City of Bolivar, MO

Spring 1999 Fire Hydrant Testing/Coding Project

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2.0 Executive Summary

TO: Terry Helton, City Administrator

CC: Milton Dickensheet, Director of City Services and City Engineering

Dale Newcomb, City Clerk, Assistant Fire Chief

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FROM: Theron Becker, Interim Fire Protection Engineer

DATE: May 19, 1999

SUBJECT: Spring 1999 Fire Hydrant Testing/Coding Project

The goals of the fire hydrant project were to systematically test Bolivar's fire hydrants and paint them according to a color code developed by the National Fire Protection Association (NFPA) and recommended by the Insurance Services Office (ISO). The results of these tests can be used, not only by the fire department, but also by the water department and city engineering services to identify deficient areas of town.

Due to different main sizes and ages, water flow will differ from hydrant to hydrant. The knowledge gained from this project will be primarily used by the fire department to determine which hydrants are best to be used in fire suppression activities. The other main use of the data from this project will be by the City Engineering Department and Water Department to identify areas of town that might need additional water supply. One other reason for this project is the upcoming Insurance Service Office (ISO) inspection. As you know, ISO rates cities based upon the fire department and water services. This rating is the basis for property fire insurance premiums in the city. ISO representatives prefer having documentation on hydrant ratings. They require information about the number of hydrants, type of hydrants, and types of mains connected to hydrants. The results of this project will provide all that information.

To meet these goals, I was hired in a temporary capacity to develop a system and start testing and coding the city's hydrants. This document explains in detail the system developed and implemented. By doing flow tests and hydraulic calculations, each hydrant in the city now has extensive data on it. This data includes location, hydraulic information, hydrant information, main information, etc.

No matter the value of this project, the value of an ongoing project is great. NFPA recommends hydrants should be tested and rated every year. This task is immense when every hydrant is to be tested, but a few hydrants per week is not difficult nor very time consuming, whether water department crew does some testing while flushing hydrants or fire department personnel does some testing after fires, etc. The ongoing testing will provide continuous knowledge of the city's water supply performance.

This document provides, in a how-to format, information on how hydrant flow tests are to be done and were done for this project.

3.1 Introduction and Objectives

"Fire *flow tests* are conducted on water distribution systems to determine the [amount of water] available at various locations for fire-fighting purposes. Additional benefit is derived from fire *flow tests* by the indication of possible deficiencies which could be corrected to ensure adequate fire flows as needed." (NFPA 291 4) Using even the most sophisticated computer programs, a mathematical test would be tedious and yield only approximations. Actual internal pipe conditions, effective diameters, and partially or completely closed valves or other obstructions can only be estimated to be entered into the computer, therefore the computer results are only as good as the estimates. Due to these various reasons, going out and getting wet while actually *flow testing* hydrants is best.

Once one or more hydrants are tested, there must be a way to quickly determine the approximate flow from them in the field. Fire Department personnel responding to or arriving at a fire scene must be able to quickly and easily select the *best* hydrant(s) for connection to a fire engine to be used in fire suppression activities. Selection of the *best* hydrant includes several factors. Two of the most important factors are location and water flow. In the past, people knowledgeable with the city's water main distribution system estimated water flow. It was a rough estimate that amounted to the bigger the main, the more water. With some sort of code or system, actual tested water flows can be easily known on a fire scene.

The National Fire Protection Association (NFPA) recommends a color code system as described in the document: *NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants.* Water flow (the amount of water flowing per time unit) is measured in gallons per minute (gpm) and NFPA's color-code assigns four colors depending upon a hydrant's gpm. The Insurance Services Office (ISO) recognizes this code and also recommends it.

This project is aimed at testing all hydrants in Bolivar and painting them according to NFPA's system. This document explains the project and can be used as a guide for future tests with supervision of a city engineer, water department personnel, or a fire protection engineer. Therefore this document is formatted in a how-to fashion. The project followed these guidelines to accomplish its goals.

Bolivar's and the author's pitot tubes.

3.2 Project Description

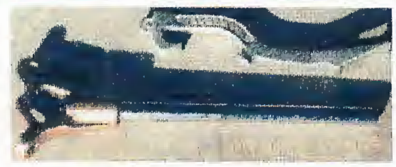
Before starting any task, tools must be identified and assembled for use. Some basic equipment needed for hydrant testing include: a pitot tube, tapped hydrant cap with gauge, small ruler accurate to 1/16th of an inch, hydrant and spanner wrenches, elbow fitting, smoothbore nozzle or playpipe, water line map, and a convenient form to record test data. A piezo tube diffuser may be substituted for the pitot tube, elbow, and nozzle.

A Pitot tube is an instrument that, when inserted into a stream of water, will display the *velocity pressure* of that stream. There are various types of pitot tubes but most (including Bolivar's) have air chambers extending past the gauge to form a handle. This air chamber serves as a shock absorber and will reduce needle vibration on the gauge.

Bolivar's tapped cap and gauge.

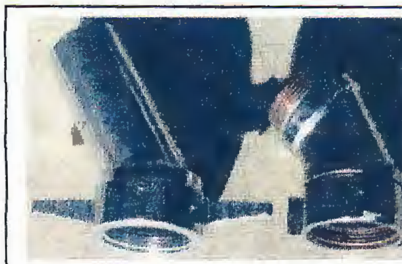
The tapped cap and gauge is used to gather the other two data items: *static* and *residual pressure*.

The ruler is needed to measure the actual diameter of the outlet orifice to be used together with the *velocity pressure* gained from the pitot tube to yield flow. Hydrant and spanner wrenches are obviously needed to open and close the hydrant and loosen and tighten caps and fittings.



Bolivar's hydrant and a spanner wrench.

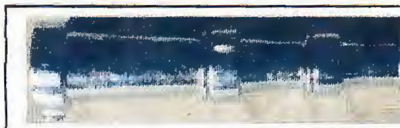
The elbow fitting is used to direct the stream of water in the direction that will cause the least damage or disruption.



Bolivar's elbows.

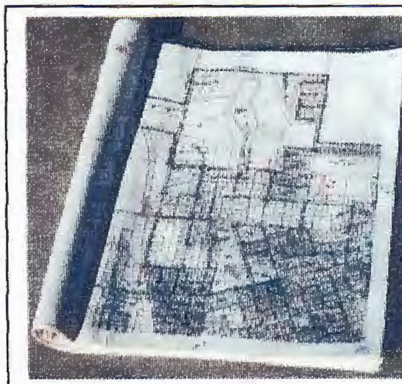
The smoothbore nozzle or playpipe is attached to the elbow fitting to yield a more accurate reading from the pitot tube.

A water line map is essential to determine main sizes, main conditions, main types, and probable direction of water travel. Finally, a of form needs to be used to record all the data gained in the field for interpretation and later use.



Bolivar's smoothbore nozzle.

A piezo tube diffuser may be obtained from many water system and fire department equipment retailers. The diffuser does just that – it diffuses the stream of water to reduce damage a straight stream might cause. There is no formula for pitot readings in a diffuse stream, so the diffuser has a built-in piezo tube before the stream becomes diffuse which acts to give the pitot reading. During this project, Bolivar's Director of City Services and City Engineering, Milton Dickensheet, volunteered and allowed me use his diffuser manufactured by The Joseph G. Pollard Co., Inc.



Map of Bolivar's water lines.

After gathering all needed equipment, the selection of hydrants to be tested and flowed needs to be done. First, determine the hydrant to be tested. This is the *test hydrant* and all data accumulated will be relevant to this location at this time. To make results relevant at other nearby locations, additional friction loss and elevation calculations must be made. For those calculation formulas see the Hydraulic Calculation

Formulas Appendix on page 19. Record which hydrant you are testing and the hydrant's condition (if it is accessible, if it is leaking, etc.).

Recording form used for this project.

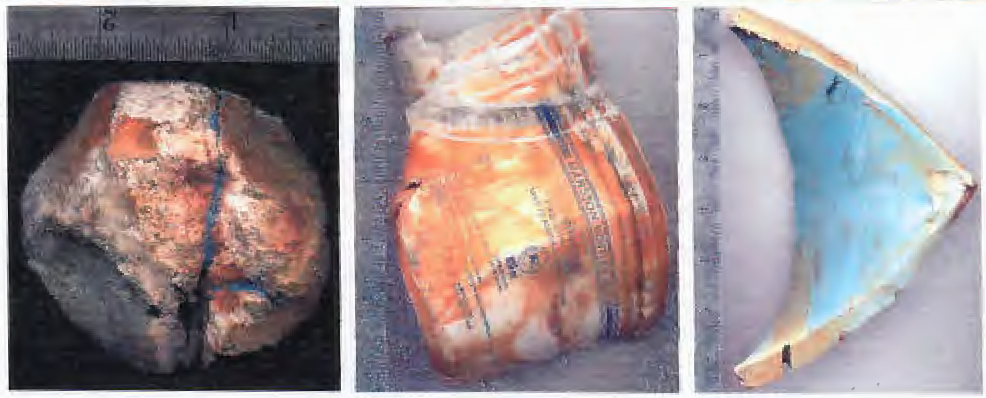
Before operating a fire hydrant, a few hazards must be identified. There are relatively few dangers when conducting *flow tests*. There are, of course, the horror stories about hydrant stems rocketing up and out of the top of a hydrant. While the possibility of this is remote, it is wise not to position your head or torso above the hydrant while operating it. It is also wise to make sure caps not removed are tight as to lessen the chance of them blowing off. Keep in mind that a two and a half-inch stream has considerable force and can knock people off their feet and even cause damage to automobiles. As with most safety ideas, they are just common sense, like testing in freezing weather should be avoided to prevent ice from forming on streets and sidewalks. Actively think with safety in mind while in the field (or anywhere for that matter).

Bolivar's Diffuser.

Sometimes mains and hydrants have not been flushed for years. This allows corrosion and particulate matter to accumulate in the mains. Do not be surprised to see brown, red, black, or gray water when first opening a hydrant. Recently laid water mains often have quite a few rocks in them due to the fact that contractors rarely flush lines before attaching them to the city's system. Even small rocks can cause quite a bit of damage to instruments and fire pumps. Therefore, every hydrant should be flushed before attaching any instrument to minimize damage. Prior to opening the hydrant, one should evaluate the site and make note of which direction would be best to flow water for a few minutes to clean out the debris in the mains. Once a suitable direction is determined, remove one cap and attach any needed fittings to direct the stream, then open the hydrant enough to flush out any foul water or debris. Keep in mind that once a hydrant is opened, it may stir up rust, settled dirt, etc. in the mains for hundreds of feet. Before finishing testing in an area, the mains need to be

Items to look for concerning the hydrant's condition. (IFSTA)

Hydrant with tapped cap.



Examples of debris that came out of Bolivar's hydrants during this project.

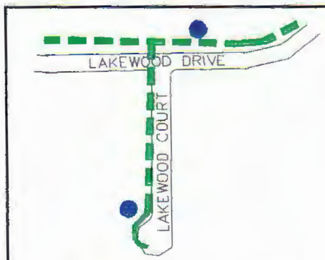
flushed for about 15 minutes to allow all suspended particulates to be removed.

After flushing, the hydrant can then be closed and the tapped cap with gauge can be attached to it for testing. Open the hydrant fully while counting the turns it took to open it. If the hydrant is operating correctly, it should take the same number of turns to close the hydrant. There should be no water flowing with the hydrant on, so the reading on the gauge will be the *static pressure*. Record this pressure.

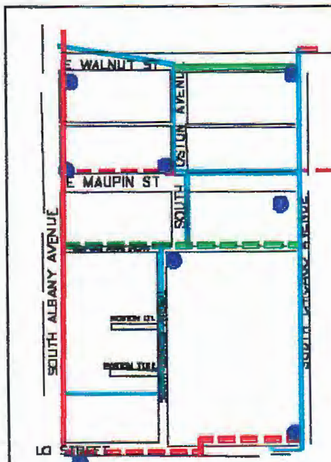
Next, a downstream hydrant must be selected to be flowed. It is called the *flow hydrant* and it must be downstream from the *test hydrant* to ensure the results are truly valid at the *test hydrant*. This is where use of a water line map is essential. Consult it now. On a dead-end line, determining the downstream hydrant is easy; just follow the line away from the source main.

Gridded systems complicate matters tremendously. Most cities (including Bolivar) use gridded systems as much as possible to increase water flow and dependability. The trick to finding a downstream hydrant on a gridded system is to consider the flow as coming from the side supplied by the larger mains. In reality, 70%-100% of the water is coming from the larger line. If both mains are the same size, either or both hydrants may be used without significantly affecting the results.

After determining the *flow hydrant*, again look around and flush the hydrant. After cleaning the hydrant of debris, one needs to take another look around taking note of traffic ways, sidewalks, areas where people are or could be, and even flower beds or fragile lawns in residential areas. During the test there is the possibility that thousands of gallons per minute will be flowing onto the ground or into the air. A 2.5" elbow fitting will allow directing the stream away from areas where that volume of water would be damaging or dangerous. Redirecting the stream is important where drainage,



Deadend main in Bolivar.



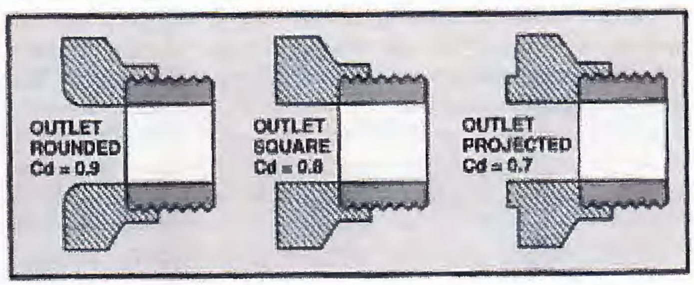
Gridded mains in Bolivar.

erosion, or traffic conditions pose a problem. The problem with using this elbow is the basic equation used to transform pitot pressures into gallons per minute requires the use of a specific mathematical coefficient depending on the outlet. There is no factor for an elbow. Therefore, in conjunction with an elbow, a straight stream nozzle must be used. As in this project's case, a diffuser can be used in lieu of the elbow and nozzle.

Hydrants with elbows to redirect stream.

Before opening the hydrant, two pieces of data must be obtained: The coefficient of discharge and the exact orifice diameter. The coefficient of discharge is a number used to adjust the formula for different types of orifices. Consult the table on page 21 in the appendix for typical coefficients of discharge. If you are using the elbow and nozzle, the coefficient must be used for the nozzle. Some nozzles have documentation on their coefficients or the manufacturer should be contacted for that information. The Typical Coefficients of Discharge Appendix is available on page 21 if manufacture's data is unobtainable. If no elbow is used, the coefficient of the hydrant must be determined. Fire hydrants come in three basic designs. Most modern designs include shoulders (where the hydrant nozzle or outlet connects to the barrel) are rounded. This is the most favorable design and its coefficient is 0.9. If the shoulders are squared off, the coefficient is 0.8. In some rare cases, the shoulders actually protrude into the hydrant barrel. This coefficient is 0.7. No sophisticated technique exists to determine the type of shoulders in a hydrant. Simply stick your fingers into the hydrant and feel the shoulder to determine its structure, then apply the appropriate coefficient.

Hydrant with diffuser.



Hydrant coefficients of discharge. (Brock 126)

The exact diameter of the orifice is vital. It needs to be measured to the nearest sixteenth of an inch. This is important because an error of one-sixteenth of an inch can result in more than a five percent error in calculated results. Use your ruler to measure either the hydrant opening diameter (which can vary from 2.35" to 2.5") or the nozzle diameter. Note: The formula used to convert the pitot reading into gallons per minute assumes a solid stream is measured. There is no practical way to calculate a stream with voids or irregular shape. The five inch steamer outlet does not produce a solid stream, it has voids in it, so it should not be used for pitot readings.

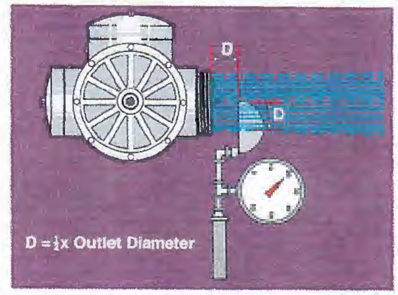


Diagram of correct pitot use. (IFSTA)

Once the hydrant is opened and water is either flowing directly out of the hydrant or through an elbow and nozzle, it is time to use the pitot tube. This is used to measure the *velocity pressure* (or pitot pressure) of the flowing stream. This pressure will later be converted to gallons per minute. The proper procedure for using a pitot tube is as follows: Hold the opening of the blade of the pitot tube in the center of the stream ½ the diameter of the nozzle opening away from the opening. This is the point where stream size is smallest and stream velocity is greatest. Hold the tube so the air chamber is slightly elevated and be sure to drain all the water before use.


