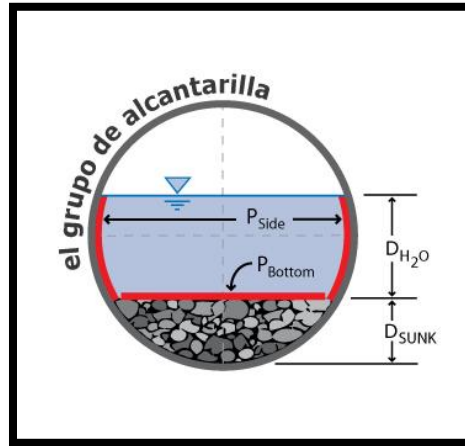


# El Grupo de Alcantarilla

## Culvert Inventory Geodatabase



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# **Culvert Inventory Geodatabase**

## **Final Report**

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**El Grupo de Alcantarilla**

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## **Abstract**

The Texas Department of Transportation, TxDOT, manages and supervises all construction and maintenance projects that improve roadway efficiency in order to move people and goods across the state of Texas. One of the entities that play an important role in the impact of the surface structure is culverts. Culverts channel water to pass underneath a roadway to allow the road to be free of hazards.

TxDOT has asked Texas State University-San Marcos, Department of Geography (El Grupo de Alcantarilla), to design a geodatabase that is capable of managing and cataloging the culverts. In addition to the geodatabase, the team was asked to create an Access database to assist the TxDOT maintenance office in the collection of culvert inventory data. With a Geodatabase available to TxDOT, they will be more prepared to provide their staff with an up to date clearinghouse of culvert information.

The culvert inventory geodatabase is important to both the hydrologists and maintenance personnel. The relationship between the two departments entering data is important so that both departments can have access to the same real time data. Once that relationship is bridged together electronically via the *internet* or *intranet*, TxDOT will have a greater range and better understanding of their equipment in the field.



## Table of Contents

1. INTRODUCTION .....	1
1.1 SUMMARY .....	1
1.2 PURPOSE.....	1
1.3 SCOPE.....	2
1.4 PROBLEM STATEMENT .....	2
2. LITERATURE REVIEW .....	2-4
3. DATA .....	4-5
4. METHODOLOGY .....	6-9
4.2 TASK 1: GEODATABASE IMPLEMENTATION .....	8
4.2 TASK 2:MICROSOFT ACCESS DATABASE IMPLEMENTATION .....	8-9
5. RESULTS .....	9-10
6. DISCUSSION.....	11-13
7. CONCLUSION.....	13-14
8. REFERENCES .....	15
APPENDIX I. Metadata.....	16-45
APPENDIX II. Group Participation .....	46-48





## **1. Introduction**

### **1.1 Summary**

For over one hundred years, the state of Texas has offered safe and reliable roadways to the public. The Texas Department of Transportation, or TxDOT, oversees these roads and has offered many resources and services to commuters and travelers since 1917. Culverts allow for adequate drainage to accommodate surface run-off beside and across roadways; as well as, maintaining natural drainage in these areas. Flooding, road failures, property damage, and erosion can occur when a culvert fails to properly convey water. These failures can create dangerous driving conditions, expensive repairs for taxpayers, costly detours, damage to the drainage system and the environment. As more and more roadways are built, culverts prove to be an integral part in the maintenance and longevity of Texas roadways.

### **1.2 Purpose**

Texas State University – San Marcos, Department of Geography, was asked to assist TxDOT in creating a geodatabase that would provide Hydrologist engineers and Maintenance personnel the real time data needed to control cost and improve culvert reliability. ArcGIS and Microsoft Access were used to create the geodatabase system. Hays County Texas was selected as the pilot study area. TxDOT will be able to use the geodatabase to catalog and manage information about culverts such as location, age, and type throughout the state of Texas. A well designed geodatabase will ensure quick and easy access to these large volumes of data and enable TxDOT to effectively manage their infrastructure.

### 1.3 Scope

The geographic extent of the study area is a road section, RM 150, in Hays County that will be used to validate the functionality of the geodatabase. The route was selected with the aid of the local TxDOT maintenance office (Section 6) who is familiar with the area and provided much needed information to the team, such as, what areas would best represent culvert diversity and age.

### 1.4 Problem Statement

The problem which this project addresses is:

***Why design a geodatabase to Inventory Culverts?*** This section deals primarily with the “what” in designing a geodatabase management system. What are the generic processes? What are the tools that are available? What types of methodologies are important when creating a geodatabase?

Once a geodatabase is created, a GIS will then be able to provide spatial visualization of the data contained therein. TxDOT has also requested an additional database be created using Microsoft Access. This will allow the TxDOT maintenance office to enter data of culverts.

## 2. Literature Review

The implementation of a GIS to inventory culvert features in a statewide road network can be a beneficial way for the Department of Transportation to control cost and better manage their infrastructure. Research was conducted on the benefits of implementing the geodatabase data model. A GIS is a particularly useful tool in managing our man-made environment and can provide valuable support to the decision making process.

The geodatabase data model allows users to implement a series of custom behaviors and to make GIS data features smarter without writing any code. Coding can be performed when a set of custom behaviors is required. The geodatabase data model brings a physical data model closer to its logical data model (Zeiler, 1999, p.5).

There are many benefits to the geodatabase data model that make it far superior to any non-object-oriented model. According to Zeiler, some of the benefits are: a uniform repository of geographic data, data entry and editing is more accurate, users work with more intuitive data objects, features have a richer context, better maps can be made, features on a map display are dynamic, shapes of features are better defined, sets of features are continuous, and many users can edit geographic data simultaneously. A principal advantage of the geodatabase data model is that it includes a framework to make it as easy as possible to create intelligent features that mimic the interactions and behaviors of real-world objects (Zeiler, 1999, p.7).

