

# **Is It a GIS? Transforming Drawings into Intelligent Maps**

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## ***Abstract***

The wave of aerial photography and drawing software has propelled many communities into the world of computer mapping. These tools help city planners visualize future development. Oftentimes the products are referred to as GIS maps, but are they really? This presentation will describe how the City of Mesquite, Nevada is migrating a large volume of AutoCAD drawings and aerial photo resources into a true GIS. The discussion will highlight the accomplishments achieved with a very small staff.

## ***Introduction***

“You’ve got to be kidding me. That’s just plain crazy. You’re doing way more work than is necessary.” With these comforting words, a counterpart revealed what she thought about the City of Mesquite’s Geographic Information System (GIS). While there are many ideas of what does or does not constitute a GIS, this presentation will chart the migration of Mesquite’s current GIS to a more robust, intelligent GIS. Some of the components of the new GIS are in place, while some are still in the planning phases. The hope is to start a dialogue that will ultimately lead to GIS that meets the needs of all its users.

## ***History***

### **Overview of the City of Mesquite**

Located in Nevada, just over the Arizona border, Mesquite is a burgeoning community. With over half of the city’s housing stock being built post 1996, growth is a fact of life in this once small town. Now boasting just over 18,000 residents, Mesquite is painfully aware of the changes that growth can change. Consequently, a true GIS is necessary to help manage the growth that is occurring.

### **How we got here**

Historically, AutoCAD has been the main mapping program within the City of Mesquite. The City’s GIS started out in the engineering department with one person creating address maps. There was no data associated with the linework—just linework. This was considered the City’s GIS.

Due to the City's rapid growth and to the fact that most GIS people are computer literate, this individual was pulled farther and farther away from GIS and closer and closer to IT. Consequently, the GIS lagged until another employee could be hired on.

As was to be expected, the new GIS Analyst was proficient in AutoCAD. Consequently, he labored for months updating the existing drawings and creating new ones. As with the previous employee, demands eventually prohibited full-time work on the City's GIS and once again it fell behind the growth curve.

Once again, the solution was to hire a new person to maintain the GIS. However, the new person was not well-versed in either AutoCAD or GIS. Therefore, the system suffered. Drawings were not updated, no real new map products were developed, bad data was entered into the database and a myriad of other effects were felt. However, the first and second employee still worked for the City and helped the GIS hobble along. However, they were not able to focus on GIS alone because it was outside the scope of their responsibilities.

Now, a fourth person has been hired and tasked with transforming the drawings and aerial images into something with intelligence associated with it. That brings us to where we are today.

### ***Current GIS situation***

With all the personnel changes, progress was hampered. Additionally, each change in personnel meant a change in philosophy. Each employee has had their own ideology on how to best organize and build a GIS. Unfortunately, little, if any, documentation exists showing the thought processes. Consequently, the existing GIS needs to be exhumed from its current status and brought into the modern GIS world.

### **Current Components**

AutoCAD Drawings-Unfortunately, most drawings that exist are just lines and floating text, no polygons or attributes. Thankfully, a few drawings have object data attached to objects within the drawings and it is possible to export the object data into an external database. The City has used Autodesk Map 3D which allows for many GIS operations, but not all.

Shapefiles-There are a variety of files that exist in shapefile format. More often than not they are duplicates of files that exist in AutoCAD and were exported into a shapefile. Some maps do exist solely in shapefile format. There are no coverages or geodatabases within the current GIS structure.

SQL Server-The City utilizes several SQL server databases to store information about subdivisions, streets and addresses. Access is used as a front-end to view and manipulate the data. However, this data is not tied to anything. *It exists independent of the drawings.* Mainly, the tables are repositories for data. Also, there is redundancy between tables. Consequently, little maintenance has been performed on them. The tables need to be parsed and brought up to new standards.

Aerial Photos-Clark County, Nevada semi-annually flies aerial photography of most of Clark County and distributes them to the various jurisdictions within the County. The distribution includes one-, two- and five-foot resolution images. Mesquite receives the sections within the city boundaries and immediate areas. Additionally, the City receives images of areas of special environmental concern surrounding Mesquite.