Example of correct pitot use. (Hall 386)

From an accuracy standpoint, pitot readings of less than 10 psi and more than 30 psi should be avoided, if possible. When the flow from a hydrant is so poor that no pressure registers on the pitot tube gauge, reduction of the diameter of the outlet with a nozzle can increase the stream velocity enough to provide a pressure reading. When the flow is so great as to leave the accurate range of the gauge, additional hydrants may be opened.

While the pitot reading is being taken at the *flow hydrant*, the pressure at the *test hydrant* must also be recorded. This is the *residual pressure*, because it represents the pressure remaining in the system while water is flowing. "It should be noted that the use of *residual pressures* of less than 20 psi is not permitted by many state health departments." (NFPA 291 4) The Department of Natural Resources (DNR) has the same requirement. This is due, in part, to the dangers involved with a *residual pressure* less than 20 psi. Once a fire engine starts pulling water from an area with deficient *residual pressures*, it decreases that pressure even further which could result in the collapse of the mains or other water system components or back-siphonage of polluted water from some other source such as leaking underground sewer lines. There is a balancing act between this 20 psi minimum and the following recommendation.

More accurate results are obtained if a significant pressure drop from static can be achieved. Sometimes this requires more than one *flow hydrant*. A 25% or 15 psi drop from static to *residual pressures* is recommended. There is no standard value, but larger pressure drops give better results. Pressure drops of this magnitude minimizes the impact of gauge inaccuracy and human error. It would be difficult to defend the significance of a three psi drop where gauge error might be two psi and sight accuracy only plus or minus one psi. To achieve this pressure drop, multiple hydrants may need to be opened. If more than one hydrant is opened, they must all be opened simultaneously and the flows from each outlet measured at the same time and added together for the total flow. The *residual pressure* must also be recorded while all hydrants are flowing. During this project, due to engineering considerations, only one hydrant was flowed irregardless of the pressure drop.

Remember to close each hydrant slowly to reduce the chance of damaging equipment or lines by causing a *water hammer.* Also, after closing a hydrant, the water should drain from drain holes under the ground to prevent it from freezing in the hydrant. To check the hydrant to verify it is draining properly, simply cover the opening(s) with your hand(s). You should be able to feel a slight suction or hear air escaping into the hydrant when you pull your hand(s) away.

Example of testing a hydrant's draining ability. (Hall 387)

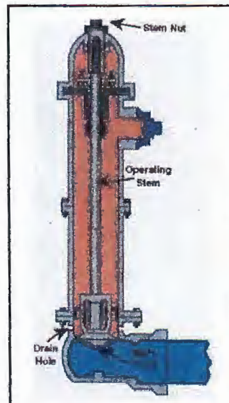


Diagram of a hydrant showing drain holes. (Hall 387)

Now we have three pieces of information: *static pressure*, *residual pressure*, and *velocity pressure*. "To have any real meaning, a *flow test* must result in these three pieces of information." (Brock 125)

The *static* and *residual pressures* are in formats readily usable, but the *velocity pressure* must be used in a calculation to determine gpm. The formula is:

$$Q = (29.83)\ (C_d)\ (D^2)\ (\sqrt{P})$$

Q = flow (gpm)

C_d = coefficient of discharge

D = orifice diameter (in)

P = *velocity pressure* (psi)

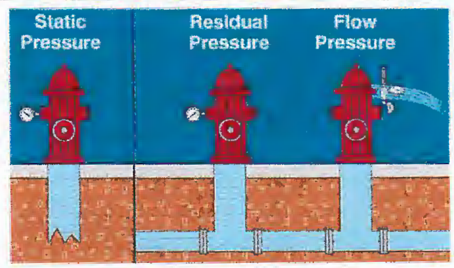


Diagram of the three data points determined in the field. (IFSTA)

For example: If the diffuser with an exact orifice diameter of 2.5" was used on a hydrant with rounded shoulders and produced a *velocity pressure* of 30 psi, the following would be done to get gpm:

$C_d = 0.9$

$D = 2.5$

$P = 30$

$Q = (29.83)\ (0.9)\ (2.5^2)\ (\sqrt{30})$

$Q = (29.83)\ (0.9)\ (6.25)\ (5.5...)$

Q = 919 gpm actual flow

This is the actual flow at the *residual pressure* read at the *test hydrant.* For consistency reasons, NFPA wants the hydrant flow rated at 20 psi *residual pressure* if the static pressure is greater than 40 psi. If the static pressure is less than 40 psi, NFPA wants the hydrant flow rated at a residual pressure that is equal to one half of the static pressure. It might be possible to attain the desired residual pressure in some situations by controlling the flow or opening other hydrants, but it can be prohibitive due to time and manpower required. Therefore, a formula is used to convert the actual flow to the rated flow. That formula and an example is below:

$$Q_2 = (Q_1)\left(|P_S - P_{R2}^{0.54}| \,/\, |P_S - P_{R1}^{0.54}|\right)$$

Q_2 = flow predicted at desired *residual pressure* (gpm)

Q_1 = total flow measured during test (gpm)

P_S = *static pressure* measured during test (psi)

P_{R2} = desired *residual pressure* (psi)

P_{R1} = *residual pressure* measured during test (psi)

The same hydrant tested in the last example that yielded 919 gpm did so at 44 psi *residual pressure* from 52 psi *static pressure*.

$Q_1 = 919$

$P_S = 52$

$P_{R2} = 20$

$P_{R1} = 44$

$Q_2 = (919)\,((52-20)^{0.54} / (52-44)^{0.54})$

$Q_2 = (919)\,(32^{0.54} / 8^{0.54})$

$Q_2 = (919)\,(6.5\ldots / 3.1\ldots)$

$Q_2 = (919)\,(2.1\ldots)$

Q_2 = **1943 gpm rated flow**

Now to discuss those difficult hydrants. Sometimes it is difficult or impossible to test a hydrant using the *test/flow hydrant* procedure. Some examples include a hydrant at the end of a dead end main (there is no downstream hydrant to flow from), or if you are working alone and do not want to leave a flowing hydrant alone while you go check the *test hydrant's residual pressure* due to traffic, children, etc.

On the topic of children, a quick note: As a fire department, public relations and public education are very important projects. Especially during warm days, children are drawn to flowing fire hydrants like magnets. From miles around, they see the arc of water in the air and come running, riding, skating, etc. During this project, I always made sure I had my stock of Hartford® plastic fire hats to distribute to the kids. As I handed out these hats, I answered *most* questions they asked and posed a few of my own. My questions include: "Who can tell me the phone number everyone should remember to dial if you need help from a fireman, policeman, or an ambulance?" Answer: 911. "Who knows what to do if your clothes catch on fire?" Answer: Stop, Drop, and Roll. Keep this in mind no matter what fire department project you are doing. Develop your own system to promote the department and educate the public on safety and fire issues.

The solution to those difficult hydrants is hydraulic calculations. In the case of a dead end hydrant, test the next-to-the-last-hydrant and use formulas to adjust the static and *residual pressures* to the *flow hydrant*. The actual flow is the same and can be directly transposed from the *test hydrant* to the *flow hydrant*. The only difference in *static pressures* is due to elevation changes. The formula for pressure change due to elevation is:

$$P_E = (0.433)\ (h)$$

P_E = pressure change due to elevation (psi)

h = difference in height (ft)

The difference in *residual pressures* is due to elevation and friction loss. The formula for pressure loss due to friction is called the Hazen-Williams formula.

$$P_f = [(4.52)\ (Q^{1.85})\ (L)]\ /\ [(C^{1.85})\ (d^{4.87})]$$

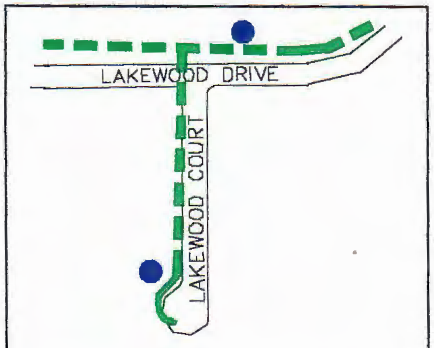
P_f = pressure loss due to friction (psi)

Q = flow (gpm)

L = length of pipe (ft)

C = pipe C-factor

d = pipe diameter (in)



Example of a hydrant on a dead end main.

An example of a hydrant needing hydraulic calculation is the one at the end of this dead end main:

Let's say you flowed that dead end hydrant while testing the other one upstream. These were your results:

N/S address	E/W address	static pressure (psi)	residual pressure (psi)	velocity pressure (psi)	actual flow (gpm)	flow at 20 psi (gpm)	color	date	time	notes
1350 S Lakewood Court	1339 W Lakewood Drive	52	44	30	919	1943	blue	4/9/99	16:10	

To transfer these numbers to the last hydrant, let's use those fun formulas. The dead end hydrant is five feet lower and 350 feet away down a six-inch plastic line. *Static pressure* is first. The only change to it is due to elevation.

$$P_E = (0.433)(h)$$

$h = 5$

$P_E = (0.433)(5)$

$P_E = 2.2...$ psi gained from gravity

The new *static pressure* is now 54 psi. Next is *residual pressure*. Add the same pressure due to elevation and subtract pressure loss due to friction loss. Our friends Hazen and Williams helps us with friction loss.

$$P_f = [(4.52)(Q^{1.85})(L)] / [(C^{1.85})(d^{4.87})]$$

$Q = 919$

$L = 350$

$C = 150$

$d = 6.09$

The C-values for pipes can be found in the appendix on page 19 as can the actual diameters of various pipes. A quick look at the formula will tell you how important the diameter is. It will be raised to a power of 4.87. So nominal diameters will reduce the accuracy of the formula by a great deal.

$P_f = [(4.52)(919^{1.85})(350)] / [(150^{1.85})(6.09^{4.87})]$

$P_f = [(4.52)(303482.5...)(350)] / [(10611.3...)(6623.5...)]$

$P_f = [480109362.6...] / [70283769.3...]$

$P_f = 6.8...$ psi lost to friction

After adding 2.2 psi from gravity and subtracting 6.8 psi from friction loss, our original 44 psi *residual pressure* is now 39 psi. Your results for that difficult hydrant are now:

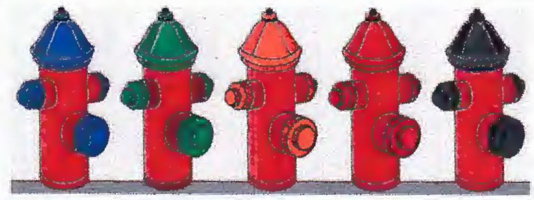
N/S address	E/W address	static pressure (psi)	residual pressure (psi)	velocity pressure (psi)	actual flow (gpm)	flow at 20 psi (gpm)	color	date	time	notes
1455 S Lakewood Court		54	39	30	919	1430	blue	4/9/99	16:10	

Now, all the hydrants can be grouped and painted according to NFPA's code. "Hydrants should be classified in accordance with their rated capacities (at 20 psi *residual pressure* or other designated value) as follows: All barrels are to be chrome yellow except in cases where another color has already been adopted [in Bolivar's case: red]. The tops and nozzle caps should be painted with the following capacity indicating color scheme to provide simplicity and consistency... It is recommended that the capacity colors be of a reflective-type paint." (NFPA 291 11)

Hydrant Class	Color	Flow
Class AA	Light Blue	1,500 gpm (5 680 L/min) or greater
Class A	Green	1,000–1,499 gpm (3 785 L/min to 5 675 L/min)
Class B	Orange	500–999 gpm (1 900 L/min to 3 780 L/min)
Class C	Red	Less than 500 gpm (1 900 L/min)

NFPA's color coding according to flow. (IFSTA)

During and after all the testing and painting occurs, there must be some form of record-keeping. Throughout this project, two forms of record-keeping were created and maintained. The first was an Excel® spreadsheet containing information on hydrant location, hydrant type, *static*, *residual*, and *velocity pressure*, coefficient of discharge used, orifice diameter used, output from that data which included actual flows, rated flows, and hydrant color, main information such as size, type, gridded or dead ended, the date and time of the test, and other notes such as the condition of the hydrant or deficiencies.



Examples of hydrant painting recommendation. (Cote 6-42)

Most of the spreadsheet information is self-explanatory. The location information was created with the North/South (n/s) address and the East/West (e/w) address. This gave a location such as 1350 S Lakewood Court and 1339 W Lakewood Drive. The 1350 in the n/s address indicates the hydrant is on the East side of Lakewood Court because it is an even number. The 1339 in the e/w address indicates the hydrant is on the North side of Lakewood Drive because it is an odd number. Therefore the hydrant is on the North-East corner of Lakewood Court and Lakewood Drive.

The date and time of the test is very important. If future tests do not yield the same data, the old data may not be invalid if the two tests occurred on different days of the week or time of day. This is due to the fact that city water consumption varies from day to day and hour to hour. For example, a test in a residential area at seven in the morning might yield less flow than one at ten in the morning due to a large number of residents taking showers, cooking, etc. The same goes for all areas of town.

The notes column of the spreadsheet is another important one. All notes from "hydrant does not drain" to "hydrant in front of easily angered resident – do not flow while he/she is home" are important for future reference.

The second form of record-keeping was a city map created in AutoCAD®, indicating hydrant locations. As the hydrants were tested, the color code was indicated on the map. Hopefully, this map may be used by fire department personnel in regards to hydrant selection. A quick consultation of this map should give a responder general information on call location, route to scene, and hydrant data.

3.3 Conclusion

The goals of this project were to systematically test Bolivar's fire hydrants and paint them according to a color code developed by the National Fire Protection Association (NFPA) and recommended by the Insurance Services Office (ISO). The results of these tests can be used, not only by the fire department, but also by the water department to identify deficient areas of town.

The knowledge gained from this project will be primarily used by the fire department to determine which hydrants are best to be used in fire suppression activities. The other main use of the data from this project will be by the City Engineering Department and Water Department to identify areas of town that might need additional water supply. One other reason for this project was the upcoming ISO inspection. ISO representatives prefer having documentation on hydrant ratings. They require information about the number of hydrants, type of hydrants, and types of mains connected to hydrants. The results of this project will provide all that information.

This document explains in detail the system developed and implemented. By doing flow tests and hydraulic calculations, each hydrant in the city now has extensive data on it.

No matter the value of this project, the value of an ongoing project is great. NFPA recommends hydrants should be tested and rated every year. This task is immense when every hydrant is to be tested, but a few hydrants per week is not difficult or very time consuming, whether water department crew does some testing while flushing hydrants or fire department personnel does some testing after fires, etc. The ongoing testing will provide continuous knowledge of the city's water supply performance.

4.1 "Quick" Guide to Hydrant Testing

1. Gather equipment.
2. Select *test* and *flow hydrants*.
   2a. Record *test hydrant's* location, hydrant type, main size, main type, and main connect.
3. Determine best direction to flow *test hydrant* to remove debris.
   3a. Open *test hydrant* while counting turns.
   3b. Close *test hydrant* slowly. Hydrant should turn the same number of times to close.
   3c. Place hand over opening to determine draining ability.
   3d. Record any problems with *test hydrant* or location.
4. Attach tapped cap to *test hydrant*.
   4a. Open *test hydrant*.
   4b. Measure and Record *static pressure*.
5. Determine best direction to flow *flow hydrant* to remove debris.
   5a. Open *flow hydrant* while counting turns.
   5b. Close *flow hydrant* slowly. Hydrant should turn the same number of times to close.
   5c. Place hand over opening to determine draining ability.
   6c. Record any problems with *flow hydrant* or location.
6. Determine best direction to allow *flow hydrant* to flow for 15 minutes.
   6a. Attach any fittings or devices (i.e. diffuser).
   6b. Measure and record orifice diameter.
   6c. Determine and record coefficient of discharge.
   6d. Open *flow hydrant*.
   6e. Measure and record *velocity pressure*.
7. Measure and record *residual pressure* from *test hydrant*.
   7a. Close *test hydrant* slowly.
   7b. Remove all fittings and put *test hydrant* back into service.
8. After 15 minutes of flowing *flow hydrant* to remove anything stirred up in the mains, close *flow hydrant* slowly.
   8a. Remove all fittings and put *flow hydrant* back into service.
9. Use pitot pressure to flow formula, $Q = (29.83)\ (C_d)\ (D^2)\ (\sqrt{P})$, to determine flow.
   9a. Record actual flow.
10. Use flow converter to desired residual formula, $Q_2 = (Q_1)\ (|P_S - P_{R2}{}^{0.54}|\ /\ |P_S - P_{R1}{}^{0.54}|)$, to determine rated flow.
    10a. Record rated flow.
11. Determine color code from rated flow.
    11a. Paint *test hydrant*.
    11b. Record *test hydrant* color in spreadsheet and on map.

