

# ***2014 WATER AUDIT AND INFRASTRUCTURE ANALYSIS REPORT***

---

***FOR  
CITY OF NATALIA, TEXAS***



## THE CITY OF NATALIA

**Prepared by:**

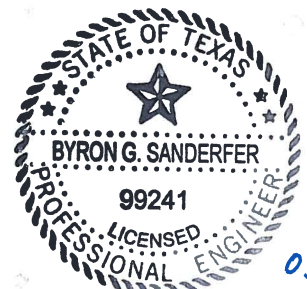


**TBPE FIRM NO. F-366**

8918 Tesoro Drive, Suite 401  
San Antonio, Texas 78217

Ph: (210) 822-2232

Fax: (210) 822-4032



*By Sanderfer* 03/06/16

## Table of Contents

Introduction.....	3
Background.....	3
Water Audit.....	5
Infrastructure Improvements Analysis.....	8
Estimated Water Rate Impact .....	12
Conclusion .....	12
References.....	14
Appendix:.....	15
A. Figure No. 1 - Location Map	
B. Figure No. 2 - City of Natalia Overview Map	
C. Figure No. 3 - Existing Water Distribution System Map	
D. 2012 TWDB Water Audit for Natalia	
E. 2014 TWDB Water Audit for Natalia	
F. 2014 Monthly Field Reports	

## Introduction

LNV, Inc. has been retained by the Edwards Aquifer Authority (EAA) for a Water Conservation Audit to identify areas where water losses are occurring and provide recommendations to reduce this amount within the City of Natalia Water System. This analysis is in general accordance with the Texas Water Development Board (TWDB), the American Water Works Association (AWWA), and the best practices for water audits of similar water systems.

This report was completed by using the top-down “desktop” water audit approach. This approach utilizes available existing records provided by the City of Natalia to review the quantity of water pumped into the system, where the water is being used, and determine areas where the water is being lost. Some estimation was required to provide values for main breaks and flushing of lines.

## Background

The City of Natalia serves approximately 1,663 residents and maintains approximately 14 miles of water distribution mains with 573 service connections (based on 2012 Water Audit Report). The city relies solely on the Edwards Aquifer for its potable water source through the use of two active wells. There are currently three wells owned by the city but only two are being used on a daily basis and connected to the system. The two active wells are located approximately 4.5 miles north of Natalia along FM 463 and supply the city through an 8-inch PVC transmission main that enters the distribution system at the intersection of FM 471 and Cresson St., Appendix C shows the current wells and distribution system based on City records and working knowledge of the system. The city does not import or export water to their system.

The distribution system is comprised of 2-inch, 6-inch, and 8-inch water distribution mains. These mains are comprised of various material types; such as PVC, Asbestos Cement, and Steel. Services to both residential and commercial properties consist of mostly Blue Poly Pipe and PVC with a few being made of Copper. Both the Blue Poly Pipe and PVC services are known to leak due to their inability to flex with ground movements. The city is looking into means of replacing the service lines with Copper as water mains are being replaced throughout

the city.

Average known water losses range between 30 percent and 35 percent which have been consistent over the past several years. The Edwards Aquifer Authority (EAA) has tasked LNV, Inc. to review the past data for the year 2014 and provide recommendations on how to minimize the water loss for the City of Natalia.

The City of Natalia owns an EAA permit for 266.67 acre-feet per calendar year. The city is allowed to withdraw this amount of water per year from the Edwards Aquifer if water restrictions are not in place. In 2014 the city pumped approximately 200 acre-feet. The amount of water used by the City of Natalia is directly related to the demand and Critical Period Management Plan reductions.

During times of drought reductions, the EAA imposes required withdraw reductions on all EAA groundwater permit holders. The EAA is tasked with managing the Edwards Aquifer by ensuring the volume of water the city pumps depends on the Critical Period Management Plan imposed on by the EAA during periods of drought. **Table No. 1, Edwards Aquifer Authority Drought Restrictions** shows the percent reduction required by all groundwater permit holders using more than 3 acre-feet per year. These reductions are enforced based on a rolling 10 day average. **Table No. 1** is a representation of what the City of Natalia is allowed to withdraw during the enforcement of the Critical Period Management Plan on an annualized basis.

Edwards Aquifer Authority Drought Restrictions			
Restriction	Aquifer Depth	Percent Reduction	Permit Amount (acft)
No Restrictions	>660	0%	266.67
Stage 1	<660	20%	213.33
Stage 2	<650	30%	186.67
Stage 3	<640	35%	173.33
Stage 4	<630	40%	160.00
Stage 5	<625	44%	149.33
Note: Permit amount is related to The City of Natalia's allowed withdraw			
<b>Table No. 1, Edwards Aquifer Authority Drought Restrictions</b>			

These reductions are imposed on the groundwater permit holders and watering restrictions are then passed on to the customers by way of restricted days allowed for irrigation purposes to help conserve water.

In the 2014 calendar year the city was required to reduce usage by 35 percent (annualized) limiting their EAA permit to withdraw at 173.33 acre-feet. The city exceeded their permit and had to go to the water market and purchase an additional 40 acre-feet (also required to meet the 35 percent reduction) allowing them to ultimately withdraw approximately 200 acre-feet. As history has shown, more droughts will come and go causing the city to keep a watchful eye on the amount of water readily available for their consumption.

## Water Audit

A Water Audit can be completed by using two methods; a top-down approach and a bottom-up approach. Both methods are trying to achieve the same goal; account for all water introduced into the water distribution system and develop a plan of action to reduce losses within the water distribution system.

This report will follow the top-down approach by using data collected by the city throughout the 2014 calendar year. **Table No. 2, 2014 Water Analysis** lists all collected data for the 2014 calendar year. This table was populated using information from the 2014 Monthly Field Reports (Appendix F). These Monthly Field Reports are completed each month by city staff and provided to city council each month as progress report regarding the usage of water per each month. Based on the values provided by the city, the average loss of water for the 2014 year was 27.08 percent. This was determined by summing up the value of Approximate Volume lost resulting from Leaks and Water Not Billed and divided by the total Volume of Water Pumped into the water distribution system. According to TWDB, the state average for water loss of all reporting water systems for the year 2014 was around 12 percent. For water systems providing service below a population of 10,000 the average water loss was 18 percent.

2014 Water Analysis							
MONTH	WATER PUMPED (GAL)	WATER BILLED (GAL)	CITY USE (GAL)	APPROX. LEAKS (GAL)	APPROX. FLUSHING (GAL)	WATER NOT BILLED (GAL)	WATER LOSS (%)
JANUARY	5,460,080	3,554,651	33,285	750,000	450,000	672,144	26.05%
FEBRUARY	5,703,810	4,215,541	37,650	600,000	150,000	700,619	22.80%
MARCH	5,014,530	3,319,439	16,600	700,000	350,000	628,491	26.49%
APRIL	5,403,730	3,437,253	39,450	800,000	450,000	677,027	27.33%
*MAY	5,447,323	3,723,712	25,603	700,000	300,000	698,008	25.66%
JUNE	5,107,490	3,635,008	26,011	600,000	200,000	646,471	24.40%
JULY	5,562,860	3,540,725	21,084	800,000	500,000	701,051	26.98%
AUGUST	5,979,290	4,359,766	24,400	600,000	250,000	745,124	22.50%
SEPTEMBER	5,979,290	4,359,766	31,000	600,000	250,000	738,524	22.39%
OCTOBER	5,925,370	4,212,722	25,751	500,000	200,000	986,897	25.09%
NOVEMBER	5,278,060	3,636,026	16,400	500,000	200,000	925,634	27.01%
DECEMBER	4,506,040	2,689,937	10,000	625,000	350,000	831,103	32.31%
TOTAL	65,367,873	44,684,546	307,234	7,775,000	3,650,000	8,951,093	
**ADJ. TOTAL (98%)	66,701,911	44,684,546	307,234	7,775,000	3,650,000	10,285,131	27.08%
*Note: Data not provided for month of May (except for leaks and flushes), Values averaged from other months							
**Note: 98% Accuracy adjustment for pumps at wells							
Note: Water Loss (%) includes Approx. Leaks and Water not Billed divided by Water Pumped							
Note: Data used to populate this table was taken from the 2014 Monthly Field Reports							
<b>Table No. 2, 2014 Water Analysis</b>							

The current distribution system is comprised of approximately 14 miles of 2-inch, 6-inch, and 8-inch water mains with material types consisting of PVC, Asbestos Cement, and Steel. The total length was determined by using existing distribution maps provided by the city and importing the information into ArcGIS 10.2.2 over an aerial image of the city and summing up each length. **Table No. 3, Length of Distribution Water Main Sizes** shows a tally of each water main size with the approximate length. Appendix C is provided to show the distribution network within the boundaries of the City of Natalia.

