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PRACTICE ON GRAVEL ROADS

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The Crunch of Development Along Gravel Roads

By Michele Manning, AICP, and Mark A. Wyckoff, FAICP

Communities on the fringe of suburban development at times find themselves in a quandary. They want to preserve their rural character and accommodate new development as well.

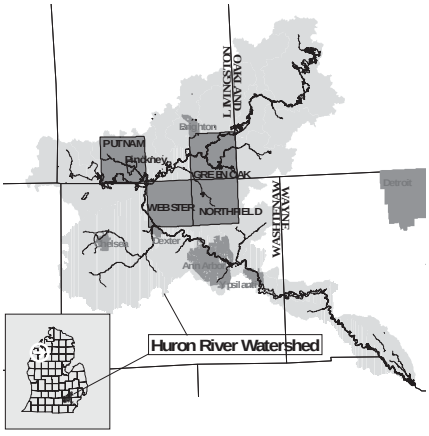
Yet more development brings more people and more traffic. The changes can also reduce rural character. How does a rural community make decisions that balance preservation of rural character with efforts to accommodate more development? The answer lies in part in knowing the thresholds above which new development diminishes rural character and existing infrastructure capacity. One new threshold has been discovered: gravel road capacity.

Rural residential development is often served by gravel roads, which are usually maintained by a county road agency. If too many vehicles use the road, then it quickly becomes pitted and bumpy and requires frequent road grading. County road agencies rarely have enough funds to meet all priority road improvement needs in urbanized areas, while funds for paving rural gravel roads to accommodate rising traffic volumes are in even more limited supply. Besides, if a road is paved, it may bring more development than rural services can accommodate.

Local governments use comprehensive plans and zoning ordinances to plan and zone land for various uses and densities. In the exercise of that authority, local officials may not know that their decisions may permit more residences than the local roads can support. It is surmised that, if local officials were aware of the traffic capacity of gravel roads prior to making planning and zoning decisions, they might factor these considerations into their zoning review and approval process. The result could be a different balance permitting new development while preserving gravel road capacity.

PROJECT PARTNERS

This article summarizes one-half of a research project designed to help answer the question: "How much development is too much?" The complete project was initiated by the Huron River Watershed Council in southeast Michigan, in cooperation with the Planning & Zoning Center, Inc. (PZC) in Lansing, Michigan. It resulted in a "how to" guidebook and training programs for local officials. Technical partners on the project included representatives from the Livingston County Road Commission, the Washtenaw County Road Commission, and the Southeast Michigan Council of Governments. Four pilot communities (all townships of about 36 square miles each) were active local partners:



Four southeastern Michigan communities, as shown, participated in the gravel road capacity study.

- Putnam Township (5,359 pop.);
- Green Oak Township (15,618 pop.);
- Northfield Township (8,252 pop.); and
- Webster Township (5,198 pop.).

With help from the Livingston and Washtenaw County road commission staffs, PZC developed a methodology to determine the current capacity of the pilot communities' gravel roads. First, the pilot community gravel roads were inventoried, rated, and scored according to five physical characteristics of each road segment. The scores were used to create capacity thresholds for each segment, depending upon the road's physical condition. Unused capacity was compared to future volumes based on a buildout analysis of local zoning densities. The results were mapped and analyzed, and options for preserving gravel road capacity were identified and fleshed out. PZC prepared sample master plan and zoning ordinance language for each option. All findings, the methodology, and sample language were incorporated into the guidebook and accompanying CD. The balance of this article examines each of these elements in more detail.

GRAVEL ROAD CAPACITY FINDINGS

The gravel road rating system devised in this research project is similar to the standard paved road rating system (level of service ratings A to F). The gravel road rating system ranges from A (best) through E (worst), depending upon the physical features of the gravel road. The best gravel roads can support higher traffic volumes than others and therefore serve more adjacent development. But there are definite limits.

Table 1 illustrates the maximum density level each class of gravel road can support, based on the results of this project. An "A" class gravel road (the best of the best) can accommodate a residential density of only one dwelling unit (DU) per 6.67 acres. A paved road is needed to accommodate higher density levels. An "average" gravel road (class "C") can accommodate a residential density of only one DU per 10.67 acres before it is over capacity, while a 1½-lane "class E" gravel road is suited for a density of only one DU per 32 acres. These are density levels much lower than is common in rural Michigan and many other parts of rural America. Very similar results are expected elsewhere.