4.2 Glossary

Complex Loop - "A piping system that is sometimes called a 'grid' and is characterized by one or more of the following: more than one inflow point, more than one outflow point, and/or more than two paths between inflow and outflow points." (Brock xi)

DNR - "[The Department of Natural Resources] preserves and protects the State's natural, cultural, and energy resources and inspires their enjoyment and responsible use for present and future generations." (www.dnr.state.mo.us)

Flow Hydrant - "The hydrant from which the water is discharged during a hydrant *flow test*." (Brock xi)

Flow Test - "Tests conducted to establish the capabilities of water supply systems and referred to as *flow tests* because they involve flowing fire hydrants. The objective of a *flow test* is to establish quantity (gallons per minute) and pressures available at a specific location on a particular water supply system." (Brock xi)

FPE - "Fire Protection Engineering is the application of science and engineering principles to protect people and their environment from destructive fire." (www.sfpe.org)

gpm - Gallons per Minute.

Gridded Piping System - see complex loop.

Hazen-Williams Formula - "An empirical formula for calculating friction loss in water systems that is the fire protection industry standard. To comply with most nationally recognized standards, the Hazen-Williams formula must be used." (Brock xii)

Hydraulics - "The branch of fluid mechanics dealing with the mechanical properties of liquids (in this text, water) and the application of these properties in engineering." (Brock xii)

IFSTA - "[The International Fire Service Training Association is a] nonprofit educational association of fire fighting personnel who are dedicated to upgrading fire fighting techniques and safety through training." (www.ifsta.org)

ISO - "[The Insurance Services Office, Inc. is the] leading supplier of statistical, actuarial, and underwriting information." (www.iso.com)

NFPA - "[The National Fire Protection Association] reduces the burden of fire on the quality of life by advocating scientifically based consensus codes and standards, research, and education for fire and related safety issues." (www.nfpa.org)

Pitot Tube - "Common device used to measure *velocity pressure* and thus fluid velocity. The pitot tube consists of a small diameter tube, usually about one-sixteenth inch in internal diameter which is connected to a pressure gauge." (Brock xii)

Pressure - Force per unit area.

psi - "In fire protection, pressure is most often dealt with in units of pounds per square inch (psi)." (Brock xii)

Residual Pressure - "The pressure that exists in the distribution system, measured at the residual hydrant at the time the flow readings are taken at the *flow hydrants*." (NFPA 291 4) "The pressure at the *test hydrant* while water is flowing. It represents the pressure remaining in the system while the test water is flowing." (Brock xiii)

Simple Loop - "A loop in which there is exactly one inflow point and one outflow point, and exactly two paths between the inflow and outflow points." (Brock xiii)

Static Pressure - "The pressure that exists at a given point under normal distribution system conditions measured at the residual hydrant with no hydrants flowing." (NFPA 291 4) "The normal pressure existing on a system before the *flow hydrant* is opened." (Brock xiii)

Water Hammer - "Stopping any flowing stream too rapidly can cause a phenomenon called *water hammer*. [A] *water hammer* is a violent increase in pressure which can be large enough to rupture the piping." (Brock xiii)

4.3 Hydraulic Calculation Formulas

Pitot pressure to flow

$$Q = (29.83)\,(C_d)\,(D^2)\,(\sqrt{P})$$

Q = flow (gpm)

C_d = coefficient of discharge

D = orifice diameter (in)

P = *velocity pressure* (psi)

Flow converter to desired residual

$$Q_2 = (Q_1)\,(|P_S - P_{R2}{}^{0.54}| \,/\, |P_S - P_{R1}{}^{0.54}|)$$

Q_2 = flow predicted at desired *residual pressure* (gpm)

Q_1 = total flow measured during test (gpm)

P_S = *static pressure* measured during test (psi)

P_{R2} = desired *residual pressure* (psi)*

P_{R1} = *residual pressure* measured during test (psi)

*note: If P_S is greater than 40 psi, then P_{R2} = 20 psi. If P_S is less than 40 psi, then $P_{R2} = P_S/2$.

Pressure change due to elevation

$$P_E = (0.433)\,(h)$$

P_E = pressure change due to elevation (psi)

h = difference in height (ft)

Hazen-Williams (pressure loss due to friction)

$$P_f = [(4.52)\,(Q^{1.85})\,(L)] \,/\, [(C^{1.85})\,(d^{4.87})]$$

P_f = pressure loss due to friction (psi)

Q = flow (gpm)

L = length of pipe (ft)

C = pipe C-factor

d = pipe diameter (in)

Common C-factors

Cast Iron = 100 to 140 depending on age and lining (140 new, 100 old)

Plastic = 150

Galvanized = 120 to 140 depending on age

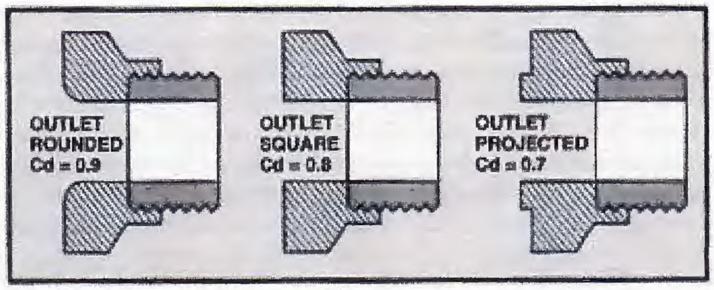
Asbestos = 140

Ductile Iron = 100 to 140 depending on age and lining

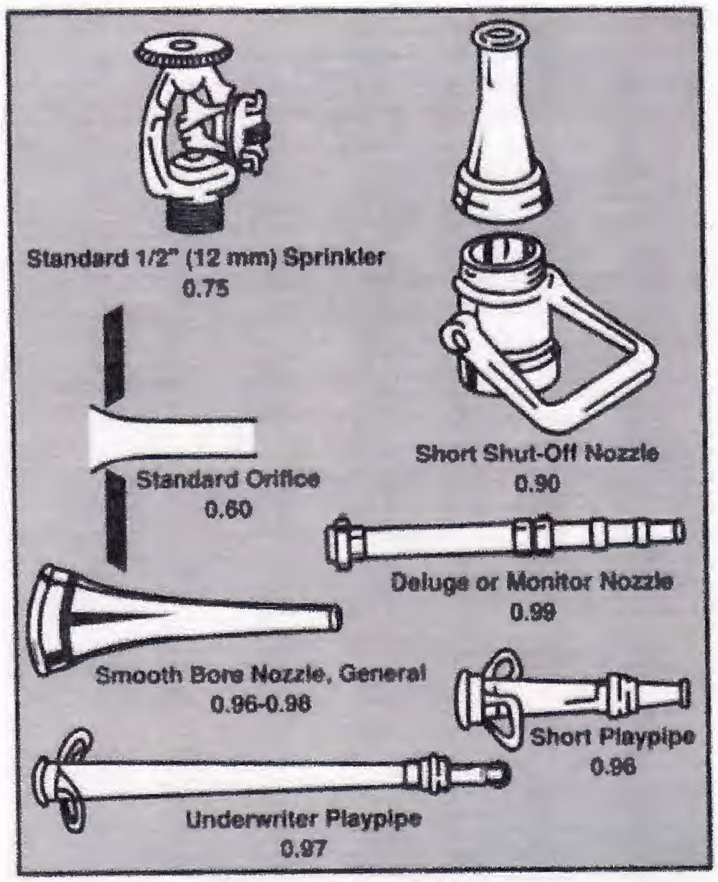
Actual Internal Pipe Diameters

Cast Iron					
nominal size	4	6	8	12	16
Unlined	4.1	6.14	8.23	12.24	16.32
Enamel	3.98	6.02	8.11	12.12	16.13
Cement	3.85	5.89	7.98	11.99	15.94
Plastic					
nominal size	4	6	8	12	
PVC CL 150	4.24	6.09	7.98	11.65	
PVC CL 200	4.08	5.86	7.68	11.2	
Permastrand	4.28	6.32	8.23	12.12	
Ductile Iron					
nominal size	4	6	8	12	16
CL 50		6.4	8.51	12.58	16.72
CL 51	4.28	6.34	8.45	12.52	16.66
CL 52	4.155	6.275	8.385	12.46	16.4
CL 54		6.16	8.27	12.34	

4.4 Typical Coefficients of Discharge



(Brock 126)



(Brock 70)

4.5 ISO Public Protection Survey Information

The following is a copy of a publication by ISO to help prepare cities for an inspection:

Insurance Services Office, Inc.
Public Protection Survey Information

The following information will be needed when our representative arrives:

General

1. A Current scaled map of the city/district showing current city/district limits and streets.

Fire Department

2. Current equipment inventories for all fire suppression apparatus in service and in reserve. Copies of our form, APPARATUS AND EQUIPMENT (one for each unit), are enclosed for your convenience.

3. A record of the date, time of day and the number of off-shift, call and volunteer members that responded to each structural alarm within the city/district in the last year.

4. The total number of structural alarms of fire and the total number of all fire related incidents for each of the last 3 years. If response is made to first alarms outside the city/district please indicate the number of responses outside the city/district, and what jurisdictions are involved.

5. Have the last three years aerial ladder, or elevated platform, and pumper service and hose tests records for each apparatus available for our review.

Water Department

6. A scaled map of all water systems indicating fire hydrants, main sizes, valves, pressure zone boundaries, and supply and storage facilities (pumps, reservoirs, tanks, etc.). A single combined map showing the city limits and the water systems is preferable; however, any available maps will be appreciated.

7. Rated and actual capacities of wells, pumps, boosters, etc.; that supply the waterworks system.

8. The total water consumption for each of the systems for the last 12 months, and maximum daily consumption that has occurred in the last 3 years. If there are different pressure zones within the system, the consumption data will be needed for each zone. Reasons for abnormally high consumption should be explained. This may be due to a main break, tank refilling after cleaning, filling a swimming pool, or other infrequent cause. If wells and pumps are not metered, please prepare the latest accurate estimate of consumption.

9. The total number of hydrants in service. This should include the number of hydrants that have a 6-inch branch connection with the number of these with a pumper outlet (with or without hose outlets), the number with 2 or more hose outlets and no pumper outlet, and the number with only a single hose outlet. Also, the number of hydrants with a 4-inch branch connection with a similar breakdown by outlets.

If there are any questions regarding the information requested above, please contact our office.

4.6 Bibliography

Brock, Pat D. Fire Protection Hydraulics and Water Supply Analysis. ©1990 Board of Regents, Oklahoma State University, Stillwater, OK.

Cote, Arthur E., P.E. Fire Protection Handbook, Eighteenth Edition. ©1997 National Fire Protection Association, Quincy, MA.

Hall, Richard and Adams, Barbara. Essentials of Fire Fighting, Fourth Edition. ©1998 Board of Regents, Oklahoma State University, Stillwater, OK.

International Fire Service Training Association. Firefighter I & II Presentations for the Fourth Edition of Essentials of Fire Fighting. ©1998 Board of Regents, Oklahoma State University, Stillwater, OK.

National Fire Protection Association. NFPA 291 – Recommended Practice for Fire Flow Testing and Marking of Hydrants, 1995 Edition. ©1997 National Fire Protection Association, Quincy, MA.

Note: Pictures not referenced were taken by the author.

4.7 Hydrant Data Gathered During Spring 1999 Project

See following pages in spreadsheet layout.

City of Bolivar
Spring 1999 Hydrant Testing Project
Theron J Becker, FPE

hydrants tested	462
blue hydrants	278
green hydrants	105
orange hydrants	35
red hydrants	25
black hydrants	19

highest actual flow	1,353	gpm
average actual flow	893	gpm
lowest actual flow	0	gpm

highest rated flow	7,839	gpm
average rated flow	1,895	gpm
lowest rated flow	0	gpm

residuals less than	42
20psi	9%

all hydrants	462
steamer hydrants	323
two 2.5" hydrants	137
one 2.5" hydrants	2

hydrants on unknown line	4	hydrants on 16" line	2	hydrants on 12" line	59	hydrants on 8" line	173
steamer	4	steamer	0	steamer	54	steamer	141
two 2.5"	0	two 2.5"	1	two 2.5"	5	two 2.5"	31
one 2.5"	0	one 2.5"	1	one 2.5"	0	one 2.5"	1
		hydrants on 6" line	157	hydrants on 4" line	66	hydrants on 2" line	1
		steamer	113	steamer	10	steamer	1
		two 2.5"	44	two 2.5"	56	two 2.5"	0
		one 2.5"	0	one 2.5"	0	one 2.5"	0

hydrants on dead	116
end mains	25%

hydrants with	81
problems	18%

Sorted by North/South Address

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
1	100 North Albany Avenue	605 East Broadway Street	Steamer	68	56	50	0.90	2.5	1,186	2,508	blue	8	Ductile Iron	Grid	3/22/1999	13:25	do not flow while funeral is in session 3/22/99
2	219 North Albany Avenue	570 East Olive Street	Steamer	70	62	50	0.90	2.5	1,186	3,192	blue	6	Plastic	Grid	5/10/1999	9:50	
3	401 North Albany Avenue	575 East Locust Street	Iowa	70	50	46	0.90	2.5	1,138	1,867	blue	8	Cast Iron	Grid	3/30/1999	15:15	
4	419 North Albany Avenue	570 East Freeman Street	Iowa	67	62	38	0.90	2.5	1,034	3,469	blue	8	Cast Iron	Grid	5/10/1999	10:10	difficult to operate 5/10/99
5	901 North Albany Avenue	533 East Summit Street	Iowa	54	6	10	0.90	2.5	531	440	red	8	Ductile Iron	Grid	5/7/1999	14:25	
6	1103 North Albany Avenue		Steamer	60	8	8	0.90	2.5	475	412	red	8	Ductile Iron	Grid	5/7/1999	14:40	inaccessible 5/7/99
7	1275 North Albany Avenue	570 East Parkview Street	Steamer	62	10	10	0.90	2.5	531	473	red	8	Plastic	Grid	5/7/1999	14:50	
8	404 South Albany Avenue	600 East Walnut Street	Iowa	76	72	34	0.90	2.5	978	4,068	blue	6	Cast Iron	Grid	4/30/1999	10:50	leaks 4/30/99
9	470 South Albany Avenue	603 East Maupin Street	Steamer	75	66	40	0.90	2.5	1,061	2,820	blue	6	Cast Iron	Grid	4/30/1999	13:50	
10	800 South Albany Avenue	570 East College Street	Steamer	55	30	30	0.90	2.5	919	1,102	green	4	Cast Iron	Grid	4/26/1999	14:35	inaccessible 4/26/99
11	921 South Albany Avenue	575 East South Street	Steamer	52	50	25	0.90	2.5	839	3,749	blue	8	Plastic	Grid	4/8/1999	10:15	
12	98 North Barker Avenue	1322 West Fairplay Street	Iowa	51	45	18	0.90	2.5	712	1,728	blue	4	Cast Iron	Grid	5/3/1999	11:30	does not drain 5/3/99
13	100 North Barker Avenue	1317 West Broadway Street	Drain	52	44	4	0.60	1.5	81	170	red	16	Plastic	Grid	3/24/1999	9:45	
14	101 South Barker Avenue	1326 West Broadway Street	Steamer	54	44	38	0.90	2.5	1,034	2,003	blue	8	Plastic	Grid	3/24/1999	9:55	
15	201 South Barker Avenue	1400 West Jackson Street	Steamer	58	52	42	0.90	2.5	1,087	2,946	blue	8	Plastic	Grid	4/20/1999	15:10	
16	100 North Benton Avenue	325 East Broadway Street	Steamer	64	40	44	0.90	2.5	1,113	1,544	blue	8	Ductile Iron	Grid	3/22/1999	12:45	
17	212 North Benton Avenue	300 East Olive Street	Iowa	63	57	50	0.90	2.5	1,186	3,437	blue	4	Cast Iron	Grid	5/10/1999	9:40	
18	401 North Benton Avenue	311 East Locust Street	Iowa	62	40	38	0.90	2.5	1,034	1,467	green	8	Cast Iron	Grid	3/30/1999	11:40	leaks 3/30/99
19	501 North Benton Avenue	311 East Freeman Street	Iowa	64	56	32	0.90	2.5	949	2,383	blue	4	Cast Iron	Grid	5/10/1999	10:50	
20	175 South Benton Avenue	401 East Jackson Street	Iowa	73	57	54	0.90	2.5	1,233	2,354	blue	6	Cast Iron	Grid	4/30/1999	14:55	leaks 4/30/99
21	1211 South Birum Avenue		Steamer	42	38	38	0.90	2.5	1,034	2,597	blue	8	Plastic	Grid	4/19/1999	13:25	
22	100 North Boston Avenue	705 East Broadway Street	Steamer	72	56	52	0.90	2.5	1,210	2,287	blue	8	Ductile Iron	Grid	3/22/1999	13:45	
23	170 North Boston Avenue	700 East Chestnut Street	Iowa	71	46	44	0.90	2.5	1,113	1,636	blue	6	Plastic	Grid	5/10/1999	11:10	
24	431 South Boston Avenue	675 East Maupin Street	Iowa	65	57	34	0.90	2.5	978	2,486	blue	6	Cast Iron	Grid	4/30/1999	14:00	leaks 4/30/99
25	504 South Boston Avenue	700 East Van Buren Street	Steamer	63	56	34	0.90	2.5	978	2,608	blue	8	Plastic	Grid	4/30/1999	14:15	
26	775 South Boston Place	719 East College Street	Iowa	61	55	30	0.90	2.5	919	2,594	blue	4	Cast Iron	Grid	4/30/1999	10:30	needs new stem nut, leaks 4/30/99
27	900 South Boston Place	722 East Auburn Street	Iowa	58	54	30	0.90	2.5	919	3,100	blue	4	Cast Iron	Grid	4/30/1999	10:20	does not drain 4/30/99
28	807 North Briarwood Drive		Steamer	72	48	36	0.90	2.5	1,007	1,528	blue	8	Cast Iron	Dead End	5/18/1999	10:20	
29	1100 North Butterfield Avenue	775 West Forest Street	Steamer	58	53	48	0.90	2.5	1,163	3,476	blue	8	Plastic	Dead End	5/6/1999	15:40	
30	100 North Canton Avenue	627 West Fairplay Street	Steamer	66	24	22	0.90	2.5	787	827	orange	6	Ductile Iron	Grid	3/24/1999	9:55	
31	170 North Canton Avenue	620 West Chestnut Street	Iowa	66	31	28	0.90	2.5	888	1,029	green	6	Ductile Iron	Grid	5/5/1999	10:40	
32	270 North Canton Avenue	620 West Olive Street	Iowa	62	47	16	0.90	2.5	671	1,170	green	6	Ductile Iron	Grid	5/5/1999	11:05	
33	400 North Canton Avenue	621 West Locust Street	Steamer	58	54	42	0.90	2.5	1,087	3,668	blue	12	Ductile Iron	Grid	3/30/1999	10:50	

