Easing the Bumps in the Road: An Information System for the Management of Grafton's Roads

An Interdisciplinary Qualifying Project
Submitted to the faculty of
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in partial fulfillment of the requirements for the
Degree of Bachelor of Science

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ABSTRACT

This project created a reusable GIS map layers for roads and road-related assets in the town of Grafton. The team inventoried roads and signs in the whole town and guardrails and sidewalks in the target area. Information such as condition, sign type, guardrail end treatment, or sidewalk material was entered into the GIS layers so that the town of Grafton has a reusable information system of its current assets. Our project also demonstrates the reusability of the database for future use by the town for paving, snow plowing, and most importantly GASB-34 analysis.

AUTHORSHIP

This report is a joint effort on the part of all project team members; however each individual chose an area of specialization to focus upon. Tantra worked largely on the GIS component of our project and created the poster. Sean worked primarily on collecting field data. Rachel served as the group's primary writer and did background research. While each section of the report could have originally been written by an individual group member, the final report was completed through equal contribution of each group member.

ACKNOWLEDGEMENT

The authors of this Interactive Qualifying Project would like to recognize all the people who helped make this project successful. We would like to thanks our advisors Fabio Carrera and Robert Hersh for their excellent guidance. Additionally, we would like to express our appreciation for the opportunity to work on this project provided by Natalie Lashmit. We are grateful for the support provided by Roger Hammond in helping us understand and obtain the necessary information to produce the final product. Finally, we would like to thank all the staff and faculty of both Grafton Department of Public Works and WPI, who helped arrange this opportunity for the team to participate in such a great learning experience.

Executive Summary

The team members, Tantra Budiman, Sean Durrigan, and Rachel Pennellatore, worked with the Department of Public Works in the town of Grafton, MA from August 2006 through May 2007. The mission of the project was to help the town of Grafton efficiently maintain its roads in a proactive manner. The business of maintaining roads and assets is extremely expensive. In 2004, Massachusetts spent over 450 million dollars on maintenance, while the U.S. spent over 160 billion dollars. Maintaining accurate records of assets and their conditions is vital to the successful functioning of the town.

However, in the town of Grafton, there is no inventory on record. Also, there is no electronic database for updating the inventory. The town of Grafton operates with paper records for road maintenance and this is done on a reactive basis. In this context, the team's main goal was to improve the documentation of Grafton's transportation infrastructure.

This project had four objectives.

1. To inventory all the roads and signs owned and maintained by the town and to also inventory the sidewalks and guardrails within a target area of Grafton chosen for its diverse representation of the town.
2. To assess the condition of all signs in the town, along with the conditions of roads, sidewalks and guardrails within the target area.
3. To identify future maintenance needs and demonstrate the reusability of data, and
4. To recommend mechanisms to keep information up to date.

Field work was done by manually tracking down the assets and recording their location along with a number of important attributes. Each asset was assigned a condition and entered directly into a Geographic Information System (GIS) on a laptop brought into the field. The team mapped these assets onto the GIS layers of the town to create a series of thematic maps crucial to an accurate and current inventory.

The team inventoried all of the roads of Grafton, totaling 120.8 miles. Attributes recorded included name, length, material, condition and ownership. All roads were broken down into segments to be better identified and given a unique identification code. Figure 1 shows the map of all of Grafton's roads.

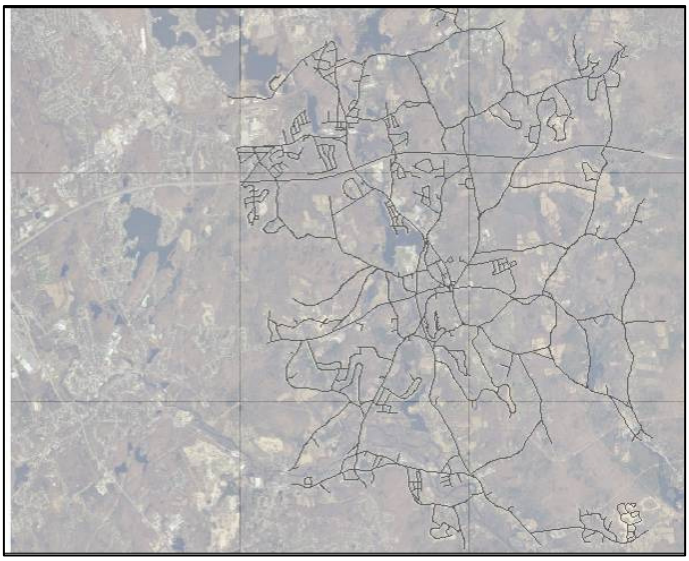

Figure 1 Roads in Grafton

The team also inventoried most of the signs in Grafton, excluding those on state or privately owned roads totaling 835 signs. Attributes for signs included type, class, shape, condition and pole material. These too were each given a unique identifying code. Figure 2 shows the signs inventoried by the team.

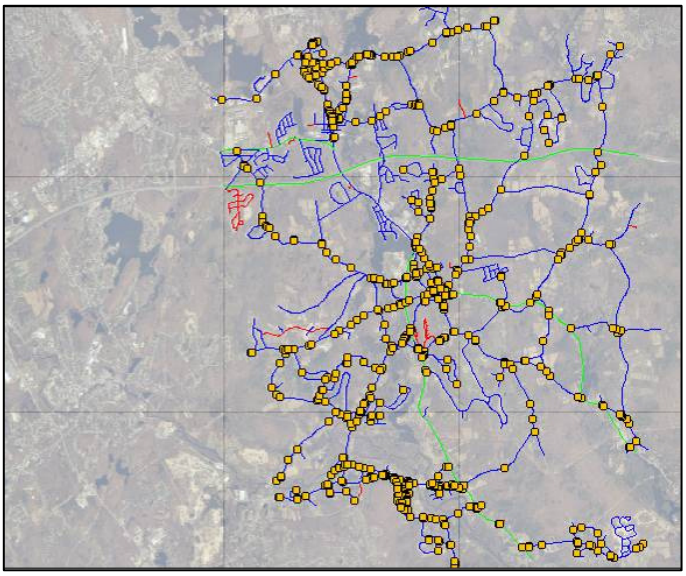

Figure 2 Signs in Grafton

In the target area, the team inventoried 29,746 feet of sidewalks, along with recording their length, condition, and material. Sidewalks were also segmented into smaller areas, again with an individual identifying code. Figure 3 is a map of the sidewalks inventoried by the team.

Figure 3 Sidewalks in Target Area

Finally for guardrails, the team inventoried 2,278 feet of guardrails in the target area and recorded their end treatments, materials, reflectors, condition, and poles. Guardrails also received a unique identifier for database purposes. The inventory of guardrails in the target area is shown in figure 4.

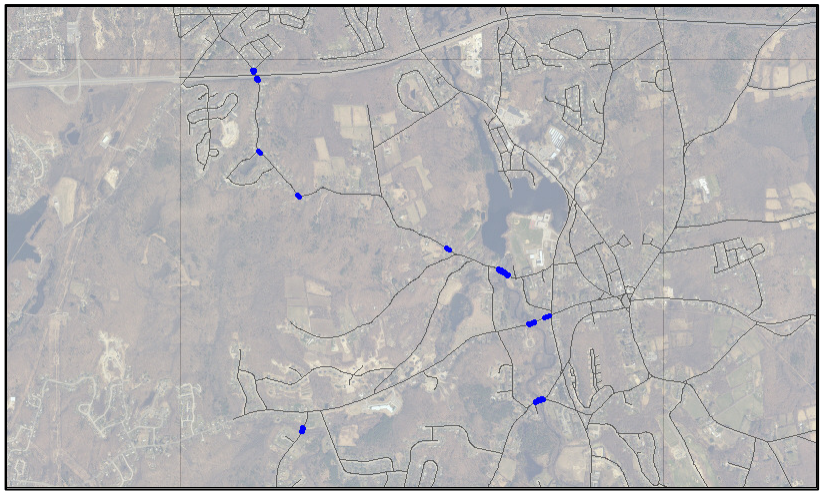

Figure 4 Guardrails in Target Area

For the purposes of assessing conditions, the team created a system based on the MassHighway Pavement Distress and Rehabilitation manual for roads and sidewalks and MassHighway Standards Manual and also on the Manual for Uniform Traffic Control Devices (MUTCD) for road signs. For guardrails, the team created their own criteria based on MUTCD. Assets were graded on a poor to excellent scale, with the number one indicating poor condition up to a five indicating excellent condition.

Once the inventory and assessment were done, the team produced a series of recommendations. The first focused on assets that were in poor or below average condition. The team recommended these assets be prioritized for maintenance for safety reasons and provided a cost estimate. Table 1 shows the cost to upgrade the roads, signs, sidewalks, and guardrails with poor and below average conditions. Figure 5 shows the location of all the assets in poor and below average conditions. Detailed locations of each asset are shown in chapter 5.2

Table 1 Cost to upgrade poor and below average condition assets

Assets	Total length/number	Cost per	Total cost
Sign	95 signs	$250/sign	$23,750
Road	5,353 feet	$39.60/foot	$211,978
Sidewalk	433 feet	$20/foot	$8,660
Guardrail	1,037 feet	$20/foot	$20,740
		Total	**$265,128**

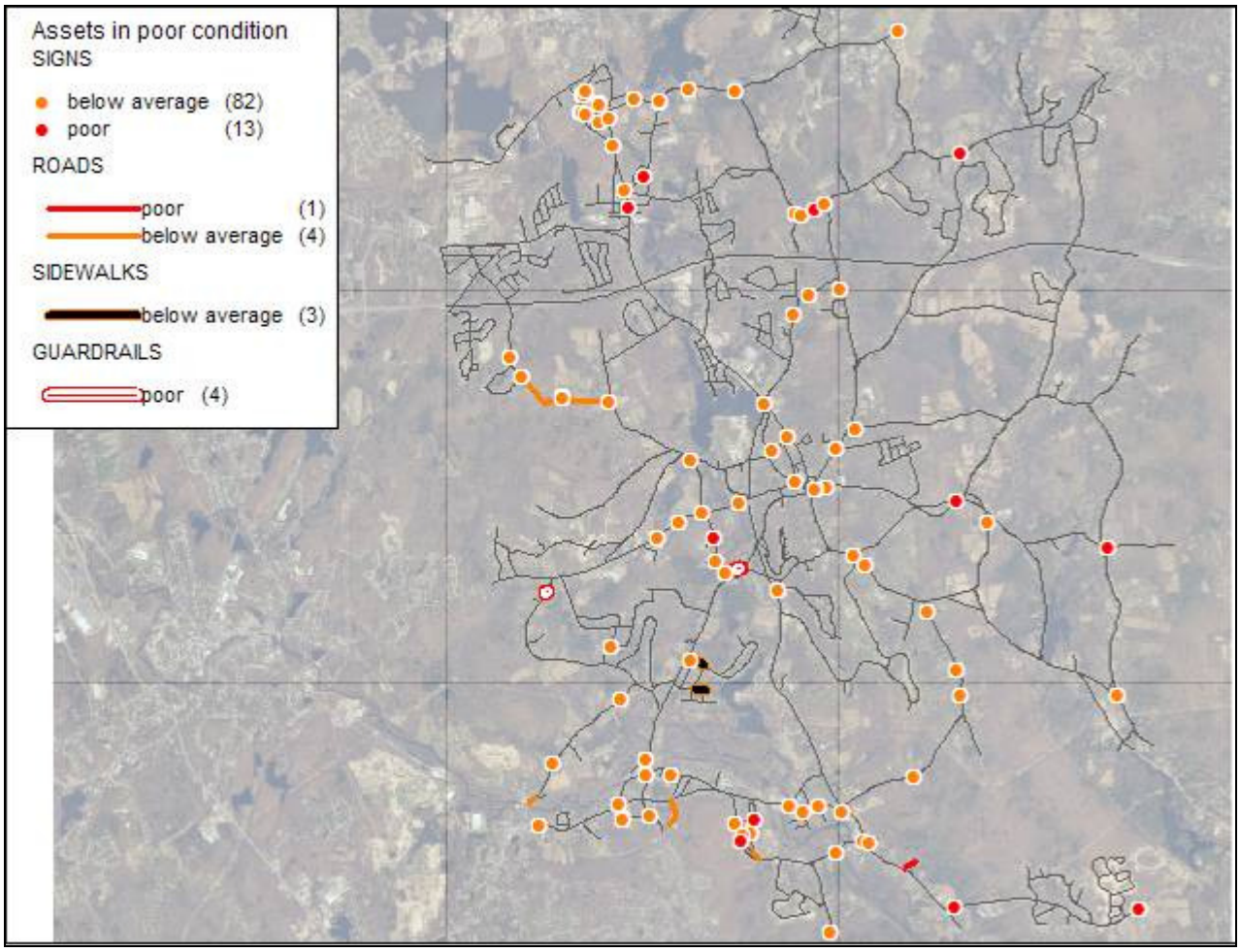

Figure 5 All assets in poor and below average conditions

Our second recommendation related to the inventory of road assets. The team managed to inventory all roads in Grafton, almost all road signs in Grafton, and the sidewalks and guardrails in the target area. We recommend that the town completes the inventory so that the data can reflect the total assets that the town has. Table 2 shows the estimate of the total assets left to inventory.