A March 2005 article from Public works magazine details the importance of a systematic approach to culvert inventory and inspection. The article is written by the public information officer with the Ohio Department of Transportation (ODOT). The article describes an instance of a culvert failure underneath a busy stretch of I-480 in Cuyahoga County. The incident was identified and addressed before a catastrophic failure of the roadway occurred.

The result of the failure was the creation of a cross-disciplinary, problem-solving process (PSP) team to confront the problem head-on and develop an approach that would prevent this type of emergency from occurring (Proctor, 2005). The culvert inspection team developed a plan that utilized existing technicians and field engineers to inspect and inventory all culverts. Each culvert is identified with a unique identification number and field-located using a global

positioning system (Proctor, 2005). This methodology allowed ODOT to adequately track the condition of each feature and to effectively prioritize and implement maintenance procedures.

### **3. Data**

The data used in the culvert inventory geodatabase project is listed below:

- 1) Texas Reference Marker System (TRM): Client Supplied (TxDOT)
- 2) Stratmap County Boundaries: Texas Natural Resources Information Systems
- 3) San Marcos, Texas Orthoimagery 2008: Capital Area Council of Governments

The shapefiles used from the TRM data for the project are:

- 1) Hays County Culverts
- 2) Hays County Reference Markers
- 3) Control Section Route Polylines
- 4) Maintenance Section

The quality of the TRM data was not a major concern; the project focuses primarily on geodatabase design rather than on data analysis. However, the data was very useful in identifying the attribute fields relevant for culvert inventory and hydrologic analysis.

The only changes to the TRM data were the locations of culverts along RM 150. When the Hays County Culverts shapefile was compared with orthoimagery, some of the locations were shown to be inaccurate.

The TRM data is important to the project because it is used to populate the tables created in the culvert inventory geodatabase. By using real values for attributes in the geodatabase tables, future users can better understand what the fields represent and the kinds of data to be inputted into the geodatabase. The TRM data obtained was not projected and remains as such. This decision was made to allow users of the system to work with the more familiar latitude and longitude system.

The second piece of data used for the project is the Stratmap County Boundaries from the Texas Natural Resources Information System (TNRIS). The data was downloaded from the Capital Area Council of Governments information clearinghouse website. The data quality is satisfactory; it accurately displays the county boundaries of the state of Texas. The county boundaries shapefile is particularly useful in the creation of maps because it will help display the county boundaries in a study area. The data did not undergo any changes; it is simply included in the geodatabase.

Finally, the last component of the data for the culvert inventory geodatabase is the San Marcos, Texas Orthoimagery 2008 from the Capital Area Council of Governments; the spatial resolution is 0.5 meter. The imagery was used to verify the positional accuracy of the culvert point features in the Hays County Culverts shapefile from TRM. After selecting the road section RM 150, the location of the culverts from the shapefile and aerial imagery were compared. If the point feature did not coincide with the culvert from the image, the location was corrected in the GIS. By correcting the location of the culverts in the shapefile, a more precise hydrologic analysis can be performed. Furthermore, the orthoimagery was not changed or processed. The data was used solely to correct the culvert locations.

## 4. Methodology

The design of the TxDOT culvert inventory geodatabase involved a two task approach (Figure 1). Task 1 focused on the use of ArcCatalog to create the geodatabase and Task 2 focused on the use of Microsoft Access to create a database with a user friendly interface.

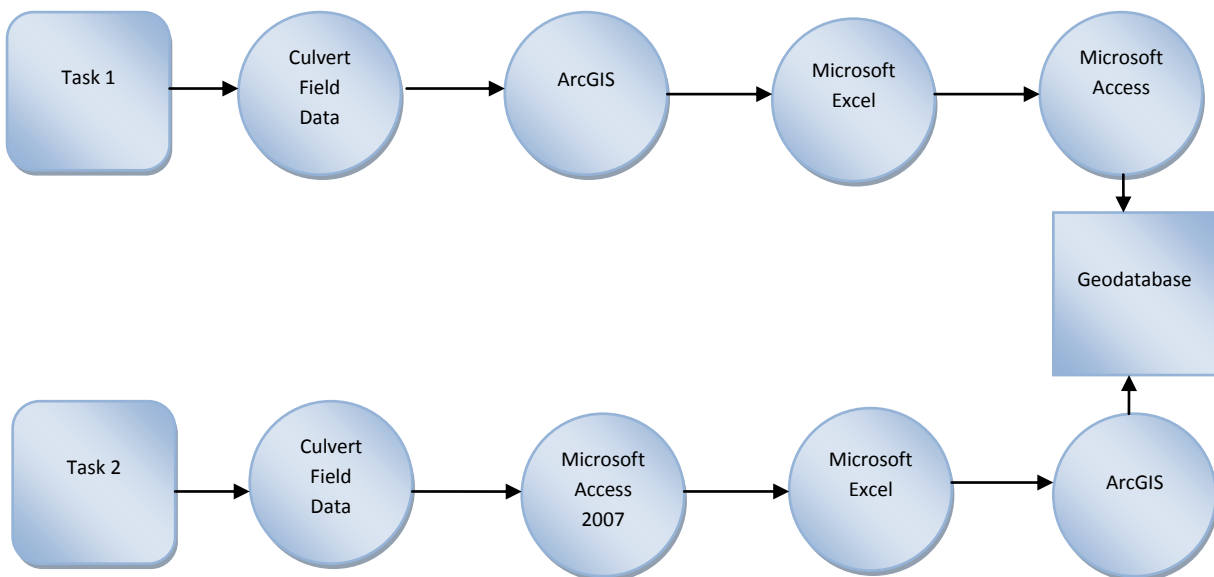


Figure 1. The Two Task Approach of the Culvert Inventory Geodatabase.

