BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Stockton Hills Water Company for an Increase in Annual Water System Operating Revenues	)))	**Case No. WR-2010-0202**

STAFF'S STATUS REPORT AND DNR SANITARY SURVEY

COMES NOW the Staff of the Missouri Public Service Commission (Staff), by and through counsel, and for its Status Report and DNR Sanitary Survey, pursuant to 4 CSR 240-3.050(19), states the following:

1. On July 12, 2010, the Office of the Public Counsel (OPC) filed its Request for Local Public Hearing.

2. On July 15, 2010, the Missouri Public Service Commission (Commission) issued an Order Setting Local Public Hearing for August 10, 2010 in Stockton, Missouri.

3. Commission Rule 4 CSR 240-3.050 (19) states, "[i]f a local public hearing is held, the staff shall file a pleading no later than five (5) working days after the hearing indicating whether any material information not previously available was provided at the local public hearing and stating whether than information might result in changes to the utility/staff disposition agreement . . ."

4. No material information was obtained at the local public hearing on August 10, 2010, that was not previously available that might result in changes to the utility/staff disposition agreement.

5. At the local public hearing, several customers of Stockton Hills discussed a Sanitary Survey that was sent to the Company by the Department of Natural Resources (DNR). The Sanitary Survey contains various recommendations from DNR. Past discussions between

the Company, DNR, Staff, and the Company's customers have taken place regarding implementation and feasibility of recommendations contained in the survey. Therefore, the discussion at the local public hearing did not provide any information that changes the utility/staff disposition agreement.

6. At the local public hearing, Commissioner Davis requested that a copy of the DNR Sanitary Survey be filed in EFIS. The Sanitary Survey is attached as Appendix A.

WHEREFORE, the Staff respectfully submits this Status Report for the Commission's information. The Staff also respectfully submits the DNR Sanitary Survey as Appendix A, as requested by Commissioner Davis at the local public hearing.

Respectfully submitted,

/s/ Samuel D. Ritchie

Sam Ritchie
Legal Counsel
Missouri Bar No. 61167

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of this Agreement Notice and the attached Appendix A has been provided, either by first-class mail, by electronic mail, by facsimile transmission or by hand-delivery, to each attorney and/or party of record for this case on this 17th day of August, 2010.

/s/ Samuel D. Ritchie

STATE OF MISSOURI

Jeremiah W. (Jay) Nixon, Governor • Mark N. Templeton, Director

DEPARTMENT OF NATURAL RESOURCES

www.dnr.mo.gov

October 28, 2009

RECEIVED

NOV 03 2009

UTILITY OPERATIONS DIVISION

Ms. Wanda Cassell, Owner
Stockton Hills Water Company
P. O. Box 276
Stockton, MO 65785

Dear Ms. Cassell:

Enclosed is a report of sanitary survey for Stockton Hills Water Company public water supply MO5036164 in Greene County, Missouri.

The public water supply system entered into a *Bilateral Compliance Agreement* on September 13, 2005, to address eight microbiological maximum contaminant level violations during 2004 and 2005. The compliance period was extended on March 23, 2006, to allow the system additional time to comply with the provisions of the agreement. Stockton Hills Water Company failed to add emergency chlorination and submit an engineering report examining the causes for and proposing corrections to the contamination issues. As a result, two additional microbiological contaminant violations occurred during April 2006 and May 2007. Notice of Violation 12262SW was issued on September 28, 2007, outlining violations of Missouri Safe Drinking Water Regulations and National Primary Drinking Water Regulations; thereby, terminating the *Bilateral Compliance Agreement* as incomplete. A Negotiated Settlement Agreement was entered July 21, 2008.

The Negotiated Settlement Agreement included the following provisions to be met for the system to become compliant:

A. Submit all samples (including microbiological samples) as required by the Missouri Safe Drinking Water Regulations, 10 CSR 60. – **Met requirement.**

B. If any samples analyzed are found to be unsafe (total coliform positive or fecal coliform positive or both), the system shall submit four (4) repeat samples for each unsafe sample with twenty-four hours of being notified of the unsafe sample by MDNR. During the next month following the month in which the exceedences occurred, the public water system further agrees that it shall submit five (5) routine samples for each sample exceeding the microbiological MCL in the previous month. – **MCL violations occurred** during September and December 2008, and January 2009. In addition, a Public Notice Violation occurred for failure to complete public notice rules in conjunction with the January 2009 MCL violation. **All repeat samples were taken as required.**

C. Monthly microbiological compliance testing samples shall only be collected from the distribution system and not from any source water wells unless specifically instructed to do so by MDNR staff. – **Met requirement.**

D. Within thirty (30) days of execution of this settlement agreement, the system agrees to submit a letter informing MDNR that it has retained the services of a Missouri registered professional engineer for the purpose of preparing a report of needed system improvements. This letter shall be addressed to Mr. Frank McDaniels, Public Drinking Water Branch, P. O. Box 176, Jefferson City, Missouri 65102. – **Met requirement.** Copy of contract agreement with Crowley, Wade, Milstead, Inc. was received August 5, 2008, by the Public Drinking Water Branch.

E. Within ninety (90) days of retaining the engineering in D. above, the system shall submit two (2) copies of an engineering report of needed improvements. The report shall be sent to the Permits and Engineering Section of the Public Drinking Water Branch for review and approval, and shall examine the need for installation of full-time disinfection, the prospective need for additional storage capacity, and any other system needs that would insure the system's ability to comply with regulatory requirements in the future. The report shall also provide a recommended prioritization of those potential needs identified with the highest priority being given to issues related to water quality. – **Requirement has not been met.** The engineering report has not been submitted to the Permits and Engineering Section of the Public Drinking Water Branch. A copy of an engineering report sealed December 2, 2008, by Mr. Joseph K. Zelk, P.E., was given to Ms. Yvonne M. Franklin, E.I.T., from the Southwest Regional Office during the sanitary survey inspection.