The greatest reason to have the aerials has been for visualization purposes. Monthly maps with the aerial and AutoCAD linework are published and sold. People like to hang them in their offices and use them as a reference tool. The other purpose is to have the aerials as a documenting tool. This enables people to see change over time. No real work has been done to catalog these images though. They all exist in the year's folder, but these folders are spread over several drives, and even duplicate each other at times.

### **Providers of data**

Engineering Firms-Applicants are required to submit electronic copies of their tentative and final maps. Also, prior to the signing of the recorded document, another copy must be submitted electronically. Additionally, as-builts for the project must be submitted after the project is complete showing the actual location of utilities. Alas, these submissions from applicants come in every possible file format and in any possible coordinate system. Most submissions are made in AutoCAD format and the applicants have no idea that their submission is going into a GIS. Consequently, the submissions are sub-par material, at best, for a GIS and create hours of labor to *make* them work.

Clark County- Most of the data that we receive from Clark County is in shapefile format. Clark County is migrating to geodatabases for the parcel base. This corresponds well with our move to geodatabases as well.

Other agencies-There are other organizations and groups that contribute data to the City, provide it in shapefile format.

### ***Potpourri of Maps and Data: Getting from Mishmash to GIS***

Before the transformation can ever occur, the process needs to happen on paper. Every step of the way needs to be diagramed and calculated. Ad hoc design and implementation is both costly and time consuming. Also, an inferior product is achieved in comparison with what could have been implemented. Consequently, consumers of the data are unhappy.

However, even before this step can happen, short-term and long-term needs and goals must be assessed. As much as anyone would love to have everything instantaneously transformed and ready, that is impossible. An implementation plan with realistic deadlines and expectations needs to be laid out. Fiscal and personnel constraints must be taken into consideration when this is done.

## **GIS Implementation Plan: Begin with the end in mind**

In order for any information system to be successful, it cannot exist in a vacuum. Those who feed into the system must have a voice. The consumers know what they need and how they need it. Administrators have ideas as well. Ultimately, each group's ideas have to meld into what will become the new geographic information system.

### ***Goals***

1. Standardize file and database structures
2. Be able to attach a spatial component to existing data
3. Write a GIS Handbook documenting database structure, file structure, and standard procedures.
4. Allow other departments to input their own data.
5. Establish QA/QC protocols for data input
6. Producing so that expenditures are made in the future
7. Enterprise GIS that every department feeds into and receives benefits from

This is what people want to be able to do with a GIS,

1. Click on a parcel and see basic information about parcel—property information, trash day, school boundaries, etc.
2. Click on a parcel and pull up all the past and current cases or actions involving that parcel
3. Determine fastest or shortest route for Public Safety to respond to calls
4. Public Safety to be able to map incidents to spatially detect trends
5. Public Works to see utilities and accompanying information and service dates.

These goals and tasks are overarching and big in nature. The challenge is to get from where we are, to these lofty goals. It is beneficial to view the current organization as a small infant. Initially, a new babe crawls. Then walks. Then runs. We need to determine which steps need to be taken in order to start crawling. Walking would be nice, running would be mind-boggling. The only way to do this is to create a GIS Implementation Plan. This plan will lay out each phase of the development process.