<b>Length of Distribution Water Main Sizes</b>		
Distribution Water Main Size	Approx. Length (LF)	Approx. Length (MI)
8"	46,920	8.89
6"	22,551	4.27
2"	5,248	0.99
Total	74,719	14.15
*Note: Numbers were approximated using existing distribution maps and ArcGIS 10.2.2 to map the system		
<b>Table No. 3, Length of Distribution Water Main Sizes</b>		

In 2012, the City of Natalia completed a Water Audit Report by using the form provided within the “Water Loss Audit Manual for Texas Utilities” developed by the Texas Water Development Board (TWDB), see Appendix D. The current 2014 Water Audit Report form completed by LNV, Inc. is shown in Appendix E. This form takes information regarding the distribution system such as length of pipes, number of services, and volume of water pumped into the system and helps the city identify how much water is actually being lost within the system. At the end of the water audit form, it asks for the unit cost of water and allows you to calculate the approximate amount of revenue lost due to the volume of water not leased within the system. In 2012 the City of Natalia lost \$99,381.92 in water revenues due to Apparent and Real Losses (See Appendix D). Based on the data collected from 2014, the City of Natalia lost approximately \$70,972.11 from Apparent and Real Losses (See Appendix E).

The City of Natalia has made improvements since the last Water Audit was performed. In 2012, the city reported a loss of approximately 34 percent as compared to 27.08 percent as indicated in the 2014 Water Audit form. The city credits this to identifying areas prone to breaks and leaks and making repairs before an issue arises. They are also keeping an eye on customer meters that show signs of pending failure or inaccuracies. These meters are replaced at the first sign of failure or inaccuracy so the proper volume of water used can be properly billed.

There are two volumes every water supplier should be aware of: Authorized Consumption and Water Losses. Authorized Consumption is comprised of Billed and Unbilled Authorized Consumption. These are classified as revenue waters. Water Losses are comprised of Apparent and Real Losses. Apparent Losses include Unauthorized Consumption, Customer

meter under-registering, and Billing adjustments/waivers. Real Losses are comprised of physical losses to the system.

According to the Field Reports provided by the city for the calendar year of 2014, a total of 66,701,911 gallons (204.7 acre-feet) were pumped into the system based on an adjusted pumping rate of 98%. Authorized Consumption totaled 48,641,780 gallons (149.3 acre-feet) and Water Loss totaled 18,060,131 gallons (55.4 acre-feet). This equates to approximately 27.08 percent of the water pumped into the system is lost through documented leaks (approximate value) and unmetered non-billed water loss.

## **Infrastructure Improvements Analysis**

The City of Natalia currently owns and maintains approximately 14 miles of water distribution mains comprised of 2-inch, 6-inch, and 8-inch diameter pipes which consist of PVC, Asbestos Cement, and Steel pipe materials. Services are comprised of Blue Poly Pipe, PVC, and Copper. LNV met with Mr. Art Smith, Director of Public Works for the City of Natalia, on two occasions to collect data and listen to his concerns regarding the distribution system. Mr. Smith provided insight regarding areas of concern and what his thoughts were regarding the loss of water.

Three concerns the city expressed to LNV were Residential/Commercial Meter inaccuracies, Production Well Meters, and Billing adjustments.

Replacing faulty or inaccurate meters requires the least amount of excavation when it comes to addressing water losses. Water meters are typically enclosed in a box/vault that is visible from the surface and replacing one takes minimal staff and time to complete. Replacing meters requires minimal excavation and minimal service impact for residents in effected areas. It also allows the city to identify where the Blue Poly Pipe and PVC services are located and plan for replacement when the distribution main supplying those services is funded. The 2012 Water Audit (copied for 2014 Water Audit) stated the Customer Water Meters were averaging 95 percent accuracy throughout the distribution system. This appears to be high and should be verified with a certified company. Since the city is actively replacing the meters on an as needed basis, the average accuracy for the customer meters is estimated to be between 85 and 95 percent. This means the city is losing money from faulty meters and the actual water loss within the system is reduced because of the inaccuracy of the meters is increased. The customer meter

accuracy loss would then reduce the amount of water lost within the system because some of it would be accounted for within the customer meter accuracy loss, Item No. 25 of the 2014 Water Audit Form (Appendix E).

The City of Natalia is currently replacing between 50-75 meters each year and with 573 service connections within the distribution system it will take between 8-12 years before all the meters have been replaced. Testing water meters for their accuracies will also help save costs because if the meter is still holding its accuracy then replacing the meter is not required. Keeping records of where meters were replaced and where ones have held their accuracy will also assist the city in determining where to spend its resources. Not every meter will be required to be replaced.

Billing adjustments will also need to be further evaluated. The automatic billing software used by the City of Natalia takes the meter readings (field readings, written by hand) and provides a bill to the customer. The issue is there is a flat rate for the first 1,000 gallons used and every 100 gallons used after the initial amount is charged by a unit fee based on the total amount of water used.

The billing records provided to LNV by the city indicate the city only charges customers by increments of 1,000 gallons. Whether these numbers are rounded up or down is unknown. Reviewing the data provided for the period of August 2014 - August 2015 suggest that the city is not billing the full amount. Several customers use 1,000 gallons for one month and then 0 gallons the next several months followed by 1,000 gallon consumption. Either the property was vacant or the gallons were not rolled over to the next month until the 1,000 gallon mark was met. The actual meter readings need to be reviewed and compared to see if each gallon is being charged and accounted for. This will show if each month is being carried over or if the billing software is starting over each month.

The city believes the billing software is starting each month over and the city is losing revenue because of rounding issues and not accounting for water being used. The city estimates approximately 200,000 to 300,000 gallons per month are being lost through the billing software not rolling over the gallons from the previous months. If this is the case, the customer billing contributes to approximately 2.4-3.6 million gallons (7.3-11 acre-feet) of revenue water not accounted for each year.

Some additional concerns expressed by the city were a few streets located on the north

side of the distribution system. Third, Fourth, Fifth, and Sixth St. between FM 471 and Pearson St. are more prone to leaks and water main breaks than the rest of the distribution system. The pipe material within this area is comprised of 6-inch Asbestos Cement pipe and 2-inch Steel pipe. That being said, these pipe need to be replaced by upsizing them to 8-inch PVC. This will allow for better pressure within the immediate area, the existing Blue Poly Pipe and PVC services should also be replaced with Copper, and allow for better fire flow because of the larger volume of water being stored directly within the system.

The city currently implements several methods for managing the distribution system.

**Table No. 4, Continued Management of System** lists several actions that can be implemented with the corresponding benefits.

