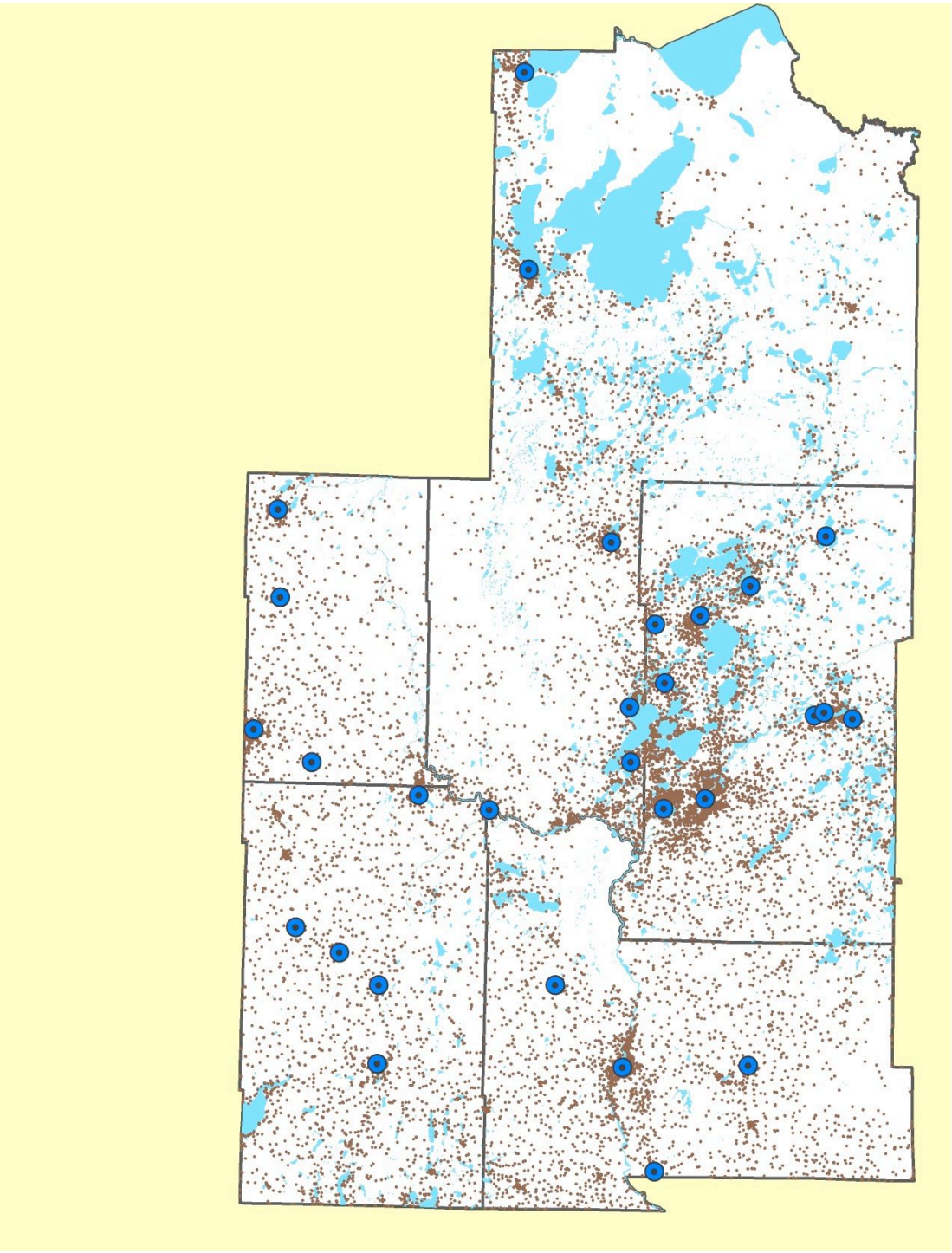
Methods

A. Logical framework

1. Each community is ranked on the basis of need and jobs. (need and jobs are provided on 0-1 scale).
2. Need and Jobs variables are weighted according to user preference, such that: **Rank = ([need] * [W need]) + ([jobs] * [W jobs])**
3. Rank is multiplied by population.
4. The number of "total units needed" is divided among all communities, directly proportionate to the product of their rank and population.
5. The number of existing units in each community is subtracted from the result.