F. Upon review and approval of the engineering report above by the Permits and Engineering Section, staff of the Public Drinking Water Enforcement Unit shall meet with the owner of the system and shall negotiate further schedule of compliance activities based on information contained within the engineering report. This negotiated schedule shall be incorporated into this agreement as an addendum. – **Requirement has not been met.**

G. During the period covered by this agreement, should further microbiological MCLs incur, the system shall install temporary emergency chlorination to include chemical metering pump, hypochlorite solution tank, chemical injection point into the well pump discharge line, and a chlorine residual chlorine levels both at the entry point into the distribution system and within the distribution system. The engineer preparing the system improvements report in E. above should prepare and forward a proposed report, plans, and specifications for installation of emergency disinfection separate from the basic needs report for pre-approval in the event that the system must quickly implement addition of emergency disinfection. However, no construction may be undertaken without first obtaining approval from MDNR. – **Requirement has not been met.**

H. Should it become necessary to begin emergency chlorination, the system shall maintain a FREE chlorine residual of not less than 0.2 milligrams/liter (mg/L) at the entry point to the distribution system and shall maintain a TOTAL chlorine residual within the distribution system of not less than 0.5 mg/L. "Hand chlorination" of the well shall not be deemed acceptable long-term treatment in response to future MCL exceedences.

I. The system agrees that, should it fail to comply with regulatory requirements contained in the Public Drinking Water Regulations contained in 10 CSR 60, it will comply with all requirements for public notifications as required by 10 CSR 60-8 and/or as directed by MDNR Public Drinking Water staff, either in the Jefferson City or the Springfield Office. – Public notice requirement was met January 2, 2009, for the September 2008 MCL violation and April 8, 2009, for the December 2008 MCL violation. **Public notice requirements have not been met** for the January 2009 MCL violation.

J. During the period covered by this agreement, the system shall operate in such a manner as to prevent future violations of the Missouri Safe Drinking Water Law and associated regulations found at 10 CSR 60.

Items noted below and in the recommendations of the sanitary survey as MANDATORY are already included in the Negotiated Settlement Agreement. Our standard method of determining which items are mandatory for compliance purposes is explained in the Sanitary Survey Principles enclosed with the report.

A brief summary of the recommendations that need to be considered at this time is noted below. The report provides additional details as well as long term recommendations. Note that all sizes, capacities, locations, and elevations listed are preliminary and complete engineering by your consulting engineer must be done and a permit obtained from the Department's Public Drinking Water Branch before any construction can be done.

Immediate Capital Needs

- Construct liquid hypochlorite injection equipment and reconstruct lines at the existing well and stand pipe located at Well 1 on County Road 1674 so that chlorinated well water flows into and out of the standpipe through separate inlet and outlet lines, thus providing 30 minutes or more of chlorinated water detention. MANDATORY.

- Construct a new well with a nominal diameter of eight inches, a nominal well yield of 155.5 gpm, and a well pump with a nominal capacity of 233 gpm.

Immediate Operational & Maintenance Practices Needs

- Develop and implement standard operating and maintenance procedures. Our Standard Operating and Maintenance Procedures For Public Water Supplies Served By Wells With Populations 25-500 and our Standard Operating Procedures to Control Bacteriological Contamination For Chlorinated Public Water Supplies (or our Standard Operating Procedures to Control Bacteriological Contamination For Public Water Supplies Served by Wells That Are Not Disinfected) may be used as models for developing these procedures. Although the language may be modified to meet local conditions, the ideas listed in the first four (4) items of our O & M procedure and the ideas listed in our bacteriological control procedure are MANDATORY.

Immediate Managerial Practices Needs

- Develop and implement standard managerial procedures. Our Standard Managerial Procedures for Public Water Supplies may be used as a model.

Immediate Financial Practices Needs

- Develop and implement standard financial procedures. Our Standard Financial Procedures for Public Water Supplies may be used as a model.

If you have any questions, please contact Mr. Jim Macy, Public Drinking Water Branch, P. O. Box 176, Jefferson City, Missouri, 65102, or by calling 573-751-5331.

Sincerely,

SOUTHWEST REGIONAL OFFICE

Mark Rader, Chief
Water, Air and Land Section

MR/yfb

c: Mr. Jim Patton, Missouri Rural Water Association
Public Drinking Water Branch
Public Service Commission

MISSOURI DEPARTMENT OF NATURAL RESOURCES
SOUTHWEST REGIONAL OFFICE
REPORT OF SANITARY SURVEY
COMMUNITY PUBLIC WATER SUPPLY
STOCKTON HILLS WATER COMPANY
CEDAR COUNTY, MISSOURI
PWS ID No. MO5036164

October 28, 2009

INTRODUCTION

A sanitary survey of Stockton Hills Water Company public water supply was made on September 8, 2009, by Ms. Yvonne M. Franklin, E.I.T. of the Missouri Department of Natural Resources. This sanitary survey was an on-site engineering inspection and review of the public water supply including its supply sources, treatment facilities, and distribution system for the purpose of evaluating their adequacy, reliability, and safety for producing and distributing drinking water. Engineering calculations made as part of this sanitary survey are enclosed.

This report is divided into eight sections including a summary on the transmittal letter, the introduction, a general overview of the public water supply, capital facilities, operation and maintenance practices, managerial practices, financial issues, and recommendations. Regulatory violations (if any) are listed in the general overview and discussed in the appropriate sections. Many of our recommendations and procedures have been standardized and these are outlined in the following documents, available upon request.

Sanitary Survey Principles
Standard Operating and Maintenance Procedures For Public Water Supplies With Populations 25-500
Standard Operating Procedures to Control Bacteriological Contamination For Public Water Supplies Served by Wells that Are Not Disinfected
Procedure for Calculating Saturation Index
Evaluation of Well, Well Pump, Aquifer Capacity, for Consolidated Formations
Procedure for Sizing and Evaluating Wells and Well Pumps
Procedure for Well Spacing
Procedure for Sizing and Evaluating Pressure Tanks and Bladder Tanks
Standard Managerial Procedures for Public Water Supplies
Standard Financial Procedures for Public Water Supplies
Procedure for Population Projections

GENERAL OVERVIEW

(1) Current information and projections estimated for 20 years and 50 years into the future are shown:

Time	Current	20 years	50 years
Population	355	724	724
Total Active Service Connections	147	300	300
Average Day Usage (gpd)	19625	40051	40051
Maximum Day Usage (gpd)	29438	60077	60077
Estimated Hourly Peak Flow (gpm)	N/A	N/A	N/A
Estimated Instantaneous Peak Flow (gpm)	341	675	675
Recommended Commercial Fire Flow (gpm for hours)	N/A	N/A	N/A
Recommended Residential Fire Flow (gpm for hours)	N/A	250	250

(2) Geographic Area & Elevations

The current boundaries of the public water supply were used for planning. The current boundaries have an elevation range of 1063 feet mean sea level (msl) to 910 feet msl. The distribution system operates as a single pressure plane, which is appropriate. The current boundaries are shown on the enclosed map.