<b>Continued Management of System</b>		
Item	Description	Benefits
1	Annually Check Accuracy of Production Well Meters	Accurately withdraw correct amounts
2	Manage water within the distribution system to reduce the amount of water used for flushing purposes	Reduce amount of water required to flush system
3	Perform Leak Detection Surveys regularly to locate areas of concern	This will identify areas that need to be replaced
4	Perform Inferred Surveys using Unmanned Aerial Vehicle to detect leaks along the transmission main from the two production wells	This will identify areas of leaks/breaks along the transmission main
5	Request residents to report concerns or suspicious activities regarding unauthorized use of water	Greater ability to catch leaks sooner with the additional eyes watching over the community
6	Request residents to report any areas that show signs of leaks (green areas/increased vegetation, soft spots, ponding)	Greater ability to catch leaks sooner with the additional eyes watching over the community
7	Verify billing software is correctly charging customers for water usage based on amount used each month and bill based on increments of 100 instead of 1,000 gallons	Identify if customers are being billed correctly and the volume of water charged is correctly being accounted for

**Table No. 4, Continued Management of System**

By implementing any number of the items listed in **Table No. 4** will help the city move towards lowering the volume of water loss each year.

Some action items to consider are listed in **Table No. 5, Improvements to Distribution System**. The items listed within this table are improvements that can be developed with a replacement schedule based on identifying areas prone to leaks and breaks.

<b>Improvements to Distribution System</b>							
Item	Description	Unit	Unit Price	Quantity	Total Cost	Approx. Volume Saved (gal/year)	Benefits
1	Perform a study to detect leaks throughout the distribution system and develop a Capital Improvements Project list with a yearly goal for construction projects	EA	Varies	N/A	N/A	N/A	This will identify areas and prioritize areas that need to be addressed
2	Replace Blue Poly Pipe and PVC services with Copper	EA	\$2,000	573	\$1,146,000	2,536,818	Reduce leaks and breaks
3	Upsize existing 2-inch and 6-inch water mains with 8-inch PVC water mains	LF	\$80	27,799	\$2,223,920	Varies	Reduce leaks and breaks; Increase available daily flow rate to customers; Increase available flow rate for fire flow; Increased capacity
4	Replace existing Asbestos and Steel water mains with 8-inch PVC water mains	LF	\$80	12,700	\$1,016,000	Varies	Reduce leaks and breaks
5	Replace Residential/Commercial Meters	EA	\$350	573	\$200,550	Varies	Improves accuracy; Correctly bill customers for usage
6	Reduce the number of "dead ends" within the distribution system by looping the ends of mains	LF	\$80	2,000	\$160,000	Varies	Reduces amount of water required to flush system; Provides loops within the system; Increased capacity for all types of demands; Provides continuous service

Note: Costs are from SAWS June 2014 Average Unit Bid Pricing

Unit Prices are approximate based on 2014 SAWS numbers and should be verified prior to any budgeting takes place

Unit Prices only include the cost for construction and do not include permit fees, engineering design, etc....

**Table No. 5, Improvements to Distribution System**

The items listed within **Table No. 5** are a building block for the city to further investigate and make a plan on how to start investing into the distribution system by replacing the more prone to leak/break areas and upsize them from the existing 2-inch or 6-inch to 8-inch PVC mains. It is key to understand and know where to best allocate your resources to receive the best investment from the use of available funds. Having a study performed identifying areas and establishing a Capital Improvements Project list is a road map the city can use to make progress in reducing the amount of water lost within their system.

## Estimated Water Rate Impact

Several measures were discussed within the Infrastructure Improvements Analysis on ways to reduce water losses. Each of these measures tackles a specific way of addressing a water loss. In order to compete these tasks, it takes additional revenue. Having studies conducted to specifically identify problem areas and establishing a list with a time line to complete will help the city make progress in managing their system.

Something the City of Natalia should consider is to complete a Development Impact Fee Study. This study allows the city to recover costs by providing public facilities for new development. Since Love's has taken residence within the city limits, other large retailers may decide to establish their presence within the city limits and collecting fees from these new developments will help offset the costs of new infrastructure to meet their demands. In addition to the Development Impact Fee Study a Rate Study needs to be completed to find ways to generate more revenue. Looking at cities of similar size and adopting their practices and billing structure would be a start.

## Conclusion

The City of Natalia has shown improvement from their Water Audit of 2012 to their 2014 Water Audit in which the water lost was reduced. A reduction from 34 percent to 27.08 percent shows the city is making progress toward reducing water lost within their system. They are using the resources they have to best manage the system they are responsible for. The City of Natalia is actively pursuing all means and methods to improving the existing infrastructure including actively pursuing grants through various agencies and organizations.

Based on the findings within this report, the city has the ability to recover approximately

\$71,000.00 worth of revenue water per year which equates to approximately 18 million gallons (55 acre-feet) of water for the year 2014.

## References

- Best Management Practices for Municipal Water Users. Report - 362 (2004). Austin, Texas: Texas Water Development Board, November 2013. PDF.  
<http://www.edwardsaquifer.org/groundwater-permit-holders/critical-period-management-plan>. n.d. Internet. 3 November 2015.
- Mark Mathis, George Kunkel, P.E., Andrew Chastain Howley. Water Loss Audit Manual for Texas Utilities. Report 367. Austin, Texas: Texas Water Development Board, March 2008. PDF.
- Water Management International ([www.wmi-water.com](http://www.wmi-water.com)). n.d.

## Appendix:

- A. Figure No. 1 - Location Map
- B. Figure No. 2 - City of Natalia Overview Map
- C. Figure No. 3 - Existing Water Distribution System Map
- D. 2012 TWDB Water Audit for Natalia
- E. 2014 TWDB Water Audit for Natalia
- F. 2014 Monthly Field Reports

## A. Figure No. 1 – Location Map



<div><div><div>015,00030,000</div><div>Feet</div></div><div><div>LNVP</div><div>engineers   architects   surveyors</div><div>TBPE FIRM NO. F-366</div></div></div> <td colspan="2" rowspan="2"><div>Location Map</div></td> <td colspan="2">LNV Proj. No.150349</td> <td rowspan="3"><div><div><div>N</div><div>W</div><div>E</div><div>S</div></div><div>Figure1</div></div></td>	<div>Location Map</div>		LNV Proj. No.150349		<div><div><div>N</div><div>W</div><div>E</div><div>S</div></div><div>Figure1</div></div>
			Date10/8/2015		
	<div>Natalia, TX</div>		Scale1 inch = 30,000 feet		
			FileNatalia Location Map		
			DraftedJS		