B. Data preparation

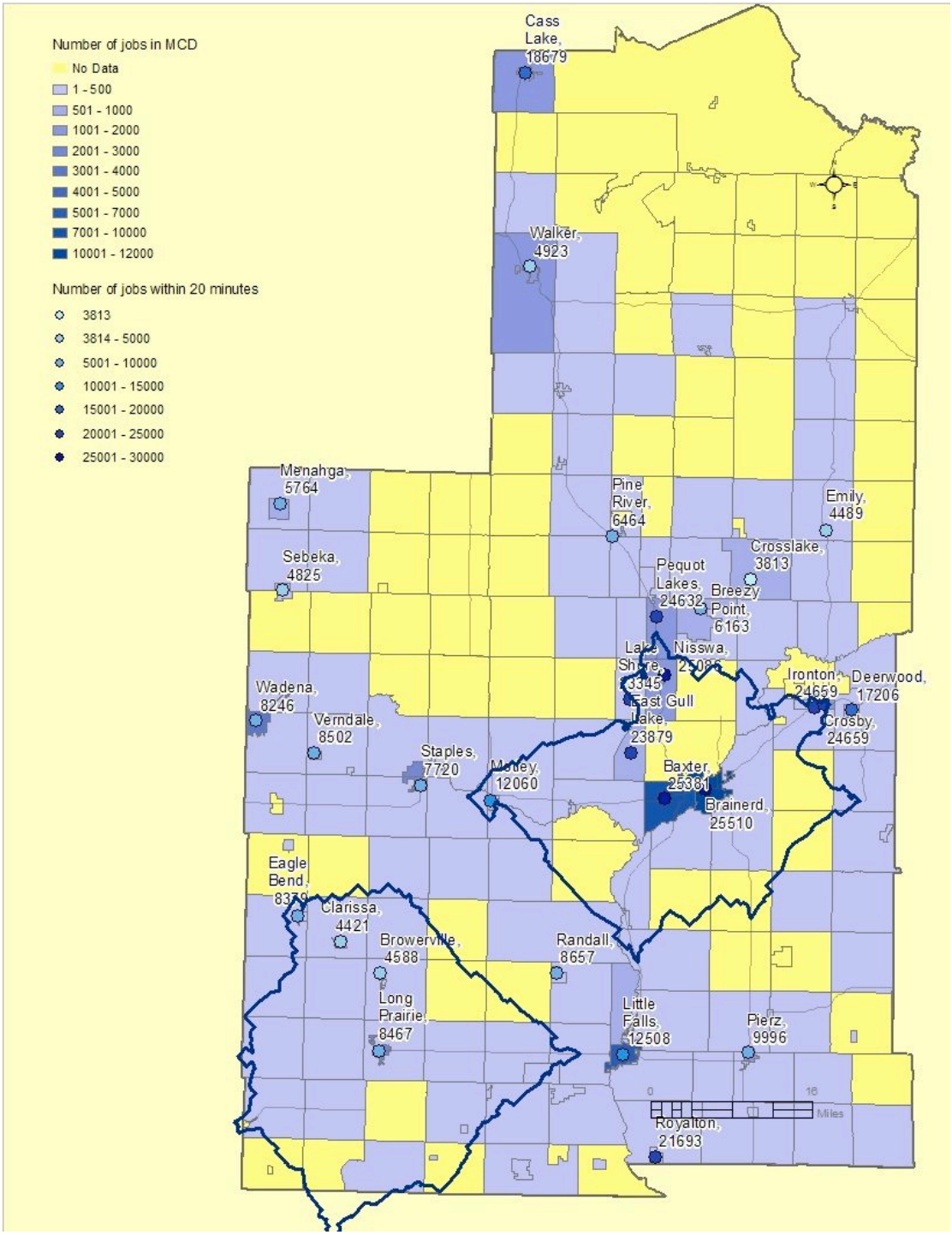
1. Site selection
   Under the assumption that affordable housing investment must take place where sufficient infrastructure exists, especially water and wastewater, the model restricted its examination to communities with a population of 500 or more. Within region 5, there exist 29 such communities that answer that criterion. Map 4 shows these communities on the background of general population dispersion in the region (a dot-density map with each dot representing ten people).



Map 4: selected municipalities on the background of overall population distribution (Each brown dot represents 10 people).