(3) Regulatory Violations

Public water regulatory violations that have occurred in the past 12 months are noted below.

(A) Category I - Violations of Missouri Safe Drinking Water Regulations
These violations can result in enforcement action if repeated or not corrected. Some violations are more serious than others, and this is explained in the comments.

1. The public water system failed to meet microbiological maximum contamination levels outlined in Safe Drinking Water Regulation 10 CSR 60-4.020 during September 2008, December 2008 and January 2009.

2. The public water system failed to certify to the Department that public notification had been made as required by Safe Drinking Water Regulation 10 CSR 60-7.010(9). This proof of public notification is for the violations that occurred during January 2009.

3. The public water system failed to have a contingency plan for a standby replacement chief operator to be available at all times in violation of Safe Drinking Water Regulation 10 CSR 60-14.010(4)(A)6.

(B) Category II - Construction Deficiencies from the January 1988 Missouri Department of Natural Resources *Design Guide for Community Public Water Supplies* Hereinafter Referred to as "Design Guide"

These deficiencies are important, and the public water system should give serious consideration to correction. However, these deficiencies are not normally subject to enforcement action unless the Department determines that these are contributing to the failure of the public water system to provide an adequate volume of safe water to customers at sufficient pressure. If this determination is made, the Department may declare the public water system inadequate or of defective design under Safe Drinking Water Regulation 10 CSR 60-4.080(5) and begin enforcement action for correction. If this determination was made during this inspection, the particular unsatisfactory feature is noted with "Violation of 10 CSR 60-4.080(5)."

4. Well capacity is inadequate compared to the Design Guide, Part 3.2.1.1.

5. The well casing and discharge piping were not protected against physical damage as required by the Design Guide, Part 3.2.7.3.a.7. (Use casing or piping, whichever is appropriate.)

6. The well is not equipped with a casing vent of adequate size to provide rapid venting of the casing(s) as required by the Design Guide, Part 3.2.7.5.

7. The top of the casing on the well was not effectively sealed against the entrance of water under all conditions as required by the Design Guide, Part 3.2.7.2.a.

8. The public water system is not making full use of the storage tank capacity during automatic fill cycles. Specifically, the water system has the ON/OFF pressure gages of the well corresponding to the water levels at 60 feet (ON) and 65 feet (OFF). Therefore, the system is only utilizing an estimated 2,937 gallons out of 15,192 gallons of nominal standpipe capacity.

9. Storage capacity is insufficient compared to the Design Guide, Part 7.1.2.a.

10. The public water system does not have an adequate well water level monitoring program.

11. The exterior of the standpipe needs cleaning and an inspection of the paint to determine if it needs repainting as required by the Design Guide, Part 7.0.16.

(C) Category III - Operational and Management Deficiencies

These deficiencies are important, and the public water system should give serious consideration to correction. However, these deficiencies are not normally subject to

enforcement action unless the Department determines that these are contributing to the failure of the public water system to provide an adequate volume of safe water at sufficient pressure. If this determination is made, the Department may declare the public water system incompetently supervised and improperly operated under Safe Drinking Water Regulation 10 CSR 60-4.080(5) and begin enforcement action for correction. If this determination was made during this inspection, the particular unsatisfactory feature is noted with "Violation of 10 CSR 60-4.080(5)."

12. The public water system does not have security fencing around the storage tank. Specifically, the tower legs are accessible and should be secured with a chain link fence and a lockable gate.

13. The public water system records show a water loss greater than 10%.

14. The public water system does not have sufficient funds for operation and maintenance of existing facilities.

15. The public water system does not have adequate funds for future improvements.

16. The public water system does not have an adequate tank inspection program for sanitary risks.

17. The public water system does not have an adequate tank interior inspection and cleaning program.

18. The public water system does not have a Department approved wellhead protection program.

19. The well house at well 1 is inadequate. The drain located within the well house was missing its screen. In addition, the drain piping had become clogged; allowing water to remain standing in the pipe at the time of the inspection.

20. The public water system does not have adequate emergency electrical power as required by the Design Guide, Part 3.2.1.3. and 6.5.6.

(D) Comments

1. The Missouri Department of Natural Resources sets drinking water standards and has determined that the presence of total coliform is a possible health concern. Total coliforms are common in the environment and are generally not harmful themselves. The presence of these bacteria in drinking water, however, generally is a result of a problem with water treatment or the pipes which distribute the water and indicates that the water may be contaminated with organisms that can cause

disease. Disease symptoms may include diarrhea, cramps, nausea and possibly jaundice, and any associated headaches and fatigue. The symptoms, however, are not just associated with disease-causing organisms in drinking water but also may be caused by a number of factors other than your drinking water. The Missouri Department of Natural Resources has set an enforceable drinking water standard for total coliforms to reduce the risk of these adverse health effects. Under this standard, no more than 5.0% of the samples collected during a month can contain these bacteria except that systems collecting fewer than 40 samples per month that have one total coliform positive sample per month are not violating the standard. Drinking water which meets this standard is usually not associated with a health risk from disease-causing bacteria and should be considered safe.

2. Public water systems are required to submit proof to the Department that public notification has been made within ten days of the date the notice was to have been made. This proof to the Department is provided through certification of compliance with public notification regulations and a representative copy of the public notice. Instructions for public notification and certification to the Department are provided to the public water system after every violation.