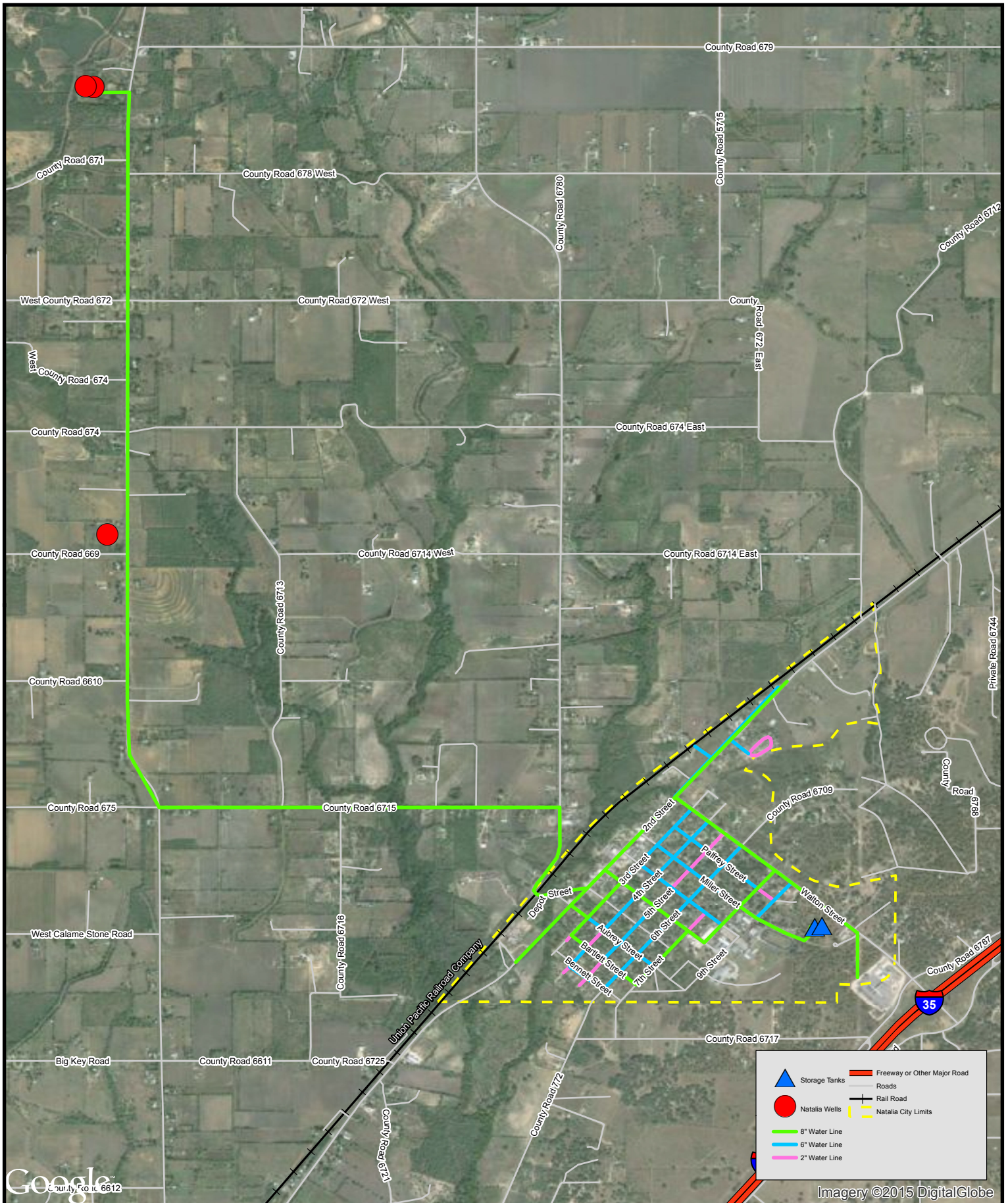
B. Figure No. 2 – City of Natalia  
Overview Map





Imagery ©2015, DigitalGlobe, Texas Orthoimagery Program

<div><div><div>07501,500</div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div>&lt;/</div></div></div>
--

C. Figure No. 3 – Existing Water  
Distribution System Map



 engineers   architects   surveyors TBPE FIRM NO. F-366	<h2 style="text-align: center;">Existing Water Distribution System Map</h2> <h3 style="text-align: center;">Natalia, TX</h3>			
	LNV Proj. No.	150349		<h2 style="text-align: center;">Figure 3</h2>
	Date	10/30/2015		
Scale	1 inch = 2,500 feet			
File	Natalia water lines			
Drafted	JS			

**D. 2012 TWDB Water Audit for**  
**Natalia**

**TEXAS WATER DEVELOPMENT BOARD**

P.O. BOX 13231, CAPITOL STATION

AUSTIN, TX 78711-3231

**2012 Water Audit Report**

**A. Water Utility General Information**

1. Water Utility Name:	<u>City of Natalia</u>			
2. Contact:				
2a. Name	<u>Art Smith</u>			
2b. Telephone #	<u>830-663-2926</u>			
2c. Email Address	<u>asmith@cityofnatalia.com</u>			
3. Reporting Period:	From	<u>1/1/2012</u>	To	<u>12/31/2012</u>
4. Source Water Utilization, percentage:	Surface Water	<u>0.00</u> %	Ground Water	<u>100.00</u> %
5. Population Served:				
5a. Retail Population Served		<u>1,663</u>	Assessment Scale	
5b. Wholesale Population Served		<u>0</u>		
6. Utility's Length of Main Lines, miles		<u>17.00</u>		<u>0</u>
7. Number of Wholesale Connections Served		<u>0</u>		
8. Total Retail Metered Connections		<u>573</u>		
9. Service Connection Density (Number of retail service connections / miles of main lines)		<u>33.71</u>		
10. Average Yearly System Operating Pressure (psi)		<u>53.00</u>		<u>0</u>
11. Volume Units of Measure:		<u>Gallons</u>		

**B. System Input Volume**

12. Produced Water	<u>71,366,000</u>	gallons	<u>0</u>
13. Production Meter Accuracy (enter percentage)	<u>98.00</u>	%	<u>0</u>
14. Corrected Input Volume	<u>72,822,449</u>	gallons	
15. Total Water Purchased	<u>0</u>	gallons	<u>0</u>
16. Total Wholesale Water Sales	<u>0</u>	gallons	<u>0</u>
<b>17. Total System Input Volume</b> (Corrected input volume, plus imported water, minus exported water)	<u>72,822,449</u>	gallons	

**C. Authorized Consumption**

			Assessment Scale
18. Billed Metered	<u>43,339,175</u>	gallons	<u>0</u>
19. Billed Unmetered	<u>0</u>	gallons	<u>0</u>
20. Unbilled Metered	<u>337,176</u>	gallons	<u>0</u>
21. Unbilled Unmetered	<u>3,925,000</u>	gallons	<u>0</u>
<b>22. Total Authorized Consumption</b>	<u>47,601,351</u>		

**TEXAS WATER DEVELOPMENT BOARD**

P.O. BOX 13231, CAPITOL STATION

AUSTIN, TX 78711-3231

**2012 Water Audit Report**

gallons

**D. Water Losses****23. Water Losses**

(Line 17 minus Line 22)

25,221,098 gallons**E. Apparent Losses**

24. Average Customer Meter Accuracy (Enter percentage)

95.00 % 0

25. Customer Meter Accuracy Loss

2,281,009 gallons

26. Systematic Data Handling Discrepancy

0 gallons 0

27. Unauthorized Consumption

182,056 gallon  
s 0**28. Total Apparent Losses**2,463,065 gallons**F. Real Losses**

29. Reported Breaks and Leaks

10,225,000 gallons 0

(Estimated volume of leaks &amp; breaks repaired during the audit period)

30. Unreported Loss

12,533,033 gallons 0

(Includes all unknown water loss)

**31. Total Real Losses**22,758,033 gallon  
s

(Line 29, plus Line 30)

32. Water Losses (Apparent + Real)

25,221,098 gallons

(Line 28 plus Line 31) = Line 23

33. Non-revenue Water

29,483,274 gallons

(Water Losses + Unbilled Authorized Consumption)

(Line 32, plus Line 20, plus Line 21)

**G. Technical Performance Indicator for Apparent Loss**

34. Apparent Losses Normalized

12 gallons

(Apparent Loss Volume / # of Retail Service Connections/365)

**H. Technical Performance Indicators for Real Loss**

35. Real Loss Volume (Line 31)

22,758,033 gallons

36. Unavoidable Annual Real Losses, volume (calculated)

0 gallons

37. Infrastructure Leakage Index (calculated)

0.00000

(Equals real loss volume divided by unavoidable annual real losses)

38. Real Losses Normalized

109 gallons(Real Loss Volume / # of Service Connections /  
365)

**TEXAS WATER DEVELOPMENT BOARD**

P.O. BOX 13231, CAPITOL STATION

AUSTIN, TX 78711-3231

**2012 Water Audit Report**

(This indicator applies if service connection density  
is greater than or equal to 32 / mile)

39. Real Losses Normalized 0 gallons

(Real Loss Volume/Miles of Main Lines/365)

(This indicator applies if service connection density  
is less than 32/mile)

Assessment  
Scale

**I. Financial Performance Indicators**

40. Total Apparent Losses (Line 28) 2,463,065 gallons

41. Retail Price of Water \$0.00339 0

42. Cost of Apparent Losses \$8,349.79  
(Apparent loss volume multiplied by retail cost of water,  
Line 40 x Line 41)

43. Total Real Losses (Line 31) 22,758,032.65

44. Variable Production Cost of Water\* \$0.00400 0  
(\*Note: in case of water shortage, real losses might be valued at  
the retail price of water instead of the variable production cost.)