2. ArcGIS Network Analyst – creating commute polygons and aggregating jobs numbers: A key consideration in determining affordable housing location is the job market in the area. However, the number of jobs located in a given municipality is not a sufficient variable, since many workers commute to work places outside their municipality. To answer that, a 20 minute commute polygon was created for each of the 29 communities, based on populated places point data and on the road network, using ArcGIS 10 Network Analyst.

   For each community, the 20 minute commute polygon was intersected with the polygon layer of number of jobs per Minor Civil Division (MCD). The number of jobs in each of the MCD polygons that intersect the 20 minute commute polygon was summed to provide the total number of jobs within a 20 minute commute per community. Map 5 shows the MCD polygons (in graduated color representing number of jobs) and two examples of 20-minute commute polygons, for the communities of Baxter and Long Prairie. The map also shows each of the 29 communities as a dot with graduated color representing the number of jobs within a 20 minute commute.



Map 5: Minor Civil Divisions, Cities and two examples of 20 minute drive time polygons (from the cities of Baxter and Long Prairie)

3. Rasterizing polygon data
   Data on jobs and on population at this stage is given per community as point data. However, data on need is provided by census tract (see map 3). The different data types present a problem for spatial analysis that requires a combination of these datasets. Point data was easily attributed to polygons standing for municipal boundaries through a table join, but there remained a mismatch between municipal boundary polygons and census tract polygons. The model answers this mismatch by rasterizing both datasets and using map algebra for pixel-by-pixel analysis. To this end, the census tract polygon layer of the need data (i.e. percentage of low income housing units spending 30% or more of income on housing) was clipped using the municipal boundaries as clip feature. Polygon layers of "need", "jobs" and "population" now have the same spatial extent, and they were rasterized using ArcGIS "Polygon to raster" tool, with a 30 meter cell size.

4. Python script to transform raster data
   To perform map algebra on the two raster layers, it was deemed useful to have both as values of 0-1. The "need" data was already as percentage, but the jobs data had values reaching upwards of 25,000. The script in figure 1 was created to transform the dataset to values of 0-1:

Transformation0_1Revised.py - C:\Workspace\Backups\CURA_April2012\Thematic_Maps\Housing\Scriptts\Transformation0_1Revised.py

File Edit Format Run Options Windows Help

```
import arcpy, sys
from arcpy import env
from arcpy.sa import *

# This script transforms an input raster file values to a range of 0-1, whereby
# the highest value in the dataset is 1 but the lowest value is not 0, but refle
# its relative value.

env.workspace = sys.argv[1]

arcpy.CheckOutExtension("Spatial")

inRaster=sys.argv[2]

def transform(rasterFile):
    Amin=arcpy.GetRasterProperties_management (rasterFile, "MINIMUM")
    Bmax=arcpy.GetRasterProperties_management (rasterFile, "MAXIMUM")
    minValue=Amin.getOutput(0)
    maxValue=Bmax.getOutput(0)
    outRaster=Raster(rasterFile)/float(maxValue)
    outRaster.save(rasterFile+"_TR")


transform(inRaster)
```

Ln: 16 Col: 0

Figure 1: Script transforming raster dataset values to 0-1 scale

C. ArcGIS 10 Model Builder and parameters

1. Model parameters
   the model has the following user input parameters: a weight parameter for the Need variable; a weight parameter for the jobs variable; percentage values for the housing stock needed in each of the affordability brackets (30%, 50% and 80% of the area median income) (these parameters default to the values provided by HUD but can be changed); number of total housing stock in the region (also defaulting to the HUD provided number); and the name of the Excel output file.