TABLE 1. RESIDENTIAL DENSITIES AND GRAVEL ROAD CAPACITY

Gravel Road Type	Dwelling Units (DU) To Be Built on 640 Acres	Traffic Generated (vehicle trips/day@10 vehicle trips per DU)	Maxiumum DUs per Acre
A	100 DU per 640 acres	800–1,000	1 DU per 6.67 acres
B	80 DU per 640 acres	600–799	1 DU per 8 acres
C	60 DU per 640 acres	400–599	DU per 10.67 acres
D	40 DU per 640 acres	200–399	1 DU per 16 acres
E	20 DU per 640 acres	0–199	1 DU per 32 acres

The guidebook provides step-by-step instructions on how to conduct a gravel road capacity analysis. While it was prepared for Michigan communities, it would not be difficult to adapt for use in other states. A geographic information system (Arcview) was utilized to determine the gravel road capacities. Following is a general overview of the steps required to conduct the analysis. Please refer to the guidebook and its appendices for detailed instructions (particularly the GIS commands needed) on conducting a gravel road analysis.

HOW TO CONDUCT A GRAVEL ROAD CAPACITY ANALYSIS

Rating the gravel roads. The first step is gathering basic data, which include traffic volume information by gravel road segment. The physical conditions of each segment also need to be inventoried and rated. Figure 1 is an example of the field sheet developed and first tested by the Livingston County Road Commission to gather basic data on each segment.

Once this was done, and traffic counts were completed for all gravel road segments, PZC associates worked with Livingston and Washtenaw County road commission staff to identify five key variables to rate each segment. The five characteristics were scored to create a gravel road classification system. Each characteristic was rated from one to three, one being the lowest and three being the highest as follows:

- Surface type
  1=earth, 2=gravel, 3=limestone
- Road width
  1=under 18', 2=18-24', 3=over 24'
- Adequate drainage
  1=No, with average daily traffic volumes over 400, 2=No, with volumes under 400, and 3=Yes
- Width of clear zone
  1=less than 5', 2=5-10', 3=over 10'
- Road alignment rating
  (comfortable travel speed)
  1=under 25 mph, 2=35 mph, 3=45 mph

FIGURE 1. SAMPLE OF GRAVEL ROAD INVENTORY FIELD WORKSHEET FROM LIVINGSTON COUNTY ROAD AGENCY

Livingston County Road Commission
Gravel Road Inventory Field Worksheet

Segment and Location:

Road Name: _____ Township: _____ Section: _____

Beginning of Segment: _____ End of Segment: _____

Length of Segment (in feet): _____ Road Classification: ☐ Primary ☐ Local

Physical Features:

Width of Segment: ☐ less than 18' ☐ 18' to 24' ☐ greater than 24'

Type of Surface Material: ☐ Earth ☐ Natural Aggregate ☐ Limestone ☐ Other

Comments: _____

Type of Roadside Vegetation: ☐ Brush ☐ Wooded ☐ Cropland/Pasture ☐ Lawn ☐ Other (Specify) ☐ Varies (Specify)

Comments: _____

Width of Clear Zone: ☐ less than 5' ☐ 5' to 10' ☐ greater than 10'

Type of Clear Zone Obstruction: ☐ Cut-slope ☐ Fill-slope ☐ Trees ☐ Other ☐ None

Comments: _____

Road Alignment Classification: ☐ Complex ☐ Moderate ☐ Slight

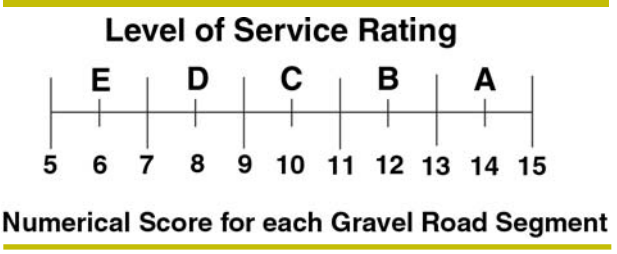
Do roadside ditches exist along the majority of the road segment? ☐ Yes ☐ No

Is roadside drainage adequate? ☐ Yes ☐ No

If no, state reason: _____

Once the roads were rated, their scores were tallied for all five characteristics. The highest score is a fifteen or an "A" rated gravel road segment. The lowest score is a five or an "E" rated gravel road segment. See Figure 2 for the ranges for the A through E physical features ratings. The photographs give visual examples of pilot community road segments represented in the ratings.