45. Cost of Real Losses \$91,032.13  
(Real Loss multiplied by variable production cost of water,  
Line 43 x Line 44)

46. Total Assessment Scale 0

47. Total Cost Impact of Apparent and Real Losses \$99,381.92

**48. Comments**

49. Total Water Loss % 34.63 %

50. GPCD (Gallons Per Capita Per Day) Input 119.97

51. GPCD (Gallons Per Capita Per Day) Loss 41.55

**E. 2014 TWDB Water Audit for**  
**Natalia**

# Texas Water Development Board

## Water Audit Worksheet

**A. WATER UTILITY GENERAL INFORMATION**

1. Water Utility Name: City of Natalia
2. Contact: Name Art Smith  
 Telephone# 830-663-2926 Email Address asmith@cityofnatalia.com
3. Reporting Period: From 01 / 01 / 2014 to 12 / 01 / 2014
4. Source Water Utilization, percentage: Surface Water 0 % Groundwater 100 %
5. Population Served:
  - a. Retail Population Served 1,663
  - b. Wholesale Population Served 0
6. Utility's Length of Main Lines, miles 14
7. Number of Wholesale Connections Served 0
8. Number of Retail Service Connections Served 573
9. Service Connection Density 40.93  
*(Number of retail service connections/Miles of main lines)*
10. Average Yearly System Operating Pressure (psi) 53
11. Volume Units of Measure (check one):  
       acre-ft             million gallons             thousand gallons      X gallons

**Assessment  
Scale**

**B. SYSTEM INPUT VOLUME**

12. Water Volume from own Sources 65,367,873
13. Production Meter Accuracy (enter percentage) 98 %
14. Corrected Input Volume 66,701,911
15. Wholesale Water Imported 0
16. Wholesale Water Exported 0
17. **System Input Volume** 66,701,911  
*(Corrected input volume, plus imported water,  
minus exported water)*

		Assessment Scale
<b>C. AUTHORIZED CONSUMPTION</b>		
18. Billed Metered	44,684,546	_____
19. Billed Unmetered	0	_____
20. Unbilled Metered	307,234	_____
21. Unbilled Unmetered	3,650,000	_____
<b>22. Total Authorized Consumption</b>	<b>48,641,780</b>	
<b>D. WATER LOSSES</b>		
<b>23. Water Losses</b> <i>(Line 17 minus Line 22)</i>	<b>18,060,131</b>	
<b>E. APPARENT LOSSES</b>		
24. Average Customer Meter Accuracy <i>(Enter percentage)</i>	95 %	_____
25. Customer Meter Accuracy Loss	2,351,818	_____
26. Systematic Data Handling Discrepancy	0	_____
27. Unauthorized Consumption	185,000	_____
<b>28. Total Apparent Losses</b>	<b>2,536,818</b>	
<b>F. REAL LOSSES</b>		
29. Reported Breaks and Leaks <i>(Estimated volume of leaks and breaks repaired during the audit period)</i>	7,775,000	_____
30. Unreported Loss <i>(Includes all unknown water loss)</i>	7,748,313	_____
<b>31. Total Real Losses</b> <i>(Line 29, plus Line 30)</i>	<b>15,523,313</b>	
32. Water Losses (Apparent + Real) <i>(Line 28 plus Line 31) = Line 23</i>	18,060,131	_____
33. Non-revenue Water <i>(Water Losses + Unbilled Authorized Consumption)</i> <i>(Line 32, plus Line 20, plus Line 21)</i>	22,017,365	_____

**G. TECHNICAL PERFORMANCE INDICATOR FOR APPARENT LOSS**

34. Apparent Losses Normalized (Apparent Loss Volume/# of Retail Service Connections/365)	12.13
---	-------

**H. TECHNICAL PERFORMANCE INDICATORS FOR REAL LOSS**

35. Real Loss Volume ( <i>Line 31</i> )	15,523,313
36. Unavoidable Annual Real Losses, volume (calculated)	3,127,893
37. Infrastructure Leakage Index (calculated) ( <i>Equals real loss volume divided by unavoidable annual real losses</i> )	0
38. Real Losses Normalized (Real Loss Volume/# of Service Connections/365) ( <i>This indicator applies if service connection density is greater than 32/mile</i> )	74.22
39. Real Losses Normalized (Real Loss Volume/Miles of Main Lines/365) ( <i>This indicator applies if service connection density is less than 32/mile</i> )	N/A

**I. FINANCIAL PERFORMANCE INDICATORS**

40. Total Apparent Losses ( <i>Line 28</i> )	2,536,818	
41. Retail Price of Water	\$0.0035	
42. Cost of Apparent Losses ( <i>Apparent loss volume multiplied by retail cost of water, Line 40 x Line 41</i> )	\$8,878.86	
43. Total Real Losses ( <i>Line 31</i> )	15,523,313	
44. Variable Production Cost of Water* (*Note: In case of water shortage, real losses might be valued at the retail price of water instead of the variable production cost.)	\$0.0040	
45. Cost of Real Losses ( <i>Real loss multiplied by variable production cost of water, Line 43 x Line 44</i> )	\$62,093.25	
46. Total Assessment Score		
47. Total Cost Impact of Apparent and Real Losses	\$70,972.11	

## Water Audit Worksheet Instructions

(All numbers used in this worksheet are for example purposes only)

The following instructions can be used in completing the Water Audit Worksheet. The instructions are labeled by line number shown on the worksheet. The Water Audit Worksheet requests that the water utility enter general information and water supply, consumption, and loss quantities. It also requests assessment scores representing the degree of validation of individual components. For those components that include an assessment line, enter a number between 1 and 5. (See Appendix 1.3 for more information.) If a component does not apply, then enter 0 (for example, if the water utility does not import any water, enter 0 for wholesale water imported). You may visit the TWDB Web site for the online version of the water audit:

<http://www.twdb.state.tx.us/conservation/municipal/waterloss/>

### A. Water Utility Information

1. **Water Utility Name:** List the formal name of the water utility for which the water audit exists.
2. **Contact:** List the name of the primary contact person responsible for completing the water audit for the water utility, the telephone number, and email address.
3. **Reporting Period:** Enter calendar year or fiscal year dates for the reporting period.
4. **Source Water Utilization:** Enter percentages to represent the proportions of surface water and groundwater withdrawn for source water supply. Remember that the total of the two percentages must equal 100%.
5. **Population Served:** List separately the retail and wholesale populations served. You may multiply the number of connections by three if needed to estimate the retail population.
6. **Utility's Length of Main Lines, miles:** List the total length of pipeline in the water distribution system in miles.
7. **Number of Wholesale Connections Served:** List the number of wholesale interconnections supplying water to other water utilities.
8. **Number of Retail Service Connections Served:** List the number of retail customer service connections served by the utility's water distribution system.
9. **Service Connection Density:** Calculate the service connection density by dividing the number of retail customer service connections by the length of miles of pipeline in the water distribution system.
10. **Average Yearly System Operating Pressure:** List the average pressure across the entire water distribution systems for the audit period. If a hydraulic model of the network exists, the average pressure can be calculated by the model; otherwise, an estimate can be used.
11. **Volume Units of Measure:** Select the volume units of measure for the water audit. The units must be consistent throughout the entire water audit. If choosing million gallons for system input (from production meters), then authorized consumption (billed and unbilled) and all other entries must also be entered in million gallons. This typically requires a conversion for billed metered consumption.