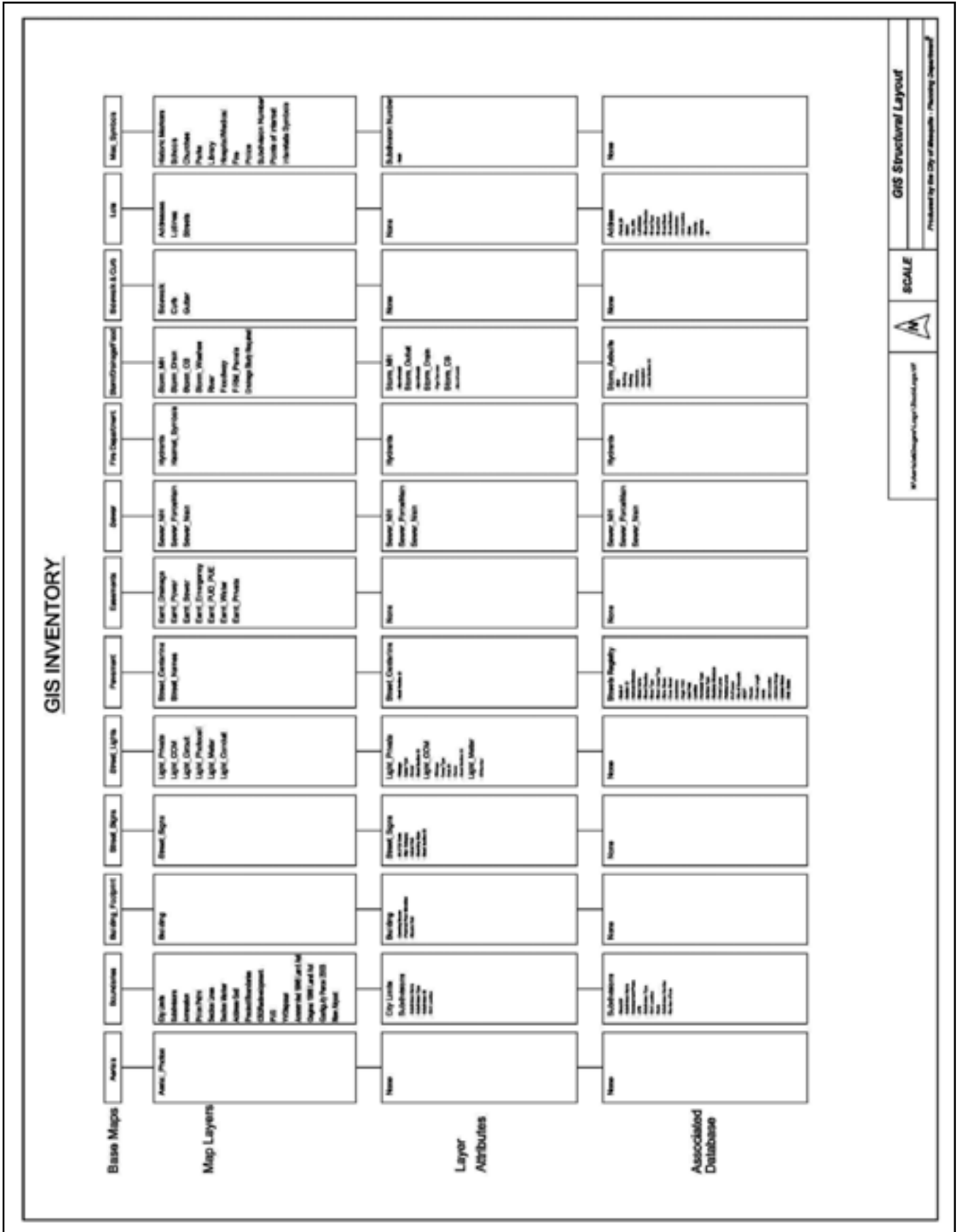
### ***Implementation***

The first steps are as follows with accompanying explanations

1. Data Structure  
Although very good when it was developed, our current data model is outdated due to the changes in technology and changes in the needs of our consumers. This schematic was originally designed in July of 2003. The last time it was modified was August 2005. This is a good example of employees being pulled away and doing other tasks. Consequently, some of this GIS Inventory does exist, while some does not. Generally the map layers and layer attributes were created. Technology has since changed and databases and geodatabases have become the industry standard. Consequently, having attributes held hostage in shapefiles is no longer the norm.