3. All community and non-transient, non-community public water systems must have a certified chief operator meeting the minimum classification required for that system. In addition, the system is required to have a contingency plan for a standby replacement chief operator, such as a second employee certified at the chief operator level, a mutual assistance agreement with a neighboring system, or a pre-arrangement with a contract operator. Larger and more complicated systems must have higher classification levels. Our records indicate this contingency plan shall be for a DS-II replacement chief operator. If this requirement is to be met through operator training and examination for certification, please contact the Department's Operator Certification Unit at 1-800-361-4827 for information on training courses and examination dates.

4. The Design Guide requires that the total developed ground water source capacity shall equal or exceed the design maximum day demand and equal or exceed the design average day demand with the largest producing well out of service. Since the system is served by a single well, it does not meet this requirement.

5. The well casing and discharge piping must be protected against deterioration, physical damage, and freezing. Paint protects the metal casing from corrosion. An insulated well house prevents freezing.

6. A well draws air at pump start-up as the water level falls and exhausts air at pump shutdown as the water level rises. A casing vent (1½" diameter or larger) must be provided to allow rapid venting. Condensate being drawn in through imperfections

in the well sanitary seal or around vertical turbine pump bases is a common cause of questionable or unsafe samples. A casing vent along with adequate wellhead sealing helps prevent this problem. The casing vent must be down-turned to prevent any spraying leaks or roof leaks from dripping into the vent, above the top of the casing to prevent flood water from being drawn into the well, and covered with an 18-mesh corrosion resistant screen to prevent insects and debris from being drawn into the well.

7. Condensate water entering unsealed openings in the well is a significant source of unsafe bacteriological samples. The openings for electrical wires and the drawdown tube should be sealed with silicone caulk. The sanitary seal on submersible pumps should be in good condition and properly installed and should not be cut to improve ease of installation. All imperfections around the base of a vertical turbine pump should be caulked with silicone caulk.

8. Once each month, the public water system should read and record the filling pump-start/stop pressures and corresponding elevations, time, and date for each elevated tower, standpipe, and ground level unpressurized storage tank. Calculate and record the volume between filling pump start/stop elevations and the tank bottom (or withdrawal pump low flow shut down on ground tanks with booster pumps). Adjust filling pump start/stop points as needed to maximize the full use of the storage tank capacity.

9. Public water supplies that do not provide fire protection shall have sufficient finished water storage to meet the minimum design operating pressure and flow for the diurnal flow pattern on the design maximum usage day with all well pumps, treatment plants, high service pumps, booster pumps or other equipment that affects pressure and flow in operation. For standpipes, the volume above the elevation, which provides 20 psig at the tower base, shall be counted as nominal capacity. Since the maximum average daily consumption is 29,438 gallons and the current nominal storage capacity is 15,192 gallons, the system is deficient in storage.

10. The public water system should measure the static water level and operating water level each quarter, keep records of these readings, look for long-term trends (particularly water table decline), and use this information to plan for the future which can include lowering well pumps (which may require higher horsepower pumps), drilling existing wells deeper, drilling new wells further apart, or switching to surface water sources with appropriate treatment.

11. Steel tanks without adequate paint coating will quickly deteriorate from corrosion. The tanks must have the exteriors cleaned and painted. If the tank interiors have not been inspected in the past three years, the interiors should be inspected, cleaned, and repainted as necessary. Note that interior paint must be approved by Missouri Department of Natural Resources Public Drinking Water Branch.

12. Safety, security and risk-reduction measures are especially important after the events of September 11, 2001, and should be implemented to reduce the water system's vulnerabilities. All water system facilities should be evaluated and re-designed to include measures to provide protection against vandalism, sabotage, terrorist acts, or access by unauthorized personnel. These protection measures should include: a) locked security doors; b) windows sized or barred to prevent access; and, c) security fencing around vulnerable areas of drinking water facilities (for example, wellheads, manholes, pump houses, treatment buildings and storage tanks).

13. The wells currently pump an average of 19,625 gallons per day or 596,933 gallons per month while the amount of water sold through individual meters averages 14737 gallons per day or 448250 gallons per month. Based upon these figures, the calculated loss of water amounts to an average of 4888 gallons per day or 148683 gallons per month, which equates to an average water loss of 24.9%. The Department recommends that no more than an average of 10% water loss occur. If you multiply the monthly electric bill for the well pump operation by this 24.9% (or 0.249) loss rate, you will see how much city revenue is spent every month to pump the additional water being lost to leaks, and this does not take into account the additional wear and tear on the pump and controls. It is recommended that this situation be brought under control.

14. The public water system should have a water operation/maintenance fund with the following elements: a) An emergency reserve should be maintained to pay for the replacement of the most expensive well pump and other emergencies; b) A fund for long term, high cost maintenance or replacement, such as tower painting, well pump replacement, backhoe replacement, truck replacement, etc., should be established and funds deposited to provide for these activities.

15. The public water system should have a plan for funding future improvements with the following elements: a) Water rates should be sufficient to accumulate funds for improvements needed to serve the current population; b) Future population needs can be funded by connection fees, which reflect a proportional cost of additional wells, towers, and other major capital improvements; c) Bonds, government loans, and grant are other sources for long-term improvements, but the interest on bonds and loans vastly increase project costs over the long run although this is not always avoidable if growth is rapid.

16. The public water system should have a sanitary risk tank inspection program with the following elements: a) Each tank should be inspected annually for sanitary risk and after each fecal coliform positive sample; b) Inspectors should look for unscreened vents; unscreened overflows; any openings left by painting crews; missing rivets in the peaked roof; a poor fit between the peaked roof and bowl wall;

a two-inch frame on the hatch; a poor hatch lid fit; openings in the decorative finial ball; the hatch lid hasp and padlock; an open hatch (wind can blow a very heavy lid open if not secured at the hasp); openings at electrical conduits; observe water for feathers, dead birds, nesting material, dead insects, and dead bats; observe the interior wells for mud dauber nests, bird droppings, insects, daylight shining through openings, and bats; look for evidence of vacuum (caved in areas on the tank walls or roof and bent support rods with crinkled areas where these attach); try to determine the likely cause of vacuum (frost plugging of metal screens, an ice plug in a vent, and evidence of ice extrusion out the hatch); and look for openings at vacuum damage sites.