**B. System Input Volume:** The total water supplied to the infrastructure. It is the total of all production meter readings for the entire year. List the volume or percentage requested in each item, along with the scores from Appendix 1.3 that in your judgment best represent the degree of validation of the data.

12. **Water Volume from own Sources:** Includes all water taken as source water from permitted sources, such as rivers, lakes, streams, and wells.
13. **Production Meter Accuracy (enter a percentage):** Achieved by calibrating or verifying the accuracy level (expressed as a percentage) of production meters. For example purposes, if the meter over-registered by 4 percent, enter 1.04; if it under-registered by 4 percent, enter .96.
14. **Corrected Input Volume (calculated automatically online):** The sum obtained when the production meter adjustment is either added to or subtracted from the system input volume. Divide “water volume from own sources” by the production meter accuracy. You must add the decimal point when the calculation is done manually (for example, to .96).

*Example: If “water volume from own sources” registered 1.8 MG/year through two production meters, which were found to be collectively under-registering flow by 4 percent, then the corrected input volume (CIV) is:*

$$\text{Corrected Input Volume} = (1,800,000)/(0.96) = 1,875,000$$

15. **Wholesale Water Imported:** Amount of purchased wholesale water transferred into the utility’s water distribution system from other water suppliers.
16. **Wholesale Water Exported:** Amount of wholesale water transferred out of the utility’s distribution system. It may be put into the system initially but is only in the system for a brief time for conveyance reasons.
17. **System Input Volume:** Calculated as the corrected input volume plus water imported minus water exported (Line 14, plus Line 15, minus Line 16).

**C. Authorized Consumption:** All water that has been authorized for use or consumption by the utility or its customers. Remember to convert these volumes into the same units as the water delivery volume. Note: Any type of legitimate consumption should be classified in one of the four components of authorized consumption.

18. **Billed Metered:** All retail water sold and metered.
19. **Billed Unmetered:** All water sold but not metered.
20. **Unbilled Metered:** All water metered but not billed, such as back flushing water, parks, golf courses, and municipal government offices.
21. **Unbilled Unmetered:** All water not billed or metered, such as flushing fire hydrants.
22. **Total Authorized Consumption:** The total of the above four components, automatically calculated in the online worksheet.

**D. Water Losses:** Water delivered to the distribution system that does not appear as authorized consumption.

23. Calculated as the difference of the system input volume and total authorized consumption (Line 17 minus Line 22).

- E. **Apparent Losses:** Water that has been consumed but not properly measured or billed. These losses represent under-registered or under-billed water that occurs via customer meter inaccuracy, systematic data handling error in the customer billing system, and unauthorized consumption:

24. **Average Customer Meter Accuracy:** List the composite accuracy percentage for your customer's meters. This percentage is typically derived from meter testing results. A representative assessment of customer meter accuracy can be obtained by testing as few as 50 meters.
25. **Customer Meter Accuracy Loss:** Obtained by dividing the billed metered water volume by the degree of average customer meter accuracy (Line 18 ÷ Line 24).

*Example: If billed metered (line 18) consumption registered 1.5 MG/year and random meter testing found customer meters to be collectively under-registering flow by 8 percent (so they are 92 percent accurate), then the customer meter accuracy loss is:*

$$\text{Custom Meter Accuracy} = [(1,500,000)/(0.92) - 1,500,000] = 130,434.78 \text{ gallons}$$

26. **Systematic Data Handling Discrepancy:** List the estimated volume of water recorded by customer meters but distorted by meter reading or billing system error.
27. **Unauthorized Consumption (theft):** Estimate amount of water loss due to theft. Include an estimate of water taken illegally from fire hydrants, as well as water loss at the customer service connection. Theft at the customer connection can include tampering with meters or meter reading equipment, in addition to illegal taps and other similar occurrences.
28. **Total Apparent Losses:** This value is calculated automatically online as the sum of customer meter accuracy loss, systematic data handling error, and unauthorized consumption.
- F. **Real Losses:** These are physical losses from the pressurized water distribution system, including water mains and all appurtenances (for example, valves and hydrants) and customer service connection piping. Real losses represent water that is lost from the distribution system prior to reaching the customer destination.
29. **Reported Breaks and Leaks:** Reported breaks and leaks are brought to the attention of the water utility by customers, public safety officials, other utilities, or other members of the general public. Usually these visible water main breaks are very disruptive and water utilities respond quickly to these events, so the run duration of the break or leak is relatively short. Estimate the total volume of water loss during the water audit period from reported breaks and leaks that were repaired during the year. Leakage flow rates must be estimated for various types of breaks and leaks, as well as the approximate duration of the breaks or leaks prior to repair.
30. **Unreported Loss:** This is a "catch-all" volume, meaning that this volume of real losses is the quantity that remains after authorized consumption, apparent losses, and reported leakage have been subtracted from the system input volume. In every water distribution system, even those employing effective active leakage control programs, there exists some amount of undetected leakage. Some of this loss is comprised of unreported leakage that has not yet been detected in leak surveys. It also includes a subcomponent known as background leakage, which is the collective weeps and seeps at pipe joints and on customer service connections that cannot be detected with acoustic sounding devices. Any degree of error in quantifying metered and estimated volumes in the water audit results in error in this component. As the validation of the water audit improves over time, so will the level of validation of the unreported loss volume.

31. **Total Real Losses:** This value is calculated automatically online as the sum of reported breaks and leaks and unreported loss.
  32. **Water Losses:** Calculated as the sum of apparent losses and real losses. This value should equal the value of Line 23. This line is included as a balancing check.
  33. **Non-revenue Water:** Calculated as the sum of apparent losses, plus real losses, plus unbilled metered consumption and unbilled unmetered consumption. This is the water that does not contribute to the water utility billings.
- G. Technical Performance Indicator for Apparent Loss:** Performance indicators are quantitative measures of key aspects within the utility. Using these indicators, the utility will have a history to track its performance from year to year. One performance indicator exists for apparent loss.
34. **Apparent Losses Normalized:** Calculated as the volume of apparent loss, divided by the number of retail customer service connections, divided by 365 days. This performance indicator allows for reliable performance tracking in the water utility's efforts to reduce apparent losses.
- H. Technical Performance Indicator for Real Loss:** Several performance indicators exist for real loss.
35. **Real Loss Volume:** This is the quantity from Line 31.
  36. **Unavoidable Annual Real Losses:** Calculated reference value using the equation shown in Table 3-2. This is a theoretical value of the technical low level of leakage that might be attained in a given water utility, based upon several system specific parameters.
  37. **Infrastructure Leakage Index:** This performance indicator is calculated as the ratio of real losses over the unavoidable annual real losses. The index measures the water utility's leakage management effectiveness and is an excellent performance indicator for comparing performance among water utilities. The lower the value of the infrastructure leakage index, the closer the utility is operating to the theoretical low level of the unavoidable annual real loss. Appendix 1.4 gives general guidance on setting preliminary leakage reduction targets using the infrastructure leakage index without changing water pressure.
  38. **Real Losses Normalized:** Calculated as the real loss volume, divided by the number of retail service connections, divided by 365. Use this calculation if the service connection density is greater than, or equal to, 32 per mile. This indicator allows for reliable performance tracking in the water utility's efforts to reduce real losses.
  39. **Real Losses Normalized:** Calculated as the real loss volume, divided by the number of miles of pipeline, divided by 365. Use this calculation if the service connection density is less than 32 per mile. This indicator allows for reliable performance tracking in the water utility's efforts to reduce real losses.