# Current GIS Inventory

Interestingly enough, this schematic was created in AutoCAD



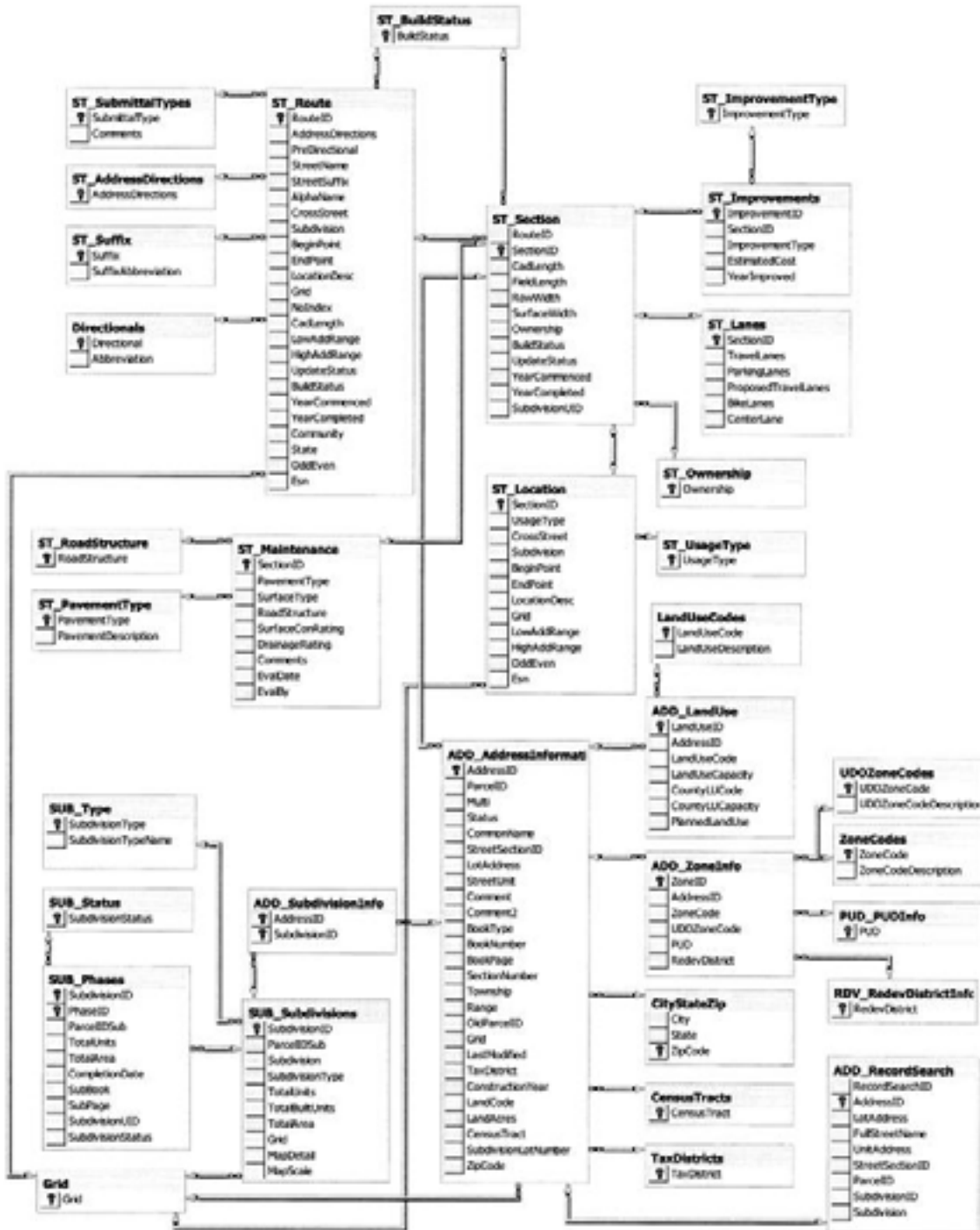
GIS Structural Layout  
 Produced by the City of Minneapolis - Planning Department

# Current Data Structure

All of this is stored in SQL Server with no spatial component

## City of Mesquite Geographic Information Data Structure

### Street and Address Information





One of the most important steps at this point is to open the model up for review within the organization. Each department needs to see and decide what data they want to store in the database. Also they need to decide the phasing for their department. The GIS staff could decide the phasing. However, each department knows their needs better and can lay out a timeline. Plus, then they feel ownership over the process.

While preparing this presentation, some technical issues came to light. Currently, the existing databases are stored in SQL Server. SQL server was chosen because of its ability to work with other programs and databases. However, the City's current level of licensing, ArcInfo, only allows for creation, editing and viewing of SQL databases—no saving back into the database. Consequently, the City either has to upgrade their licensing or export everything out of SQL into Access and then create geodatabases from there. The City is leaning towards upgrading the licensing because going from SQL to Access would be a step backwards, rather than forwards. However, as of the writing of this presentation, final resolution had yet to be reached.