17. The public water system should have a tank interior inspection and cleaning program with the following elements: a) Each tank interior should be inspected and cleaned every two to five years depending on silt build up; b) the type and general condition of the interior paint should be determined, especially on any paint that appears to be high in lead or chromium; c) glass-coated interiors should be inspected for cracking, corrosion and other signs of coating deterioration (spalding, cracking, leaking, etc.); d) if rusting is present, determine the approximate percent of rusted area, the extent, nature and depth of pitting, and the condition of the remaining coating (chalking, blistering, loose, blotchy, etc.); and, e) concrete structures should be inspected for signs of deterioration (spalding, cracking, leaking, etc.). All work shall be conducted in a clean and sanitary manner, and all surfaces shall be thoroughly cleaned and disinfected before a storage facility is returned to service. It is the responsibility of the public water system to either conduct or require water quality tests to demonstrate the good sanitary condition of the tank interior before it is returned to service. Follow all environmental laws and rules to dispose of chlorinated water, sludge debris, and other wastes.

18. A wellhead protection program is a program that identifies the area of recharge for each well, identifies existing sources of contamination within these recharge areas, protects recharge areas from new sources of contamination through zoning and land acquisition, plans for problems from existing sources of contamination and locates new wells in protected areas. An added benefit of having a Department-approved wellhead protection program is that it increases a water system's ranking when competing for state and federal funding of future water system improvements. For more information on development of a wellhead protection program or the Department's approval process, contact Mr. Ken Tomlin, Missouri Department of Natural Resources-Public Drinking Water Branch, P.O. Box 176, Jefferson City, Missouri, 65102, or by calling 573-751-5331.

19. Each well house should be weather proof, have a locked door/chain link fence, have adequate space for operation/maintenance, have a floor drain, have a heater for winter, and not be used to store chemicals. The well discharge piping (ductile iron) should be kept painted.

20. When power failure would result in cessation of minimum essential service, an alternate power supply should be provided to meet average day demand. Each public water system should have an emergency electrical power source which may include a permanent or portable generator at each well and pump station, a tractor connection at each well or pump station, or service from two power companies.

CAPITAL FACILITIES

(1) Wells and Well Pumps

(A) The public water supply has one existing wells briefly described below:

		Well #1
Location:	County	Cedar
	Latitude	
	Longitude	
	¼, ¼, ¼, Sec., T, R	SE, SW, Section 29, T 34N, R 26W
	Street/Road	County Road 1674
	Elevation ft. m.s.l.	1063 ft. msl.
Well:	Total Depth (feet)	525 feet
	Casing Depth (feet)	305 feet
	Pressure Grout (yes/no)	yes
	Nominal Diameter (inches)	6"
Pump:	Type (V Turb. or Subm.)	Submersible
	Manufacturer	Unknown
	Model	Unknown
	Nominal Capacity (gpm at psig)	26 gpm
	Pump Depth (feet)	Unknown
	Drop Pipe Diameter (inches)	Unknown
	Drop Pipe Material	Unknown
	Drop Pipe Schedule	Unknown
Motor:	Nominal HP	Unknown
	Manufacturer	Unknown
	Model	Unknown
	Phase (1 or 3)	Unknown
Appurtenances:		
	Screened Casing Vent (yes, no)	yes
	Draw Down Tube/Gage (yes, no)	yes
	Check Valve (yes, no)	yes
	Gate Valve (yes, no)	yes
	Master Meter (yes, no)	yes
	Raw Water Tap (yes, no)	yes
	Finished Water Tap (yes, no)	no
	Pressure Gage (yes, no)	no

Appurtenances (continued):

Screened Air Release (yes, no)	N/A
Top of Casing Sealed (yes, no)	no
Top of Casing 12"/18" height (yes, no)	yes
Run-Time Meter (yes, no)	no

Annual Pumpage 13,665,600 gallons per year

(B) Analysis of Existing Wells Capacity

Daily pumpage capacity with all wells pumping continuously = 37,440 gpd
Daily pumpage capacity with largest well out of service and all other wells pumping continuously = 0 gpd
Daily pumpage capacity with all wells pumping 8 hours ON, 16 hours OFF = 12,480 gpd

(C) These daily pumpage capacities were compared to the current 20-year, and 50-year usages, the well construction was reviewed, the well spacing was reviewed, and the following conclusions were drawn:

The existing well does not have adequate capacity to meet current average daily pumpage needs while providing Southwest Regional Office's conservative run/rest cycle of 8 hours ON, 16 hours OFF which allows time for well recharge. Our preliminary analysis shows the new well should have a nominal capacity of 155.5 gallons per minute, a nominal diameter of eight inches, and a well pump with a nominal capacity of 233 gallons per minute.

(2) Disinfection

None of the current public water supply wells have disinfection but a review of the bacteriological record indicates disinfection facilities are needed at this time. The following improvements are based on 30 minutes chlorinated water unadjusted detention time with 0.5 mg/L free chlorine concentration and meeting 4-LOG virus removal with adjusted detention time, 0.5 mg/L free chlorine concentration, pH of six (6) to nine (9), and a well water temperature of 15° C as outlined in the January 1992 MDNR-PDWP Guidance Manual For Surface Water System Treatment Requirements.

(3) Storage

Storage consists of the standpipe listed in the following table:

Tank Identifier	Standpipe
Tank Location	County Road 1674
Pressure Zone Identifier	1
Pressure Zone High Elevation (feet msl)	1063 feet msl
Pressure Zone Low Elevation (feet msl)	910 feet msl
Tank Shape	standpipe
Tank Overflow Elevation (feet msl)	1132 feet msl
Tank Nominal Volume at Overflow (gallon)	40,536 gallons
Tank Usable Storage Volume (gallon)	15,192 gallons
Tank Usable Fire Volume (gallon)	15,192 gallons

(4) Distribution Piping

The existing distribution system consists of approximately 2,450 lineal feet of 5" PVC pipe; 2,950 lineal feet of four-inch (4") and 8,650 lineal feet of three-inch (3") PVC pipe; 7,850 lineal feet of two and a half (2½") PVC pipe; and 9,230 lineal feet of two-inch (2") PVC pipe. The major loop around the system consists of five-inch, four-inch, three-inch, two and a half-inch, and two-inch PVC mains. The water system experienced 24.9% water loss for the period covering July 2008 through June 2009, which exceeds the Southwest Regional Office 10% water loss recommendation. No fire flow measurements or calculations were conducted as the system does not provide fire flow.