## I. Financial Performance Indicators

40. **Total Apparent Losses:** List the volume from line 28.
41. **Retail Price of Water:** Water utility rate structures usually feature multiple tiers of pricing based upon volume consumed. For the water audit, it is best to use a single composite price rate to represent the retail cost of water, which is used to place a value on the apparent losses. The largest number of accounts in most utilities is residential accounts; therefore, the residential pricing tier may be used in place of weighted calculations to determine a composite rate.
42. **Cost of Apparent Losses:** Calculated by multiplying the apparent loss volume by the retail price of water. This represents the potential amount of missed revenue due to apparent losses.
43. **Total Real Losses:** List the volume from line 31.
44. **Variable Production Cost of Water:** Marginal production cost including variable costs, which are typically the costs of raw water, energy, and chemicals. If applicable, the cost of raw water should include the price of take or pay contracts. These costs are applied to determine the cost impact of real losses. In cases of water shortage, real losses might be valued at the retail price of water instead of the variable production cost.
45. **Cost of Real Losses:** Calculated by multiplying the real loss volume by the variable production cost of water. These costs represent the additional operating costs incurred by the water utility due to the real losses (in other words, leakage).
46. **Total Assessment Score:** Add the individual assessment scores to obtain a total.
47. **Total Cost Impact of Apparent and Real Losses:** Calculated by adding lines 42 and 45. This amount indicates the cost inefficiency encountered by the water utility for losses. This cost value can be objectively weighed against potential loss control programs to determine the cost effectiveness of such programs.

If you or the utility has any software application questions, please call Juan Moran-Lopez at 512-463-0987 or email: [Juan.Moran-Lopez@twddb.texas.gov](mailto:Juan.Moran-Lopez@twddb.texas.gov)

For more information on water audits, visit the American Water Works Association Web site: <http://www.awwa.org/Resources/topicspecific.cfm?ItemNumber=3653&navItemNumber=1583>

## F. 2014 Monthly Field Reports

To Governing Body  
 From: Art Smith  
 Subject: Field Report for January 2014

Sent sewer samples to Pollution Control 2, 9, 16, 23, 30  
 Sent water site samples to Pollution Control 16

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$402.21	2,141	132.54	16.20
Ford F-150 #2	\$418.95	1,406	137.22	11.00
Chevy	\$163.02	776	53.45	14.52
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	1,000	\$19.00
Natalia PD	2,000	\$21.00
Sewer Plant	9,000	\$35.00
Library	5,000	\$27.00
Little League	0	\$0.00
Veterans Memorial	0	\$0.00
Fire Department	2,000	\$21.00
Fire Trucks	11,285	\$40.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	750,000	500,000
Flushing	450,000	300,000

Cost for Leaks & Flushing  
 \$173.09

City Water Use	1,233,285	\$359.09
Total Gallons Pumped	5,460,080	
Gallons Sold	3,554,651	
Well #7	2,000	\$0.29
Total Usage	4,787,936	
Gallons Lost	672,144	\$96.95
Loss Percentage	14.04%	
Total City's Cost		\$456.32

Services turned off. 18  
 Survices turned on. 17

One service remains turned off due to non-payment. They have not contacted the office.

16 water meters were replaced.

To Governing Body  
 From: Art Smith  
 Subject: Field Report for February 2014

Sent sewer samples to Pollution Control 6, 13, 20, 27  
 Sent water site samples to Pollution Control 13

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$374.08	1,894	118.44	16.20
Ford F-150 #2	\$289.81	813	93.11	12.00
Chevy	\$161.03	632	52.45	12.05
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	1,000	\$19.00
Natalia PD	1,000	\$19.00
Sewer Plant	20,000	\$62.00
Library	10,000	\$37.00
Little League	0	\$0.00
Veterans Memorial	0	\$0.00
Fire Department	1,000	\$19.00
Fire Trucks	1,650	\$20.30
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	600,000	750,000
Flushing	150,000	450,000

Cost for Leaks & Flushing  
 \$108.18

City Water Use	787,650	\$307.48
Total Gallons Pumped	5,703,810	
Gallons Sold	4,215,541	
Well #7	0	\$0.00
Total Usage	5,003,191	
Gallons Lost	700,619	\$101.06
Loss Percentage	14.00%	
Total City's Cost		\$408.53

Services turned off. 12  
 Services turned on. 12

To Governing Body

From: Art Smith

Subject: Field Report for March 2014

Sent sewer samples to Pollution Control 6, 13, 20, 27

Sent water site samples to Pollution Control 13

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$245.88	1,318	75.92	16.20
Ford F-150 #2	\$312.63	1,187	97.16	11.00
Chevy	\$274.53	759	84.55	8.98
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	1,000	\$19.00
Natalia PD	2,000	\$21.00
Sewer Plant	2,000	\$21.00
Library	3,000	\$23.00
Little League	2,000	\$21.00
Veterans Memorial	0	\$0.00
Fire Department	1,000	\$19.00
Fire Trucks	2,600	\$21.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	700,000	600,000
Flushing	350,000	150,000

Cost for Leaks & Flushing  
\$151.45

City Water Use	1,066,600	\$319.45
Total Gallons Pumped	5,014,530	
Gallons Sold	3,319,439	
Well #7	0	\$0.00
Total Usage	4,386,039	
Gallons Lost	628,491	\$90.65
Loss Percentage	14.33%	
Total City's Cost		\$410.10

Services turned off. 23

Services turned on. 21

Two services remain turned off due to non-payment.

To Governing Body

From: Art Smith

Subject: Field Report for April 2014

Sent sewer samples to Pollution Control 3, 10, 17, 24

Sent water site samples to Pollution Control 24

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$435.52	1,774	127.93	16.50
Ford F-150 #2	\$337.86	902	98.82	13.00
Chevy	\$192.01	937	55.99	16.74
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	2,000	\$21.00
Natalia PD	1,000	\$19.00
Sewer Plant	12,000	\$42.00
Library	6,000	\$29.00
Little League	8,000	\$33.00
Veterans Memorial	0	\$0.00
Community Garden	1,000	\$19.00
Fire Department	0	\$0.00
Fire Trucks	6,450	\$29.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	800,000	700,000
Flushing	450,000	350,000

Cost for Leaks & Flushing  
\$180.30

City Water Use	1,289,450	\$395.30
Total Gallons Pumped	5,403,730	
Gallons Sold	3,437,253	
Well #7	2,000	\$0.29
Total Usage	4,726,703	
Gallons Lost	677,027	\$97.65
Loss Percentage	14.32%	
Total City's Cost		\$493.24

Services turned off. 18

Services turned on. 16

Two services remain turned off due to non payment.