Table 2 Estimated total number of assets left to do

Assets	Estimated assets for the town of Grafton	Total assets that the team assessed	Total assets left to do
Signs	908 signs	835 signs	73 signs
Sidewalk	99,086 ft	29,746 ft	69,340 ft
Guardrail	7,560 ft	2,278 ft	5,282 ft

Besides completing the inventory, the team also recommended how the road data could be used in the future by DPW. The data could most obviously be used to keep track of the town's road assets and also to track the condition of each asset. Other possible use of the data collected include GASB-34 analysis, plowing, paving, and painting costs for the roads, accident analysis and prevention, and planning emergency vehicle routes. These uses would require input of additional attributes into the database such as width of the road and date of installation. Table 3 shows the additional attributes that would need to be incorporated into the additional analyses.

Table 3 Additional attributes for further usage of the database

Attributes	Use
Width	Paving, crosswalk painting, plowing passes, emergency vehicle access
Traffic flow	Predicting the life expectancy of road, prioritizing road maintenance
Installation date	GASB-34 compliance, prioritizing road maintenance

The team also recommended the town to require developers of new roads in Grafton to submit all topographical data of a new road construction in electronic form and to establish penalties for non-compliance. These recommendations would save the town manpower and money and ensure accurate record keeping. This process is shown in Figure 6.

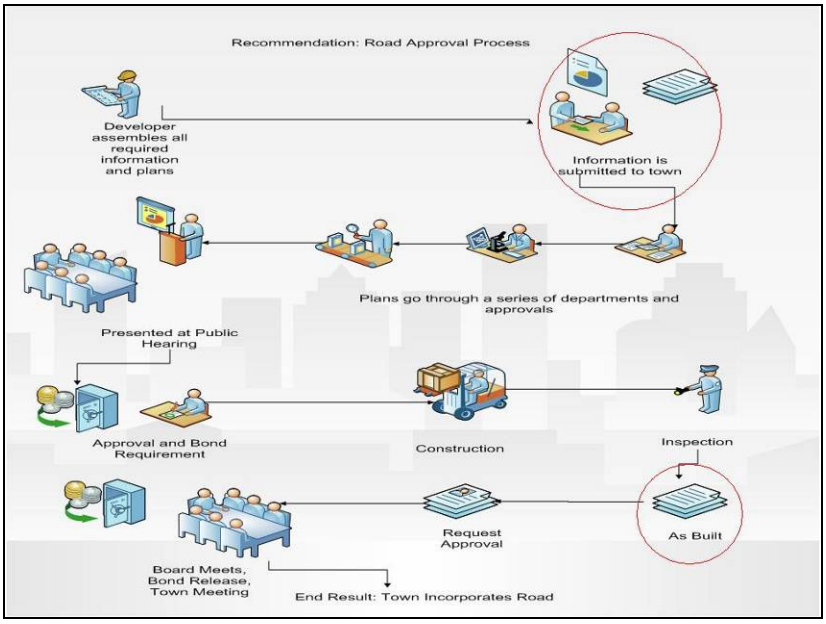

Figure 6 Recommended road approval process

The team also recommended the town to improve communication between DPW and local police and private contractors so as to ensure accurate and updated conditions of road assets in the database. This recommendation is shown in Figure 7. Currently, there is no direct communication between a developer and local police with the Department of Public Works (DPW) in Grafton. This communication channel would help DPW staffs obtain the up-to-date condition of the town's assets.

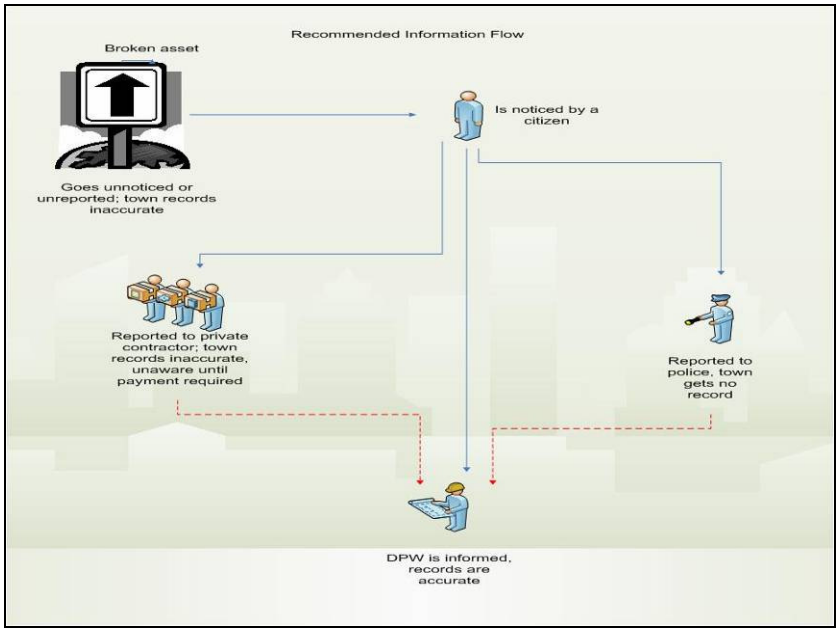

Figure 7 Recommended communication flow

The team worked throughout the year to provide Grafton with the methods to successfully inventory and assess its road infrastructural assets. The team tested its theories and methods on the roads of Grafton and was able to accurately report and record data, in addition to performing many types of evaluations and analyses. With our recommendations, we believe that Grafton can successfully implement the methods shown in this report to achieve better maintenance and management of its road assets while also improving safety.

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1 Introduction

There are many responsibilities and powers that are held by a government. Citizens give up individual rights and powers and bestow them upon the government in order for the betterment of the society as a whole. Public works is a large part of ensuring a town or city runs smoothly. Within a town, roads are one of the most important public works assets. Good road conditions and timely repair are essential for the daily life and safety of the town. In order to effectively do this, there must be an easy and accurate system in place to monitor these assets.

In the U.S., according to a 2004 survey, there were 3,981,512 miles of road. [1] Massachusetts itself had 35,592 miles of public road, over 87% of which is maintained by local governments.[2] The state of Massachusetts spent over 609.5 million dollars since 1994 on road construction and maintenance.[3]

Currently Grafton does not have system where it monitors all assets and their conditions. Their records may be scattered among repair companies or police departments, or not filed. This causes them to perform more reactive maintenance. Since Grafton does not have the mean to monitor its assets, repair is done when the infrastructure is in a poor condition rather than through preventative maintenance. To address this issue, our team created an information system that would make this data accessible and help Grafton keep track of its maintenance and repairs.

Our team's goal was to provide the city of Grafton with an inventory of all its road infrastructure assets and to evaluate the conditions of those assets. Our team did the field work necessary by first marking the location of all important assets. We assessed the condition with a number of standards, some from the state of Massachusetts and some through a created ranking system. Our team also recorded information about the other attributes of the infrastructure such as type for road signs and end treatment for guardrails. This information used by the Department of Public Works to archive necessary information and to keep its information current.

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[1] U.S. Department of Transportation, U.S. Highway Administration. *Highway Statistics 2005 Public Road Length Table HM-20*. Washington, DC: 2006, http://www.fhwa.dot.gov/policy/ohim/hs05/pdf/hm20m.pdf.
[2] U.S. Department of Transportation, U.S. Highway Administration. *Highway Statistics 2005 Federal-Aid Highway Length - Table HM-14*. Washington, DC: 2006, http://www.fhwa.dot.gov/policy/ohim/hs05/pdf/hm14m.pdf.
[3] Executive Office of Transportation. *Massachusetts Transportation Facts*. Boston, MA: Bureau of Transportation Planning and Development, 2004, http://www.eot.state.ma.us//downloads/factbook.pdf.

Through this information system, Grafton can start to anticipate repairs and maintenance costs and do more preventative maintenance. Assets that are in need of maintenance can be identified before they reach a state of total disrepair. The detailed mapping can also help Grafton manage other aspects of city life such as road work, traffic patterns, mail, and bus routes.

With the information system created, DPW staff can update and access any information about the road infrastructure. Information such as value, installation date when available, location, and attributes of any asset will be easily available.

2 Background

In this background chapter, we will discuss how roads have become a very important and costly utility to people in their daily lives. Every year, millions of dollars are spent to maintain the condition of infrastructures to ensure the safety of the users.

2.1 ROADS AND RELATED ASSETS

Roads and their infrastructures, despite not having a long history, have quickly become an integral part of society. This infrastructure such as guardrails, traffic signs, traffic lights, and the road network itself, have become indispensable to the millions of people using them every day. Since the invention of the car in the early 1900's, the number of automobiles has grown exponentially. As of 2002, there are 4.6 million registered vehicles in Massachusetts.[4] That number was up 25 percent from 1992 data. With that many vehicles on the road, transportation maintenance is critical in this state.

Most people on the roads take for granted the work that goes into making sure the roads are properly maintained and safe. Roads must be in good driving condition, and the signs and lights on them ensure the safety of travelers. In most cities and towns in the U.S., the Department of Public Works is responsible for the conditions and maintenance of this infrastructure.

"Roads are one of the most expensive responsibilities that towns have," said Bob Mumford, transportation program manager with the Cape Cod Commission, the regional planning agency[5]. In Massachusetts, road construction projects statewide totaled over $4.2 billion dollars per year for the past seven years.[6] Transportation spending is expected to average $ 610 million dollars per year for the next five years[7].

Massachusetts has 122 maintenance facilities statewide, and data collected by the Highway Department shows the conditions of state-maintained highway in Massachusetts

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[4] Executive Office of Transportation. *Massachusetts Transportation Facts*. Boston, MA: Bureau of Transportation Planning and Development, 2004, http://www.eot.state.ma.us//downloads/factbook.pdf.
[5] Frederick Melo. "Cape's Infrastructure is Old, Overburdened, and Expensive to Maintain." http://archive.capecodonline.com/special/capecar/rulesof5.htm (accessed January 24, 2007).
[6] Massachusetts Highway Department, Commonwealth of Massachusetts. "Transportation Facts." http://www.mhd.state.ma.us/default.asp?pgid=content/transfacts01&sid=aboutText (accessed February 23, 2007).
[7] ibid

in 2002 (Figure 8). Conditions were assessed based on a standard set forth by Mass Highway.

Condition	# of Miles	Percent
Excellent	914	37.8%
Good	893	36.8
Fair	478	19.8
Poor	135	5.6

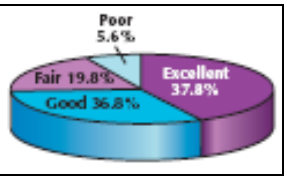

Figure 8 Conditions of state-maintained highway in Massachusetts

2.2 CREATION AND INCORPORATION OF ROADS

When a town decides that it wants to build or incorporate a private road as town property, there are a series of steps that must be taken before that happens. Step one is to form a road association. The association may be made up of abutters of one or several roads with a common interest. Secondly, the road association must have preliminary discussion to determine if they would like to road to become a public way. The town would accept responsibility for maintenance of the road, but abutters lose control of the road. In step three, if the association decides it would like the road to be public, ownership of the road is determined. Roads may be owned by subdivisions, contractors, creators, heirs, or other associations. Next, it is determined whether any additional land is required. Towns have standards such as minimum width, turning radii, and turnaround dimensions. If the existing road does not meet town requirements, negotiations must be entered into with the abutters to acquire the necessary extra area. Private property such as fences or mailboxes may remain on the town road at the discretion of the Commissioner, but will not be the responsibility of the town. The next step is to determine any improvements that the road requires. Standards are described in state manuals. The Road Committee may make recommendations to the town meeting when the road is considered for transfer to town property. The cost of any improvements will be paid by the Road Committee, as the road will not yet be town property. Step six is to review everything and decide to proceed. Once all the information about costs, improvements, and properties is gathered, the committee should review and reaffirm its decision to incorporate the road into the town. Once it has done that, the Road Association must acquire the title to the road. A deed for each area used to create the road must be gotten, and the road will be

mapped and described. This will allow the Registry of Deeds and the Commissioner to clearly determine the boundaries of the road.[8]

Next, the Road Association must pay the costs of the road necessary to meet the minimum of required standards set forth in any ordinances. Once that is done, a request is made to the Road Committee to inspect the road. The road is inspected for any deficiencies, and the committee is advised of how to proceed. A deed is then drawn up granting the road to the town, including all land under and space over the road. In the final step, the Road Association must petition the Selectman to create the town road. Included with the petition must be evidence that the Road Association was created legally and with power to operate. Also, they must include minutes from a meeting that prove the road was legally voted on to be given to the town. A statement of the type of road that the committee wishes to make must be presented, along with copies of the maps and boundaries of the road, and the deed giving the road to the town.[9] Figure 9 is a chart of the whole process in a few short steps.