OPERATIONAL AND MAINTENANCE PRACTICES

Southwest Regional Office has developed size appropriate Operation & Maintenance (O & M) procedures which are enclosed. This should be used as a model to develop a specific O & M procedure for this PWS. Once developed, this procedure should be implemented, updated annually, and updated copies routinely provided to all PWS personnel who perform O & M functions.

MANAGERIAL PRACTICES

The managerial practices outlined in the regulations are summarized in the enclosed Standard Managerial Procedures for Public Water Supplies. These are only mandatory for public water supplies that commenced operation after October 1, 1999. For other supplies, these procedures are recommended as good practice.

FINANCIAL PRACTICES

The financial practices outlined in the regulations are summarized in the enclosed Standard Financial Procedures For Public Water Supplies. These are only mandatory for public water supplies that commenced operation after October 1, 1999. For other supplies, these procedures are recommended as good practice.

RECOMMENDATIONS

Determine the cause of the total coliform positive samples and take corrective action. Submit two (2) copies of an engineering report, plans, and specifications each bearing the seal and signature of a professional engineer registered in Missouri, along with an application for a construction permit to Missouri Department of Natural Resources Public Drinking Water Branch, P.O. Box 176, Jefferson City, Missouri 65102, telephone 573-751-5331. Submit amendments to these engineering documents as directed by the Public Drinking Water Branch. Upon obtaining an Approval to Construct (construction permit) from the Public Drinking Water Branch, construct the improvements. Our analysis shows the items noted below as MANDATORY are the minimum capital improvements needed to bring this public water supply into regulatory compliance. The items below that are not noted as MANDATORY are strongly recommended as capital improvements needed to better ensure this public water supply achieves regulatory compliance. Note that all sizes, capacities, elevation, and locations are preliminary estimates and that your engineer will determine the actual design that must also be approved by the Public Drinking Water Branch.

1. Construct liquid hypochlorite injection equipment and reconstruct lines at the existing well and stand pipe located at well 1 so that chlorinated well water flows into and out of the standpipe through separate inlet and outlet lines, thus providing 30 minutes or more of chlorinated water detention. MANDATORY.

2. Begin certifying completion of public notification of all future violations when instructed, and contact Ms. Patty Ritchie, Public Notice Coordinator, Missouri Department of Natural Resources, Public Drinking Water Branch, P.O. Box 176, Jefferson City, Missouri 65102, 573-751-5331, for direction and assistance in completion of the missed public notice certifications.

3. Develop a contingency plan for a standby replacement chief operator certified at the DS-II level or higher and submit their name, address, telephone number, and certification number in writing to the Department of Natural Resources, 2040 West Woodland, Springfield, Missouri 65807. If the standby replacement chief operator is obtained through contract, the public water system shall have a written agreement indicating the responsibilities of that operator, including but not necessarily limited to those listed in regulation 10 CSR 60-14.010(4)(F)1. (copy enclosed). If applicable, a copy of this agreement shall be included with this submittal.

4. Obtain a construction permit from the Missouri Department of Natural Resources Public Drinking Water Branch and construct an additional well to community public water system standards that together with the existing wells have a combined capacity equaling or exceeding the design maximum day demand. To obtain this construction permit, submit two copies of an engineering report, plans, and specifications each bearing the seal of a professional engineer registered in Missouri along with an application for a construction permit to Missouri Department of Natural Resources, Public Drinking Water Branch, P.O Box 176, Jefferson City, Missouri 65102, 573-751-5331.

5. Construct a new well with a nominal diameter of eight inches, a nominal well yield of 155.5 gpm, and a well pump with a nominal capacity of 233 gpm.

6. Paint the exterior of the well casing and discharge piping.

7. Install adequately sized casing vent on the well.

8. Seal all casing openings on the well with silicone caulk.

9. Begin maintaining a storage tank water level monitoring and adjustment program.

10. Obtain a construction permit from the Missouri Department of Natural Resources Public Drinking Water Branch and construct additional storage to community public water system standards. To obtain this construction permit, submit two copies of an engineering report, plans, and specifications each bearing the seal of a professional engineer registered in Missouri along with an application for a construction permit to Missouri Department of Natural Resources, Public Drinking Water Branch, P.O Box 176, Jefferson City, Missouri 65102, 573-751-5331.

11. Maintain an adequate well water level monitoring program.

12. Clean the exterior of the standpipe. In addition, if the standpipe needs repainted, complete this maintenance item. If the interior has not been inspected in the past three years, the interior should be inspected, cleaned, and repainted with Missouri Department of Natural Resources Public Drinking Water Branch approved paint as necessary.

13. Construct a chain link fence with a lockable gate around the storage tank.

14. Use every method available to determine cause of excessive water loss and make the needed repairs. The Missouri Rural Water Association (MRWA) has leak detection equipment available. The MRWA can be contacted at 6101 East Angel Lane, Ashland, Misssouri 65010, or by phone at 573-657-5533.

15. Develop and institute a program to provide sufficient funds for the operation and maintenance of existing facilities.

16. Develop and institute a program to provide sufficient funds for future improvements.

17. Develop and institute an adequate tank inspection program for sanitary risks.

18. Develop and institute an adequate tank interior inspection and cleaning program.

19. Develop a Department-approved wellhead protection program.

20. Improve the well house at well 1 by installing a chain link fence, clearing the floor drain of the clog and installing a screen/cover over the drain.