FIGURE 2. PHYSICAL FEATURES RATINGS



Livingston County Road Commission

Washtenaw County Road Commission

Left: Level A Road (Pingree Road, Putnam Township). Right: Level B Road (Scully Road, Webster Township).

Livingston County Road Commission

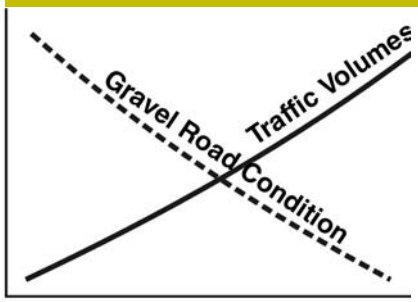
Washtenaw County Road Commission

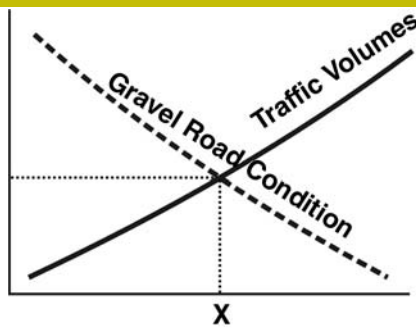
Livingston County Road Commission

Left: Level C Road (Fairlane Road, Green Oak Township). Center: Level D Road (Five Mile Road, Northfield Township). Right: Level E Road (Doyle Road, Putnam Township).

Gravel road capacity analysis. The next step is to determine the capacities for each road segment by rating level from A to E. Figure 3 illustrates generally how "capacities" for the gravel roads were determined.

FIGURE 3. FINDING THE MAXIMUM CAPACITY OF A GRAVEL ROAD





A lengthy series of regression curves was created with the pilot community data. Once gravel road segments were rated and scored, "midpoint thresholds" and a "range of acceptable volume" were generated for each gravel road rating and recorded on Table 2. A community conducting a gravel road capacity analysis for the first time can set its own thresholds by conducting a similar analysis (as documented in Appendix B to the guidebook), or, if the road segments are similar to those in this study, it may choose to utilize the thresholds in this study.

Calculating unused capacity. The next step in the gravel road capacity analysis involves comparing the existing traffic volumes to threshold depending upon the road rating. A road becomes "overcapacity" if it is over the threshold for its rating. For example, a road rated a "C" may have an average daily volume of 800 vehicles. If so, it would be considered "overcapacity" because it was over the acceptable volume range for a "C" rated gravel road (i.e., 400 to 600 vehicles per day). Therefore, roads have "unused capacity" if they are below or within the "range of acceptable volume" in Table 2.

Parcels along gravel road segments that had "unused capacity" in the pilot communities were mapped in light green on Map 2 (posted on the APA website at http://www.planning.org/ZoningPractice/currentissue.htm). Those in pink were lands bordering gravel road segments that are

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During April 12-23, go online to participate in our "Ask the Author" forum, an interactive feature of Zoning Practice. *Michele Manning, AICP, and Mark A. Wyckoff, FAICP, will be available to answer questions about this article. Go to the APA website at* ***www.planning.org*** *and follow the links to the Ask the Author section. From there, just submit your questions about the article using an e-mail link. The author will reply, posting the answers cumulatively on the website for the benefit of all subscribers. This feature will be available for selected issues of* Zoning Practice *at announced times. After each online discussion is closed, the answers will be saved in an online archive available through the APA* Zoning Practice *web pages.*

About the Authors

Michele Manning, AICP, is a transportation and land-use planner with the Planning & Zoning Center, Inc. Mark A. Wyckoff, FAICP, is president of the Planning & Zoning Center, Inc. and editor of *Planning & Zoning News*, a Michigan-specific magazine now in its 21st year. The information and graphics in this article are derived from a much longer article with a similar title that was published and copyrighted as the feature story in the November 2003 issue of *Planning & Zoning News*. Permission is granted by the Planning & Zoning Center, Inc. of Lansing, Michigan, to reproduce this material in *Zoning Practice*. For further information go to www.pzcenter.com.