Sorted by North/South Address

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
34	1600 South Canton Avenue	650 West Woodland Drive	Steamer	0	0	0	0.90	2.5	0	0	black	6	Plastic	Grid	4/21/1999	15:35	
35	1700 South Canton Avenue		Steamer	0	0	0	0.90	2.5	0	0	black	6	Plastic	Grid	4/21/1999	15:35	
36	1020 South Carl Avenue	1903 West Northwood Street	Steamer	46	43	38	0.90	2.5	1,034	3,320	blue	8	Plastic	Grid	4/19/1999	13:50	leaks oil 4/1/99
37	1241 South Carl Avenue		Steamer	48	38	38	0.90	2.5	1,034	1,804	blue	8	Plastic	Grid	4/19/1999	13:50	
38	1450 South Carl Avenue		Steamer	38	31	28	0.90	2.5	888	1,522	blue	8	Plastic	Dead End	4/19/1999	10:10	
39	1770 South Carl Avenue	1875 West Aldrich Road	Steamer	39	34	28	0.90	2.5	888	1,852	blue	12	Cast Iron	Grid	4/19/1999	10:10	
40	101 North Chicago Avenue	732 East Broadway Street	Steamer	78	60	52	0.90	2.5	1,210	2,276	blue	8	Ductile Iron	Grid	3/22/1999	14:05	
41	206 North Chicago Avenue		Steamer	75	65	52	0.90	2.5	1,210	3,038	blue	8	Ductile Iron	Grid	5/10/1999	11:25	
42	375 North Chicago Avenue	734 East Locust Street	Steamer	70	56	52	0.90	2.5	1,210	2,406	blue	8	Ductile Iron	Grid	3/30/1999	15:30	does not drain, does not close 3/30/99
43	506 North Chicago Avenue		Steamer	63	60	30	0.90	2.5	919	3,870	blue	8	Ductile Iron	Grid	5/10/1999	14:20	
44	751 North Chicago Avenue		Iowa	61	31	30	0.90	2.5	919	1,088	green	4	Cast Iron	Dead End	5/10/1999	14:25	
45	405 South Chicago Avenue	734 East Walnut Street	Iowa	69	49	38	0.90	2.5	1,034	1,678	blue	8	Asbestos	Grid	4/30/1999	11:05	
46	501 South Chicago Avenue	728 East Maupin Street	Iowa	64	51	28	0.90	2.5	888	1,715	blue	4	Cast Iron	Grid	4/30/1999	14:20	
47	575 South Chicago Avenue	737 East Buffalo Street	Steamer	60	53	34	0.90	2.5	978	2,508	blue	8	Asbestos	Grid	4/26/1999	15:05	
48	300 South Chicago Place		Steamer	71	47	38	0.90	2.5	1,034	1,554	blue	6	Plastic	Dead End	4/30/1999	11:15	
49	609 South Chicago Place	770 East Buffalo Street	Iowa	65	58	38	0.90	2.5	1,034	2,825	blue	8	Asbestos	Grid	4/29/1999	14:00	
50	775 South Chicago Place	775 East College Street	Iowa	62	56	34	0.90	2.5	978	2,798	blue	4	Cast Iron	Grid	4/26/1999	15:15	top stem berring restraining nut loose 4/26/99
51	903 South Chicago Place	814 East Auburn Street	Iowa	62	56	28	0.90	2.5	888	2,539	blue	6	Cast Iron	Grid	4/30/1999	10:10	leaks oil, does not drain 4/30/99
52	101 South Clark Avenue	400 West Broadway Street	Steamer	70	58	54	0.90	2.5	1,233	2,452	blue	8	Ductile Iron	Grid	3/23/1999	14:00	
53	201 South Clark Avenue	400 West Jackson Street	Steamer	70	64	34	0.90	2.5	978	3,074	blue	6	Plastic	Grid	4/26/1999	11:15	
54	301 South Clark Avenue	400 West Madison Street	Iowa	72	67	56	0.90	2.5	1,256	4,447	blue	4	Cast Iron	Grid	4/26/1999	11:00	difficult to operate 4/26/99
55	611 South Clark Avenue		Iowa	57	52	20	0.90	2.5	750	2,211	blue	4	Cast Iron	Grid	4/21/1999	11:55	
56	829 South Clark Avenue		Iowa	52	50	10	0.90	2.5	531	2,371	blue	4	Cast Iron	Grid	4/21/1999	11:45	
57	920 South Clark Avenue	375 West South Street	Iowa	52	35	40	0.90	2.5	1,061	1,493	green	6	Cast Iron	Grid	4/9/1999	11:10	
58	1475 South Clark Avenue	401 West High Street	Steamer	44	42	38	0.90	2.5	1,034	3,958	blue	8	Cast Iron	Grid	4/8/1999	15:15	
59	1701 South Clark Avenue	400 West Gordon Street	Iowa	48	24	26	0.90	2.5	856	930	orange	4	Plastic	Grid	4/8/1999	15:00	
60	98 North Claud Avenue	800 West Fairplay Street	Iowa	83	28	28	0.90	2.5	888	992	orange	6	Ductile Iron	Grid	5/5/1999	10:25	
61	201 North Claud Avenue	801 West Chestnut Street	Iowa	62	33	24	0.90	2.5	822	1,004	green	4	Cast Iron	Grid	5/5/1999	10:10	does not drain, does no close, leaks, difficult to operate 5/5/99
62	375 North Claud Avenue	800 West Locust Street	Steamer	60	40	36	0.90	2.5	1,007	1,464	green	12	Ductile Iron	Grid	3/30/1999	10:40	
63	449 North Claud Avenue	800 West Freeman Street	Iowa	51	49	22	0.90	2.5	787	3,458	blue	12	Ductile Iron	Grid	5/5/1999	14:25	
64	604 North Claud Avenue		Iowa	50	43	38	0.90	2.5	1,034	2,270	blue	4	Plastic	Grid	5/5/1999	14:40	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
65	700 North Claud Avenue	721 West Division Street	Iowa	52	48	24	0.90	2.5	822	**2,527**	**blue**	6	Asbestos	Grid	5/7/1999	9:20	
66	1075 North Claud Avenue	800 West Forest Street	Iowa	56	54	48	0.90	2.5	1,163	**5,537**	**blue**	12	Ductile Iron	Grid	5/6/1999	15:30	
67	100 South Claud Avenue	708 West Broadway Street	Iowa	66	10	8	0.90	2.5	475	**427**	**red**	4	Cast Iron	Grid	3/24/1999	9:10	leaks 3/24/99
68	270 South Claud Avenue		Steamer	56	50	50	0.90	2.5	1,186	**3,122**	**blue**	8	Asbestos	Grid	4/21/1999	10:45	
69	615 South Colony Avenue		Steamer	37	29	26	0.90	2.5	856	**1,345**	**green**	6	Plastic	Dead End	4/20/1999	14:00	
70	780 South Colony Avenue		Steamer	37	32	26	0.90	2.5	856	**1,734**	**blue**	8	Plastic	Grid	4/20/1999	13:55	
71	1775 South Colony Avenue	2511 West Aldrich Road	Steamer	32	26	20	0.90	2.5	750	**1,274**	**green**	12	Plastic	Grid	3/25/1999	10:40	
72	1802 South Colony Avenue		Steamer	44	34	32	0.90	2.5	949	**1,523**	**blue**	6	Plastic	Grid	4/5/1999	10:15	
73	1938 South Colony Avenue	2575 West Cambridge Street	Steamer	46	40	20	0.90	2.5	750	**1,656**	**blue**	6	Plastic	Grid	4/5/1999	10:25	
74	300 South Denver Place		Steamer	70	48	34	0.90	2.5	978	**1,524**	**blue**	6	Plastic	Dead End	4/30/1999	11:40	
75	901 South Denver Place	906 East Auburn Street	Iowa	61	53	28	0.90	2.5	888	**2,146**	**blue**	6	Cast Iron	Grid	4/30/1999	9:55	does not drain 4/30/99
76	975 South Denver Place	909 East South Street	Iowa	58	42	32	0.80	2.5	844	**1,346**	**green**	4	Cast Iron	Grid	4/8/1999	14:25	does not drain 4/8/99
77	1075 South Denver Place	875 East Colgate Street	Iowa	66	42	25	0.90	2.5	839	**1,192**	**green**	6	Plastic	Grid	4/8/1999	10:45	
78	1175 South Denver Place	907 East Drake Street	Iowa	66	32	25	0.90	2.5	839	**988**	**orange**	4	Cast Iron	Grid	4/8/1999	10:45	
79	103 North Dunnegan Avenue	1201 West Broadway Street	Iowa	56	14	8	0.90	2.5	475	**437**	**red**	16	Plastic	Grid	3/24/1999	9:30	
80	123 North Dunnegan Avenue	1200 West Fairplay Street	Iowa	54	47	20	0.90	2.5	750	**1,762**	**blue**	4	Cast Iron	Grid	5/3/1999	16:00	does not drain 5/3/99
81	175 South Dunnegan Avenue	1201 West Jackson Street	Iowa	57	53	30	0.90	2.5	919	**3,055**	**blue**	8	Plastic	Grid	4/21/1999	9:25	leaks 4/21/99
82	203 South Dunnegan Avenue	1200 West Jackson Street	Steamer	55	49	32	0.90	2.5	949	**2,460**	**blue**	8	Plastic	Grid	4/21/1999	9:15	
83	411 South Dunnegan Avenue	1200 West Maupin Street	Iowa	52	48	46	0.90	2.5	1,138	**3,498**	**blue**	8	Asbestos	Grid	4/20/1999	15:30	
84	112 North Elgin Avenue	1105 East Broadway Street	Steamer	78	54	50	0.90	2.5	1,186	**1,911**	**blue**	8	Ductile Iron	Grid	3/23/1999	9:50	
85	220 North Elgin Avenue		Steamer	73	65	28	0.90	2.5	888	**2,465**	**blue**	6	Ductile Iron	Grid	5/10/1999	15:25	
86	401 North Elgin Avenue	927 East Locust Street	Iowa	70	24	22	0.90	2.5	787	**823**	**orange**	6	Cast Iron	Grid	3/30/1999	16:00	
87	300 South Elgin Avenue		Steamer	68	43	32	0.90	2.5	949	**1,350**	**green**	6	Plastic	Dead End	4/30/1999	11:50	
88	808 South Elgin Avenue	1000 East College Street	Iowa	63	54	40	0.90	2.5	1,061	**2,469**	**blue**	6	Cast Iron	Grid	4/30/1999	9:30	
89	824 South Elgin Avenue	1001 East Auburn Street	Iowa	67	60	28	0.90	2.5	888	**2,483**	**blue**	6	Cast Iron	Grid	4/30/1999	9:45	
90	600 South Elgin Place	1000 East Buffalo Street	Iowa	72	60	52	0.90	2.5	1,210	**2,671**	**blue**	8	Asbestos	Grid	4/29/1999	14:20	
91	175 North Flint Avenue	1110 East Chestnut Street	Iowa	80	60	57	0.90	2.5	1,267	**2,293**	**blue**	6	Cast Iron	Grid	5/18/1999	8:45	
92	312 North Flint Avenue		Steamer	76	64	44	0.90	2.5	1,113	**2,557**	**blue**	6	Ductile Iron	Grid	5/10/1999	15:40	does not drain 5/10/99
93	401 North Flint Avenue	1045 East Locust Street	Iowa	72	38	32	0.90	2.5	949	**1,194**	**green**	6	Cast Iron	Grid	3/30/1999	16:15	
94	700 North Flint Avenue	1101 East Division Street	Iowa	72	44	40	0.90	2.5	1,061	**1,482**	**green**	6	Cast Iron	Grid	3/29/1999	16:40	
95	517 South Flint Avenue		Steamer	71	56	38	0.90	2.5	1,034	**2,003**	**blue**	8	Plastic	Dead End	4/29/1999	14:35	
96	581 South Flint Avenue	1075 East Buffalo Street	Steamer	75	64	38	0.90	2.5	1,034	**2,467**	**blue**	8	Asbestos	Grid	4/29/1999	14:30	
97	200 North Gary Avenue	1301 East Chestnut Street	Steamer	81	63	40	0.90	2.5	1,061	**2,051**	**blue**	6	Cast Iron	Grid	5/18/1999	9:00	beware of rocks in main 5/18/99