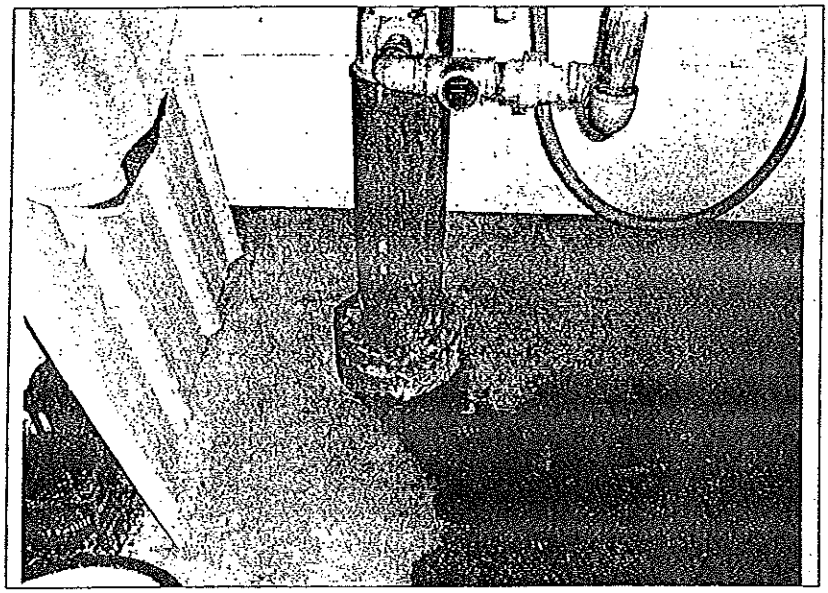
21. Provide sufficient emergency electrical power to operate all pumps that are essential to maintaining water supply and pressure.

SUBMITTED BY:

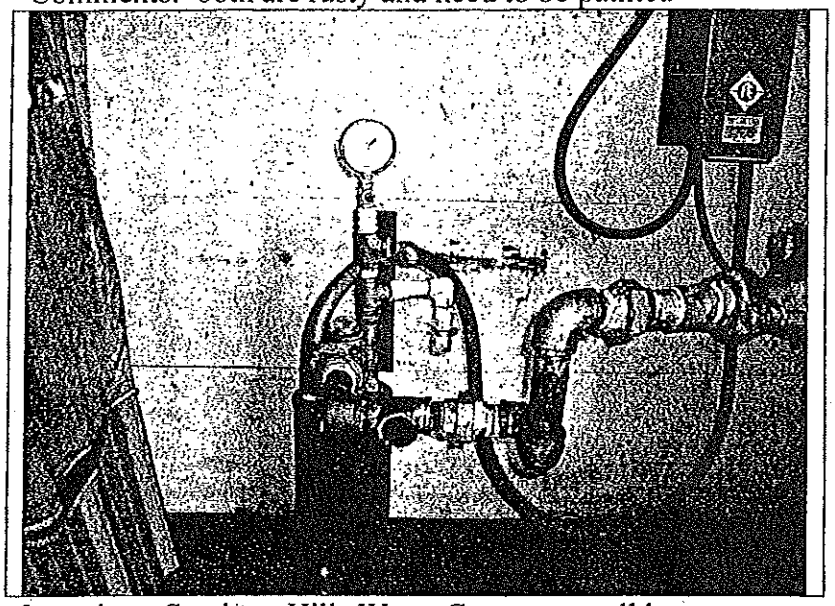
Yvonne M. Franklin, E.I.T.
Environmental Engineer
MO EIT #42573-E

APPROVED BY:

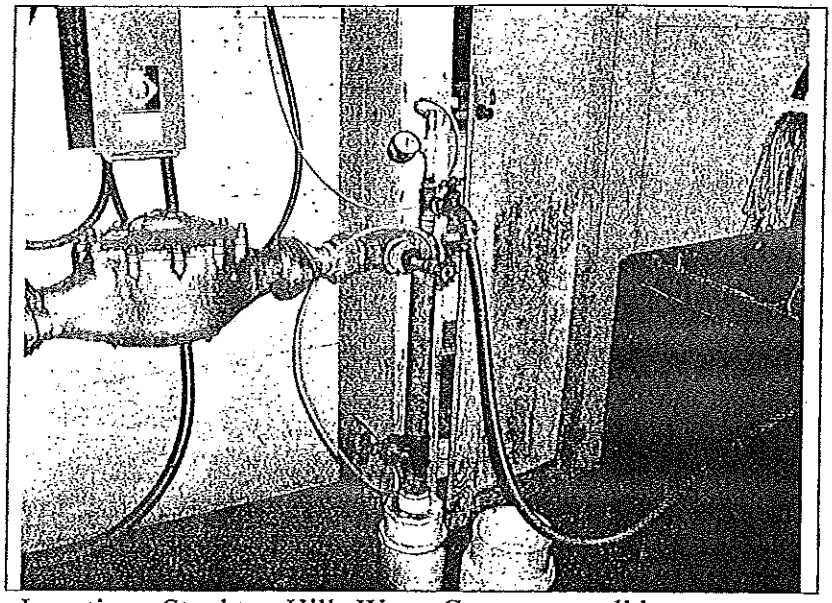
Clinton J. Finn, P.E., Chief
Drinking Water Engineering and
Technical Assistance Unit
MO PE #2002003159



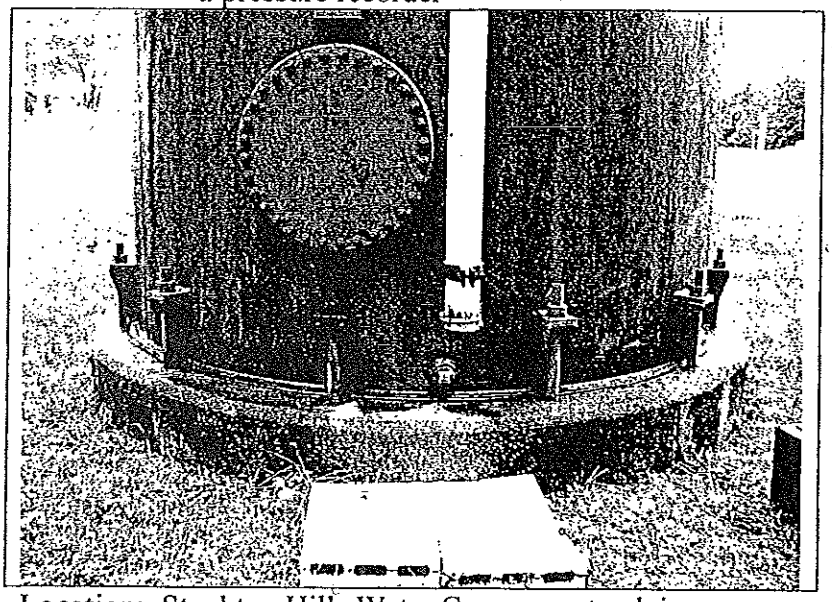
Location: Stockton Hills Water Company well house
Photographer: Yvonne M. Franklin, E.I.T.
Photograph Date: September 8, 2009
Direction of View: down at well surface casing and casing
Comments: both are rusty and need to be painted