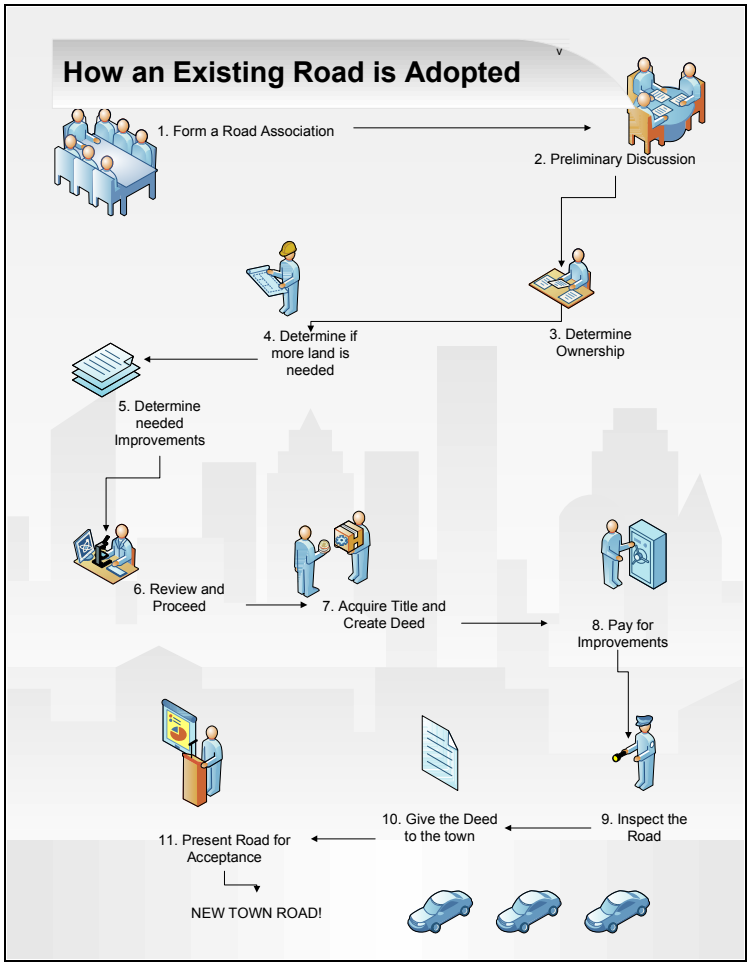

Figure 9 How an Existing Road is Adopted

[8] Grafton town official

[9] Town of Acton Maine. *Acton's Town Business: Creating a Town Way from a Private or Camp Road (Draft)* 2003, http://www.actonmaine.com/town/msc/townway.pdf.

However, many roads that are presented for acceptance are being built by a developer in conjunction with a contractor. New roads are mainly created along with residential subdivisions. The first step is a planning stage which can take between six and twenty-four months. Developers must consider traffic levels, intended usage, environmental and also economic usage, cost, and safety issues.[10] As far as a town's data requirements, the town of Spencer, a town near Grafton, has specific bylaws. They require the plans to have the area of the roads, boundaries, direction, length, and location of existing structures, among other things. They also must include zoning, owner's names and lands that are adjacent, the purpose of the road, and any changes they intend to make.[11]

In the second stage, the design aspect takes place. This can last between 15 and 24 months. Developers and contractors consider the type of road, location, and length and size based on a number of factors including the road's intended function and type of land it is being built on, whether flat, hilly, urban, etc. Preliminary designs are drawn up, and proposed to the owners of the road, and submitted to the town for approval.

In order for the plans to be approved, copies of the plans must be submitted, along with an application and fees. It is then reviewed by the development office and town clerk. Further on, it must also be approved by the Board of Health, a reviewing engineer, the town staff, and the planning board. If approved by all of these people, it then passes to a public hearing in which any citizens may express concerns.

If approved then, the planning board will issue a certificate of decision, and require a bond of the developers in the amount to cover construction and performance costs. Then the developer may begin construction. When construction is finished, he may request an inspection by the town. If the road is found to be in compliance with the requirements and laws, the developer may apply to release the bond held by the town.

The last step is to request approval to become a public road. The planning board will again meet, and discuss the possibility of acceptance. When the planning board votes

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[10] Virginia Department of Transportation. "How a Road Gets Build Fact Sheet." http://www.virginiadot.org/projects/pr-howroadblt.asp (accessed February 13, 2007).

[11] Development and Inspection Services. *Subdivision Regulations Town of Spencer*. Spencer, MA: Town of Spencer, 2007, http://spencerma.gov/1/Files/Subdivision%20Regulations%20for%20Web.pdf.

to accept the road, they will become responsible for maintenance. Figure 10 shows a flowchart of the whole process in a few steps.

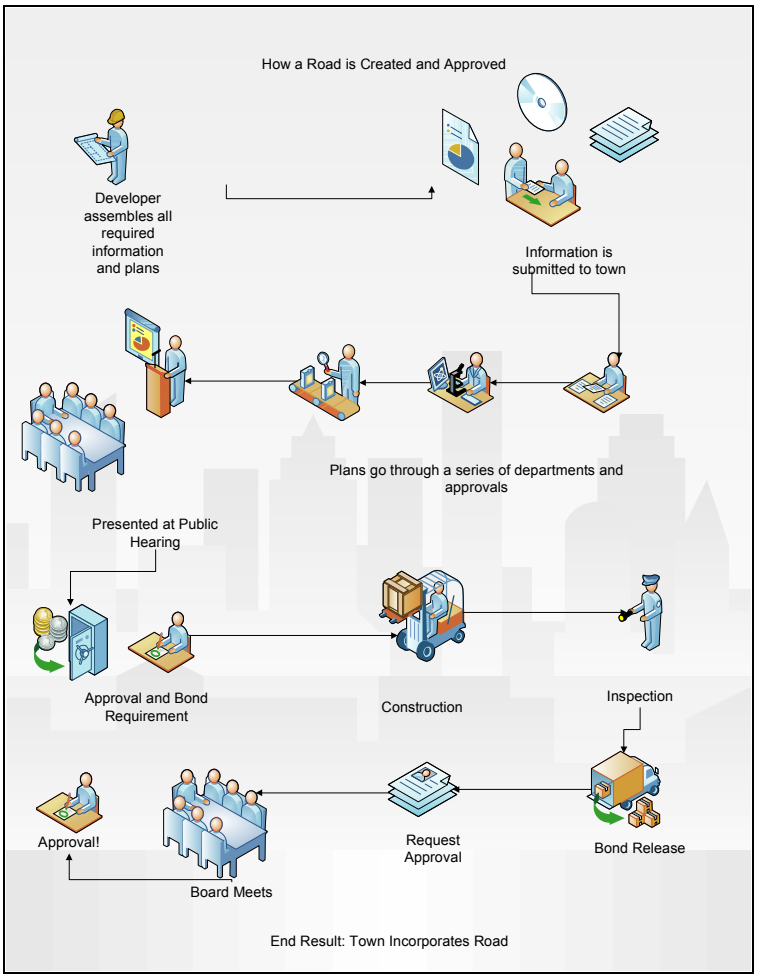

Figure 10 How a New Road is Created and Approved

When private roads become public roads, the governments must have ways of keeping track of their infrastructural assets. They are built to last much longer than any other capital assets. Infrastructures are built at different times and degrade at different rates due to a number of factors such as frequent use, weather, building materials, and capacity. Figure 11 shows the division of roads in Massachusetts in the year 2002.

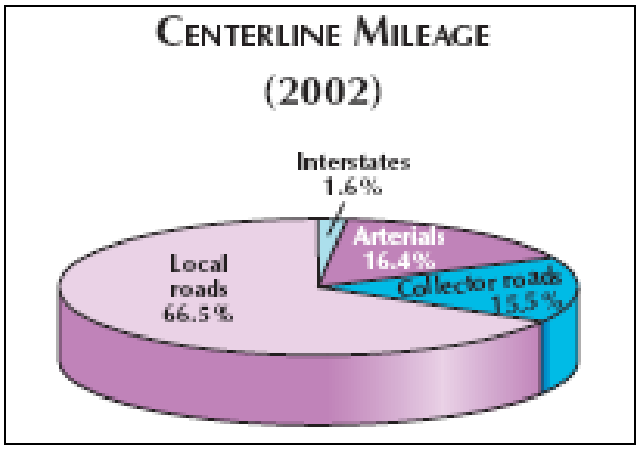

Figure 11 Road Jurisdictions in Massachusetts by length

Arterials refer to main roads or channels with many branches. Collector roads are roads which tend to lead traffic from neighborhood areas and local roads to areas of activity in the community, or occasionally to an expressway or freeway. As we can see from Figure 11, there are more local roads than state-maintained roads. Maintenance of local roads will be hard since the roads are owned by a lot of different towns thus there is a need for a standard so that these towns can maintain the roads in a similar way.

2.3 GOVERNMENTAL ACCOUNTING STANDARD BOARD (GASB)

While keeping track of the condition of the infrastructure itself is important, just as critical is the financing behind it. The cities and towns of Massachusetts get a budget from the state, which usually is not sufficient to cover all of their infrastructural expenses. They also collect revenue from taxes on residents. It is important that budgets can be prioritized on infrastructures that need immediate replacement.

The Governmental Accounting Standards Board (GASB) is a private, non-profit organization that establishes and improves financial standards and accounting for state and local governments. It also helps governments determine their ability to pay debts and provide services to its citizens. It is composed of several members, namely auditors of government financial statements and members of the academic community.[12] The mission of GASB is to establish and improve standards of state and local governmental

[12] Finance Office, City of Saco Maine. "GASB 34 (Governmental Accounting Standards Board)." http://www.sacomaine.org/departments/finance/gasb34.shtml (accessed November 15, 2006).

accounting and financial reporting so that they can produce useful report that can be used for financial report for government, auditors, or any other users.[13]

The GASB-34 statement was issued June 30, 1999.[14] It requires governments to provide a detailed account of the values of not only its roads, but all the related fixed infrastructural assets such as bridges, roads, sewers, road signs, and traffic lights. GASB #34 also defines fixed infrastructure assets as "long-lived capital assets that normally are stationary in nature and normally can be preserved for a significantly greater number of years than most capital assets…"[15]

By using the GASB-34 report, the state government, auditors, and others can then assess the fiscal needs of each local government, prioritize investments, and allocate funds as needed. This report is required annually. Over time the reports, if carried out properly, can show improvements in budget management, and predict future maintenance needs.

The aim of the GASB report is to maintain a detailed record of the value of local inventory, and to determine the needs of the local governments. The report could help both the state and the towns to analyze debts and assess eligibility for federal loans. It also provides a picture of the services provided to the citizens, and at what operating costs. In simpler terms, GASB forces towns to operate more like a business, by knowing the exact values of their assets. With that information available, they can look at the different portions of the budget they allow versus the value of the infrastructures. A good business policy is to allow ten percent for maintenance and repair. According to Grafton town official, Grafton allocates far less than the recommended 10 percent.

One mentioned benefit of the GASB # 34 method is called "proactive maintenance."[16] The theory behind proactive maintenance is that spending one dollar on preventative maintenance at the appropriate time in the asset's serviceable lifetime may save up to four dollars for future maintenance costs. The GASB #34 required conditions

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[13] Governmental Accounting Standards Board. "GASB-34." http://www.gasb.org/repmodel/index.html (accessed September 19, 2006).
[14] Cagle, Ron and Brad Lanning. "GIS-Based Compliance with GASB 34: An Illustration." Myrtle Beach, SC, Jordan, Jones & Goulding, Inc, March 17-20, 2002, http://www.sc-ec.org/PDFs/2002SCEC/24GIS%20Based%20Compliance.pdf.
[15] Finance Office, City of Saco Maine. "GASB 34 (Governmental Accounting Standards Board)." http://www.sacomaine.org/departments/finance/gasb34.shtml (accessed November 15, 2006).
[16] Fairfax County Virginia. "Asset Management." http://www.fairfaxcounty.gov/dpwes/wastewater/asset_management.htm (accessed March 4, 2007).

and values can help predict the best time to perform preventative maintenance. The ultimate goal is to reduce spending while increasing the life span of the infrastructures.

In order to comply with GASB-34, towns must submit a complete annual financial report. Contained in the report must be the accurate monetary value of each infrastructure component the town must evaluate. The value is determined by the age and condition of each asset. Towns will have on record the installation date of each asset and the conditions can be determined by referring to state issued manuals outlining and providing standards for each condition level. Public workers must go out into the city or town and manually assess each infrastructure. It is very time consuming and requires a manpower that some cities or towns do not have. Other towns in Massachusetts are fortunate enough to either have that manpower readily available to them, or have already implemented an information system for tracking their assets. Grafton, however, does not have adequate personnel to conduct these assessments, nor does it have in place an online system of reporting. Our project created an information system so that the town of Grafton can keep track of its road assets and eventually comply with GASB. A little history of Grafton and how the town currently maintains its road assets will be explained in the following section.