Sorted by North/South Address

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
98	401 North Gary Avenue	1121 East Locust Street	Iowa	68	36	34	0.90	2.5	978	**1,218**	**green**	6	Cast Iron	Grid	3/30/1999	16:30	
99	300 South Gary Avenue		Steamer	69	33	32	0.90	2.5	949	**1,121**	**green**	6	Plastic	Dead End	4/30/1999	12:15	
100	604 South Gary Avenue	1200 East Buffalo Street	Steamer	74	62	48	0.90	2.5	1,163	**2,619**	**blue**	8	Asbestos	Grid	4/29/1999	14:50	
101	618 South Gary Avenue	1201 East Austin Street	Steamer	69	56	46	0.90	2.5	1,138	**2,330**	**blue**	6	Plastic	Grid	4/29/1999	15:05	
102	802 South Gary Avenue	1200 East College Street	Iowa	72	64	30	0.90	2.5	919	**2,525**	**blue**	6	Cast Iron	Grid	4/29/1999	15:20	
103	911 South Gary Avenue	1118 East Auburn Street	Iowa	73	32	30	0.90	2.5	919	**1,056**	**green**	4	Cast Iron	Grid	4/29/1999	15:30	
104	1775 South Georgia Drive	1301 West Aldrich Road	Steamer	48	40	38	0.90	2.5	1,034	**2,035**	**blue**	12	Cast Iron	Grid	3/24/1999	14:25	
105	2801 South Grant Avenue		Steamer	45	28	26	0.90	2.5	856	**1,054**	**green**	6	Ductile Iron	Dead End	4/26/1999	13:45	
106	2861 South Grant Avenue		Steamer	50	36	24	0.90	2.5	822	**1,241**	**green**	6	Ductile Iron	Grid	3/31/1999	10:40	
107	100 North Hartford Avenue	1301 East Broadway Street	Iowa	82	54	54	0.90	2.5	1,233	**1,894**	**blue**	8	Cast Iron	Grid	3/23/1999	10:30	leaks 3/23/99
108	400 North Hartford Avenue	1300 East Locust Street	Steamer	70	50	46	0.90	2.5	1,138	**1,867**	**blue**	8	Plastic	Dead End	3/26/1999	15:45	
109	700 North Hartford Avenue	1301 East Division Street	Iowa	66	40	36	0.90	2.5	1,007	**1,370**	**green**	6	Cast Iron	Grid	3/26/1999	16:00	
110	712 North Hartford Avenue	1300 East Lindon Street	Iowa	68	38	34	0.90	2.5	978	**1,261**	**green**	6	Asbestos	Grid	3/26/1999	16:15	does not drain 3/26/99
111	1020 North Hartford Avenue	1300 East Forest Street	Steamer	68	24	18	0.90	2.5	712	**746**	**orange**	6	Asbestos	Dead End	3/26/1999	16:30	
112	1206 North Hartford Avenue		Steamer	68	16	14	0.90	2.5	628	**601**	**orange**	6	Asbestos	Dead End	3/26/1999	16:45	
113	100 South Hartford Avenue	1350 East Broadway Street	Steamer	83	60	64	0.90	2.5	1,342	**2,313**	**blue**	12	Cast Iron	Dead End	5/18/1999	13:55	
114	1875 South Hartford Avenue		Steamer	58	40	34	0.90	2.5	978	**1,465**	**green**	8	Plastic	Dead End	3/26/1999	14:05	
115	2009 South Hartford Avenue		Steamer	56	40	36	0.90	2.5	1,007	**1,560**	**blue**	8	Plastic	Dead End	3/26/1999	14:20	
116	2145 South Hartford Avenue		Steamer	52	38	34	0.90	2.5	978	**1,529**	**blue**	8	Plastic	Grid	3/26/1999	14:35	
117	2270 South Hartford Avenue	1310 East Hughs Street	Steamer	46	32	28	0.90	2.5	888	**1,240**	**green**	6	Plastic	Grid	3/26/1999	14:50	
118	2385 South Hartford Avenue	1470 East Hughs Street	Steamer	48	36	30	0.90	2.5	919	**1,452**	**green**	6	Plastic	Grid	3/26/1999	15:05	
119	2430 South Hartford Avenue	1500 East Wollard Street	Steamer	46	36	32	0.90	2.5	949	**1,590**	**blue**	6	Plastic	Dead End	3/31/1999	14:30	
120	2575 South Hartford Avenue	1375 East Mount Giliad Road	Steamer	48	38	34	0.90	2.5	978	**1,706**	**blue**	12	Ductile Iron	Grid	3/31/1999	13:20	
121	2791 South Hartford Avenue	1375 East Stewart Street	Steamer	45	36	26	0.90	2.5	856	**1,485**	**green**	8	Plastic	Dead End	4/26/1999	13:45	
122	2981 South Hartford Avenue		Steamer	42	26	26	0.90	2.5	856	**1,016**	**green**	8	Plastic	Dead End	3/22/1999	9:45	does not drain 3/22/99
123	1300 South Hedgewood Drive	950 West Drake Street	Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
124	1570 South Hedgewood Drive	951 West Woodland Drive	Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	
125	1700 South Hedgewood Drive		Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	
126	1751 South Hedgewood Drive		Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	
127	1809 South Hedgewood Drive	900 West Aldrich Road	Steamer	38	34	28	0.90	2.5	888	**2,060**	**blue**	8	Plastic	Grid	3/24/1999	14:40	
128	1931 South Hedgewood Drive		Steamer	36	34	28	0.90	2.5	888	**2,908**	**blue**	8	Plastic	Grid	4/2/1999	10:50	
129	2121 South Hedgewood Drive		Steamer	36	31	28	0.90	2.5	888	**1,773**	**blue**	8	Plastic	Grid	4/2/1999	10:50	does not drain 4/2/99
130	1770 North Highland Terrace	1217 West Aldrich Road	Steamer	48	42	38	0.90	2.5	1,034	**2,376**	**blue**	12	Cast Iron	Grid	3/24/1999	14:10	
131	675 North Holt Avenue	1940 East Division Street	Steamer	92	50	46	0.90	2.5	1,138	**1,523**	**blue**	8	Ductile Iron	Dead End	3/29/1999	15:35	
132	1206 North Hutcheson Drive	1475 East Pennell Street	Steamer	70	18	16	0.90	2.5	671	**657**	**orange**	6	Ductile Iron	Dead End	3/26/1999	16:55	Intermediate School
133	1641 South Ingman Avenue	110 West Estep Drive	Iowa	52	36	26	0.90	2.5	856	**1,244**	**green**	?	?	?	4/5/1999	15:35	
134	100 South Killingsworth Avenue	2200 West Broadway Street	Steamer	44	36	34	0.90	2.5	978	**1,771**	**blue**	12	Ductile Iron	Grid	3/23/1999	11:40	
135	200 South Killingsworth Avenue	2200 West Jackson Street	Steamer	40	36	30	0.90	2.5	919	**2,192**	**blue**	12	Ductile Iron	Grid	3/26/1999	13:20	
136	215 South Killingsworth Avenue		Steamer	40	32	26	0.90	2.5	856	**1,403**	**green**	8	Plastic	Dead End	3/26/1999	13:05	
137	401 South Killingsworth Avenue		Steamer	38	30	28	0.90	2.5	888	**1,416**	**green**	8	Plastic	Dead End	3/26/1999	12:50	
138	412 South Killingsworth Avenue		Steamer	40	32	28	0.90	2.5	888	**1,456**	**green**	12	Ductile Iron	Grid	3/26/1999	12:35	
139	800 South Killingsworth Avenue	2174 West College Street	Steamer	40	30	28	0.90	2.5	888	**1,291**	**green**	12	Ductile Iron	Grid	3/26/1999	11:50	needs grease 3/26/99
140	1011 South Killingsworth Avenue	2200 West Northwood Street	Steamer	38	32	28	0.90	2.5	888	**1,655**	**blue**	12	Ductile Iron	Grid	3/26/1999	11:35	
141	1112 South Killingsworth Avenue		Steamer	38	30	26	0.90	2.5	856	**1,365**	**green**	12	Ductile Iron	Grid	3/26/1999	11:20	
142	1402 South Killingsworth Avenue		Steamer	40	34	28	0.90	2.5	888	**1,701**	**blue**	8	Cast Iron	Dead End	3/26/1999	11:05	needs grease 3/26/99
143	1800 South Killingsworth Avenue	2175 West Aldrich Road	Steamer	36	28	24	0.90	2.5	822	**1,274**	**green**	12	Cast Iron	Grid	3/25/1999	9:55	
144	1800 South Killingsworth Avenue	2200 West Aldrich Road	Steamer	36	26	22	0.90	2.5	787	**1,081**	**green**	12	Plastic	Grid	3/25/1999	10:10	
145	1919 South Killingsworth Avenue		Steamer	40	36	32	0.90	2.5	949	**2,264**	**blue**	6	Plastic	Dead End	3/30/1999	14:35	
146	1350 South Lakewood Circle	1339 West Lakewood Drive	Steamer	52	44	30	0.90	2.5	919	**1,943**	**blue**	6	Plastic	Grid	4/9/1999	16:10	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
147	1455 South Lakewood Circle		Steamer	54	39	30	0.90	2.5	919	**1,430**	**green**	6	Plastic	Dead End	4/9/1999	16:10	
148	701 North Lemmon Avenue		Steamer	62	53	55	0.90	2.5	1,244	**2,859**	**blue**	?	?	?	9/15/2000	18:15	
149	700 North Leonard Place	1423 East Division Street	Iowa	72	44	40	0.90	2.5	1,061	**1,482**	**green**	6	Cast Iron	Grid	3/29/1999	16:15	
150	770 North Leonard Place	1400 East Lindon Street	Iowa	70	38	30	0.90	2.5	919	**1,169**	**green**	6	Cast Iron	Grid	3/29/1999	16:30	
151	270 South Lillian Avenue	429 West Madison Street	Iowa	67	62	24	0.90	2.5	822	**2,757**	**blue**	4	Cast Iron	Grid	4/21/1999	10:20	
152	450 South Lillian Avenue	470 West Maupin Street	Iowa	65	50	18	0.90	2.5	712	**1,288**	**green**	4	Asbestos	Grid	4/21/1999	13:15	
153	706 South Lillian Avenue	426 West College Street	Iowa	55	40	26	0.90	2.5	856	**1,352**	**green**	4	Cast Iron	Grid	4/21/1999	13:15	
154	922 South Lillian Avenue	427 West South Street	Iowa	50	48	40	0.90	2.5	1,061	**4,580**	**blue**	6	Cast Iron	Grid	4/9/1999	11:10	
155	1214 South Lillian Avenue		Iowa	44	41	20	0.90	2.5	750	**2,307**	**blue**	8	Cast Iron	Grid	4/8/1999	15:45	
156	1327 South Lillian Avenue		Steamer	44	42	20	0.90	2.5	750	**2,871**	**blue**	8	Cast Iron	Grid	4/8/1999	15:45	
157	1460 South Lillian Avenue		Steamer	44	42	38	0.90	2.5	1,034	**3,958**	**blue**	12	Cast Iron	Grid	4/8/1999	15:30	
158	1470 South Lillian Avenue	500 West High Street	Steamer	44	39	40	0.90	2.5	1,061	**2,476**	**blue**	8	Cast Iron	Grid	4/8/1999	15:15	
158	1470 South Lillian Avenue	500 West High Street	Steamer	46	44	38	0.90	2.5	1,034	**4,132**	**blue**	8	Cast Iron	Grid	7/9/2002	14:09	
159	1775 South Lillian Avenue	401 West Aldrich Road	Steamer	42	38	36	0.90	2.5	1,007	**2,528**	**blue**	12	Cast Iron	Grid	3/24/1999	14:00	
160	100 South Lillian Place	476 West Broadway Street	Steamer	64	50	48	0.90	2.5	1,163	**2,158**	**blue**	8	Ductile Iron	Grid	3/23/1999	14:15	
161	218 South Lillian Place	570 West Madison Street	Iowa	62	55	36	0.90	2.5	1,007	**2,649**	**blue**	4	Cast Iron	Grid	4/21/1999	10:30	
162	100 North Main Avenue	103 East Broadway Street	Steamer	70	58	50	0.90	2.5	1,186	**2,359**	**blue**	8	Cast Iron	Grid	3/22/1999	6:35	
163	201 North Main Avenue	101 West Chestnut Street	Steamer	60	52	48	0.90	2.5	1,163	**2,772**	**blue**	4	Cast Iron	Grid	3/25/1999	15:10	
164	375 North Main Avenue	100 West Locust Street	Iowa	56	40	34	0.90	2.5	978	**1,516**	**blue**	12	Ductile Iron	Grid	3/25/1999	14:55	
165	517 North Main Avenue	100 West Hickory Street	Steamer	60	46	44	0.90	2.5	1,113	**1,962**	**blue**	6	Plastic	Grid	3/25/1999	14:40	
166	643 North Main Avenue	100 West Division Street	Steamer	58	34	26	0.90	2.5	856	**1,097**	**green**	6	Plastic	Grid	3/25/1999	14:25	
167	905 North Main Avenue	101 West Summit Street	Iowa	54	16	12	0.90	2.5	581	**547**	**orange**	4	Cast Iron	Grid	3/25/1999	14:10	
168	1010 North Main Avenue	100 East Forest Street	Steamer	60	42	38	0.90	2.5	1,034	**1,592**	**blue**	6	Cast Iron	Grid	3/25/1999	13:55	
169	1075 North Main Avenue		Steamer	64	48	46	0.90	2.5	1,138	**1,965**	**blue**	8	Ductile Iron	Dead End	5/6/1999	16:30	
170	1200 North Main Avenue	119 East Pennell Street	Iowa	64	14	12	0.90	2.5	581	**542**	**orange**	4	Cast Iron	Dead End	3/25/1999	13:40	
171	1600 North Main Avenue	101 East Park Ridge Drive	Steamer	60	38	36	0.60	1.5	242	**334**	**red**	8	Plastic	Dead End	3/25/1999	13:20	
172	1761 North Main Avenue	100 West Rountree Street	Steamer	70	44	42	0.60	1.5	261	**372**	**red**	6	Plastic	Dead End	3/25/1999	13:00	does not drain 3/25/99
173	175 South Main Avenue	101 East Jackson Street	Steamer	70	58	52	0.90	2.5	1,210	**2,615**	**blue**	4	Cast Iron	Grid	3/22/1999	7:10	
174	177 South Main Avenue	101 East Jackson Street	Iowa	70	48	42	0.90	2.5	1,087	**1,694**	**blue**	4	Cast Iron	Grid	3/22/1999	7:15	needs grease 3/22/99
175	301 South Main Avenue	100 West Jefferson Street	Iowa	74	52	48	0.90	2.5	1,163	**1,888**	**blue**	6	Cast Iron	Grid	3/25/1999	15:30	
176	328 South Main Avenue		Steamer	74	62	50	0.90	2.5	1,186	**2,673**	**blue**	8	Cast Iron	Grid	3/25/1999	15:45	
177	400 South Main Avenue	106 West Walnut Street	Iowa	68	38	34	0.90	2.5	978	**1,261**	**green**	4	Cast Iron	Grid	3/25/1999	15:05	
178	800 South Main Avenue	104 East College Street	Iowa	60	48	40	0.90	2.5	1,061	**2,033**	**blue**	6	Plastic	Grid	3/26/1999	10:10	
179	901 South Main Avenue	100 West Auburn Street	Steamer	60	48	44	0.90	2.5	1,113	**2,132**	**blue**	6	Plastic	Grid	3/26/1999	10:25	
180	1001 South Main Avenue	130 West South Street	Steamer	54	28	22	0.90	2.5	787	**910**	**orange**	6	Cast Iron	Grid	3/26/1999	10:40	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
181	1801 South Maple Tree Lane	240 West Aldrich Road	Steamer	54	42	40	0.90	2.5	1,061	1,862	blue	12	Cast Iron	Grid	3/24/1999	13:40	
182	2025 South Maple Tree Lane		Steamer	54	40	40	0.90	2.5	1,061	1,714	blue	8	Plastic	Dead End	3/24/1999	13:40	
183	100 North Market Avenue	305 East Broadway Street	Steamer	66	50	46	0.90	2.5	1,138	2,013	blue	8	Ductile Iron	Grid	3/22/1999	12:20	
184	200 North Market Avenue	301 East Chestnut Street	Steamer	63	58	34	0.90	2.5	978	3,127	blue	6	Ductile Iron	Grid	5/10/1999	9:20	
185	703 North Market Avenue	303 East Division Street	Iowa	60	26	22	0.90	2.5	787	859	orange	4	Cast Iron	Grid	3/29/1999	10:55	
186	900 North Market Avenue	301 East Summit Street	Iowa	54	45	32	0.90	2.5	949	1,946	blue	4	Cast Iron	Grid	5/7/1999	13:45	
187	1013 North Market Avenue	275 East Vivian Street	Iowa	56	48	24	0.90	2.5	822	1,852	blue	4	Cast Iron	Grid	5/7/1999	13:30	does not close, does not drain 5/7/99
188	1025 North Market Avenue	270 East Forest Street	Iowa	59	51	22	0.90	2.5	787	1,851	blue	8	Cast Iron	Grid	5/7/1999	13:20	
189	1270 North Market Avenue	300 East Parkview Street	Steamer	62	12	8	0.90	2.5	475	432	red	8	Plastic	Grid	5/7/1999	15:15	
190	1871 North Market Avenue	251 East Rountree Street	Steamer	70	10	8	0.90	2.5	475	430	red	6	Plastic	Dead End	3/29/1999	14:45	
191	171 South Market Avenue	271 East Jackson Street	Steamer	68	50	42	0.90	2.5	1,087	1,847	blue	6	Cast Iron	Dead End	3/19/1999	16:30	
192	270 South Market Avenue	301 East Jefferson Street	Iowa	72	54	54	0.90	2.5	1,233	2,187	blue	8	Cast Iron	Grid	3/19/1999	16:05	
193	321 South Market Avenue		Steamer	76	56	52	0.90	2.5	1,210	2,110	blue	?	?	?	3/19/1999	15:45	
194	970 South Martin Avenue	2003 West Northwood Street	Steamer	45	42	38	0.90	2.5	1,034	3,250	blue	8	Plastic	Grid	4/19/1999	13:10	
195	1211 South Martin Avenue		Iowa	42	39	38	0.90	2.5	1,034	3,033	blue	4	Plastic	Grid	4/19/1999	13:40	
196	1230 South Martin Avenue		Steamer	42	40	38	0.90	2.5	1,034	3,776	blue	4	Plastic	Grid	4/19/1999	13:40	
197	205 North McColm Avenue	1519 East Chestnut Street	Steamer	86	65	39	0.90	2.5	1,048	1,945	blue	8	Plastic	Grid	5/18/1999	9:35	
198	405 North McColm Avenue	1475 East Locust Street	Iowa	78	46	44	0.90	2.5	1,113	1,535	blue	6	Plastic	Grid	3/30/1999	16:45	
199	503 North McColm Avenue	1575 East Laverne Street	Steamer	71	49	39	0.90	2.5	1,048	1,650	blue	6	Plastic	Grid	5/18/1999	9:50	
200	675 North McColm Avenue	1508 East Division Street	Iowa	76	44	42	0.90	2.5	1,087	1,471	green	6	Cast Iron	Grid	3/29/1999	16:00	
201	1331 South Meadow Lane		Steamer	44	36	38	0.90	2.5	1,034	1,872	blue	6	Plastic	Grid	4/9/1999	16:40	
202	1501 South Meadow Lane	1600 West Patton Road	Steamer	43	35	34	0.90	2.5	978	1,731	blue	8	Plastic	Grid	4/19/1999	9:15	
203	1665 South Meadow Lane		Steamer	40	39	34	0.90	2.5	978	4,933	blue	8	Plastic	Grid	4/19/1999	9:00	
204	1775 South Meadow Lane	1601 West Aldrich Road	Steamer	46	40	36	0.90	2.5	1,007	2,222	blue	12	Cast Iron	Grid	3/25/1999	9:10	
205	1101 South Mill Place	314 West Colgate Street	Iowa	50	34	34	0.80	2.5	870	1,221	green	6	Plastic	Grid	4/9/1999	10:50	
206	1070 South Mission Avenue		Iowa	0	0	0	0.90	2.5	0	0	black	6	Plastic	Dead End	4/21/1999	15:35	
207	1150 South Mission Avenue		Iowa	0	0	0	0.90	2.5	0	0	black	6	Plastic	Dead End	4/21/1999	15:35	
208	1300 South Mission Avenue	751 West Drake Street	Iowa	0	0	0	0.90	2.5	0	0	black	6	Plastic	Dead End	4/21/1999	15:35	
209	1570 South Mission Avenue	751 West Woodland Drive	Iowa	0	0	0	0.90	2.5	0	0	black	6	Plastic	Grid	4/21/1999	15:35	
210	1700 South Mission Avenue		Iowa	0	0	0	0.90	2.5	0	0	black	6	Plastic	Grid	4/21/1999	15:35	
211	1770 South Mission Avenue	751 West Aldrich Road	Iowa	0	0	0	0.90	2.5	0	0	black	6	Plastic	Grid	4/21/1999	15:35	
212	875 North Missouri Avenue	800 West Summit Street	Iowa	53	20	24	0.90	2.5	822	822	orange	4	Cast Iron	Grid	5/7/1999	9:25	
213	101 South Missouri Avenue	210 West Broadway Street	Steamer	66	58	50	0.90	2.5	1,186	3,051	blue	8	Ductile Iron	Grid	3/23/1999	13:25	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi) Underlined text indicates a less accurate method was used.	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83) (Cd)(D^2) (P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/ (PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
214	201 South Missouri Avenue	200 West Jackson Street	Iowa	70	55	34	0.90	2.5	978	1,874	blue	6	Plastic	Grid	4/26/1999	11:25	
215	575 South Missouri Avenue	217 West Buffalo Street	Iowa	60	55	18	0.90	2.5	712	2,188	blue	4	Plastic	Grid	4/26/1999	11:55	
216	675 South Missouri Avenue	201 West Austin Street	Iowa	60	48	32	0.90	2.5	949	1,818	blue	4	Cast Iron	Grid	4/26/1999	11:50	
217	1100 South Missouri Avenue	134 West South Street	Iowa	58	36	25	0.90	2.5	839	1,127	green	6	Cast Iron	Grid	4/8/1999	10:15	
218	1115 South Missouri Avenue	120 West Drake Street	Iowa	54	10	6	0.90	2.5	411	358	red	4	Cast Iron	Grid	4/5/1999	16:20	
219	2105 South Morrisville Road		Steamer	40	34	16	0.90	2.5	671	1,286	green	4	Plastic	Grid	4/1/1999	14:30	
220	2175 South Morrisville Road	605 West San Martin Street	Steamer	40	32	12	0.90	2.5	581	953	orange	4	Plastic	Grid	4/1/1999	15:05	
221	2475 South Morrisville Road	609 West Wollard Street	Steamer	40	36	26	0.60	1.5	205	490	red	4	Plastic	Grid	4/1/1999	15:30	
222	101 North Oakland Avenue	1005 West Fairplay Street	Iowa	60	43	24	0.90	2.5	822	1,305	green	4	Cast Iron	Grid	5/3/1999	15:40	
223	135 North Oakland Avenue	1002 West Chestnut Street	Iowa	55	36	24	0.90	2.5	822	1,143	green	4	Cast Iron	Grid	5/3/1999	15:30	
224	313 North Oakland Avenue	1000 West Locust Street	Steamer	60	58	43	0.90	2.5	1,100	5,547	blue	?	?	?	9/15/2000	18:54	
225	500 North Oakland Avenue	917 West Freeman Street	Iowa	53	52	50	0.90	2.5	1,186	7,839	blue	12	Ductile Iron	Grid	5/5/1999	13:55	
226	624 North Oakland Avenue		Steamer	58	56	50	0.90	2.5	1,186	5,818	blue	12	Ductile Iron	Grid	5/5/1999	14:15	
227	700 North Oakland Avenue	975 West Division Street	Steamer	60	50	48	0.90	2.5	1,163	2,458	blue	12	Ductile Iron	Grid	3/29/1999	9:45	
228	820 North Oakland Avenue	1000 West Summit Street	Steamer	58	54	50	0.90	2.5	1,186	4,002	blue	12	Ductile Iron	Grid	5/6/1999	15:05	
229	970 North Oakland Avenue	1000 West Forest Street	Steamer	62	59	48	0.90	2.5	1,163	4,834	blue	12	Ductile Iron	Grid	5/6/1999	15:20	
230	1500 North Oakland Avenue		Steamer	66	54	50	0.90	2.5	1,186	2,451	blue	8	Cast Iron	Dead End	5/6/1999	10:25	will not close 5/6/99
231	1520 North Oakland Avenue		Steamer	64	54	50	0.90	2.5	1,186	2,641	blue	8	Cast Iron	Dead End	5/6/1999	10:00	
232	1530 North Oakland Avenue		Steamer	64	58	50	0.90	2.5	1,186	3,480	blue	12	Ductile Iron	Dead End	5/6/1999	9:55	cacti needs to be trimmed around hydrant and sprinkler system OS&Y 5/6/99
233	1800 North Oakland Avenue	975 West Oak Terrace	Steamer	78	68	56	0.90	2.5	1,256	3,244	blue	12	Ductile Iron	Dead End	3/29/1999	14:00	
234	129 South Oakland Avenue	1001 West Jackson Street	Iowa	55	50	18	0.90	2.5	712	2,036	blue	4	Cast Iron	Grid	4/21/1999	9:45	
235	230 South Oakland Avenue	975 West Maupin Street	Iowa	54	52	30	0.90	2.5	919	4,244	blue	8	Asbestos	Grid	4/21/1999	9:40	
236	701 South Oakland Avenue	970 West College Street	Steamer	53	49	44	0.90	2.5	1,113	3,478	blue	8	Plastic	Grid	4/19/1999	15:10	needs grease 4/19/99