The authors would like to recognize that the project could not have been completed successfully without outstanding efforts from the following individuals: Laura Rubin, Kris Olsson, and Elizabeth Riggs from the Huron River Watershed Council; Michael Craine and Steve Wasilyk from the Livingston County Road Commission; Steve Puuri, Ken Reiter, and Bob Polens from the Washtenaw County Road Commission; and Gerald Rowe and Ted Starbuck from the Southeast Michigan Council of Governments. We also greatly appreciate the contributions of the members of the Local Advisory Committee for the project.

presently over capacity. Land in the stippled light blue are served by paved roads and are ignored in this analysis.

this result is also mapped (see Map 3 on the APA website at www.planning.org/ZoningPractice/currentissue.htm).

TABLE 2. VOLUMES BY GRAVEL ROAD PHYSICAL FEATURE RATING

Physical Features Ratings (numerical score)	Midpoint Thresholds (based on existing daily traffic volume and the regression analysis)	Range of Acceptable Volume
A (13–15)	900 vehicles/day	800–1,000 vehicles/day
B (11–12.9)	700 vehicles/day	600–800 vehicles/day
C (9.0–10.9)	500 vehicles/day	400–600 vehicles/day
D (7–8.9)	300 vehicles/day	200–400 vehicles/day
E (5–6.9)	100 vehicles/day	<200 vehicles/day

Source: Planning & Zoning Center, Inc.

Land access analysis. By subtracting out existing traffic volumes from the maximum acceptable volume level for each gravel road segment, the "unused" capacity can be calculated and allocated to the buildable, undeveloped abutting land. Using the ITE *Trip Generation Manual* standard of 10 trips per day per single-family residential dwelling unit, the number of dwelling units that could be built without exceeding existing road capacity is then calculated (assuming no additional through traffic).

Buildout analysis. Similarly, the maximum number of dwelling units that are permitted under existing zoning can be calculated and then compared with existing unused capacity from the last step. Using GIS,

Map 3 reveals that most of the land in the pilot townships served by gravel road segments will be over capacity at buildout if the land is developed at the existing zoned densities (magenta color). This is simply a function of the base zoning density. Table 1 shows the density at which the capacity of gravel roads is exceeded, based on the classification of the gravel road. Since the maximum capacity of an "A" class gravel road segment is exceeded at a density of one dwelling unit per 6.67 acres and most of the land in the pilot townships is zoned at densities of 1 DU/2 acres to 1 DU/5 acres, there is no way to escape being over capacity at buildout. (Most of the gravel road segments are not "A" class; they are a lower class and can sustain even less traffic.) Much of Putnam Township remains green or under capacity at buildout on Map 3 because most of the land is zoned at one DU per 10 acres.

Obviously, the density at which land is zoned has an enormous influence on the amount of traffic generated from that land and its subsequent impact on the capacity of the abutting roads. The significance of this research is that the threshold at which gravel road capacity is exceeded is quite low. If a community wishes to preserve rural character and the capacity of its existing gravel roads, then the permitted zoning density on abutting lands should not be higher than the gravel road can accommodate, or the preservation goals cannot be achieved–unless some other density reduction measures are taken.

WEB-BASED ENHANCEMENTS FOR *ZONING PRACTICE*

In order to provide better and additional graphics to enhance the reading experience of *Zoning Practice* subscribers, with this issue we are initiating the practice of referencing color illustrations, such as color-coded maps, on the *Zoning Practice* web pages of APA's website. We invite you to check out the additional illustrations at **www.planning.org/ZoningPractice/currentissue.htm**. We will do this whenever we determine that we can use the Internet to heighten the informational value we are delivering to our subscribers.

Identification of options to preserve gravel road capacity. Once the gravel road capacities at buildout are revealed, a community should take the opportunity to revisit its long-term development goals as they relate to permitted zoning density in areas served by gravel roads. Did the analysis show an unexpected result? Is the community willing to accept gravel road degradation if new development occurs at permitted densities? In many areas, county road agencies may be planning for paving improvements, but are those improvements in the part of the community that the municipality has already zoned for growth? How should the community respond?

If a gravel road will exceed capacity at buildout (or is already over capacity), what actions can prevent further degradation in the gravel road quality? The following options are worth considering:

- Reduce density overall. If densities in the zoning ordinance create more traffic than gravel roads can accommodate, the community may be able to scale back zoning density to better match road capacity.
- Transfer density to an area where that is more appropriate, such as areas with existing utilities, paved roads, etc.
- Concentrate density where there is access to a paved road.
- Preserve more land surrounding low-capacity gravel roads in an undeveloped state.
- Add significant urban infrastructure including paved roads where more intensive development is desired.
- Short of paving a road, significant improvements could be made to the gravel road to allow higher traffic volumes. Table 3 provides for alternatives to paving when new development will exceed existing capacity, but will generate less traffic than that necessary to pave a road.