2. Once the data model and the implementation schedule have been decided upon, the data quality itself has to be addressed. Currently, within the database there are question marks, *N/A*'s, and other entries that are not consistent with what should be in a field.

A lot of time will have to be spent parsing the data and filling in any blanks in the data before it can be migrated over to the new data model.

3. Establish a unique identifier assigned and managed by the City of Mesquite

The one thing that is most unique (if varying degrees of uniqueness exist) is their address. Consequently, each address in the city should have a unique identifier. By so doing, the city is finally able to manage its own data. Although each parcel in the city is assigned a parcel number, this parcel number is created and maintained by Clark County—not the City of Mesquite. If we truly desire to manage our own data, we have to have an identifier that is unique to and assigned by the City of Mesquite. Then, we start to effectively track information through the system.

Additionally, it is of consequence that one parcel can have many addresses. Consequently, an attempt to track information by parcel number would be frivolous because the parcel could have five different homes on it.

A story was told by the GIS manager of a large city. He said that the police had had problems with a certain house in a disreputable neighborhood in town. The



police were constantly breaking up parties and arresting people for drug deals in the neighborhood. Eventually, the whole block was razed and a new residential development was built in its place. However, the old address for this crack house was used again in the new development. He said that the police would check on this house because of past problems and not realize that it was completely new and that the old house and the accompanying problems were gone.

This is the problem with using an address alone as a unique identifier. How many files exist in government offices that are based on address alone, no true unique identifier? Mesquite has this problem.

He said that they ultimately solved the problem when they gave each address a unique identifier. The old police reports were still attached to 123 Smith Street but now they were attached to 123 Smith Street (ID No. 1234). The new house could then be addressed as 123 Smith Street (ID No. 5678). The old address ID now distinguished between the old house and the new house. A distinction could be made because any reports generated would show the old id. The new residents didn't have any more problems with the police.