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
237	1024 South Oakland Avenue		Steamer	55	52	46	0.90	2.5	1,138	4,289	blue	8	Plastic	Grid	4/19/1999	15:00	needs grease 4/19/99
238	1175 South Oakland Avenue	1075 West Lakewood Drive	Steamer	59	56	34	0.90	2.5	978	3,909	blue	6	Plastic	Grid	4/9/1999	15:55	
239	1329 South Oakland Avenue		Steamer	54	50	48	0.90	2.5	1,163	3,692	blue	6	Plastic	Grid	4/9/1999	15:40	stem nut leaks 4/9/99
240	1609 South Oakland Avenue	1101 West Highland Terrace	Steamer	44	42	18	0.90	2.5	712	2,724	blue	6	Asbestos	Grid	4/9/1999	15:15	inaccessible 4/9/99
241	1775 South Oakland Avenue	1009 West Aldrich Road	Steamer	36	32	30	0.90	2.5	919	2,070	blue	8	Asbestos	Grid	3/24/1999	14:50	
242	2600 South Oakland Avenue	970 West Maurice Street	Steamer	34	25	26	0.60	1.5	205	289	red	6	Plastic	Dead End	4/1/1999	16:00	
243	2305 South Orchard Avenue		Iowa	39	22	15	0.90	2.5	650	700	orange	4	Plastic	Grid	9/15/2000	17:02	
244	2403 South Orchard Avenue		Steamer	34	30	26	0.60	1.5	205	449	red	4	Plastic	Grid	4/1/1999	15:30	
245	2427 South Orchard Avenue		Iowa	0	0	0	0.90	2.5	0	0	black	4	Plastic	Grid	4/21/1999	14:10	yard ornament 4/21/99
246	2524 South Orchard Avenue	970 West Maurice Street	Iowa	34	26	26	0.60	1.5	205	308	red	6	Plastic	Dead End	4/1/1999	15:30	
247	2755 South Orchard Avenue	901 West Stewart Street	Steamer	34	25	26	0.60	1.5	205	289	red	6	Plastic	Dead End	4/1/1999	16:00	
248	100 North Park Avenue	525 West Broadway Street	Iowa	64	8	6	0.90	2.5	411	361	red	4	Cast Iron	Dead End	3/23/1999	15:35	does not drain, does not close 3/23/99
249	217 North Park Avenue	600 West Olive Street	Iowa	63	37	16	0.90	2.5	671	881	orange	4	Cast Iron	Grid	5/5/1999	11:05	
250	402 North Park Avenue	575 West Locust Street	Iowa	60	34	32	0.90	2.5	949	1,198	green	12	Ductile Iron	Grid	3/30/1999	11:05	
251	601 North Park Avenue	601 West Freeman Street	Iowa	56	50	22	0.90	2.5	787	2,071	blue	4	Cast Iron	Grid	5/5/1999	14:50	resident @ 601 W Freeman requested water dept fill dirt around his meter, message conveyed 5/5/99
252	970 North Park Avenue	570 West Forest Street	Steamer	62	58	54	0.90	2.5	1,233	4,389	blue	12	Ductile Iron	Grid	5/6/1999	15:55	
253	2170 South Park Avenue		Steamer	46	32	30	0.90	2.5	919	1,284	green	8	Cast Iron	Dead End	4/1/1999	14:25	
254	616 North Park Place		Iowa	53	45	30	0.90	2.5	919	1,975	blue	4	Cast Iron	Grid	5/5/1999	15:05	inaccessible 5/5/99
255	652 North Park Place	700 West Division Street	Iowa	50	28	24	0.90	2.5	822	972	orange	6	Asbestos	Grid	3/29/1999	10:20	
256	1640 North Park Ridge Drive		Steamer	66	49	50	0.90	2.5	1,186	2,031	blue	8	Plastic	Dead End	9/15/2000	15:33	
257	1786 North Park Ridge Drive		Steamer	74	10	8	0.90	2.5	475	433	red	8	Plastic	Dead End	3/29/1999	14:20	only flow wide open as long as necessary for test. This goes for all residuals <20psi 3/29/99
258	170 North Pike Avenue	216 West Chestnut Street	Steamer	63	54	54	0.90	2.5	1,233	2,869	blue	8	Ductile Iron	Dead End	5/7/1999	10:05	
259	270 North Pike Avenue	218 West Olive Street	Iowa	62	55	54	0.90	2.5	1,233	3,245	blue	8	Ductile Iron	Grid	5/7/1999	10:00	leaks 5/7/99
260	300 North Pike Avenue	175 West Olive Street	Steamer	59	57	34	0.90	2.5	978	4,866	blue	8	Cast Iron	Grid	5/7/1999	9:45	
261	317 North Pike Avenue	300 West Locust Street	Steamer	56	52	48	0.90	2.5	1,163	3,808	blue	12	Ductile Iron	Grid	3/30/1999	11:20	
262	438 North Pike Avenue		Steamer	56	54	46	0.90	2.5	1,138	5,420	blue	8	Ductile Iron	Grid	5/7/1999	10:20	
263	620 North Pike Avenue	175 West Ivory Street	Steamer	55	51	42	0.90	2.5	1,087	3,508	blue	8	Ductile Iron	Grid	5/7/1999	10:35	
264	670 North Pike Avenue	575 West Division Street	Steamer	52	42	36	0.90	2.5	1,007	1,887	blue	8	Ductile Iron	Grid	3/29/1999	10:40	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83) (Cd)(D^2) (P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/ (PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
265	100 South Pike Avenue	276 West Broadway Street	Steamer	66	56	50	0.90	2.5	1,186	**2,705**	**blue**	8	Ductile Iron	Grid	3/23/1999	13:40	
266	402 South Pike Avenue	274 West Walnut Street	Steamer	66	60	40	0.90	2.5	1,061	**3,188**	**blue**	8	Cast Iron	Grid	3/18/1999	10:45	
267	475 South Pike Avenue	307 West Maupin Street	Iowa	57	55	10	0.90	2.5	531	**2,565**	**blue**	4	Cast Iron	Grid	4/21/1999	11:35	leaks oil 4/21/99
268	712 South Pike Avenue		Steamer	53	52	50	0.90	2.5	1,186	**7,839**	**blue**	8	Cast Iron	Grid	4/26/1999	14:05	leaks oil 4/21/99
269	970 South Pike Avenue	275 West South Street	Iowa	54	44	25	0.90	2.5	839	**1,625**	**blue**	8	Cast Iron	Grid	4/8/1999	10:00	does not drain 4/8/99
270	1018 South Pike Avenue		Steamer	54	50	8	0.90	2.5	475	**1,507**	**blue**	8	Cast Iron	Grid	4/8/1999	9:45	
271	1101 South Pike Avenue	302 West Colgate Street	Steamer	52	50	43	0.90	2.5	1,100	**4,917**	**blue**	8	Plastic	Grid	4/8/1999	9:25	
272	1301 South Pike Avenue	302 West Anderson Drive	Steamer	52	48	45	0.90	2.5	1,126	**3,460**	**blue**	8	Plastic	Grid	4/8/1999	9:10	
273	1401 South Pike Avenue		Steamer	50	48	45	0.90	2.5	1,126	**4,858**	**blue**	8	Plastic	Grid	4/8/1999	8:55	
274	1475 South Pike Avenue	301 West High Street	Steamer	50	48	43	0.90	2.5	1,100	**4,749**	**blue**	8	Plastic	Grid	4/8/1999	8:40	
275	1875 South Pike Avenue	301 West Bradford Street	Steamer	52	44	38	0.90	2.5	1,034	**2,187**	**blue**	8	Plastic	Dead End	4/1/1999	10:35	
276	2025 South Pike Avenue	301 West Maple Street	Steamer	52	42	38	0.90	2.5	1,034	**1,938**	**blue**	8	Plastic	Dead End	4/1/1999	10:35	
277	200 North Pomme De Terre Avenue		Iowa	84	40	38	0.90	2.5	1,034	**1,266**	**green**	6	Plastic	Dead End	3/23/1999	11:05	
278	100 South Pomme De Terre Avenue	1650 East Broadway Street	Steamer	90	65	64	0.90	2.5	1,342	**2,341**	**blue**	12	Cast Iron	Dead End	5/18/1999	14:30	
279	211 North Rechow Avenue		Iowa	49	44	22	0.90	2.5	787	**2,033**	**blue**	4	Cast Iron	Grid	5/3/1999	11:50	inaccessible, leaks 5/3/99
280	317 North Rechow Avenue	1300 West Locust Street	Steamer	50	38	36	0.90	2.5	1,007	**1,651**	**blue**	8	Cast Iron	Grid	3/30/1999	9:40	
281	175 North Redel Place		Steamer	94	38	36	0.90	2.5	1,007	**1,170**	**green**	6	Asbestos	Dead End	3/23/1999	16:15	
282	200 North Redel Place		Iowa	94	32	30	0.90	2.5	919	**1,011**	**green**	6	Asbestos	Dead End	3/23/1999	16:00	
283	800 North Redel Place	2001 East Division Street	Steamer	89	40	40	0.90	2.5	1,061	**1,277**	**green**	8	Ductile Iron	Dead End	5/5/1999	11:25	
284	900 North Redel Place	1901 East Meadow Drive	Steamer	98	52	23	0.90	2.5	805	**1,070**	**green**	6	Plastic	Grid	5/18/1999	11:20	
285	101 North Russell Avenue	1501 West Fairplay Street	Steamer	49	40	38	0.90	2.5	1,034	**1,946**	**blue**	8	Plastic	Grid	5/3/1999	10:40	
286	201 North Russell Avenue	1501 West Chestnut Street	Steamer	48	43	38	0.90	2.5	1,034	**2,622**	**blue**	8	Plastic	Grid	5/3/1999	10:35	does not drain 5/3/99
287	301 North Russell Avenue	1501 West Olive Street	Iowa	46	41	40	0.90	2.5	1,061	**2,585**	**blue**	8	Plastic	Grid	5/3/1999	10:25	
288	375 North Russell Avenue	1400 West Pine Street	Steamer	49	30	32	0.90	2.5	949	**1,193**	**green**	6	Cast Iron	Dead End	5/3/1999	10:50	
289	218 North Springfield Avenue	200 East Olive Street	Iowa	60	34	28.5	0.90	2.7	1,045	**1,318**	**green**	4	Plastic	Grid	3/9/1999	15:15	leaks 3/9/99
290	500 North Springfield Avenue	203 East Freeman Street	Steamer	62	40	28	0.90	2.5	888	**1,259**	**green**	4	Cast Iron	Grid	3/9/1999	15:08	
291	608 North Springfield Avenue		Steamer	64	42	65	0.90	2.5	1,353	**1,967**	**blue**	6	Plastic	Grid	3/9/1999	14:25	
292	100 South Springfield Avenue	200 East Broadway Street	Steamer	70	56	52	0.90	2.5	1,210	**2,406**	**blue**	8	Cast Iron	Grid	3/22/1999	6:25	
293	201 South Springfield Avenue	200 East Jackson Street	Steamer	70	56	54	0.90	2.5	1,233	**2,452**	**blue**	8	Cast Iron	Grid	3/22/1999	6:45	
294	201 South Springfield Avenue	200 East Jackson Street	Iowa	70	48	42	0.90	2.5	1,087	**1,694**	**blue**	8	Cast Iron	Grid	3/22/1999	6:50	needs grease 3/22/99
295	301 South Springfield Avenue	116 East Jefferson Street	Iowa	76	60	43	0.90	2.5	1,100	**2,164**	**blue**	8	Cast Iron	Grid	3/9/1999	15:20	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
296	402 South Springfield Avenue	200 East Walnut Street	Iowa	76	30	24	0.90	2.5	822	914	orange	8	Cast Iron	Grid	3/22/1999	7:55	
297	500 South Springfield Avenue	200 East Maupin Street	Steamer	70	46	35	0.90	2.5	993	1,476	green	4	Cast Iron	Grid	3/9/1999	15:32	
298	604 South Springfield Avenue	600 East Buffalo Street	Steamer	64	48	35	0.90	2.5	993	1,714	blue	6	Plastic	Grid	3/3/1999	15:40	
299	900 South Springfield Avenue	700 East Auburn Street	Steamer	54	20	18	0.90	2.5	712	712	orange	8	Plastic	Grid	3/9/1999	15:47	
300	1024 South Springfield Avenue	700 East South Street	Steamer	56	44	33	0.90	2.5	964	1,745	blue	8	Cast Iron	Grid	3/9/1999	15:56	
301	1100 South Springfield Avenue	701 East Colgate Street	Steamer	60	44	40	0.90	2.5	1,061	1,741	blue	8	Cast Iron	Grid	3/9/1999	16:07	
302	1200 South Springfield Avenue	701 East Drake Street	Iowa	60	58	35	0.90	2.5	993	5,005	blue	8	Cast Iron	Grid	3/18/1999	12:50	
303	1400 South Springfield Avenue		Steamer	66	50	50	0.90	2.5	1,186	2,099	blue	8	Plastic	Grid	3/18/1999	13:10	
304	1700 South Springfield Avenue	800 East Estep Drive	Steamer	64	48	48	0.90	2.5	1,163	2,007	blue	8	Plastic	Grid	3/18/1999	13:35	inaccessible 3/18/99
305	1775 South Springfield Avenue	875 East Aldrich Road	Steamer	54	40	38	0.90	2.5	1,034	1,670	blue	12	Cast Iron	Grid	3/18/1999	14:20	
306	1800 South Springfield Avenue	900 East Aldrich Road	Steamer	54	40	38	0.90	2.5	1,034	1,670	blue	12	Cast Iron	Grid	3/18/1999	14:00	
307	1875 South Springfield Avenue		Steamer	52	40	38	0.90	2.5	1,034	1,757	blue	12	Cast Iron	Dead End	3/18/1999	14:40	
308	2004 South Springfield Avenue		Steamer	50	40	36	0.90	2.5	1,007	1,822	blue	12	Cast Iron	Grid	3/18/1999	15:00	
309	2150 South Springfield Avenue		Steamer	50	38	34	0.90	2.5	978	1,605	blue	12	Cast Iron	Grid	3/18/1999	15:45	
310	2201 South Springfield Avenue		Steamer	48	36	32	0.90	2.5	949	1,500	blue	12	Cast Iron	Dead End	3/18/1999	16:05	
311	2265 South Springfield Avenue		Steamer	44	34	32	0.90	2.5	949	1,523	blue	12	Galvanized	Dead End	3/18/1999	16:25	
312	2275 South Springfield Avenue		Steamer	44	30	28	0.90	2.5	888	1,188	green	6	Plastic	Grid	3/31/1999	10:00	
313	2280 South Springfield Avenue		Steamer	48	34	32	0.90	2.5	949	1,380	green	12	Galvanized	Grid	3/22/1999	8:15	
314	2365 South Springfield Avenue		Steamer	42	30	26	0.90	2.5	856	1,187	green	6	Plastic	Grid	3/31/1999	10:20	
315	2371 South Springfield Avenue		Steamer	44	30	26	0.90	2.5	856	1,145	green	6	Plastic	Grid	4/21/1999	13:55	
316	2375 South Springfield Avenue	1075 East Wollard Street	Steamer	46	34	28	0.90	2.5	888	1,348	green	12	Galvanized	Dead End	3/22/1999	8:35	
317	2400 South Springfield Avenue	101 East Wollard Street	Steamer	48	36	32	0.90	2.5	949	1,500	blue	12	Galvanized	Grid	3/31/1999	14:15	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
318	2465 South Springfield Avenue		Steamer	44	30	26	0.90	2.5	856	**1,145**	**green**	6	Plastic	Grid	4/21/1999	13:55	
319	2471 South Springfield Avenue		Steamer	42	32	28	0.90	2.5	888	**1,359**	**green**	6	Plastic	Grid	4/1/1999	9:00	
320	2475 South Springfield Avenue		Steamer	44	30	26	0.90	2.5	856	**1,145**	**green**	6	Plastic	Grid	4/1/1999	9:25	
321	2477 South Springfield Avenue		Steamer	42	32	28	0.90	2.5	888	**1,359**	**green**	6	Plastic	Grid	4/1/1999	9:15	
322	2479 South Springfield Avenue		Steamer	44	32	26	0.90	2.5	856	**1,244**	**green**	12	Galvanized	Dead End	3/22/1999	9:10	
323	2500 South Springfield Avenue	1101 East Mount Giliad Road	Steamer	42	32	30	0.90	2.5	919	**1,407**	**green**	12	Galvanized	Grid	3/22/1999	9:25	
324	2175 South Springfield Place		Steamer	50	38	30	0.90	2.5	919	**1,507**	**blue**	6	Plastic	Grid	4/1/1999	14:20	
325	100 North Sunset Avenue	1703 West Fairplay Street	Steamer	46	34	34	0.90	2.5	978	**1,485**	**green**	8	Plastic	Grid	3/24/1999	10:35	
326	206 North Sunset Avenue	1613 West Chestnut Street	Steamer	47	42	40	0.90	2.5	1,061	**2,638**	**blue**	8	Plastic	Grid	5/3/1999	10:00	
327	220 North Sunset Avenue	1670 West Olive Street	Steamer	47	41	34	0.90	2.5	978	**2,204**	**blue**	8	Plastic	Grid	5/3/1999	10:10	
328	1230 South Sunset Avenue		Steamer	46	29	28	0.90	2.5	888	**1,117**	**green**	8	Plastic	Dead End	4/19/1999	9:45	
329	1440 South Sunset Avenue	1675 West Patton Road	Steamer	42	32	28	0.90	2.5	888	**1,359**	**green**	8	Plastic	Dead End	4/19/1999	9:45	
330	1660 South Sunset Avenue		Steamer	43	35	24	0.90	2.5	822	**1,454**	**green**	8	Plastic	Grid	4/19/1999	9:30	
331	1770 South Sunset Avenue	1775 West Aldrich Road	Steamer	44	38	34	0.90	2.5	978	**2,068**	**blue**	12	Cast Iron	Grid	3/25/1999	9:25	
332	1000 North Thornridge Circle	1901 East Thornridge Drive	Steamer	85	64	21	0.90	2.5	769	**1,415**	**green**	6	Plastic	Grid	5/18/1999	10:55	
333	1551 South University Avenue		Steamer	62	34	32	0.90	2.5	949	**1,182**	**green**	?	?	?	4/5/1999	14:25	needs grease 4/5/99
334	1670 South University Avenue		Steamer	64	24	22	0.90	2.5	787	**829**	**orange**	?	?	?	4/5/1999	14:40	
335	1701 South University Avenue		Steamer	62	44	30	0.90	2.5	919	**1,452**	**green**	?	?	?	4/5/1999	14:50	needs grease 4/5/99
336	1751 South University Avenue		Steamer	64	40	34	0.90	2.5	978	**1,357**	**green**	?	?	?	4/5/1999	15:00	needs grease, leaks, does not drain 4/5/99
337	1775 South University Avenue	105 East Aldrich Road	Steamer	62	48	44	0.90	2.5	1,113	**2,014**	**blue**	12	Cast Iron	Grid	3/24/1999	13:20	
338	1300 South Village Lane	850 West Drake Street	Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	
339	1570 South Village Lane	851 West Woodland Drive	Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	
340	1700 South Village Lane		Steamer	45	40	42	0.90	2.5	1,087	**2,593**	**blue**	6	Plastic	Grid	9/15/2000	16:16	
341	1770 South Village Lane	851 West Aldrich Road	Steamer	0	0	0	0.90	2.5	0	**0**	**black**	6	Plastic	Grid	4/21/1999	15:35	
342	1809 South Village Lane	800 West Aldrich Road	Steamer	40	36	30	0.90	2.5	919	**2,192**	**blue**	8	Plastic	Grid	3/24/1999	14:20	
343	1931 South Village Lane		Steamer	38	34	26	0.90	2.5	856	**1,985**	**blue**	8	Plastic	Grid	4/2/1999	10:40	
344	2115 South Village Lane		Steamer	38	32	26	0.90	2.5	856	**1,594**	**blue**	8	Plastic	Grid	4/2/1999	10:40	does not drain 4/2/99
345	475 North Water Avenue	414 East Freeman Street	Iowa	65	62	22	0.90	2.5	787	**3,397**	**blue**	8	Cast Iron	Grid	5/10/1999	10:25	leaks 5/10/99
346	701 North Water Avenue	475 East Division Street	Iowa	56	18	16	0.90	2.5	671	**652**	**orange**	8	Cast Iron	Grid	3/29/1999	11:10	
347	823 North Water Avenue	432 East Summit Street	Iowa	53	39	8	0.90	2.5	475	**754**	**orange**	4	Cast Iron	Grid	5/7/1999	14:10	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
348	400 North West Avenue	831 West Locust Street	Steamer	62	54	48	0.90	2.5	1,163	**2,846**	**blue**	12	Ductile Iron	Grid	3/30/1999	10:25	
349	424 North West Avenue	819 West Pine Street	Iowa	57	55	22	0.90	2.5	787	**3,804**	**blue**	8	Plastic	Grid	5/5/1999	13:45	
350	101 North Williams Avenue	1103 West Fairplay Street	Iowa	56	48	22	0.90	2.5	787	**1,773**	**blue**	4	Cast Iron	Grid	5/3/1999	16:10	
351	200 North Williams Avenue	1025 West Chestnut Street	Iowa	54	39	24	0.90	2.5	822	**1,279**	**green**	4	Cast Iron	Grid	5/3/1999	15:45	does not drain 5/3/99
352	311 North Williams Avenue	1100 West Locust Street	Iowa	56	34	30	0.90	2.5	919	**1,199**	**green**	8	Cast Iron	Grid	3/30/1999	10:10	
353	421 North Williams Avenue		drain	56	18	10	0.90	2.5	531	**515**	**orange**	8	Cast Iron	Dead End	5/5/1999	9:40	
354	419 North Williams Place		Iowa	55	14	12	0.98	1.5	228	**209**	**red**	8	Cast Iron	Dead End	5/5/1999	9:00	
355	565 North Williams Place	1200 West Freeman Street	Steamer	57	15	4	0.90	2.5	336	**313**	**red**	2	Plastic	Dead End	5/5/1999	9:20	
356	101 North Wilson Avenue	343 East Broadway Street	Steamer	62	54	48	0.90	2.5	1,163	**2,846**	**blue**	8	Ductile Iron	Grid	3/22/1999	13:05	
357	202 North Wilson Avenue	401 East Chestnut Street	Iowa	64	56	50	0.90	2.5	1,186	**2,979**	**blue**	6	Ductile Iron	Grid	5/10/1999	10:00	
358	275 North Wilson Avenue	340 East Olive Street	Iowa	65	60	36	0.90	2.5	1,007	**3,298**	**blue**	6	Ductile Iron	Grid	5/10/1999	9:30	
359	401 North Wilson Avenue	333 East Locust Street	Iowa	68	56	54	0.90	2.5	1,233	**2,607**	**blue**	8	Cast Iron	Grid	3/30/1999	15:00	
360	421 North Wilson Avenue	320 East Freeman Street	Steamer	66	62	32	0.90	2.5	949	**3,549**	**blue**	6	Asbestos	Grid	5/10/1999	10:40	
361	221 North Winfred Avenue	1329 East Chestnut Street	Steamer	80	58	56	0.90	2.5	1,256	**2,159**	**blue**	8	Plastic	Grid	5/18/1999	9:25	
362		575 East Aldrich Road	Steamer	58	42	40	0.90	2.5	1,061	**1,693**	**blue**	12	Cast Iron	Grid	3/24/1999	12:00	
363		729 East Aldrich Road	Steamer	60	44	42	0.90	2.5	1,087	**1,784**	**blue**	12	Cast Iron	Grid	3/24/1999	11:40	
364		1380 East Aldrich Road	Steamer	46	30	28	0.90	2.5	888	**1,154**	**green**	8	Plastic	Dead End	3/24/1999	11:25	
365		2420 West Aldrich Road	Steamer	32	20	18	0.90	2.5	712	**832**	**orange**	6	Plastic	Grid	4/2/1999	11:45	
366		2450 West Aldrich Road	Steamer	32	26	18	0.90	2.5	712	**1,209**	**green**	12	Plastic	Grid	3/25/1999	10:25	
367		2601 West Aldrich Road	Steamer	34	24	20	0.90	2.5	750	**999**	**green**	12	Plastic	Grid	3/25/1999	10:55	
368		2701 West Aldrich Road	Steamer	34	28	22	0.90	2.5	787	**1,182**	**green**	12	Plastic	Dead End	3/25/1999	11:10	
369		700 East Anderson Drive	Steamer	54	20	14	0.90	2.5	628	**628**	**orange**	?	?	?	4/5/1999	15:50	
370		220 West Anderson Drive	Iowa	48	42	38	0.90	2.5	1,034	**2,376**	**blue**	8	Galvanized	Grid	4/5/1999	15:25	
371		2110 West Ankrom Place	Iowa	43	22	24	0.90	2.5	822	**863**	**orange**	6	Plastic	Dead End	4/20/1999	14:30	
372		214 West Auburn Street	Steamer	62	50	48	0.90	2.5	1,163	**2,287**	**blue**	6	Plastic	Grid	4/26/1999	14:25	
373		2215 West Auburn Street	Steamer	38	35	22	0.90	2.5	787	**2,132**	**blue**	8	Plastic	Grid	4/20/1999	11:15	
374		2251 West Auburn Street	Steamer	37	30	22	0.90	2.5	787	**1,330**	**green**	6	Plastic	Grid	4/20/1999	11:15	
375		2216 West Austin Drive	Steamer	42	38	28	0.90	2.5	888	**2,229**	**blue**	8	Plastic	Grid	4/20/1999	14:15	
376		2305 West Austin Drive	Steamer	39	34	26	0.90	2.5	856	**1,784**	**blue**	8	Plastic	Grid	4/20/1999	14:10	
377		400 West Bradford Street	Steamer	52	43	38	0.90	2.5	1,034	**2,052**	**blue**	8	Plastic	Dead End	4/1/1999	10:35	
378		903 East Broadway Street	Steamer	82	52	48	0.90	2.5	1,163	**1,720**	**blue**	8	Ductile Iron	Grid	3/22/1999	14:25	
379		1111 East Broadway Street	Steamer	80	56	52	0.90	2.5	1,210	**1,985**	**blue**	8	Ductile Iron	Grid	3/23/1999	10:10	does not drain 3/23/99
380		1450 East Broadway Street	Steamer	85	64	64	0.90	2.5	1,342	**2,471**	**blue**	12	Cast Iron	Dead End	5/18/1999	14:10	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
381		1550 East Broadway Street	Steamer	85	66	64	0.90	2.5	1,342	2,608	blue	12	Cast Iron	Dead End	5/18/1999	14:20	
382		1750 East Broadway Street	Steamer	91	65	64	0.90	2.5	1,342	2,309	blue	12	Cast Iron	Dead End	5/18/1999	14:35	
383		1425 West Broadway Street	Steamer	46	38	34	0.90	2.5	978	1,849	blue	8	Plastic	Grid	3/24/1999	10:15	
		1680 West Broadway Street	Steamer	51	45	40	0.90	2.5	1,061	2,576	blue	?	?	?	9/15/2000	17:45	
384		1801 West Broadway Street	Steamer	42	26	24	0.90	2.5	822	976	orange	8	Plastic	Dead End	3/24/1999	10:50	
385		1901 West Broadway Street	Steamer	44	36	34	0.90	2.5	978	1,771	blue	8	Plastic	Grid	3/23/1999	14:50	
386		1903 West Broadway Street	Steamer	44	36	36	0.90	2.5	1,007	1,822	blue	8	Plastic	Grid	3/23/1999	15:10	
387		2004 West Broadway Street	Steamer	44	38	36	0.90	2.5	1,007	2,128	blue	8	Ductile Iron	Dead End	3/23/1999	14:35	
388		1407 West Cambridge Street	Steamer	52	40	30	0.90	2.5	919	1,561	blue	6	Plastic	Grid	4/1/1999	10:00	
389		2211 West Cambridge Street	Steamer	41	32	30	0.90	2.5	919	1,452	green	6	Plastic	Grid	9/15/2000	18:37	no manhole cover across street 9/15/00
390		2421 West Cambridge Street	Steamer	44	39	22	0.90	2.5	787	1,836	blue	6	Plastic	Grid	4/5/1999	11:05	
391		813 East Colgate Street	Steamer	62	60	28	0.90	2.5	888	4,596	blue	6	Plastic	Grid	4/8/1999	13:45	
392		951 East Colgate Street	Steamer	74	56	52	0.90	2.5	1,210	2,190	blue	6	Plastic	Grid	4/8/1999	14:05	
393		2216 West Colgate Street	Steamer	38	34	18	0.90	2.5	712	1,651	blue	8	Plastic	Dead End	4/20/1999	9:30	does not close, does not drain 4/20/99
394		2252 West Colgate Street	Steamer	36	30	18	0.90	2.5	712	1,288	green	6	Plastic	Dead End	4/20/1999	9:35	flow only onto street, not to the west as to not wash away garden 4/8/99
395		2216 West College Drive	Steamer	39	35	26	0.90	2.5	856	2,013	blue	8	Plastic	Grid	4/20/1999	13:30	valve turned off, corrected 4/20/99
396		2316 West College Drive	Steamer	38	32	26	0.90	2.5	856	1,594	blue	6	Plastic	Grid	4/20/1999	13:45	
397		214 West College Street	Steamer	62	59	48	0.90	2.5	1,163	4,834	blue	6	Plastic	Grid	4/26/1999	14:20	leasks, leaks oil, inaccessible 4/26/99
398		931 West College Street	Steamer	58	47	44	0.90	2.5	1,113	2,174	blue	8	Plastic	Grid	4/19/1999	15:15	
399		822 East Division Street	Steamer	62	42	36	0.90	2.5	1,007	1,503	blue	6	Ductile Iron	Grid	3/29/1999	11:25	
400		917 East Division Street	Iowa	64	55	12	0.90	2.5	581	1,369	green	6	Cast Iron	Grid	5/10/1999	14:50	
401		1751 East Division Street	Steamer	78	42	40	0.90	2.5	1,061	1,373	green	8	Ductile Iron	Dead End	3/29/1999	15:50	
402		2051 East Division Street	Steamer	90	37	40	0.90	2.5	1,061	1,233	green	8	Ductile Iron	Dead End	5/5/1999	11:25	
403		941 East Drake Street	Steamer	74	52	55	0.90	2.5	1,244	2,021	blue	6	Plastic	Grid	4/8/1999	11:00	
404		251 West Drake Street	Iowa	56	46	42	0.90	2.5	1,087	2,172	blue	8	Cast Iron	Grid	4/5/1999	16:45	needs grease, inaccessible 4/5/99
405		651 West Drake Street	Steamer	0	0	0	0.90	2.5	0	0	black	6	Plastic	Dead End	4/21/1999	15:35	
406		2206 West Drake Street	Steamer	38	33	20	0.90	2.5	750	1,543	blue	8	Plastic	Dead End	4/20/1999	9:50	
407		2252 West Drake Street	Iowa	36	28	20	0.90	2.5	750	1,163	green	6	Plastic	Dead End	4/20/1999	9:55	
408		2216 West Erskine Street	Steamer	39	35	24	0.90	2.5	822	1,934	blue	8	Plastic	Dead End	4/20/1999	10:10	
409		2252 West Erskine Street	Steamer	39	29	24	0.90	2.5	822	1,179	green	6	Plastic	Dead End	4/20/1999	10:10	