The first step was to examine and interpret the data collected during the client interview with TxDOT. This data was identified for inclusion into the geodatabase project based on the following criteria:

- Availability of shape files.
- The importance of demand among TxDOT Engineers and Maintenance personnel.

- Relationships between engineering and maintenance involved in the geodatabase.
- Ease of mapping to support culvert identification, e.g. location, size, shape.

Based on the selected criteria, the culvert inventory geodatabase project dataset included overtopping history, orthoimagery, and TRM data that contained the location of each culvert in Hays County Texas.

Geodatabase activities in task 1 involved implementation of the client’s data with the team’s software for encoding and decoding the data. The Microsoft Access based task involved converting the geodatabase data into a table compatible with the Access 2007 software system. The conversion details of these two tasks are discussed in a subsequent section of this report.

The two tasks of the geodatabase project correspond directly to the two user interfaces represented in Tables 1 and 2. Task 1’s goal was to meet the TxDOT Hydrologist goal identified in Table 1 (access to a broader range of data in the geodatabase) by using ArcGIS, while task 2 met the maintenance field office goal identified in Table 2 (access to a smaller, but more detailed, database) by using Microsoft Access.

Table 1. Usage from the Hydrologist perspective.

ArcGIS	User	Goal
Data Component	TxDOT Hydrologist	Access to a broader range of data
Process Component	TxDOT Hydrologist	Access to geospatial progress capabilities

Table 2. Usage from the County Maintenance office perspective.

Microsoft Access	User	Goal
Data Component	Maintenance Worker	Access to a more detailed database
Process Component	Maintenance Worker	Access to a more user friendly database

#### 4.1 TASK 1: GEODATABASE IMPLEMENTATION

A geodatabase was designed with the intention of managing a culvert inventory by using ArcGIS. A significant advantage to this approach was that the existing shapefiles and culvert data acquired from TxDOT could be used to extract the data by converting certain attribute data from numerous shapefiles into one geodatabase. This way the data would not have to be reformatted to ArcGIS and the process can then be transformed into a map. Using the map the user can view the attribute data and actual locations of culvert features.

#### 4.2 Task 2: MICROSOFT ACCESS DATABASE IMPLEMENTATION

In contrast to the ArcGIS implementation in Task 1, the Microsoft Access implementation benefits from an extensive Access knowledge base. The two major components in Task 2 are the tables and the form. Data is entered into Access by the use of a form. This form provides straight input to the database table through the use of queries and macros and saves each record that reflects the user's preference. A user manual is provided (see appendix 2),



which explains the correct instructions, procedures and abbreviations needed in data entry and the correct use of the software.

## 5. RESULTS

Upon completion of the project, El Grupo de Alcantarilla created a fully functional geodatabase that utilizes both ArcGIS and Microsoft Access. Along with the geodatabase, the team has also developed a user manual to assist in the functionality and operation of the Access form and geodatabase. Figures 2 and 3 illustrate the design of the geodatabase and the Microsoft Access form respectively.