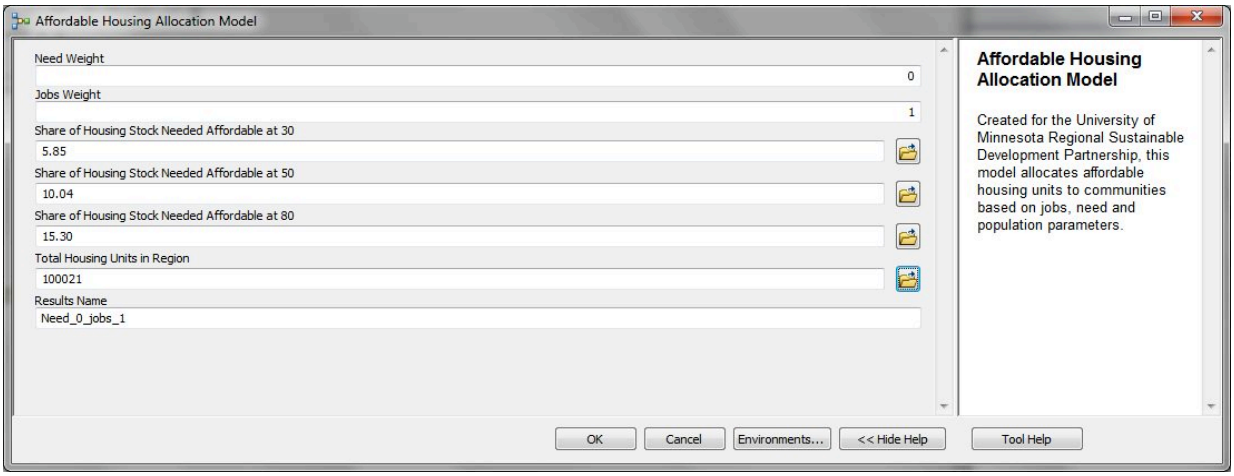


Figure 2: user interface of model tool

2. Geoprocessing operations
   The model runs through a series of geoprocessing and map algebra operations:

   a. Map algebra 1: weight of jobs variable is multiplied by job value (0-1)
   b. Map algebra 2: weight of need variable is multiplied by job value (0-1)
   c. Map algebra 3: resulting values of jobs and need are added to provide a rank per pixel
   d. Rank is multiplied by population
   e. Raster to polygon – deriving polygons inside the municipal boundaries with the final ranking values
   f. Spatial join: final ranking value is attributed to each municipality, using the municipal boundary polygon. Because there can be different values inside each boundary polygon, merge rule “mean” was assigned to the ranking value (showing as GRIDCODE in the resulting table).
   g. The result is a polygon shapefile with a field of rank values for each city polygon. The next step is to transform that to a value that can be used to derive the number of units per city from the total number of units needed. Value “Rank_share” will be a float for each city, whereby the sum of all values will equal 1:

i. "Get field value" provides the sum of all GRIDCODE (rank) values (SumGrid)
ii. "Field calculator" with expression: [GRIDCODE] / [SumGrid] results in the **relative share of each rank from the total of all cities**.

h. This Rank_share value was joined to a point shapefile of the same cities (using city name as key)

Intermediate result: a point shapefile with 29 features. The city features have a float field ranking each according to jobs, need and population, based on a calculation that incorporates weights for the jobs and need variable. The sum of all values in that field is 1.

i. "Field calculator": For each affordability bracket, the number of total housing units needed in the region is multiplied by the "Rank_share" value. From the result, the number of existing units is subtracted.

3. Output (ETL tool)
A spatial ETL too was constructed to export the shapefile table into an Excel spreadsheet, which can be easily used by non GIS practitioners.