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR-20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
410		220 West Estep Drive	Steamer	48	38	32	0.90	2.5	949	1,655	blue	8	Cast Iron	Grid	4/5/1999	15:15	leaks 4/5/99
411		905 West Fairplay Street	Iowa	63	12	10	0.90	2.5	531	484	red	4	Cast Iron	Dead End	5/5/1999	9:55	needs grease, inaccessible, leaks 5/5/99
412		569 West Forest Street	Steamer	61	57	54	0.90	2.5	1,233	4,333	blue	12	Ductile Iron	Dead End	5/6/1999	16:05	does not drain 5/6/99
413		1207 West Freeman Street	Steamer	56	14	10	0.90	2.5	531	488	red	6	Ductile Iron	Dead End	5/5/1999	9:40	
414		2211 West Heritage Street	Steamer	42	27	24	0.90	2.5	822	1,011	green	6	Plastic	Grid	4/5/1999	10:50	
415		2411 West Heritage Street	Steamer	44	32	22	0.90	2.5	787	1,144	green	6	Plastic	Grid	4/5/1999	11:05	
416		2519 West Heritage Street	Steamer	46	33	20	0.90	2.5	750	1,091	green	6	Plastic	Grid	4/5/1999	10:25	
417		621 West Jackson Street	Iowa	61	50	24	0.90	2.5	822	1,673	blue	4	Cast Iron	Grid	4/21/1999	10:10	
418		823 West Jackson Street	Iowa	59	47	14	0.90	2.5	628	1,186	green	4	Cast Iron	Grid	4/21/1999	10:00	leaks, does not drain 4/21/99
419		1500 East Laird Street	Steamer	74	20	14	0.90	2.5	628	628	orange	6	Plastic	Dead End	3/26/1999	17:20	W of High School, Vo-Ag Wing
420		1100 West Laird Street	Steamer	72	64	60	0.90	2.5	1,300	3,571	blue	8	Plastic	Dead End	5/6/1999	14:25	does not drain 5/6/99
421		1150 West Laird Street	Steamer	69	60	60	0.90	2.5	1,300	3,245	blue	8	Plastic	Dead End	5/6/1999	14:40	
422		1200 West Laird Street	Steamer	76	57	60	0.90	2.5	1,300	2,330	blue	8	Plastic	Dead End	5/6/1999	14:50	
423		1575 West Lakewood Drive	Steamer	47	43	30	0.90	2.5	919	2,577	blue	6	Plastic	Grid	4/9/1999	16:25	difficult to operate 4/9/99
424		1821 East Laverne Street	Steamer	84	48	42	0.90	2.5	1,087	1,484	green	8	Cast Iron	Dead End	5/18/1999	10:05	
425		1891 East Laverne Street	Steamer	86	52	42	0.90	2.5	1,087	1,556	blue	8	Cast Iron	Dead End	5/18/1999	10:00	
426		905 East Lindon Street	Steamer	63	34	12	0.90	2.5	581	719	orange	6	Plastic	Dead End	5/10/1999	14:55	
427		904 East Locust Street	Steamer	70	46	44	0.90	2.5	1,113	1,654	blue	6	Cast Iron	Grid	3/30/1999	15:45	
428		1210 West Locust Street	Steamer	52	38	36	0.90	2.5	1,007	1,573	blue	8	Cast Iron	Grid	3/30/1999	9:55	
429		1312 West Locust Street	Iowa	50	36	34	0.90	2.5	978	1,477	green	8	Cast Iron	Grid	3/30/1999	9:25	
430		827 East Maupin Street	Steamer	64	37	28	0.90	2.5	888	1,156	green	6	Cast Iron	Dead End	4/30/1999	14:30	
431		123 West Maupin Street	Iowa	62	58	32	0.90	2.5	949	3,379	blue	4	Cast Iron	Grid	4/26/1999	11:35	
432		1310 West Maupin Street	Iowa	51	47	42	0.90	2.5	1,087	3,286	blue	8	Asbestos	Grid	4/20/1999	15:20	
433		2150 East Meadow Drive	Steamer	94	35	23	0.90	2.5	805	909	orange	6	Plastic	Grid	5/18/1999	11:20	
434		1420 East Mount Giliad Road	Steamer	42	34	36	0.90	2.5	1,007	1,738	blue	12	Ductile Iron	Grid	3/31/1999	11:40	
435		1551 East Mount Giliad Road	Steamer	46	38	34	0.90	2.5	978	1,849	blue	12	Ductile Iron	Dead End	3/31/1999	13:20	
436		1209 West Northwood Circle	Steamer	51	42	32	0.90	2.5	949	1,851	blue	6	Plastic	Dead End	4/19/1999	14:40	
437		1130 West Northwood Street	Steamer	53	49	32	0.90	2.5	949	2,966	blue	8	Plastic	Grid	4/19/1999	14:35	needs stem nut bearing cover 4/19/99
438		1320 West Northwood Street	Steamer	48	47	44	0.90	2.5	1,113	6,729	blue	8	Plastic	Grid	4/19/1999	14:25	
439		1513 West Northwood Street	Steamer	44	38	36	0.90	2.5	1,007	2,128	blue	8	Plastic	Grid	4/19/1999	14:10	needs new caps, leaks oil 4/19/99
440		901 West Oak Terrace	Steamer	70	58	52	0.90	2.5	1,210	2,615	blue	8	Galvanized	Dead End	3/29/1999	13:45	
441		454 East Parkview Street	Steamer	63	10	12	0.90	2.5	581	519	orange	8	Plastic	Grid	5/7/1999	15:00	