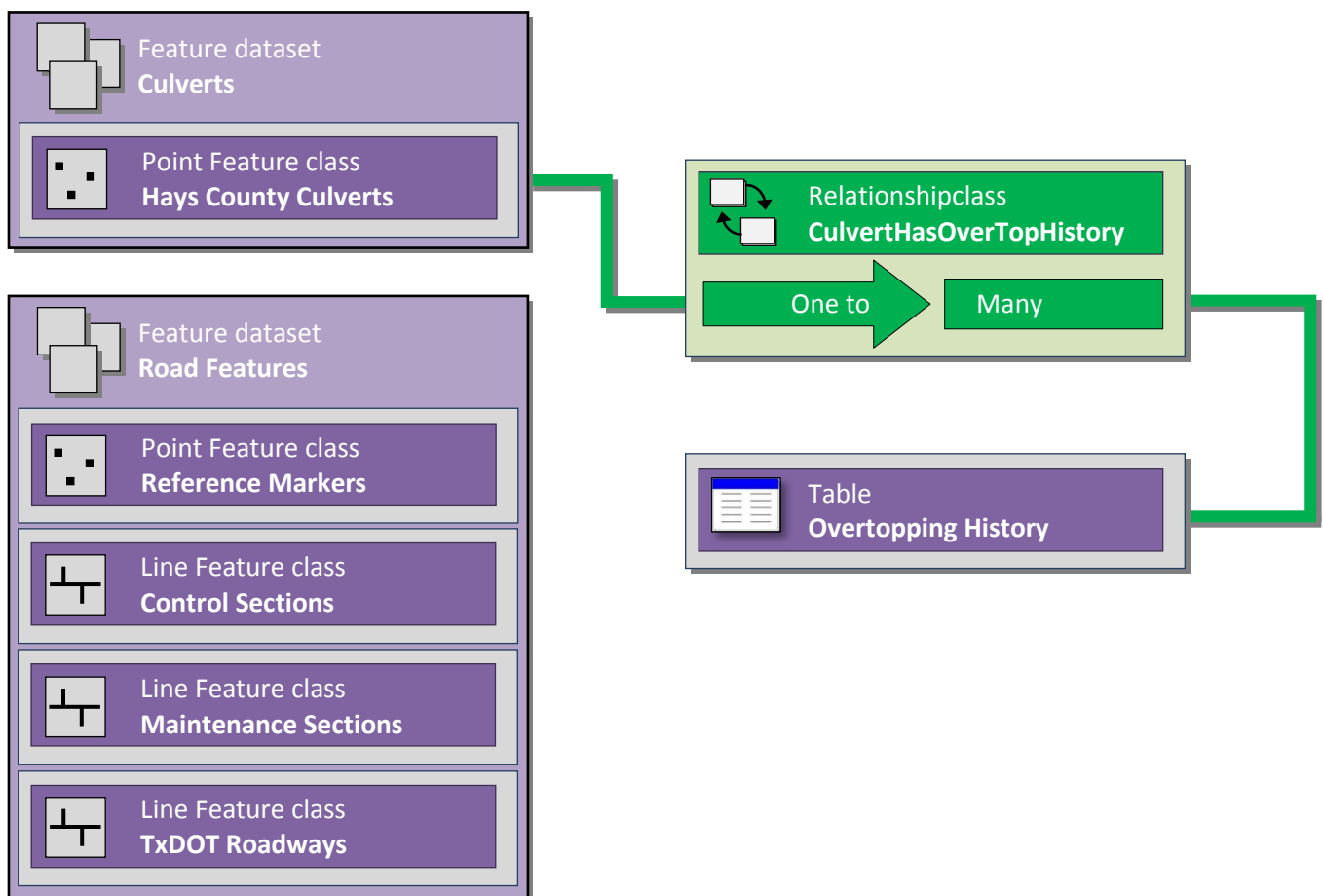


Figure 2. Diagram of the geodatabase

Thursday, April 28, 2011  
11:10:05 AM

## TxDOT Culvert Inventory

County:  RTE\_PRFX\_C:  Runoff\_Coefficient:   
 Highway:  Route\_Num:  Flow\_Dir:   
 Ref\_Num:  Latitude:  Material\_Type:   
 REFDISP:  Longitude:  Age:   
 RDBD:  Culvert\_ID:  Barrels:   
 RWYCODE:  Length:  Safety\_Rail:   
 RWYGRD:  Width:  Headwall:   
 RWYSKEW:  Height:  Wingwalls:   
 INTFTYPE:  Diameter:  Safety\_End\_Treatment:   
 RWYNOTE:  Stream\_Name:  OverTopping\_History:   
 DFO:  Drainage\_Area:  Condition:   
 CSECT:  Time\_Concentration:  Maint\_Worker:   
 MSECT:  Curve\_Number:  Photos:

**Overtopping History subform:**

DATE_	CULVERT_ID	NOTES
*		

Record: 1 of 1 | Unfiltered | Search

**Notes:**

Figure 3. The Microsoft Access form

## 6. DISCUSSION

The culvert inventory geodatabase will allow TxDOT to catalog culverts in an organized and efficient way. This program will allow TxDOT to make the transition to a computerized system that maintains records of small culverts. The department will be able to improve maintenance on these features because the culvert data will be organized and easily accessible to all employees. Overtopping events will be recorded more efficiently and thus facilitate analysis for future infrastructure development. By creating a system where this information can be entered, stored, and easily accessed, the department can dramatically improve the planning of future culverts.

The culvert inventory geodatabase accomplishes the goal of establishing a system for a culvert inventory. It is a successful system because of the accessibility and ease of use by both technicians and maintenance workers. One of the major uses of the system is data entry by the local TxDOT maintenance workers. This was the biggest challenge for the project because the design of the user interface was critical in determining the functionality of the system. After assessing the needs and expectations of our client and the local TxDOT maintenance workers, the design of the interface was tested with real data from culverts on road segment RM 150 in Hays County, Texas. The geodatabase proves to be a successful design because after entering the data in the user interface, the data appeared in the table as a new record. The data was then exported as a Microsoft Excel document; the table was introduced into the GIS and the process was complete.

With the experiences gained from this project, the group would apply a different approach if the project were to be repeated again. Instead of designing the tables in ArcGIS, the design of the tables would have been done in Microsoft Access.

Also, another modification to the methodology of the project would have been to build an application in ArcGIS using ArcObjects. However, due to time constraints the group had to proceed with the project and develop a product using the tools we were most familiar with. If the time frame allowed, the group would conduct more research on developing custom applications for ArcGIS.

The time frame was a big constraint for the culvert inventory geodatabase project. Many improvements could have been done to the product if the group had more time to do research and learn how to better use the tools we had. If the group had more time, the development of custom reports in Microsoft Access would have been a very useful extension to the product. Also, a larger geodatabase with more relational tables could have made the geodatabase more flexible and efficient.

El Grupo de Alcantarilla has various recommendations for future project extensions, since the culvert inventory geodatabase can only be used by one user at a time, it is strongly encouraged to transition to an enterprise level GIS. With this in place, the capabilities of the culvert geodatabase can be greatly expanded. The enterprise GIS will enable TxDOT to have a centralized server that stores the culvert data for the entire state of Texas. This geodatabase would have an unlimited size, could use web applications, and the data could be edited/entered from anywhere in the state. Another recommendation is to establish a standardized naming convention for each attribute in the geodatabase. An example of this case would be a distance measurement (feet vs. inches). Consistency in data handling procedures is necessary to ensure that the data entered does not violate the specifications of the program and remains consistent. Field data acquisition utilizing a Global Positioning System (GPS) would streamline data collection and improve the positional accuracy of the dataset. GPS units, such as those by

Trimble, allow for an easy migration of data into a GIS. A standardized data dictionary could be developed and deployed with units statewide. This would help to ensure consistent data collection and are relatively easy to use.

The final recommendation is to develop a system to assign unique identifiers to culverts and other road features. With the increasing use of Quick Reference (QR) codes (developed by Denso-Wave to inventory auto parts for Toyota, Japan), culverts can be assigned a QR code for a fast digital identification. The codes are two dimensional barcodes capable of storing such things as attribute information and web links. By using a digital tablet or smart phone capable of scanning QR codes, the code can direct the user to a web based application for data entry. This method will simplify the data entry process and cut down on costs.

## **7. CONCLUSION**

What we found is that both Task 1 and Task 2 provided successful solutions for the creation of a geodatabase, each with benefits and limitations. Through the efforts of using ArcGIS, a more complete solution was found in Task 2. Some of the findings are accounted for by familiarity with ArcGIS and the experiences of working with geodatabases in the past. It is also noted that the challenges of Task 1 increased with the complexities inherited when we tried to convert some of the culvert data fields to Access from GIS.