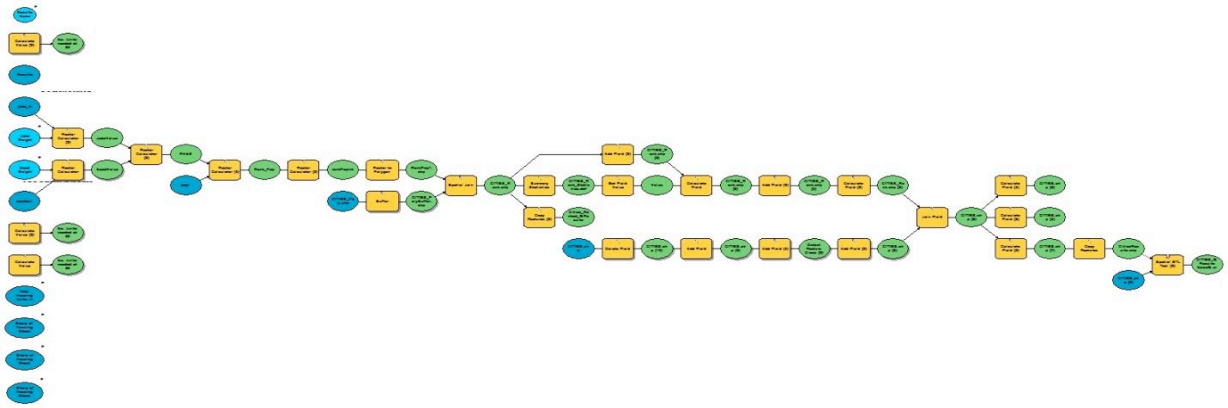
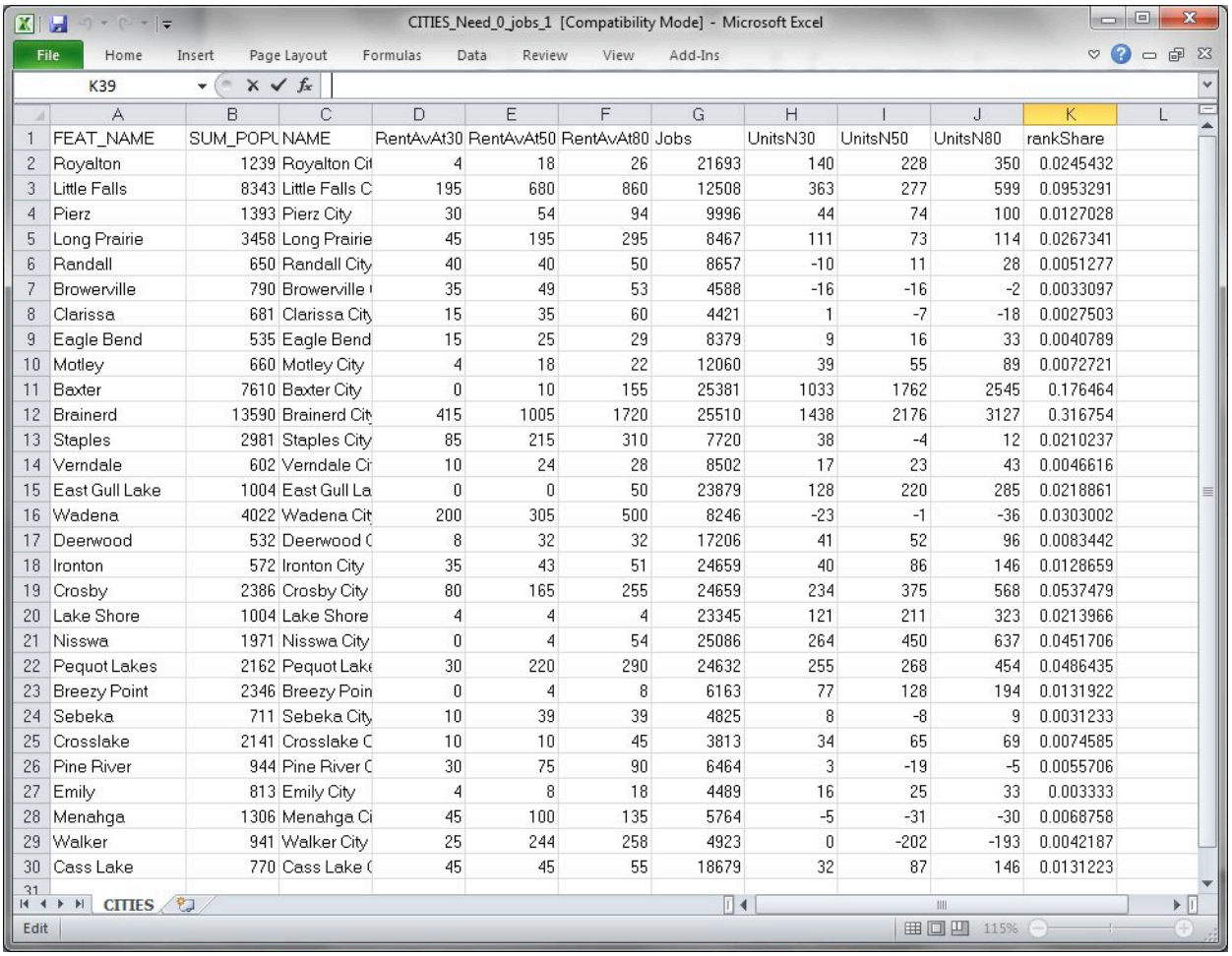


Figure 3: a graphical representation of the model

Results

The result of the project is a tool that can be used for planning affordable housing development in the region. In fact, the model was already presented to a group of planning practitioners who work on housing in the region, and to HUD officials. The fact that the model output provides a spreadsheet with actual numbers of units to be developed was greatly welcomed by the practitioners, who noted that the tool will be put to use by decision makers in the region.