Sorted by North/South Address

ID	North/South Address	East/West Address	Hydrant Type	Static Pressure (psi)	Residual Pressure (psi)	Velocity Pressure (psi)	Coefficient of Discharge	Orifice Diameter (in)	Actual Flow (gpm)Q =(29.83)(Cd)(D^2)(P^1/2)	Rated Flow (gpm) Q2=Q1((PR 20)^0.54/(PR-PS)^0.54)	Color >1500gpm, 1000-1499gpm, 500-999gpm, 1-500gpm, 0gpm	Main Size (in)	Main Type	Main Connection	Date	Time	Notes
				Underlined text indicates a less accurate method was used.													
442		1601 East Parkview Street	Steamer	72	20	16	0.90	2.5	671	671	orange	6	Plastic	Dead End	3/26/1999	17:30	High School Parking Lot
443		1601 East Pennell Street	Iowa	74	20	18	0.90	2.5	712	712	orange	6	Asbestos	Dead End	3/26/1999	17:15	High School Sports Complex leaks, needs grease 3/26/99
444		1340 West Pine Street	Steamer	54	30	28	0.90	2.5	888	1,072	green	6	Plastic	Grid	5/3/1999	11:05	
445		1451 West San Martin Street	Steamer	48	36	32	0.90	2.5	949	1,500	blue	8	Plastic	Grid	4/1/1999	9:40	
446		1511 West San Martin Street	Steamer	48	31	32	0.90	2.5	949	1,243	green	6	Plastic	Dead End	4/1/1999	9:40	
447		651 East South Street	Steamer	52	50	40	0.90	2.5	1,061	4,743	blue	8	Plastic	Grid	4/8/1999	10:30	
448		728 East South Street	Iowa	58	52	32	0.80	2.5	844	2,286	blue	4	Cast Iron	Grid	4/8/1999	14:25	
449		2213 West South Street	Steamer	38	35	12	0.90	2.5	581	1,575	blue	8	Plastic	Dead End	4/20/1999	9:10	
450		2251 West South Street	Steamer	36	32	12	0.90	2.5	581	1,309	green	6	Plastic	Dead End	4/20/1999	9:10	inaccessible 4/20/99
451		2360 West South Street	Steamer	0	0	0	0.70	2.5	0	0	black	6	Plastic	Dead End	4/20/1999	9:00	yard ornament 4/20/99
452		405 East Summit Street	Steamer	54	49	18	0.90	2.5	712	2,004	blue	8	Plastic	Grid	5/7/1999	13:55	
453		1885 East Thornridge Drive	Steamer	74	36	35	0.90	2.5	993	1,200	green	6	Plastic	Grid	5/18/1999	10:40	
454		2150 East Thornridge Drive	Steamer	94	25	23	0.90	2.5	805	836	orange	6	Plastic	Grid	5/18/1999	11:05	
455		875 East Walnut Street	Steamer	66	42	34	0.90	2.5	978	1,390	green	6	Plastic	Dead End	4/30/1999	11:30	needs grease 4/30/99
456		1075 East Walnut Street	Steamer	65	40	32	0.90	2.5	949	1,304	green	6	Plastic	Dead End	4/30/1999	12:00	
457		575 West Walnut Street	Steamer	64	60	48	0.90	2.5	1,163	4,244	blue	8	Asbestos	Grid	4/21/1999	11:00	
458		1408 West Wells Street	Steamer	50	38	30	0.90	2.5	919	1,507	blue	6	Plastic	Grid	4/1/1999	10:15	
459		251 East White Oak Place	Steamer	72	44	40	0.60	1.5	255	356	red	6	Plastic	Dead End	3/29/1999	15:00	
460		280 East Wildwood Place	Steamer	63	17	7	0.90	2.5	444	428	red	8	Plastic	Grid	5/7/1999	15:40	
461		1270 East Wollard Street	Steamer	44	34	32	0.90	2.5	949	1,523	blue	8	Plastic	Dead End	3/31/1999	14:15	
462		1320 East Wollard Street	Steamer	46	34	30	0.90	2.5	919	1,395	green	8	Plastic	Dead End	3/31/1999	14:30	
463		1600 East Wollard Street	Steamer	46	24	32	0.90	2.5	949	1,039	green	6	Plastic	Dead End	3/31/1999	13:50	
464		1122 West Woodland Circle	Iowa	44	27	18	0.90	2.5	712	858	orange	4	Plastic	Dead End	4/9/1999	15:15	