Any comparison success of either Task 1 or Task 2 raised the question: *What types of methodologies are important when creating a geodatabase?* The team found that open exchanges of communication were key in creating a geodatabase that fit TxDOT's culvert management requirements. The team received adequate data from TxDOT to fulfill the needs of the project. In addition, the success of any geodatabase system is the extent to which it serves

the user needs. The team discovered that needs varied significantly depending on the user's perspective (Access user vs. GIS user).

The team was able to gather information from TxDOT, through a series of scheduled interviews, and gain knowledge about the current data collection procedures that the maintenance office is now conducting. Through these interviews and discussions it was apparent that the data collection occurs through the use of TxDOT forms, data packets and photos. The need to eliminate this procedure was one of the main ideas behind creating a geodatabase. The other was to create a localized data repository to share, perhaps in the future, with other counties and districts on a state level.

A geodatabase data model was the best suited to this project in many ways. Creating a geodatabase is comparable to having many compressed files in one location. This will allow TxDOT to store culvert data in a central location for easy access and management. The compressed data is a direct-access format, so TxDOT will not have to uncompress it each time they access it; ArcGIS and ArcReader read it directly. Also, having the geodatabase in a compressed form re-encodes the files resulting in a process that removes redundancy.

## 8. REFERENCES

Arctur, D., and Zeiler, M. 1999. *Designing Geodatabases: Case Studies in GIS Data Modeling*. Redlands: ESRI

"Systematically approaching culvert inventory and inspection." Public Works Magazine Online. 1 March 2005. 3 May 2011 < <http://www.pwmag.com/industry-news.asp?sectionID=774&articleID=271430>>

Zeiler, M. 1999. *Modeling Our World: The ESRI Guide to Geodatabase Design*. Redlands: ESRI

## APPENDIX I. Metadata

### RM0150\_Culverts

**Data format:** Personal GeoDatabase Feature Class

**File or table name:** RM0150\_Culverts

**Coordinate system:** Geographic

**Theme keywords:** Culvert Inventory

**Abstract:** El Grupo de Alcantarilla made the selection from a Hays County, Texas culverts shapefile obtained from the Texas Department of Transportation. The Hays County, Texas culverts shapefile was created from the Texas Reference Marker System dataset.

### FGDC and ESRI Metadata:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)
- [Geoprocessing History](#)

Metadata elements shown with blue text are defined in the Federal Geographic Data Committee's (FGDC) [Content Standard for Digital Geospatial Metadata \(CSDGM\)](#). Elements shown with green text are defined in the [ESRI Profile of the CSDGM](#). Elements shown with a green asterisk (\*) will be automatically updated by ArcCatalog. ArcCatalog adds hints indicating which FGDC elements are mandatory; these are shown with gray text.

---

### Identification Information:

**Citation:**

**Citation information:**

**Originators:** REQUIRED: The name of an organization or individual that developed the data set.

**\*Title:**

RM0150\_Culverts



**\*File or table name:** RM0150\_Culverts

**Publication date:** REQUIRED: The date when the data set is published or otherwise made available for release.

**\*Geospatial data presentation form:** vector digital data

**\*Online linkage:**

[\\ZOOEY\J\TxDOTCulvertInventoryDEMO\Culvert\\_Inventory\\_Geodatabase.mdb](\\ZOOEY\J\TxDOTCulvertInventoryDEMO\Culvert_Inventory_Geodatabase.mdb)

**Description:**

**Abstract:**

El Grupo de Alcantarilla made the selection from a Hays County, Texas culverts shapefile obtained from the Texas Department of Transportation. The Hays County, Texas culverts shapefile was created from the Texas Reference Marker System dataset.

**Purpose:**

The purpose of the dataset is to validate the functionality of the culvert inventory geodatabase.

**Language of dataset:** English

**Time period of content:**

**Time period information:**

**Single date/time:**

**Calendar date:** 5/1/2011

**Time of day:** 12:00 p.m.CDT

**Currentness reference:**

publication date

**Status:**

**Progress:** Complete

**Maintenance and update frequency:** As needed

**Spatial domain:**

**Bounding coordinates:**

\***West bounding coordinate:** -97.979947

\***East bounding coordinate:** -97.882996

\***North bounding coordinate:** 30.046350

\***South bounding coordinate:** 29.990492

**Local bounding coordinates:**

\***Left bounding coordinate:** -97.979947

\***Right bounding coordinate:** -97.882996

\***Top bounding coordinate:** 30.046350

\***Bottom bounding coordinate:** 29.990492

**Keywords:**

**Theme:**

**Theme keywords:** Culvert Inventory

**Theme keyword thesaurus:** RM0150

**Place:**

**Place keywords:** RM0150 Hays County, Texas

**Temporal:**

**Temporal keywords:** Spring 2011

**Access constraints:** N/A

**Use constraints:**

N/A

**Point of contact:**

**Contact information:**

**Contact person primary:**

**Contact person:** El Grupo de Alcantarilla

**Contact organization:** Texas State University-San Marcos

**Contact position:** Student

**Data set credit:**

Texas Department of Transportation

**Security information:**

**Security classification:** Top secret

**\*Native dataset format:** Personal GeoDatabase Feature Class

**\*Native data set environment:**

Microsoft Windows Vista Version 6.1 (Build 7600) ; ESRI ArcCatalog 9.3.0.1770

[Back to Top](#)

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**Data Quality Information:**

**Lineage:**

**Process step:**

**Process contact:**

**Contact information:**

**Contact organization primary:**

**Contact organization:** El Grupo de Alcantarilla

[Back to Top](#)

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## Spatial Data Organization Information:

\***Direct spatial reference method:** Vector

### Point and vector object information:

#### SDTS terms description:

\***Name:** RM0150\_Culverts

\***SDTS point and vector object type:** Entity point

\***Point and vector object count:** 18

### ESRI terms description:

\***Name:** RM0150\_Culverts

\***ESRI feature type:** Simple

\***ESRI feature geometry:** Point

\***ESRI topology:** FALSE

\***ESRI feature count:** 18

\***Spatial index:** TRUE

\***Linear referencing:** FALSE

[Back to Top](#)

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## Spatial Reference Information:

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#### Coordinate system name:

\***Geographic coordinate system name:** GCS\_North\_American\_1983

### Geographic:

\***Latitude resolution:** 0.000000

\***Longitude resolution:** 0.000000

\***Geographic coordinate units:** Decimal degrees

**Geodetic model:**

\***Horizontal datum name:** North American Datum of 1983

\***Ellipsoid name:** Geodetic Reference System 80

\***Semi-major axis:** 6378137.000000

\***Denominator of flattening ratio:** 298.257222

**Vertical coordinate system definition:****Altitude system definition:**

\***Altitude resolution:** 0.000100

\***Altitude encoding method:** Explicit elevation coordinate included with horizontal coordinates

[Back to Top](#)

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**Entity and Attribute Information:****Detailed description:**

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\***Entity type count:** 18

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\***Attribute alias:** OBJECTID

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**\*Attribute definition source:**

ESRI

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**\*Unrepresentable domain:**

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**\*Attribute label:** WIDTH

**\*Attribute alias:** WIDTH

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**\*Attribute precision:** 0

**\*Attribute scale:** 0

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**\*Attribute label:** HEIGHT

**\*Attribute alias:** HEIGHT

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** DIAMETER

**\*Attribute alias:** DIAMETER

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** STREAM\_NAME

**\*Attribute alias:** STREAM\_NAME

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

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**\*Attribute label:** DA

**\*Attribute alias:** DA

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

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**\*Attribute label:** Tc

**\*Attribute alias:** Tc

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** CN

**\*Attribute alias:** CN

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** RC

**\*Attribute alias:** RC

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** FLOW\_DIR

**\*Attribute alias:** FLOW\_DIR

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

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**\*Attribute label:** MAT\_TYPE

**\*Attribute alias:** MAT\_TYPE

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

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**\*Attribute label:** AGE

**\*Attribute alias:** AGE

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** BARRELS

**\*Attribute alias:** BARRELS

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision:** 0

**\*Attribute scale:** 0

**Attribute:**

**\*Attribute label:** SAFETY\_RAIL

**\*Attribute alias:** SAFETY\_RAIL

**\*Attribute type:** String

**\*Attribute width:** 255

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: HEADWALL**

**\*Attribute alias: HEADWALL**

**\*Attribute type: String**

**\*Attribute width: 255**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: WINGWALLS**

**\*Attribute alias: WINGWALLS**

**\*Attribute type: String**

**\*Attribute width: 255**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: SFTY\_END\_TRTMT**

**\*Attribute alias: SFTY\_END\_TRTMT**

**\*Attribute type: String**

**\*Attribute width: 255**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: OVERTOP\_HIST**

**\*Attribute alias: OVERTOP\_HIST**

**\*Attribute type: String**

**\*Attribute width: 255**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

\***Attribute label:** CONDITION

\***Attribute alias:** CONDITION

\***Attribute type:** String

\***Attribute width:** 255

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** MAINT\_WKR

\***Attribute alias:** MAINT\_WKR

\***Attribute type:** String

\***Attribute width:** 255

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** NOTES

\***Attribute alias:** NOTES

\***Attribute type:** String

\***Attribute width:** 255

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** PHOTOS

\***Attribute alias:** PHOTOS

\***Attribute type:** String

\***Attribute width:** 255

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** Shape

\***Attribute alias:** Shape

\***Attribute definition:**

Feature geometry.

\***Attribute definition source:**

ESRI

\***Attribute type:** Geometry

\***Attribute width:** 0

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute domain values:**

\***Unrepresentable domain:**

Coordinates defining the features.

[Back to Top](#)

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## **Distribution Information:**

**Resource description:** Downloadable Data

[Back to Top](#)

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## **Metadata Reference Information:**

\***Metadata date:** 20110504

\***Language of metadata:** en

**Metadata contact:**

**Contact information:**

**Contact organization primary:**

**Contact person:** REQUIRED: The person responsible for the metadata information.

**Contact organization:** El Grupo de Alcantarilla



**Contact address:**

**Address type:** REQUIRED: The mailing and/or physical address for the organization or individual.

**City:** REQUIRED: The city of the address.

**State or province:** REQUIRED: The state or province of the address.

**Postal code:** REQUIRED: The ZIP or other postal code of the address.

**Contact voice telephone:** REQUIRED: The telephone number by which individuals can speak to the organization or individual.

\***Metadata standard name:** FGDC Content Standards for Digital Geospatial Metadata

\***Metadata standard version:** FGDC-STD-001-1998

\***Metadata time convention:** local time

**Metadata security information:**

**Metadata security classification:** Top secret

**Metadata extensions:**

\***Online linkage:** <http://www.esri.com/metadata/esriprof80.html>

\***Profile name:** ESRI Metadata Profile

## Hays\_Control\_Sections

**Data format:** Personal GeoDatabase Feature Class

**File or table name:** Hays\_Control\_Sections

**Coordinate system:** Lambert Conformal Conic

**Theme keywords:** Control Sections

**Abstract:** Shapefile obtained from the Texas Department of Transportation, created from the Texas Reference Marker System dataset.

## FGDC and ESRI Metadata:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)
- [Geoprocessing History](#)

Metadata elements shown with blue text are defined in the Federal Geographic Data Committee's (FGDC) [Content Standard for Digital Geospatial Metadata \(CSDGM\)](#). Elements shown with green text are defined in the [ESRI Profile of the CSDGM](#). Elements shown with a green asterisk (\*) will be automatically updated by ArcCatalog. ArcCatalog adds hints indicating which FGDC elements are mandatory; these are shown with gray text.