To Governing Body  
 From: Art Smith  
 Subject: Field Report for June 2014

Sent sewer samples to Pollution Control 5, 12, 19, 26  
 Sent water site samples to Pollution Control 19

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$412.50	1,720	121.938	15.60
Ford F-150 #2	\$345.95	1,282	102.39	11.60
Chevy	\$377.31	1,328	111.93	11.86
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	2,000	\$21.00
Natalia PD	1,000	\$19.00
Sewer Plant	2,000	\$21.00
Library	1,000	\$19.00
Little League	12,000	\$42.00
Veterans Memorial	0	\$0.00
Community Garden	2,000	\$21.00
Fire Department	1,000	\$19.00
Fire Trucks	2,011	\$21.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	600,000	700,000
Flushing	200,000	300,000

Cost for Leaks & Flushing  
 \$115.39

City Water Use	826,011	\$206.00
Total Gallons Pumped	5,107,490	
Gallons Sold	3,635,008	
Well #7	0	\$0.00
Total Usage	4,461,019	
Gallons Lost	646,471	\$93.25
Loss Percentage	14.49%	
Total City's Cost		\$299.25

Services turned off. 25  
 Survices turned on. 25

To Governing Body  
 From: Art Smith  
 Subject: Field Report for July 2014

Sent sewer samples to Pollution Control 3, 10, 17, 24, 31  
 Sent water site samples to Pollution Control 10

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$415.43	2,096	122.441	16.70
Ford F-150 #2	\$422.21	1,554	124.02	11.30
Chevy	\$282.23	882	83.81	10.52
GMC 1ton	\$408.65	1,004	106.35	9.44

City Water Use

	Gallons	Cost
City office	1,000	\$19.00
Natalia PD	1,000	\$19.00
Sewer Plant	13,000	\$44.50
Library	0	\$0.00
Little League	1,000	\$19.00
Veterans Memorial	0	\$0.00
Fire Department	0	\$0.00
Fire Trucks	2,084	\$21.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	800,000	600,000
Flushing	500,000	200,000

Cost for Leaks & Flushing  
 \$187.51

City Water Use	1,321,084	\$333.01
Total Gallons Pumped	5,562,860	
Gallons Sold	3,540,725	
Well #7	2,000	\$0.29
Total Usage	4,861,809	
Gallons Lost	701,051	\$101.12
Loss Percentage	14.42%	
Total City's Cost		\$434.42

Services turned off. 15  
 Services turned on. 12

2 services remain locked due to non-payment, and the other service is still off due to the death of the resid

To Governing Body  
 From: Art Smith  
 Subject: Field Report for August 2014

Sent sewer samples to Pollution Control 7, 14, 21, 28  
 Sent water site samples to Pollution Control 14

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$294.81	1,374	89.21	16.10
Ford F-150 #2	\$406.39	1,415	122.72	12.00
Chevy	\$204.85	796	61.70	12.90
GMC 1ton	\$517.25	1,118	135.94	8.20

City Water Use

	Gallons	Cost
City office	2,000	\$21.00
Natalia PD	1,000	\$19.00
Community Garden	1,000	\$19.00
Sewer Plant	5,000	\$27.00
Library	0	\$0.00
Little League	0	\$0.00
Veterans Memorial	0	\$0.00
Fire Department	1,000	\$19.00
Fire Trucks	11,400	\$39.50
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	600,000	800,000
Flushing	250,000	500,000

Cost for Leaks & Flushing  
 \$122.60

City Water Use	874,400	\$146.50
Total Gallons Pumped	5,979,290	
Gallons Sold	4,359,766	
Well #7	0	\$0.00
Total Usage	5,234,166	
Gallons Lost	745,124	\$107.47
Loss Percentage	14.24%	
Total City's Cost		\$253.97

Services turned off. 18  
 Services turned on. 17

One service remains shut off because the resident moved out.

To Governing Body

From: Art Smith

Subject: Field Report for September 2014

Sent sewer samples to Pollution Control 4, 11, 18, 25

Sent water site samples to Pollution Control 11

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$360.47	1,743	112.405	16.50
Ford F-150 #2	\$413.05	1,569	128.52	13.00
Chevy	\$242.01	960	75.74	12.68
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	1,000	\$19.00
Natalia PD	0	\$0.00
Sewer Plant	21,000	\$64.50
Library	1,000	\$19.00
Little League	4,000	\$25.00
Veterans Memorial	0	\$0.00
Fire Department	0	\$0.00
Fire Trucks	1,000	\$19.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	600,000	600,000
Flushing	250,000	250,000

Cost for Leaks & Flushing  
\$122.60

City Water Use	881,000	\$292.10
Total Gallons Pumped	5,979,290	
Gallons Sold	4,359,766	
Well #7	0	\$0.00
Total Usage	5,240,766	
Gallons Lost	738,524	\$106.52
Loss Percentage	14.09%	
Total City's Cost		\$403.10

Services turned off. 6

Services turned on. 6

To Governing Body  
 From: Art Smith  
 Subject: Field Report for October 2014

Sent sewer samples to Pollution Control 2, 9, 16, 23, 31  
 Sent water site samples to Pollution Control 9

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$378.77	1,948	125.898	16.60
Ford F-150 #2	\$377.33	1,669	124.74	12.00
Chevy	\$249.99	1,024	84.37	12.14
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	1,000	\$19.00
Natalia PD	1,000	\$19.00
Sewer Plant	1,000	\$19.00
Library	0	\$0.00
Little League	2,000	\$21.00
Veterans Memorial	0	\$0.00
Fire Department	1,000	\$19.00
Fire Trucks	16,751	\$52.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	500,000	600,000
Flushing	200,000	250,000

Cost for Leaks & Flushing  
 \$100.97

Estimated Water Loss from billing method  
 (included in City Water Use)  
 250,000

City Water Use	975,854	\$272.97
Total Gallons Pumped	5,925,370	
Gallons Sold	4,212,722	
Well #7	2,000	\$0.29
Total Usage	5,188,576	
Gallons Lost	736,794	\$106.27
Loss Percentage	14.20%	
Total City's Cost		\$383.24

Services turned off. 17  
 Services turned on. 16

1 service remains turned off for nonpayment.

To Governing Body

From: Art Smith

Subject: Field Report for November 2014

Sent sewer samples to Pollution Control 6, 13, 20, 25

Sent water site samples to Pollution Control 13

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$241.90	1,476	90.32	15.80
Ford F-150 #2	\$312.47	1,248	115.12	12.50
Chevy	\$154.23	838	56.21	14.90
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	2,000	\$22.00
Natalia PD	1,000	\$20.00
Sewer Plant	1,000	\$20.00
Library	0	\$0.00
Little League	8,000	\$34.00
Veterans Memorial	0	\$0.00
Fire Department	1,000	\$20.00
Fire Trucks	400	\$20.00
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	500,000	500,000
Flushing	200,000	200,000

Cost for Leaks & Flushing  
\$100.97

Estimated Water Loss from billing method  
(included in City Water Use)  
250,000

City Water Use	966,503	\$259.97
Total Gallons Pumped	5,278,060	
Gallons Sold	3,636,026	
Well #7	2,000	\$0.29
Total Usage	4,602,529	
Gallons Lost	675,531	\$97.44
Loss Percentage	14.68%	
Total City's Cost		\$360.06

Services turned off. 8

Survices turned on. 8

To Governing Body

From: Art Smith

Subject: Field Report for December 2014

Sent sewer samples to Pollution Control 4, 11, 18, 23, 30

Sent water site samples to Pollution Control 18

City vehicles for the month.

	Amount	Miles	Gallons	MPG
Ford F-150 #1	\$99.44	1,014	63.537	16.00
Ford F-150 #2	\$266.12	1,402	115.80	12.50
Ford F-150 #3	\$204.94	1,054	95.54	14.50
Chevy	\$138.11	658	55.81	11.80
GMC 1ton	Not in Daily Use			

City Water Use

	Gallons	Cost
City office	1,000	\$20.00
Natalia PD	1,000	\$20.00
Sewer Plant	3,000	\$24.00
Library	0	\$0.00
Little League	2,000	\$22.00
Veterans Memorial	0	\$0.00
Fire Department	0	\$0.00
Fire Trucks		
Scotts	3,000	\$23.00

	Gallons	Last Month
Leaks	625,000	500,000
Flushing	350,000	200,000

Cost for Leaks & Flushing  
\$140.63

Estimated Water Loss from billing method  
(included in City Water Use)  
250000

City Water Use	1,235,144	\$249.63
Total Gallons Pumped	4,506,040	
Gallons Sold	2,689,937	
Well #7	0	\$0.00
Total Usage	3,925,081	
Gallons Lost	580,959	\$83.80
Loss Percentage	14.80%	
Total City's Cost		\$334.87

Services turned off.

Services turned on.