2.4 THE TOWN OF GRAFTON

The town of Grafton is located in Massachusetts, southeast of Worcester. It was named for Charles Fitzroy, Duke of Grafton. In 1724, the original 40 proprietors of Grafton petitioned to buy 7,500 acres of land from the Indian owners. It was established in 1735 after being split off from Sutton as one of three towns founded to Christianize the Nipmuck Indians living in the area. In earlier times it was known as the Plantation of Hassanemesco, which means "place of small stones." Early business in the town centered on the manufacturing of textiles, and mills characterized the town. The town was made up of six villages, characterizing individual community centers.[17] Last census data (2000) indicates that 14,894 people reside in the town, which spans just 22.83 square miles. That was a significant increase as the 1990 census data only showed a population of

[17] "Grafton, Massachusetts." City-Data.com. http://www.city-data.com/city/Grafton-Massachusetts.html (accessed November 26, 2006).

approximately 8,800 people. The town of Grafton contains 84 miles of road that is maintained by the town itself, with an additional 19 miles of highway maintained by the state of Massachusetts. [18] Route 122 and Route 140 both pass through Grafton.

In the town, there are only five roads which remain unpaved, three of which are privately owned roads. Grafton has also looked at recent studies conducted by traffic analysts in the area, which indicate that the traffic flow is expected to increase by one percent each coming year, more than twice the state average according to Grafton official.

Grafton takes its pride on being what Roger Hammond, the Director of Public Works in Grafton, has called a "bedroom community." It is comprised primarily of residential areas. Due to zoning regulations, there are not many areas that allow commercial enterprise. Also, there are not many large tracts of land that would be needed to establish larger businesses. However, the town has seen a steady upward trend in new housing. In 2005, approximately 225 new housing plots were started, with the option still for 500-600 more available.

Grafton had total available revenue of $36, 169,766 for the 2006 fiscal year.[19] Of that amount, $19,774,960 was raised in taxes. Added to that was $8,305, 410 from the state of Massachusetts. An additional $3,861,000 was through local receipts, which are fees that the town collects through things like dog licenses, zoning permits, gun permits and other permits for which the town charges its residents. In free cash, which is money left over from last year's budget, the town collected $600,000. There is also a stabilization fund, which was described as money which the town just saves, which pulled in $516,932. Grafton is a town which is very conservative in its spending.

The records of its assets are not as detailed and accurate as its financial position. Currently, the town is using paper record which is highly inefficient. Paper records could be damaged over time, lost, or could be hard to keep track of due to the sheer volume of papers which have accumulated in the course of the years. The town would also like to see a digital conversion for security purposes. For instance, a fire could destroy paper records, but a digital file could be backed up and stored elsewhere. Additionally, paper records allow for mistakes in simple communication such as illegible handwriting. An

[18] Grafton town official
[19] Grafton town official

online system would eliminate smaller mistakes. In addition, Grafton does not have on record any of the installation dates of their road infrastructures. Roger Hammond says the only indicator would be the material used. For example, in the 1980's, most guardrails in Grafton were built of wood, while more modern ones are steel, yet no specific date will be able to be found. It also lacks data on how many infrastructures it actually owns.

Grafton currently maintains their infrastructure on more of a reactive basis. It repairs broken or malfunctioning infrastructures as it gets reported to them. Its maintenance funding comes from the annual budget. The Department of Public Works would like to be more proactive, but funding is limited and plans for projects must be presented in a five year plan and approved before work begins, and inflation can elevate costs far beyond the original estimates. During repairs, Grafton deals with maintenance through contracting, because it does not have the equipment to handle it themselves. Mainline paving, electrical work, and plumbing all must be hired out as Grafton cannot do the repairs itself.

3 Methodology

This project was intended to help the Department of Public Works of Grafton, Massachusetts maintain and manage its road-related infrastructures by computerizing current paper-based system.

The objectives of our project are:

5. To inventory all the roads and signs owned and maintained by the town and to also inventory the sidewalks and guardrails within a target area of Grafton chosen for its diverse representation of the town.
6. To assess the condition of all signs in the town, along with the conditions of roads, sidewalks and guardrails within the target area.
7. To identify future maintenance needs and demonstrate the reusability of data, and
8. To recommend mechanisms to keep information up to date.

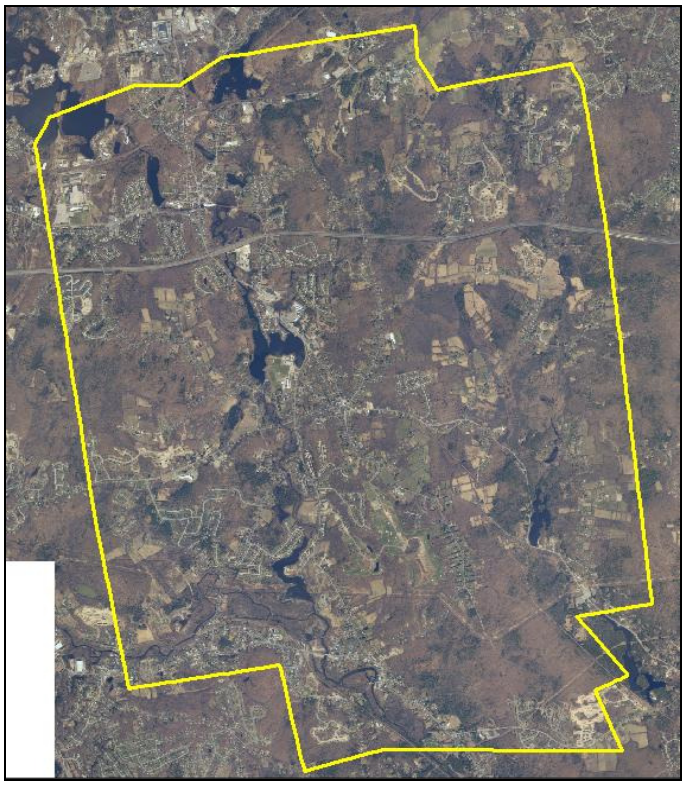

Figure 12 Town Boundary of Grafton

The focus of the project was to inventory and assess the condition of public roads and its related infrastructures in the town of Grafton, Massachusetts. For assessing roads, we used the Massachusetts Highway Department pavement handbook as a guide for the extent and severity of road damage. For other infrastructures such as guardrails, traffic lights, street signs, and sidewalks we used similar condition assessment standards that had been used in other projects. Finally, we used MapInfo software to develop a GIS based mapping system that incorporates associated

attributes for each infrastructure, such as length, condition, and location. Figure 12 shows the boundaries of the town of Grafton, with figure 13 showing our focus target area outlined in blue.

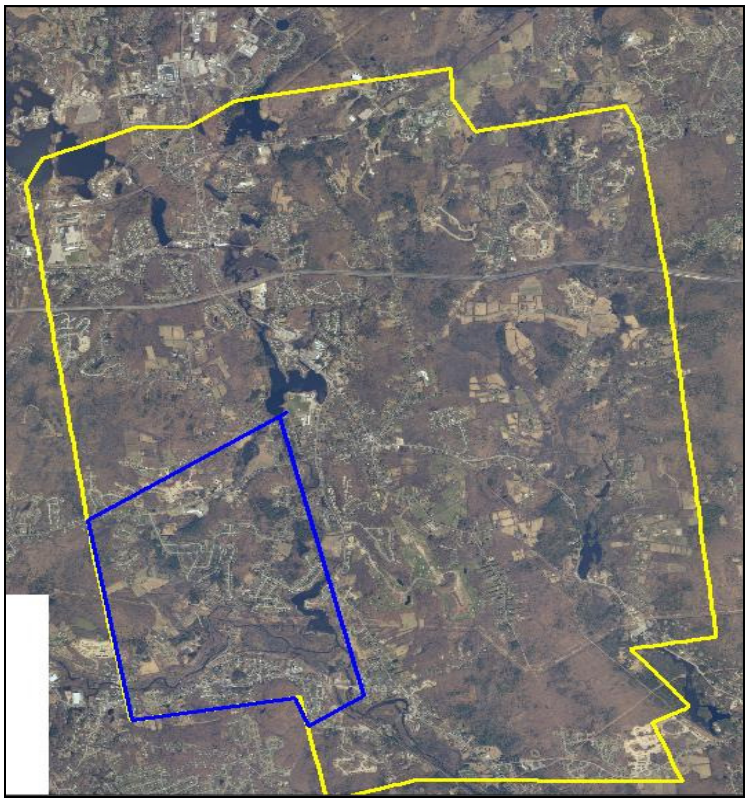

Figure 13 Target Area of Grafton

3.1 INVENTORYING ROADS AND RELATED ASSETS

In order to estimate the value of road and road related assets, it was important to determine the major road assets that would be incorporated into the system. Before the assets could be identified, it was necessary to create a unique ID for each segment of road. The ID would consist of the name of the street followed by numbers. We inventoried the roads and the following road related assets:

- Signs
- Sidewalks
- Guardrails

Certain attributes were also needed to be recorded for other road related assets. These assets must receive their own ID, like the roads, so that each one was unique and its unique attributes could be recorded. Since we were taking our data in segments, the

ID began with the street name on which it is located. Next was two letters to describe which type of road asset it is. These ID's were listed as follows: SW= sidewalks; GR= guard rails; SS= street signs. Each individual asset received a unique ID number at the end to distinguish it from other assets located on the same street. For example, a guard rail on Worcester St. would have the following ID: WorcesterSt_GR_001.

The physical characteristics of the roads and their related assets were required to determine their value, so it can be used to comply with GASB-34. It was also vital to record this information so that it is easily accessible by the town of Grafton. In order to do this, we determined the attributes that were embedded into each segment or infrastructure.

The data for all of this information was recorded by using portable computer out in the field. Digital pictures were taken to provide examples of varying conditions for roads and assets.

3.1.1 Inventorying Roads

Using the map layer of Grafton, MA given to us by the sponsor, we generated road segments between intersections. Attributes that were important, such as length and condition, were added to these segments. The road attributes that we chose to study were length and conditions. The section of the road with the minimum width can be determined by using tape measure. Unfortunately, due to time constraints, the team did not measure a numerical value for minimum width of the roads. Private and state owned roads were not inventoried; their maintenance is not the responsibility of the Grafton Department of Public Works. The length of a road was easily given in feet from the centerline layer in MapInfo.

3.1.2 Inventorying Signs

The type, pole material, condition, and location of signs were recorded. The number of signs in total was recorded for town data management, along with signs that still need to be replaced in the town. Types of signs was recorded and checked for visibility and legibility. Some signs share a steel pole or wooden pole. For this case the signs were placed in close proximity of each other in MapInfo. By doing this, all of the

signs are visible, and anyone physically in that part of Grafton will know that those signs are located on the same pole.

Due to the large amount of different types of signs, each sign was put in a specific sign class. Base on the Manual on Uniform Traffic Control Devices (MUTCD), we created four classes for sign, which consist of traffic control, traffic warning, information, and caution. Traffic control signs are signs that control the traffic flow. Traffic warning signs let the road users know about certain danger on the road if the users do not follow the signs. Information signs give information for the road user that is not related with traffic flow. Caution signs give warning to the road user regarding danger on the road that is not related with traffic rules.

3.1.3 Inventorying Sidewalks

In the case of sidewalks, the length, condition, materials and location were recorded. The team checked the location with a map of Grafton matched to our own footwork and manual placing of the sidewalk locations and attribute inventorying. Sidewalks, like roads, were segmented at each road intersection. This was done to save time and labor and allow us to move on to other parts of town quicker. A sidewalk segment was not divided where there are driveways. The sidewalk layer in MapInfo will show sidewalks as a continuous line with no breaks where the sidewalk becomes a driveway. Again this was done to conserve time.

3.1.4 Inventorying Guardrails

The condition, material, location, number of poles, and end treatments were recorded for guardrails. Guardrails that are in poor condition and need to be replaced are emphasized in the report. These guardrails are those that have heavy damage due to automobile collisions or have poles that are rotting or heavily damaged. Guardrails on opposite sides of a road were given their own ID. In addition, guardrails that were separated by an object such as a bridge or driveway were considered separate assets and given their own ID.

3.2 ASSESSING THE CONDITION OF ROADS AND RELATED ASSETS

This section will demonstrate how the team created a system of condition assessments and how they applied to the roads and related assets of the town of Grafton.

3.2.1 Assessing the Condition of Roads

Figure 14 Excellent Road

Figure 15 Above Average Road

Figure 16 Average Road

Figure 17 Below Average Road

Figure 18 Poor Road

The condition of roads was rated on a scale of one to five; five being excellent condition and one being poor. This takes into account four forms of pavement distress that may devalue the road, all of which are defined in the Massachusetts Highway Department Pavement Distress and Rehabilitation Manual. There are surface deficiencies such as potholes, flushing, delamination, raveling, and weathering. Surface deformations include rippling, rutting, shoving, tenting, cracking, and lane/shoulder deterioration such as drop-off and separation. Conditions of roads will be defined with the following values:

5- **Excellent**: Little to no pavement distress. Any distress is low in severity and extent.
4- **Above Average**: Contains pavement distress but is low in severity and extent.
3**- Average**: Contains pavement distress, but is mostly low to moderate in severity and extent.
2- **Below Average**: Contains several types of distress ranging from moderate to heavy in severity and extent.
1- **Poor**: Contains distress that is mostly heavy in severity and extent.