---

### Identification Information:

**Citation:**

**Citation information:**

**Originators:** REQUIRED: The name of an organization or individual that developed the data set.

**\*Title:**

Hays\_Control\_Sections

**\*File or table name:** Hays\_Control\_Sections

**Publication date:** REQUIRED: The date when the data set is published or otherwise made available for release.

**\*Geospatial data presentation form:** vector digital data

**\*Online linkage:**

[\\ZOOEY\J\TxDOTCulvertInventoryDEMO\Culvert\\_Inventory\\_Geodatabase.mdb](\\ZOOEY\J\TxDOTCulvertInventoryDEMO\Culvert_Inventory_Geodatabase.mdb)

**Description:**

**Abstract:**

Shapefile obtained from the Texas Department of Transportation, created from the Texas Reference Marker System dataset.

**Purpose:**

To display the control sections of Hays County, Texas.

**Language of dataset:** English

**Time period of content:**

**Time period information:**

**Single date/time:**

**Calendar date:** REQUIRED: The year (and optionally month, or month and day) for which the data set corresponds to the ground.

**Currentness reference:**

publication date

**Status:**

**Progress:** Complete

**Maintenance and update frequency:** As needed

**Spatial domain:**

**Bounding coordinates:**

\***West bounding coordinate:** -98.272989

\***East bounding coordinate:** -97.711942

\***North bounding coordinate:** 30.281130

\***South bounding coordinate:** 29.798620

**Local bounding coordinates:**

\***Left bounding coordinate:** 2199067.609267

\***Right bounding coordinate:** 2375095.707669

\***Top bounding coordinate:** 14014118.702903

\***Bottom bounding coordinate:** 13840153.225375

**Keywords:**

**Theme:**

**Theme keywords:** Control Sections

**Theme keyword thesaurus:** REQUIRED: Reference to a formally registered thesaurus or a similar authoritative source of theme keywords.

**Place:**

**Place keywords:** Hays County, Texas

**Temporal:**

**Temporal keywords:** Spring 2011

**Access constraints:** N/A

**Use constraints:**

N/A

**Point of contact:**

**Contact information:**

**Contact organization primary:**

**Contact organization:** El Grupo de Alcantarilla

**Data set credit:**

Texas Department of Transportation

**\*Native dataset format:** Personal Geodatabase Feature Class

**\*Native data set environment:**

Microsoft Windows Vista Version 6.1 (Build 7600) ; ESRI ArcCatalog 9.3.0.1770

[Back to Top](#)

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## Data Quality Information:

**Lineage:**

**Process step:**

**Process description:**

Dataset copied.

**Source used citation abbreviation:**

\\TPP-674292-1\D\$\Comanche\_2009.gdb

**Process step:**

**Process description:**

Dataset copied.

**Process date:** 20110202

**Process time:** 07484800

**Source used citation abbreviation:**

**Process step:**

**Process description:**

Dataset copied.

**Process date:** 20110202

**Process time:** 07541700

**Source used citation abbreviation:**

[Back to Top](#)

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## Spatial Data Organization Information:

**\*Direct spatial reference method:** Vector

**Point and vector object information:**

**SDTS terms description:**

- \***Name:** Hays\_Control\_Sections
- \***SDTS point and vector object type:** String
- \***Point and vector object count:** 39

**ESRI terms description:**

- \***Name:** Hays\_Control\_Sections
- \***ESRI feature type:** Simple
- \***ESRI feature geometry:** Polyline
- \***ESRI topology:** FALSE
- \***ESRI feature count:** 39
- \***Spatial index:** TRUE
- \***Linear referencing:** TRUE

[Back to Top](#)

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**Spatial Reference Information:****Horizontal coordinate system definition:****Coordinate system name:****\*Projected coordinate system name:**

NAD\_1983\_StatePlane\_Texas\_South\_Central\_FIPS\_4204\_Feet

**\*Geographic coordinate system name:** GCS\_North\_American\_1983**Planar:****Map projection:**

\***Map projection name:** Lambert Conformal Conic

**Lambert conformal conic:**

\***Standard parallel:** 28.383333

\***Standard parallel:** 30.283333

\***Longitude of central meridian:** -99.000000

\***Latitude of projection origin:** 27.833333

\***False easting:** 1968500.000000

\***False northing:** 13123333.333333

**Planar coordinate information:**

\***Planar coordinate encoding method:** coordinate pair

**Coordinate representation:**

\***Abscissa resolution:** 0.000328

\***Ordinate resolution:** 0.000328

\***Planar distance units:** survey feet

**Geodetic model:**

\***Horizontal datum name:** North American Datum of 1983

\***Ellipsoid name:** Geodetic Reference System 80

\***Semi-major axis:** 6378137.000000

\***Denominator of flattening ratio:** 298.257222

**Vertical coordinate system definition:**

**Altitude system definition:**

\***Altitude resolution:** 0.000100

\***Altitude encoding method:** Explicit elevation coordinate included with horizontal coordinates

[Back to Top](#)

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**Entity and Attribute Information:**

**Detailed description:**

\***Name:** Hays\_Control\_Sections

**Entity type:**

\***Entity type label:** Hays\_Control\_Sections

\***Entity type type:** Feature Class

\***Entity type count:** 39

**Attribute:**

\***Attribute label:** OBJECTID\_1

\***Attribute alias:** OBJECTID\_1

\***Attribute definition:**

Internal feature number.

\***Attribute definition source:**

ESRI

\***Attribute type:** OID

\***Attribute width:** 4

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute domain values:**

\***Unrepresentable domain:**

Sequential unique whole numbers that are automatically generated.