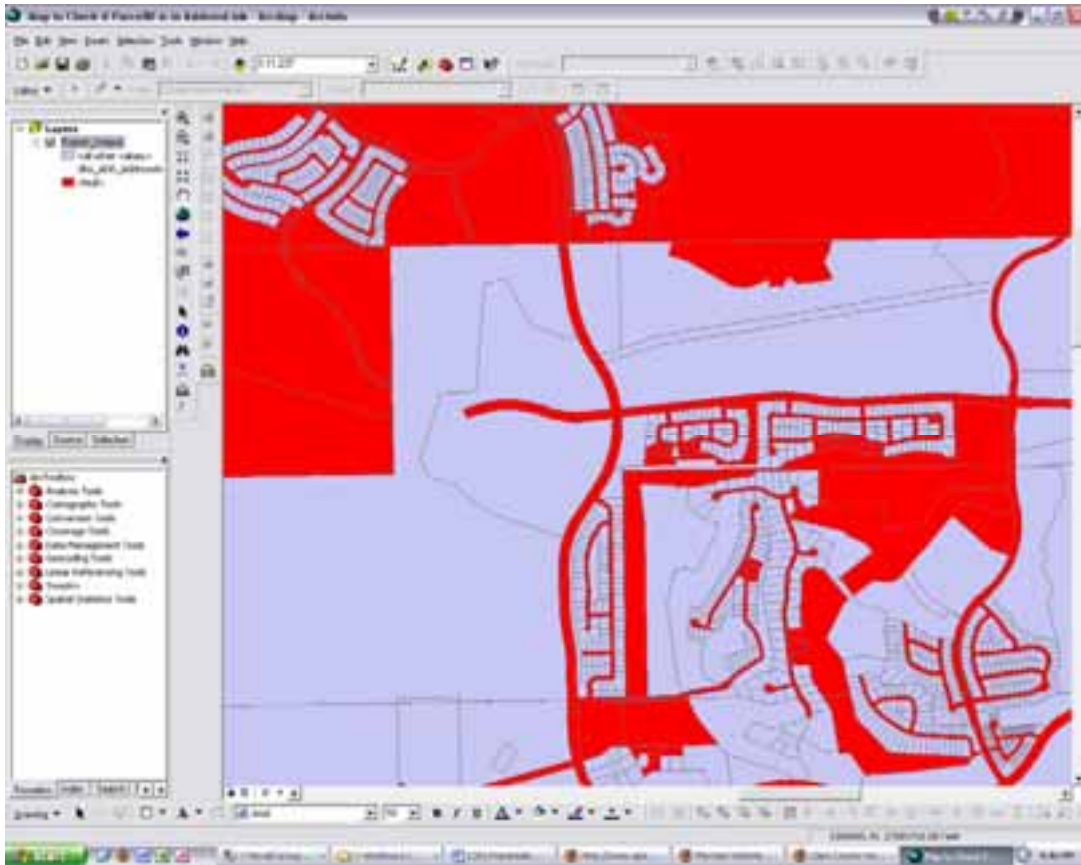
#### 4. Assignment of Address ID

The story about the drug house serves as a good example of the importance of unique identifiers. The City of Mesquite started assigning a unique identifier, Address ID, to addresses several years ago. However, the concept has not been carried out to its fullest. Every single parcel must have an Address ID.

Address ID	Address	City	State	Zip	County	Parcel ID	Area	Other
10000	10000	10000	10000	10000	10000	10000	10000	10000
10001	10001	10001	10001	10001	10001	10001	10001	10001
10002	10002	10002	10002	10002	10002	10002	10002	10002
10003	10003	10003	10003	10003	10003	10003	10003	10003
10004	10004	10004	10004	10004	10004	10004	10004	10004
10005	10005	10005	10005	10005	10005	10005	10005	10005
10006	10006	10006	10006	10006	10006	10006	10006	10006
10007	10007	10007	10007	10007	10007	10007	10007	10007
10008	10008	10008	10008	10008	10008	10008	10008	10008
10009	10009	10009	10009	10009	10009	10009	10009	10009
10010	10010	10010	10010	10010	10010	10010	10010	10010
10011	10011	10011	10011	10011	10011	10011	10011	10011
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10015	10015	10015	10015	10015	10015	10015	10015	10015
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10099	10099	10099	10099	10099	10099	10099	10099	10099
10100	10100	10100	10100	10100	10100	10100	10100	10100

Table showing the current Address ID Database

The Address ID database needs to be rectified against the new parcels monthly when the City receives a new parcel base from Clark County. This task is best done spatially.



Above is a screen capture of a join between the Address ID Database (Address Link) and the parcel layer provided by Clark County. Purple parcels have both an address ID and a parcel ID. Red parcels have a parcel ID but no address ID, or the address ID does exist but it has not been linked to the new parcel ID.

## 5. Junction Table

In order to track the changes in addresses, a junction table must be created. This table will link the history of an address. The first column provides the old address ID. The second column provides the new address ID. And the third column records the date of the change. The date does not have to be exact. It only serves to create a chronology as the database queries address ID's.

## 6. The Walls

Once the foundation has been laid, the walls can start to be built. This is where the implementation plan comes into play. Priorities and phasing must be deciding based on workload, financial constraints, personnel constraints and other outlying factors. This discussion has yet to happen for the City of Mesquite. This will be a part of next year's presentation on the progress that we have made.

## 7. Aerials: A Blessing and a Curse

Because we have spring and fall aerial photos from 1999 to the present, we have a great record. However, as can happen with data, the more of it you have, the less you value what you have. Consequently, the aerials we have are stored in multiple places, there are duplicates and we don't know which aerials are the most recent of each section.

Due to advances in technology, these raster images can now be stored in a raster catalog in a geodatabase. Clark County was good enough to give the City a copy of a sample image catalog that they had created and are using. This simple act will save hours of work trying to set up the catalog.

While the discussion about the data model and the Implementation Plan is going on, aerials can be cataloged because this does not require group consensus.