Figures 14 through 18 illustrate roads in excellent through poor condition, respectively.

3.2.2 Assessing the Condition of Signs

Figure 19 Excellent Sign

Figure 20 Above Average Sign

Figure 21 Average Sign

Figure 22 Below Average Sign

Figure 23 Poor Sign

The condition of street signs used the method previous projects used to value their condition. Like roads, they were rated from one to five; five being the best, and one the worst. The values are defined as follows:

5**- Excellent:** Street sign is new or efficiently maintained.
4**- Above Average:** Street sign is easily readable with few imperfections.
3**- Average:** Street sign is legible with partial fading or damage.
2**- Below Average:** Street sign is partially unreadable or heavily damaged.
1**-Poor:** Street sign principally unreadable with high level of damage or visual impairments.

Figures 19 through 23 illustrate examples of street signs in each of the five conditions.

3.2.3 Assessing the Condition of Sidewalks

Figure 24 Excellent Sidewalk

Figure 25 Above Average Sidewalk

Figure 26 Average Sidewalk

Figure 27 Below Average Sidewalk

Sidewalks were defined on the same one to five scale, which is defined as follows:

5- **Excellent**: Sidewalk is new or efficiently maintained.
4- **Above Average**: Sidewalk is smooth and traversable with few imperfections.
3- **Average**: Sidewalk has slight damage due to use and weathering.
2- **Below Average**: Sidewalk is deteriorating with cracks and missing pavement.
1- **Poor**: Sidewalk is traversed with difficulty with severe pavement damage.

No sidewalks in poor condition were found in the target area. Figures 24 through 27 illustrate examples of sidewalks in excellent through below average condition.

3.2.4 Assessing the Condition of Guardrails

Figure 28 Excellent Guardrail

Figure 29 Average Guardrail

Figure 30 Poor Guardrail

The guardrail infrastructure, for purposes of conformity, followed the one to five scales. However there are no assessments for above average and below average condition, labels 4 and 2.

5- **Excellent**: Guardrail is new or very efficiently maintained

4-

3- **Average**: Guardrail is upright but has slight damage or wear

2-

1- **Poor**: Guardrail is not effectively upright and has high levels of damage

Figures 28 through 30 show examples of the three levels of guardrail condition.

3.3 IDENTIFYING FUTURE MAINTENANCE NEEDS AND REUSABILITY OF DATA

The team gathered data that can be used for various applications. Due to time limitations and the difficulties of some data collection, not all attributes of the assets could be collected.

In reviewing the literature, the team identified additional attributes that could be implemented in the future so that the data can be used for various purposes such as preventative maintenance, snow plowing, paving, and GASB-34 analysis. We described these analyses in section 4.3.

3.4 RECOMMENDING MECHANISMS TO KEEP INFORMATION UP TO DATE

Currently, when the developer submits proposal to make a new road, the proposal is paper based. If the town requires the developer to submit it in electronic format, this gives the town the ability to incorporate the data directly into the GIS system. To make certain the road data is accurate, the developer has to submit the as built data of the assets.

The condition of the assets will change throughout the year thus it is necessary to update the condition on a regular basis. The team created flow charts to help the town of Grafton to keep the data up-to-date. The first flowchart will help the town to keep their inventory up-to-date while the second one will help the town to update the condition of the assets. Both results are shown in section 5.3.

4 Results and Analyses

This section of the report displays the data collected by the team and immediate and future uses of the information.

4.1 INVENTORIED ROADS AND ASSETS

The data for this report was collected by hand in the town of Grafton between November 2006 and March 2007. Each asset, its location, and attributes were recorded on a laptop computer in the field.

4.1.1 Inventoried Roads

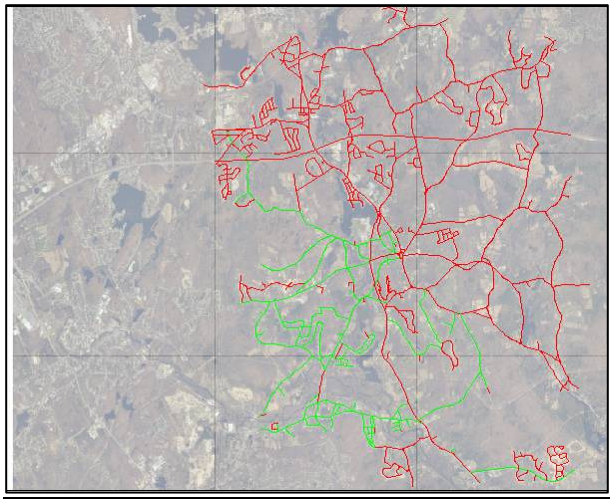

Figure 31 Roads in Grafton

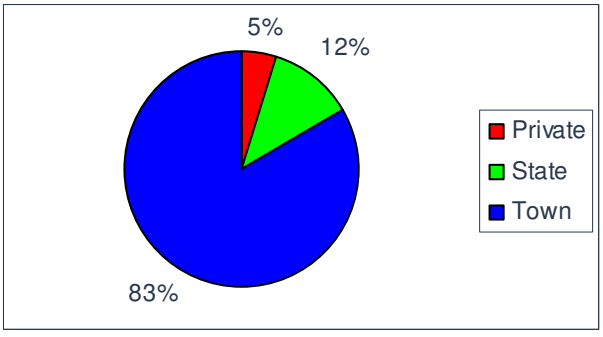

Figure 32 Road distribution based on ownership

All roads in the town of Grafton were segmented at each intersection and given a unique identifier to distinguish them from other segments of road. The condition of the road was also recorded.

The town of Grafton has 100.8 miles of town roads, 5.8 miles of private roads, and 14.2 miles of state road. The team managed to inventory all of the roads, totaling 120.8 miles. Figure 31 shows the roads in Grafton, with the green roads indicating the target area. Figure 32 shows the percent distribution of roads based on ownership. As we can see from Figure 31, the town owns more than ¾ of the roads in Grafton.

4.1.2 Inventoried Signs

Street signs were inventoried with a unique ID, its type, location, and pole material. The following figure shows all of the signs inventoried in the test area.

Figure 33 shows the location of 835 signs in Grafton inventoried by the team. The next figure shows the same signs, separated by sign class. For example, stop signs are part of the traffic control class, while street signs are under information class.

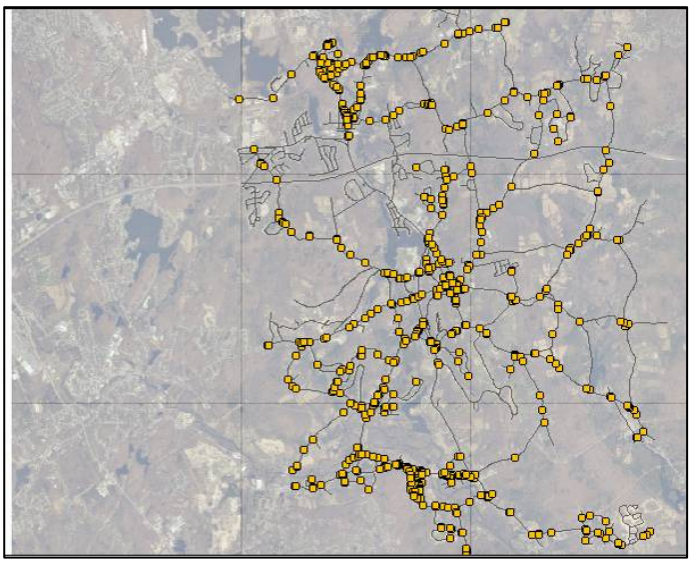

Figure 33 Signs in Grafton

There are four different sign classes. The distribution of these sign classes in the town of Grafton is shown in Figure 34. Information and traffic control classes are the most numerous in the town.

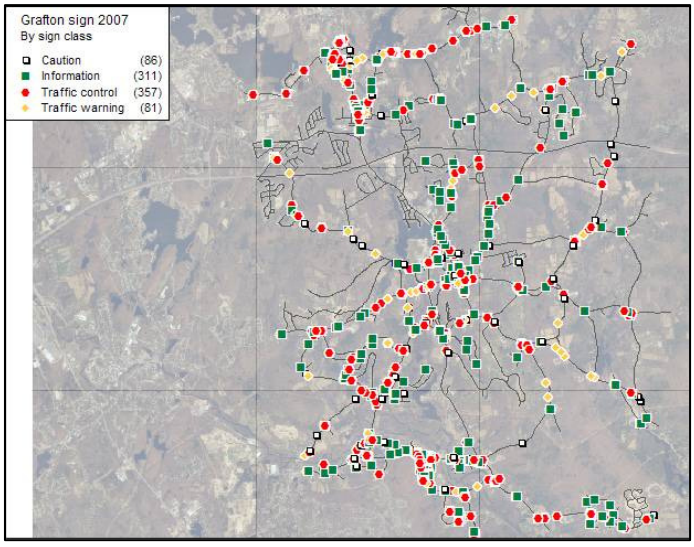

Figure 34 Classes of sign in Grafton

4.1.3 Inventoried Sidewalks

Like roads, sidewalks were segmented at each road intersection and given a unique ID to distinguish them from other roads. Figure 35 shows all of the inventoried sidewalks in the target area.

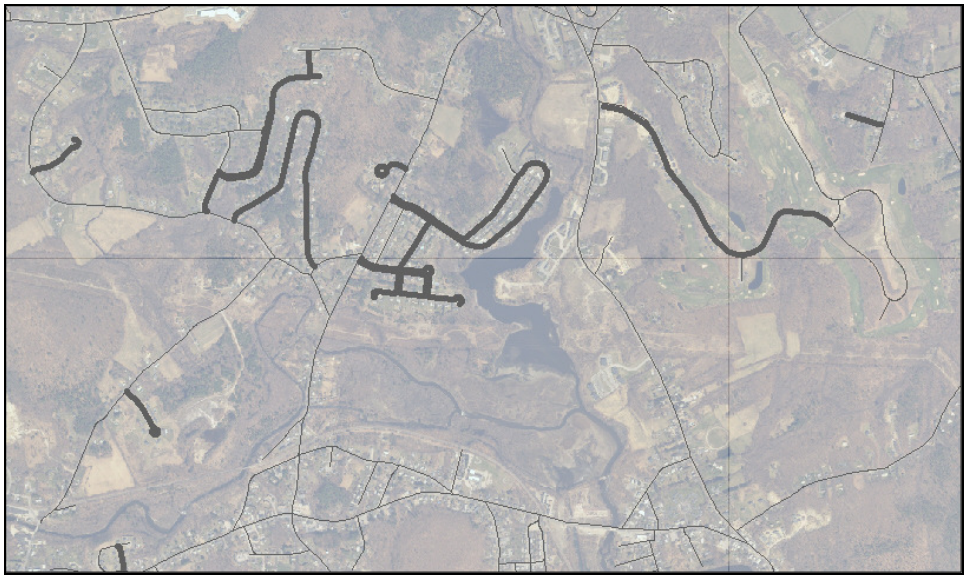

Figure 35 Inventoried sidewalks in Target Area

The inventoried sidewalks in the target area had a total of 29,746 feet. The material used to build the sidewalk was also recorded. The two types we observed were asphalt and concrete, with 84 percent being made of asphalt. Figure 36 shows the materials of sidewalks by location.

Figure 36 Materials of sidewalk

4.1.4 Inventoried Guardrails

Guardrails were inventoried with a unique ID, location, material, number of poles and type of end treatment. Figure 36 shows the inventoried guardrails in the target area.

Figure 37 Guardrails in Target Area

The team inventoried a total of 25 guardrails in Grafton's target area, which totaled 2,278 ft. Sixty-four percent of the guardrails are of the steel type, with 84 percent having a boxing glove end treatment. Figure 38 shows the guardrail based on the end treatment.

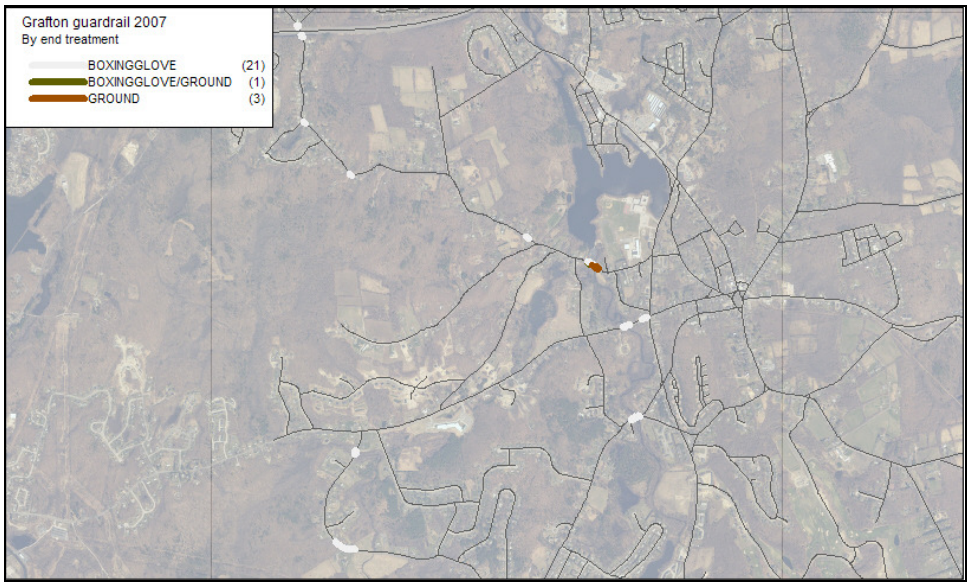

Figure 38 End treatments of guardrail

4.2 CONDITION OF ROADS AND ASSETS

In addition to inventorying all of the roads and their related assets, a condition was assigned to each road and asset. These conditions were on a scale of 1-5 and are discussed in more detail in the methodology.