**Attribute:**

\***Attribute label:** OBJECTID

\***Attribute alias:** OBJECTID

\***Attribute definition:**

Internal feature number.

\***Attribute definition source:**



ESRI

\***Attribute type:** Double

\***Attribute width:** 8

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute domain values:**

\***Unrepresentable domain:**

Sequential unique whole numbers that are automatically generated.

**Attribute:**

\***Attribute label:** SHAPE

\***Attribute alias:** Shape

\***Attribute definition:**

Feature geometry.

\***Attribute definition source:**

ESRI

\***Attribute type:** Geometry

\***Attribute width:** 0

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute domain values:**

\***Unrepresentable domain:**

Coordinates defining the features.

**Attribute:**

\***Attribute label:** RTE\_NM

\***Attribute alias:** RTE\_NM

\***Attribute type:** String

\***Attribute width:** 15

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: C\_SEC**

**\*Attribute alias: C\_SEC**

**\*Attribute type: String**

**\*Attribute width: 15**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: FROM\_DFO**

**\*Attribute alias: FROM\_DFO**

**\*Attribute type: Double**

**\*Attribute width: 8**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: TO\_DFO**

**\*Attribute alias: TO\_DFO**

**\*Attribute type: Double**

**\*Attribute width: 8**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

**\*Attribute label: CS\_FLAG**

**\*Attribute alias: CS\_FLAG**

**\*Attribute type: String**

**\*Attribute width: 15**

**\*Attribute precision: 0**

**\*Attribute scale: 0**

**Attribute:**

\***Attribute label:** BIN

\***Attribute alias:** BIN

\***Attribute type:** Integer

\***Attribute width:** 4

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** CREATE\_DT

\***Attribute alias:** CREATE\_DT

\***Attribute type:** String

\***Attribute width:** 25

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** EDIT\_DT

\***Attribute alias:** EDIT\_DT

\***Attribute type:** String

\***Attribute width:** 25

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** EDIT\_NM

\***Attribute alias:** EDIT\_NM

\***Attribute type:** String

\***Attribute width:** 25

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute:**

\***Attribute label:** Shape\_Length

\***Attribute alias:** Shape\_Length

\***Attribute definition:**

Length of feature in internal units.

\***Attribute definition source:**

ESRI

\***Attribute type:** Double

\***Attribute width:** 8

\***Attribute precision:** 0

\***Attribute scale:** 0

**Attribute domain values:**

\***Unrepresentable domain:**

Positive real numbers that are automatically generated.

[Back to Top](#)

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### **Distribution Information:**

**Resource description:** Downloadable Data

**Standard order process:**

**Digital form:**

**Digital transfer information:**

\***Transfer size:** 0.000

\***Dataset size:** 0.000

[Back to Top](#)

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### **Metadata Reference Information:**

\***Metadata date:** 20110504

\***Language of metadata:** en

**Metadata contact:**

**Contact information:**

**Contact organization primary:**

**Contact person:** REQUIRED: The person responsible for the metadata information.

**Contact organization:** El Grupo de Alcantarilla

**Contact address:**

**Address type:** REQUIRED: The mailing and/or physical address for the organization or individual.

**City:** REQUIRED: The city of the address.

**State or province:** REQUIRED: The state or province of the address.

**Postal code:** REQUIRED: The ZIP or other postal code of the address.

**Contact voice telephone:** REQUIRED: The telephone number by which individuals can speak to the organization or individual.

\***Metadata standard name:** FGDC Content Standards for Digital Geospatial Metadata

\***Metadata standard version:** FGDC-STD-001-1998

\***Metadata time convention:** local time

**Metadata extensions:**

\***Online linkage:** <http://www.esri.com/metadata/esriprof80.html>

\***Profile name:** ESRI Metadata Profile

## **APPENDIX II. Group participation**

Jason Kleinert

- Logo design
- Project proposal
- Contributed sections
- Edited/formatted the final report
- Contributed to the presentation
- Client point of contact
- Set project timeline
- Updated team on project status
- Conducted research and completed online ESRI courses
- Designed the geodatabase
- Designed the database tables
- Built the geodatabase and corresponding tables
- Led client teleconferences
- Progress report
- Contributed sections
- Edited/formatted the final report
- Contributed to the presentation
- Directed the design of the user interface
- Solved technical problems
- Designed, edited and sent the poster out to printing
- Contributed to the final presentation

- Designed demo for the final presentation
- Final report
- Contributed sections
- Edited/formatted the final report
- Created the geodatabase diagram
- Wrote the majority of the user manual
- Prepared final deliverables

#### Thomas Platt

- Gathered Data from TxDOT to determine fields for geodatabase.
- Designed Team Logo
- Created Team Name El Grupo de Alcantarilla
- Designed and Edited Access Tables
- Designed and Edited Access Forms
- Contributed and Edited the Introduction, Methodology and Conclusion Request for Proposal
- Contributed and Edited the Progress Report and Power Point slides
- Contributed and Edited Abstract, Introduction, Methodology, and Conclusion

#### Andres Aguirre

- Contacted the Hays County TxDOT maintenance office to schedule meetings
- Helped write the proposal, progress report and final report
- Helped develop the power points for the presentations

- Using orthoimagery aerial images, corrected the locations of culverts in RM 150
- Developed maps of the corrected culverts to show the Hays County TxDOT maintenance office
- Assisted in developing the design of the project poster

#### Kyle Vonderau

- Help with data collection and interpretation for conceptual database design
- Attended two TxDot maintenance meetings
- Attended two conference calls with client
- Help develop Progress report
- Developed time-table and table of contents for Project Proposal
- Created webpage design and layout using Dreamweaver CS5
- Structured all data and files for website
- Created alternative culvert inspection report
- Edited and revised Final Report
- Contributed material for Final deliverables