TABLE 3. POTENTIAL GRAVEL ROAD IMPROVEMENTS BASED ON EXISTING TRAFFIC VOLUMES

Design Feature	Under 400 Vehicles Per Day	400 to 800 Vehicles Per Day	800 to 1,000 Vehicles Per Day	Over 1,000 Vehicles Per day
Surface (with adequate substructure)	4'' Natural Gravel	6'' 23A Gravel	6'' to 8'' 23A Limestone	• Requires improved design • Paving likely • Traffic impact analysis of project necessary to determine options and allocation of responsibility for making and paying for improvements
Surface (with adequate substructure)	4'' 23A Gravel	6'' 23A Gravel (consider sand subbase)	6'' to 8'' 23A Limestone (consider sand subbased or biaxial geogrid)	
Drainage	Eliminate ponding water	Eliminate ponding water and erosive cuts in the roadway	Establish roadside ditches	
Width	18'–20'	24'–28'	30'–34'	
Clear Zone	As required for maintenace	As required for maintenance and outside of flow lines	Beyond flow line of the ditch	
Vertical Alignment Stopping Sight Distance Goals	35 mph	35 mph	45 mph	

ALTERNATIVE APPROACHES TO INTEGRATE THE NEW INFORMATION INTO LOCAL PLANS AND ZONING REGULATIONS

The following options for zoning regulations matched to gravel road capacities are presented in the guidebook, along with sample ordinance language and corresponding sample master plan language.

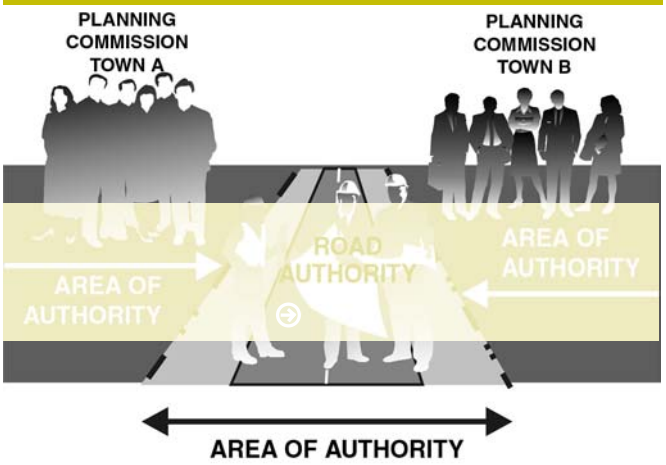
- *Option One*: Enhanced permit coordination between local governments and the local road agency. Under this option, a community does not approve a site plan before the local road agency reviews a driveway permit application and vice versa.

OBTAINING THE GUIDEBOOK

How Much Development is Too Much?: A Guidebook on Using Impervious Surface and Gravel Road Capacity Analysis to Manage Growth in Rural and Suburban Communities was written by Kris Olsson and Elizabeth Riggs of the Huron River Watershed Council, along with Michele Manning and Mark Wyckoff of the Planning and Zoning Center, Inc. The 71-page guidebook provides the reader a "how-to guide" on conducting impervious surface and gravel road capacity analysis. In addition, the appendices contain model plan and ordinance language along with white papers that document the technical details of the impervious surface and gravel road capacity analysis.

Copies of the guidebook can be purchased from the Huron River Watershed Council, 1100 N. Main Street, Suite 210, Ann Arbor, MI 48104; ph 734/769-5123 for the cost of postage and handling, which depend on the number of copies ordered. The document can also be downloaded at http://comnet.org/hrwc/program/restopic.htm.

THE MISSING LINK—INTEGRATING TRANSPORTATION AND LAND USE DIVISIONS



WHY CARE ABOUT GRAVEL ROAD CAPACITIES?

- It is especially important to a rural community that values gravel roads as a part of its rural character.
- It is important if the community has zoned or planned for development at densities that warrant paving, but paving is not planned for.
- If available funds for road construction are low, then paving roads may be beyond a community's financial means.
- Land-use decisions that increase traffic on gravel roads are made by local governments and not by the road agencies that pay to maintain the roads.
- This is one way to achieve better integration of land-use and transportation decisions (see figure at left).

Each would condition permit approval on the grant of a permit by the other.