4.2.1 Roads Condition

Seventy percent of the roads in Grafton's target area were given a condition rating of above average (4). There was one road that qualified as poor condition, in addition to four in below average condition. Figure 39 shows the condition of the roads by location and color.

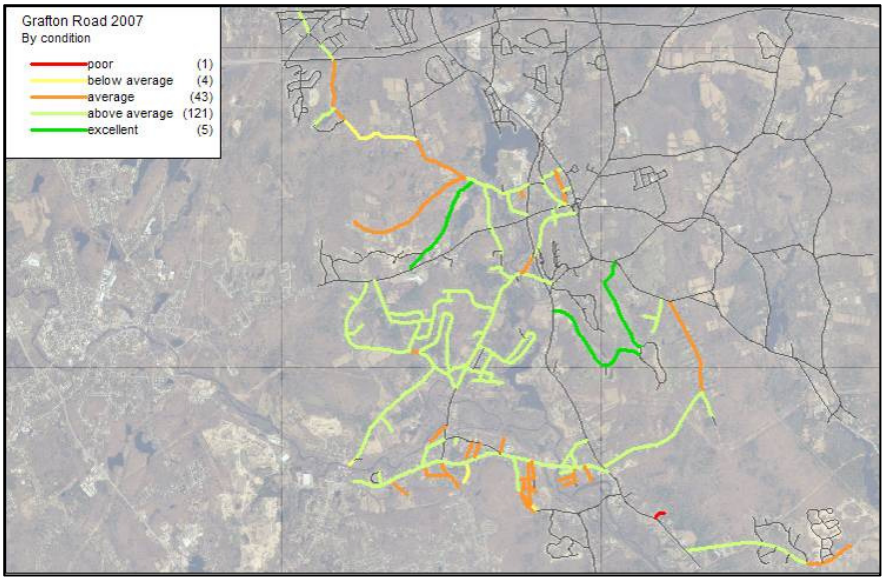

Figure 39 Assessed roads in target area

Table 3 summarizes the road distribution in the target area based on the condition. We can see that about 90% of the roads in the target area are in average or better conditions.

Table 4 Road distribution based on condition

Condition	Length (ft)	% of Road
Poor	475	0.3%
Below average	4878	3.2%
Average	35,366	23.2%
Above average	97,737	64.2%
Excellent	13,794	9.1%
Total	152,250	100%

4.2.2 Signs Condition

Road signs are categorized by the condition grading from poor condition (1) to excellent (5). Figure 40 shows the distribution of signs by condition.

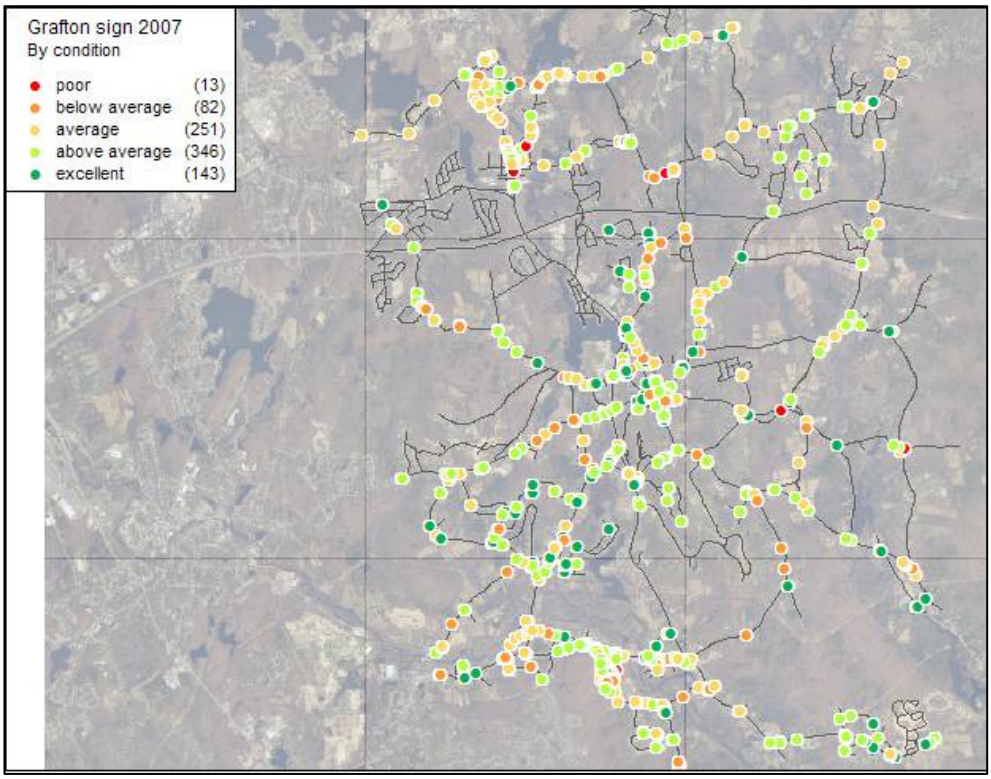

Figure 40 Signs condition

Forty-one percent of the signs in the town of Grafton can be assessed at above average condition level (4). Only 13 signs need to be replaced soon due to their poor condition, but 82 others are below average and should be considered for maintenance or replacement soon.

Figure 41 shows the percentage of signs based on the condition. We can see that almost 90% of the road signs are in average or better condition.

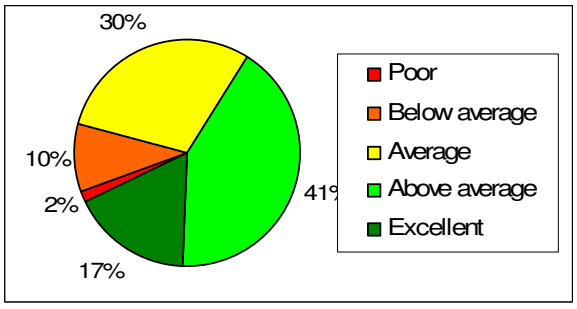

Figure 41 Signs distribution based on condition

4.2.3 Sidewalks Condition

We found that 6,366 feet of the sidewalks assessed were in excellent condition (5). Above average condition accounted for 15% sidewalks surveyed. Another 17,940 feet were in average condition (3).

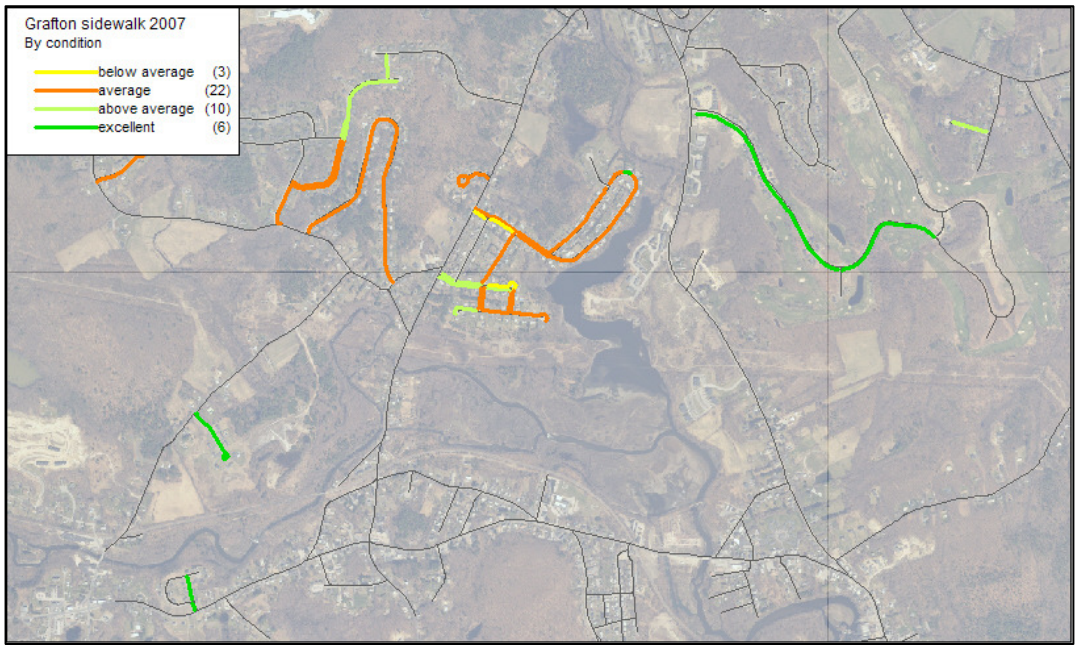

Figure 42 Sidewalks condition

Figure 42 shows the distribution of the sidewalk based on condition while Table 4 shows the length of sidewalk for each condition in the target area.

Table 5 Sidewalk distribution based on condition

Condition	Length (ft)	% of total
Below average	1073	3.6%
Average	17940	60.3%
Above average	4367	15%
Excellent	6366	21.1%

4.2.4 Guardrails Condition

In Grafton, the team found that four of the guardrails, accounting for 16 percent of surveyed guardrails assessed were in excellent condition. Sixty-eight percent were average, and another 16 percent of the guardrails were assessed in poor condition. Figure 43 shows the condition of the guardrails by location in the target area.

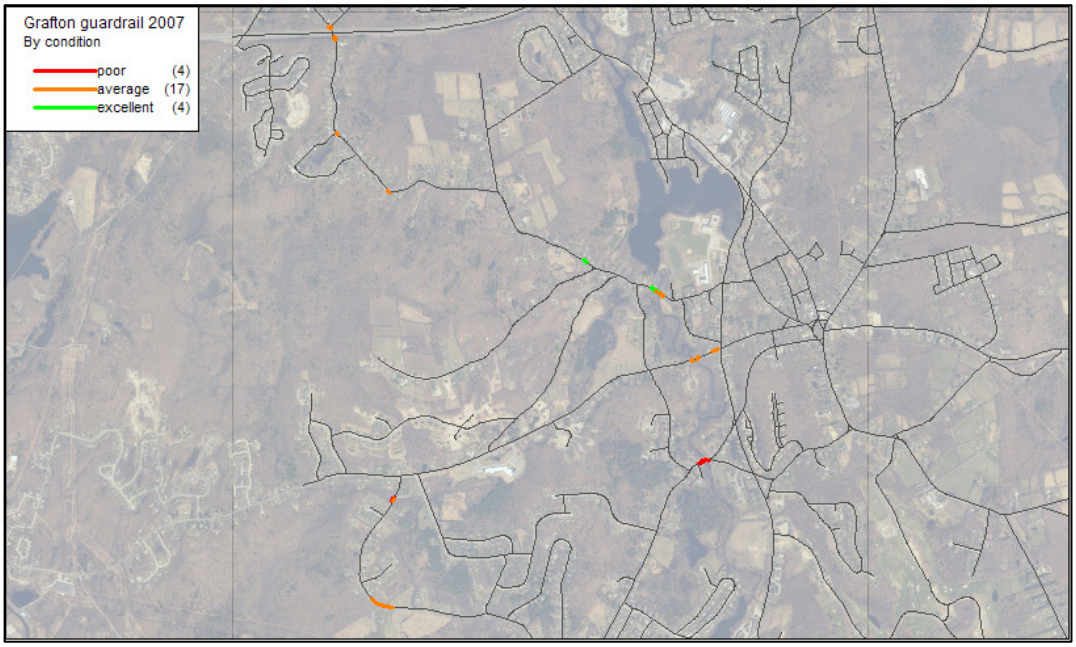

Figure 43 Guardrails condition

Table 5 shows the distribution of guardrail in the target area based on the condition.

Table 6 Guardrail distribution based on condition

Condition	Length (ft)	% of total
Poor	433	19%
Average	1515	66.5%
Excellent	330	14.5%

4.3 APPLYING THE INFORMATION SYSTEM

The DPW can make use of the data collected for some immediate applications. By collecting additional data, such as road width and date of installation, the town can implement future applications.

4.3.1 Immediate Applications

4.3.1.1 D.P.W. Operations

A considerable amount of time and manpower could be saved by the implementing the information system. By working with the information system about the town's road assets and conditions, DPW staff can save the town the cost of surveying areas of town that have had recent repairs or maintenance.