ID	Name	Status	Image Length	Image Area
1	1999-01-01	OK	1024x1024	1048576
2	2000-01-01	OK	1024x1024	1048576
3	2001-01-01	OK	1024x1024	1048576
4	2002-01-01	OK	1024x1024	1048576
5	2003-01-01	OK	1024x1024	1048576
6	2004-01-01	OK	1024x1024	1048576
7	2005-01-01	OK	1024x1024	1048576
8	2006-01-01	OK	1024x1024	1048576
9	2007-01-01	OK	1024x1024	1048576
10	2008-01-01	OK	1024x1024	1048576
11	2009-01-01	OK	1024x1024	1048576
12	2010-01-01	OK	1024x1024	1048576
13	2011-01-01	OK	1024x1024	1048576
14	2012-01-01	OK	1024x1024	1048576
15	2013-01-01	OK	1024x1024	1048576
16	2014-01-01	OK	1024x1024	1048576
17	2015-01-01	OK	1024x1024	1048576
18	2016-01-01	OK	1024x1024	1048576
19	2017-01-01	OK	1024x1024	1048576
20	2018-01-01	OK	1024x1024	1048576
21	2019-01-01	OK	1024x1024	1048576
22	2020-01-01	OK	1024x1024	1048576
23	2021-01-01	OK	1024x1024	1048576
24	2022-01-01	OK	1024x1024	1048576
25	2023-01-01	OK	1024x1024	1048576
26	2024-01-01	OK	1024x1024	1048576
27	2025-01-01	OK	1024x1024	1048576
28	2026-01-01	OK	1024x1024	1048576
29	2027-01-01	OK	1024x1024	1048576
30	2028-01-01	OK	1024x1024	1048576
31	2029-01-01	OK	1024x1024	1048576
32	2030-01-01	OK	1024x1024	1048576

Screenshot of Image Catalog

## **Role of Consultants**

Overall, there are great expectations out of GIS in both the short- and long-terms. Due to time constraints, some of the expectations cannot be accomplished by staff alone. Therefore, the services of outside consultants can potentially be utilized. This idea has yet to be finalized but it is an option since time is of the essence.

## ***How do you maintain the integrity of the new system***

### **Education**

The first step in maintaining integrity is to educate those contributing data. Only when they see their role, will better data be created and consequently, a better final product will be created. Otherwise, the GIS will continue to get mediocre data and consequently, mediocre results. Therefore, a workshop showing them how they contribute and what their data does would resolve the majority of data input issues.

### **Data Submission Guidelines**

Data that we receive from outside parties, namely engineering firms, needs to have a set of submission guidelines in place to avoid hours of labor. The data submission guidelines can include what needs to be submitted, in what format and the coordinate system.

### **Quality Assurance and Quality Control**

It is fairly simple to maintain the integrity of the data when the creator is the only one inputting the data. However, one of the goals is to establish an enterprise GIS. Consequently, many users begin feeding in data and not everyone always has the same standards. Some parameters can be built into the database, but ultimately a QA/QC program has to be put in place.

### **Documentation**

Documentation. Documentation. Documentation. Each step of the GIS Implementation Plan needs to *documented*. As painful as it can be at times, this exercise has proven the need for future users to understand the rationale for making decisions and when and how those decisions were carried out.

### **Procedures Manual**

In order to insure consistency, certain activities need to be carried out in the same fashion every time. A Procedures Manual would guarantee that anyone carrying out a specific task would do it in like fashion as previous person. Also, ambiguity and mystery are removed from enshrouding GIS; thus, freeing up personnel to perform more technical procedures and analysis.

## **Maintenance Schedule**

A maintenance schedule needs to be created as well. Often changes are made and the rationale is soon forgotten. Consequently, it is easier to spend half an hour twice a week parsing data than it is to spend two weeks a year trying to remember and then parse the data. Once the maintenance schedule is created, an individual needs to be devoted to its implementation and upkeep. Sounds simple, but when employees wear multiple hats, it becomes more difficult.

## **Conclusion**

In the coming months, hopefully the counterpart, who once scoffed at the current GIS, will applaud the advances that have been made. With snags at every turn, designing and implementing a GIS is not for the faint of heart. Hopefully, in a year's time, there will be progress to report on. If not, please feel free to say, "You've got to be kidding me."

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