- *Option Two*: If allowed under state law (or if state law could be amended), the local road agency could explicitly deny a driveway permit where the development to be served would put the gravel road over capacity. If the number of dwelling units were reduced to be below the available gravel road capacity, then the driveway permit would be issued. Alternatively, if the road were improved so that capacity were increased sufficiently to accommodate adequately the traffic from new dwelling units, then the driveway permit would be issued.
- *Option Three*: "By right" density is tied to available gravel road capacity, and higher density is available by special land-use permit only if the road is paved. This approach has been used in Oakland Township, Michigan, for over 15 years. It avoids downzoning litigation and provides a mechanism for ensuring that gravel roads are paved when development density is high enough to need it.
- *Option Four*: Use the level-of-service ratings and capacities from Table 2 as a basis for the gravel road portion of an adequate public facilities ordinance. This approach ensures that no new development occurs until all the major public facilities the development will affect are determined to be adequate.
- *Option Five*: A community could create incentives to concentrate development or transfer of development rights (TDR) from areas served by gravel roads to areas where facilities (especially paved roads) are adequate.
- *Option Six*: Clustering development where access is gained from a paved road and capacities are greater would relieve pressure on gravel roads, if the parcel can be accessed from both a paved and a gravel road.

LOCAL ACTION ON A SELECTED ALTERNATIVE

Finally, engage in a community dialogue on each option considered. It is important to select the option that best advances local objectives and is within the resources available to the community. The municipal attorney and county road agency need to be closely consulted as options are explored.

Once an option is adopted, monitor and refine the ordinance language as needed to best achieve the community goals and minimize legal risks.

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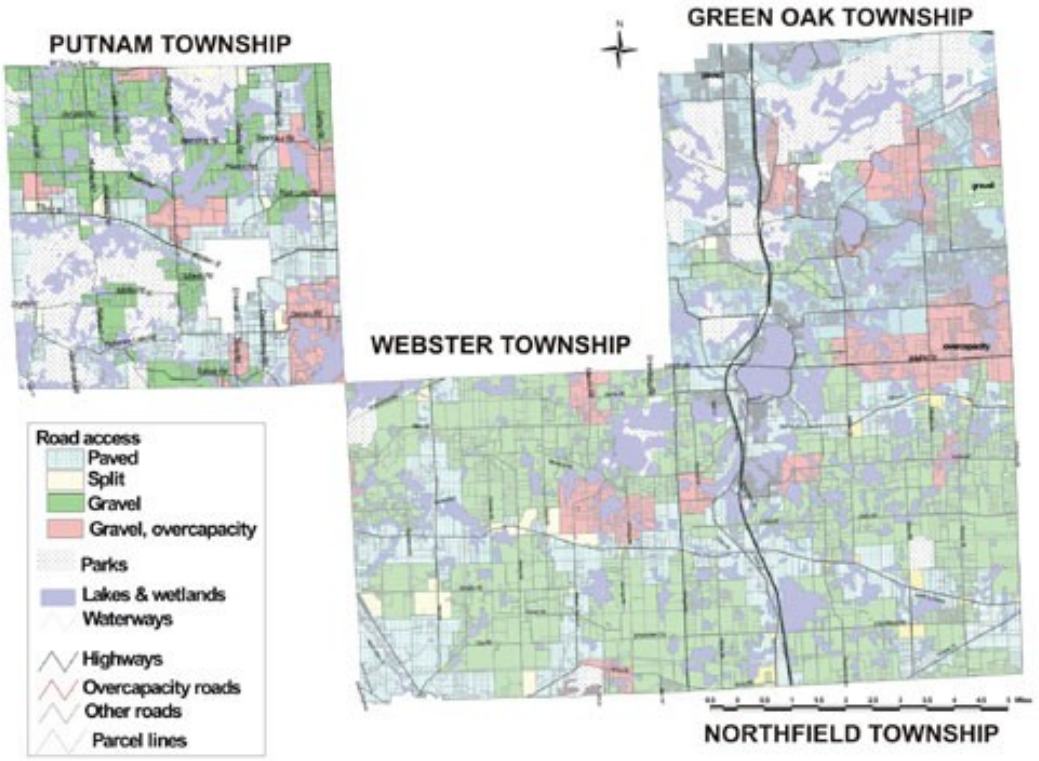
Map 4: Existing Gravel and Paved Road Capacity in the Four Pilot Townships



Map 5: Gravel and Paved Roads in the Four Pilot Townships at Buildout