4.3.1.2 Preventative Maintenance

Preventative maintenance is another use for the information system. The data collected shows which of the town's assets are in need of repairs. A schedule could be developed to repair or replace assets before they reach poor condition. Preventative maintenance has also been proven to save more money, because it is easier and usually cheaper to repair than it is to completely replace.[20] If Grafton begins to record the dates of installation or repairs, then an analysis of life expectancies for the assets could be determined. An average span of time for each asset's utility could be determined.

4.3.2 Future applications

4.3.2.1 GASB-34 Analysis

One objective of this project was to provide the town of Grafton with most of the information it needs to produce the required GASB-34 analysis. GASB-34 applies only to assets with an installation date of 1980 or later. However, our team could not obtain the installation date of the road assets. If the town of Grafton can add installation date into the data, it can use the data to comply with GASB-34.

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[20] Melo, Frederick. "Cape's Infrastructure is Old, Overburdened, and Expensive to Maintain." http://archive.capecodonline.com/special/capecar/rulesof5.htm (accessed January 24, 2007).

4.3.2.2 *Plowing*

Plowing is a major concern of New England towns in winter. It is the responsibility of the towns to ensure reasonably safe driving conditions to citizens after a snowstorm. The unpredictable weather and snowfall can end up costing towns considerably more than their scheduled budget. Figure 44 shows the truck that is usually used by towns to plow.

Figure 44 Plowing truck

Also, the MassHighway Department mandates that drivers be compensated for no less than four hours of work at a given time. The plowing season can continue until May 31, should there be a need. In the 2006 agreement, plowers could be paid starting at a base rate of $51.50 per hour.[21] That amount of money for multiple plows, multiple hours, and multiple storms can quickly deplete a town's reserve.

In a 2003 snowstorm, more than 1.6 million dollars had to be allocated by the Federal Emergency Management agency (FEMA)[22], and that was just one bad winter storm.

The town of Grafton allocates a snow removal budget of $150,000 per year. Planning ahead could save the town money, by making sure its equipment is in working order when the town needs it, and staying ahead of the storm. Also, with traffic data, the town can determine which of its major and busy roads must be cleared first and also which sidewalks must be cleaned.

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[21] Executive Office of Transportation. *2006-2007 Hourly Rental Rates and Vehicle Codes*. Boston, MA: Massachusetts Highway Department, 2006, http://www.mhd.state.ma.us/downloads/snowice/attachmentA.xls.

[22] Federal Emergency Management Agency. "More than $1.6 Million Obligated for Snow Removal." U.S. Department of Homeland Security. http://www.fema.gov/news/newsrelease.fema?id=2481 (accessed April 22, 2007).

Grafton could estimate the costs of plowing by using an equation to determine total costs for storms. The factors the town needs to consider are the number of plowers employed, fuel costs, road lengths, average driving speeds, and pay rates for the plowers.

The total costs would be equal to:

(Number of plowers)*(pay rate)*(number of hours needed to plow)*(cost of fuel needed)

The time needed to plow can be found by dividing the road lengths by the average driving speed of plows.

This equation could be done for each road or storm to get an accurate estimate of what a fully-funded snow removal budget may look like. The town could then compare the costs of MassHighway employees to that of private snow removal companies to save money, since there is nothing they can do to prevent the snow.

Another use for the information in winter is the amount of spray, salt or sand needed to cover the roads. By using the data of total road lengths and widths, the town can easily add up the amount of the snow deterrent it needs, without overstocking or running out.

4.3.2.3 Paving

The same can be said for road paving. Again, knowing the lengths and widths of road can ensure the right amount of tar with proper calculations. Also, by searching the database, the town can see which roads are in poor condition and accurately anticipate the repaving of high traffic areas on a regular schedule more easily. Similarly to plowing, the town can then calculate driving speed by pay rates of drivers, and estimate costs of road maintenance.

4.3.2.4 Painting

Painting also has costs which most people do not realize. Knowing the lengths and types of roads in the town, painting costs can also be determined for highway lane lines, arrows, and crosswalks. Knowing where each of these indicators needs to be, and their measurements can predict a base cost for paint, and traffic volumes can predict how often

they would need to be repainted. Again, total costs could be determined when labor was factored in with supply costs and time requirements.

4.3.2.5 Emergency Vehicles

One benefit of implementing traffic data is to plan emergency routes. Emergency vehicles could avoid high traffic areas in times of great need and greatly reduce response time to emergencies, saving immeasurable amounts in damages and lives. Also, with the widths of roads available in the database, the town could ensure that all roads were wide enough to allow any emergency vehicle access.

4.3.2.6 Accident Prevention

Another predictor for the information could be accident prevention. Traffic data could be analyzed to see if any area of town is more susceptible to car accidents than another. Although there are many other factors that could contribute to an accident, such as reckless driving, sun glare, or unfavorable driving conditions, it could be worthwhile to investigate the conditions of roads in the accident prone area, as well as the visibility of road signs and the sightlines or guardrail conditions. Any improvements made on the town's part could save the injury and trouble of preventable accidents later.

5 Recommendations

From the data collected and analyses done, the team can make several recommendations for the town of Grafton.

5.1 COMPLETING THE INVENTORY

In this project, we inventoried roads for the whole town, signs for almost the whole town, and sidewalks and guardrails in the target area. By completing the inventory, the town of Grafton will be able to keep track of its assets. We estimated a total of 9 road signs per mile, 983 feet of sidewalk per mile, and 75 feet of guardrails per mile. From this data, we can estimate the amount/number of assets left to do. The estimate is shown in Table 7.

Table 7 Estimated total number of assets in town

Assets	Length of roads covered	Assets in the roads covered	Estimated assets per mile	Estimated assets for the town of Grafton
Signs	95 mile	835 signs	9 signs	908 signs
Sidewalk	30.45 mile	29,746 ft	983 ft	99,086 ft
Guardrail	30.45 mile	2,278 ft	75 ft	7,560 ft

From the data in Table 7, we can estimate the amount of assets left to do. The result is shown in Table 8.

Table 8 Estimated total number of assets left to do

Assets	Estimated assets for the town of Grafton	Total assets that the team assessed	Total assets left to do
Signs	908 signs	835 signs	73 signs
Sidewalk	99,086 ft	29,746 ft	69,340 ft
Guardrail	7,560 ft	2,278 ft	5,282 ft

Besides completing the inventory, adding new attributes can give further use of the data. Table 9 will show what additional attributes can be added into the database and what they can be used for.

Table 9 Additional attributes for further usage of the database

Attributes	Use
Width	Paving, crosswalk painting, plowing passes, emergency vehicle access
Traffic flow	Predicting the life expectancy of road, prioritizing road maintenance
Installation date	GASB-34 compliance, prioritizing road maintenance

5.2 PRIORITIZING ROAD ASSETS MAINTENANCE

The team first recommends that the road assets found to be in poor and below average are replaced. The team has provided a cost analysis below.

5.2.1 Replacing Signs in Poor and Below Average Conditions

The replacement value of a single sign is estimated to be $250. There are 95 signs in poor and below average condition in Grafton. To replace these would cost $23,750. The town of Grafton should replace the signs in poor condition as first priority. The locations of the signs in poor and below average conditions are shown in Figure 45. In Figure 45, the signs in poor condition are shown with the name of the street where they are located.

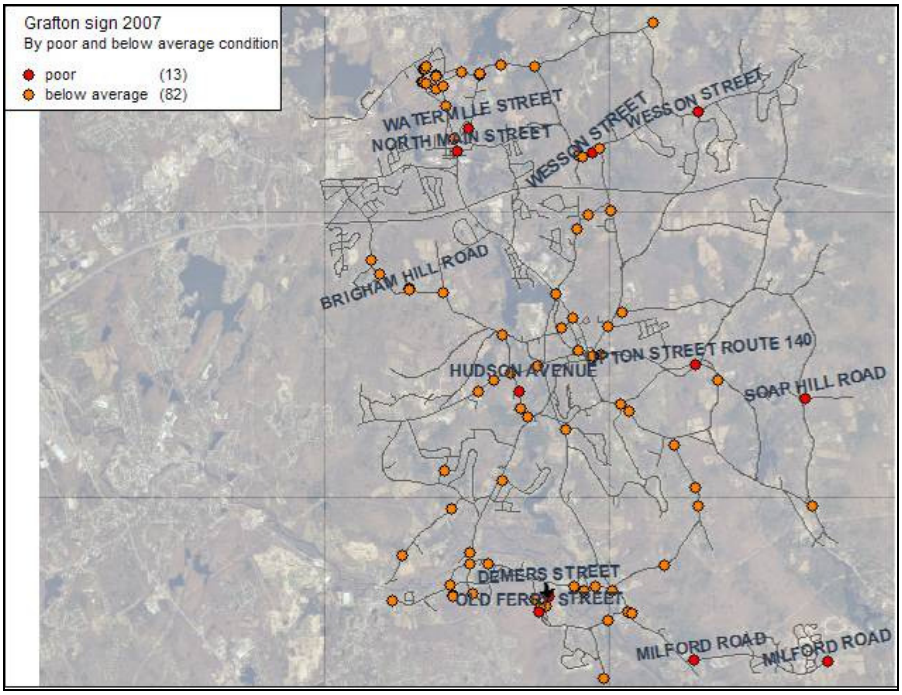

Figure 45 Signs in poor and below average condition

When evaluating by sign class, there are 50 signs in the traffic control and traffic warning classes in poor and below average condition. These are extremely important to fix immediately as they are mandatory signs that control the traffic flow. Figure 46 shows the location of the signs in poor and below average conditions. In Figure 46, the signs in poor condition are shown with the name of the street where they are located. The total cost to replace these 50 signs is $7,500.

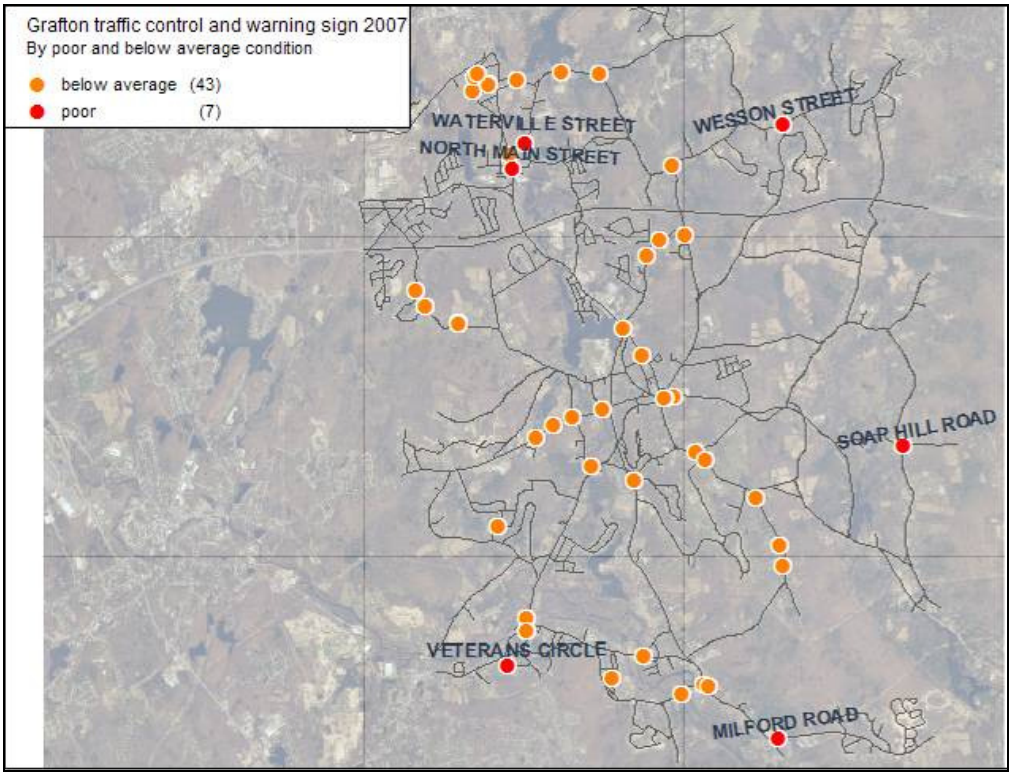

Figure 46 Traffic control and warning signs in poor and below average conditions

5.2.2 Replacing Roads in Poor and Below Average Conditions

Road repaving costs $39.60 per foot. Since there are 5,353 feet of poor and below average roads in the target area, the cost of repaving those roads equals approximately $212,000 dollars. Figure 47 shows the locations and names of the roads.