	A	B	C	D	E	F	G	H	I	J	K	L
1	FEAT_NAME	SUM_POPU	NAME	RentAvAt30	RentAvAt50	RentAvAt80	Jobs	UnitsN30	UnitsN50	UnitsN80	rankShare	
2	Royalton	1239	Royalton Cit	4	18	26	21693	140	228	350	0.0245432	
3	Little Falls	8343	Little Falls C	195	680	860	12508	363	277	599	0.0953291	
4	Pierz	1393	Pierz City	30	54	94	9996	44	74	100	0.0127028	
5	Long Prairie	3458	Long Prairie	45	195	295	8467	111	73	114	0.0267341	
6	Randall	650	Randall City	40	40	50	8657	-10	11	28	0.0051277	
7	Browerville	790	Browerville (	35	49	53	4588	-16	-16	-2	0.0033097	
8	Clarissa	681	Clarissa City	15	35	60	4421	1	-7	-18	0.0027503	
9	Eagle Bend	535	Eagle Bend	15	25	29	8379	9	16	33	0.0040789	
10	Motley	660	Motley City	4	18	22	12060	39	55	89	0.0072721	
11	Baxter	7610	Baxter City	0	10	155	25381	1033	1762	2545	0.176464	
12	Brainerd	13590	Brainerd Cit	415	1005	1720	25510	1438	2176	3127	0.316754	
13	Staples	2981	Staples City	85	215	310	7720	38	-4	12	0.0210237	
14	Verndale	602	Verndale Ci	10	24	28	8502	17	23	43	0.0046616	
15	East Gull Lake	1004	East Gull La	0	0	50	23879	128	220	285	0.0218861	
16	Wadena	4022	Wadena Cit	200	305	500	8246	-23	-1	-36	0.0303002	
17	Deerwood	532	Deerwood (	8	32	32	17206	41	52	96	0.0083442	
18	Ironton	572	Ironton City	35	43	51	24659	40	86	146	0.0128659	
19	Crosby	2386	Crosby City	80	165	255	24659	234	375	568	0.0537479	
20	Lake Shore	1004	Lake Shore	4	4	4	23345	121	211	323	0.0213966	
21	Nisswa	1971	Nisswa City	0	4	54	25086	264	450	637	0.0451706	
22	Pequot Lakes	2162	Pequot Lake	30	220	290	24632	255	268	454	0.0486435	
23	Breezy Point	2346	Breezy Poin	0	4	8	6163	77	128	194	0.0131922	
24	Sebeka	711	Sebeka City	10	39	39	4825	8	-8	9	0.0031233	
25	Crosslake	2141	Crosslake C	10	10	45	3813	34	65	69	0.0074585	
26	Pine River	944	Pine River C	30	75	90	6464	3	-19	-5	0.0055706	
27	Emily	813	Emily City	4	8	18	4489	16	25	33	0.003333	
28	Menahga	1306	Menahga Ci	45	100	135	5764	-5	-31	-30	0.0068758	
29	Walker	941	Walker City	25	244	258	4923	0	-202	-193	0.0042187	
30	Cass Lake	770	Cass Lake (	45	45	55	18679	32	87	146	0.0131223	
31												

Figure 4: Result of the model: an Excel spreadsheet. Columns H, I and J list the number of units to be developed at each affordability bracket.

Limitations, challenges and problems

1. Limitations

Several assumptions were made in the creation of the model. While justified, some highlight the limited accuracy of the model. For example, the model relies on an analysis deriving the number of jobs that exist within a 20 minute commute from a given city (see map 5). While ArcGIS network Analyst allows for the creation of drive time polygons (see examples on the map), data on jobs is only available as Minor Civil Division (MCD) polygons. The number of jobs within 20 minutes from the city was derived by intersecting drivetime polygons with MCD polygons, and aggregating jobs figures from all MCD polygons. This resulted in including all jobs even from MCD's that are only partially within the drivetime polygon. In the absence of a point dataset on jobs, however, this limitation was considered to be the best available option.

The data describing 'need' for affordable housing is from a MN Housing dataset of the following variable: "percentage of low income households that spend 30% or more of their income on housing". This was taken as a good indicator on the level of need, but it is probably not the only possible one.