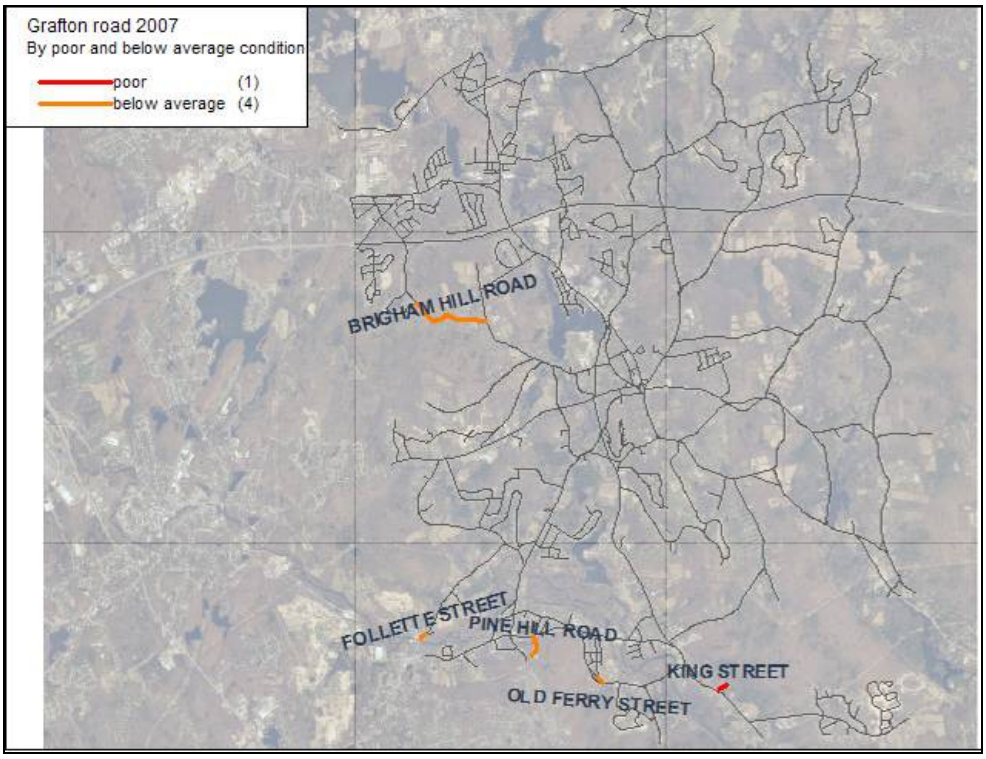

Figure 47 Roads in poor and below average conditions

5.2.3 Replacing Guardrails in Poor Condition

In the target area, the team found 433 feet of poor guardrails. At $20 per foot, it will cost $10,900 to replace the poor guardrails in the target area. Figure 48 shows the name of the roads where the guardrails are located.

Figure 48 Guardrails in poor condition

5.2.4 Replacing Sidewalks in Below Average Condition

There are 1,073 feet of below average condition sidewalk in the target area. With an estimate of $20 per foot for replacement cost, it would cost a total of approximately $7,550 to replace the target area sidewalks. Figure 49 shows the name of the roads where the sidewalks are located.

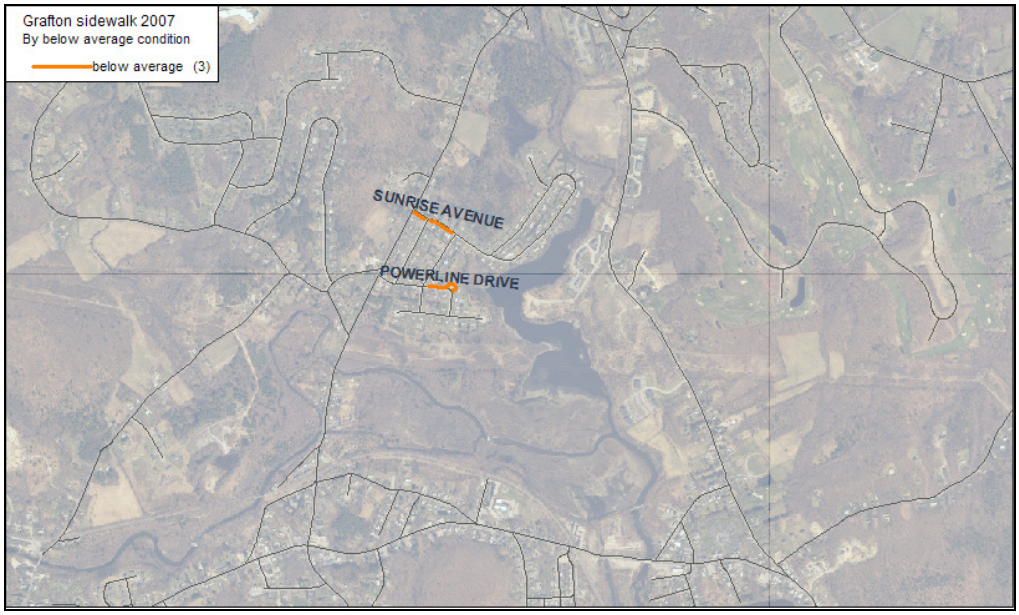

Figure 49 Sidewalks in below average condition

The cost to replace the assets in poor and below average conditions is summarized in table 10.

Table 10 Cost to upgrade poor and below average condition assets

Assets	Total length/number	Cost per	Total cost
Sign	95 signs	$250/sign	$23,750
Road	5,353 feet	$39.60/foot	$211,978
Sidewalk	433 feet	$20/foot	$8,660
Guardrail	1,037 feet	$20/foot	$20,740
		Total	**$265,128**

5.3 KEEPING THE INVENTORY INFORMATION UP TO DATE

To ensure that the inventory and condition of the information is up to date, we recommend the following systems.

5.3.1 Updating the Inventory

The team recommends that Grafton implement a system to obtain information about new roads and assets as they are created and adopted by the town. As most new roads in Massachusetts are created almost entirely in the private sector, contractors and developers would be the first to possess all the necessary information about the road and its assets.[23] The majority of private roads eventually get accepted by the town, and thus the town becomes the maintainer of the road. Figure 50 shows the process by which improved communication could be valuable to maintaining accurate asset condition in the inventory.

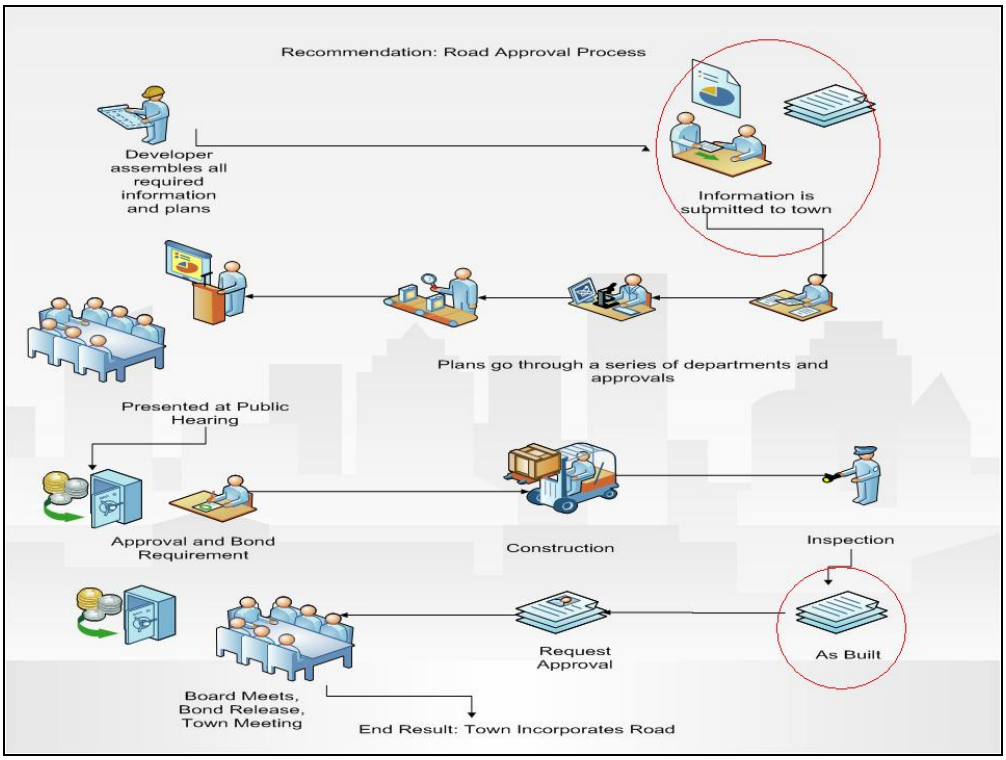

Figure 50 Recommendation on road approval process

[23] Fabio Carrera and Joseph Ferreira Jr. "The Future of Spatial Data Infrastructures: Capacity-Building for the Emergence of Municipal SDI's." *International Journal of Spatial Data Infrastructures Research (Under Review)* (2007), http://ece.wpi.edu/CityLab/Publications/Journals/IJSDIR-07-Carrera-Ferreira.pdf.

We encourage Grafton to require GIS data of the road such as centerline, shape, and length for entrance into the database before the road becomes accepted. This data should be submitted in electronic format in the steps marked with red circle. Also on record should be the contractor or developer, the date of completion of the road, and the date the road was incorporated as part of the town.[24] Fees could be established for non-compliance with the required data, or even refusal to accept the road until the information is supplied. This also applies to repairs done by the D.P.W. The employees should also update the database whenever they notice a condition change or perform maintenance or replacement of an asset.

5.3.2 Updating the Condition

We recommend that the Department of Public Works sets up a line of communication to be used at least monthly, in regards to the status of town assets. One major problem in keeping accurate records is that local resident will not always report problems about road related assets to the Department of Public Works, often local residents contact the local police, or a private contractor. If this information is not passed on to the Department of Public Works, the information system will eventually fail due to a lack of knowledge that the system needs updating. The Department of Public Works should work with the police so that any maintenance or replacements of town property be reported to the Department of Public Works in a timely manner in the interest of keeping accurate records and costs. This process is shown in Figure 51.

[24] Fabio Carrera and Joseph Ferreira Jr. "The Future of Spatial Data Infrastructures: Capacity-Building for the Emergence of Municipal SDI's." *International Journal of Spatial Data Infrastructures Research (Under Review)* (2007), http://ece.wpi.edu/CityLab/Publications/Journals/IJSDIR-07-Carrera-Ferreira.pdf.

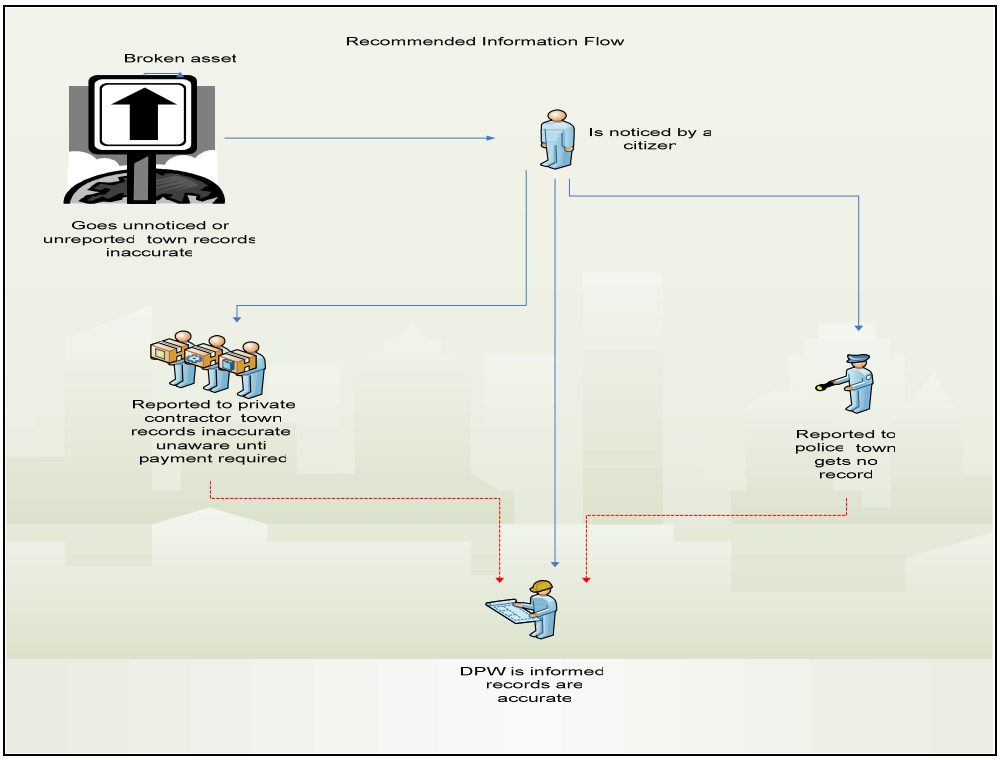

Figure 51 Recommended information flows

Another attribute that can be added into the system is a check mark to show whether the assets have achieved the standard criteria such as width, height, or material set by the government. This would help the town of Grafton in updating the assets so that all assets can comply with the state regulation for each asset.

We also recommend that the citizens of Grafton be given the opportunity to comment of the condition of the road infrastructure. This can be done by setting up an online comment box for the citizen so that whenever a citizen notices a change in the condition of an asset, he or she can submit comments online, possibly on the town's website. The website should at least provide a box where local residents can provide specific details about the asset such as the location and condition. The online comment system will be better than a phone system because there will be written records of the condition of the infrastructure.

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