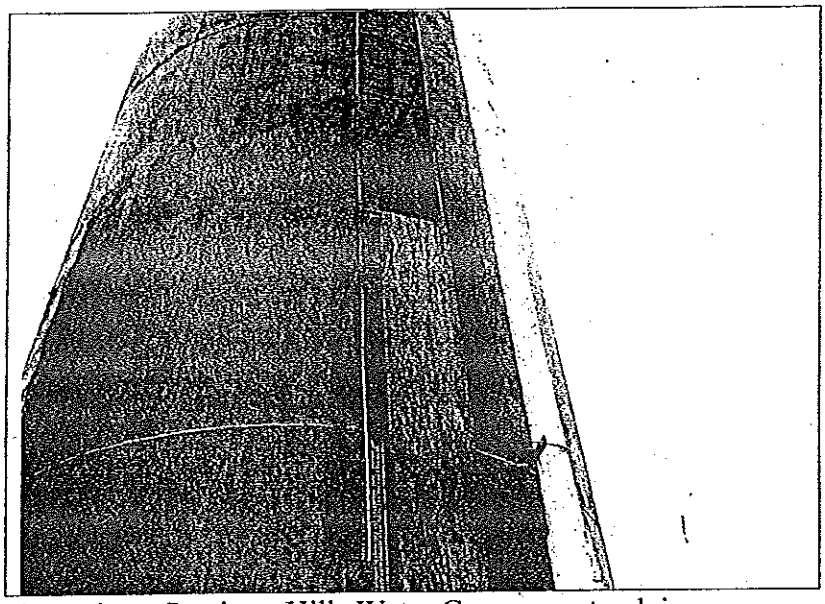
Location: Stockton Hills Water Company well house
Photographer: Yvonne M. Franklin, E.I.T.
Photograph Date: September 8, 2009
Direction of View: at well head
Comments: discharge piping, casing vent and drawdown gage



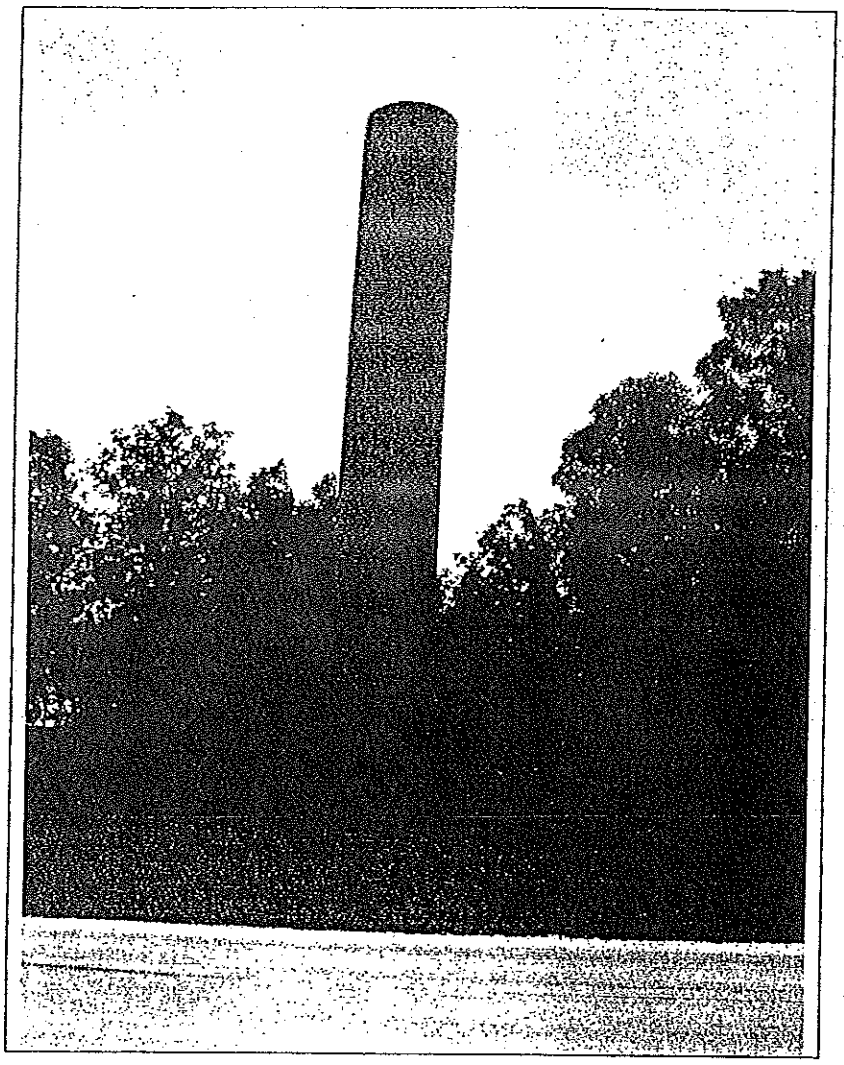
Location: Stockton Hills Water Company well house
Photographer: Yvonne M. Franklin, E.I.T.
Photograph Date: September 8, 2009
Direction of View: point where discharge pipe enters distribution system
Comments: master meter, pressure gage, tubing connection for chlorination, tubing connected to a pressure recorder



Location: Stockton Hills Water Company standpipe
Photographer: Yvonne M. Franklin, E.I.T.
Photograph Date: September 8, 2009
Direction of View: downward
Comments: overflow pipe and 6 concrete blocks being used as a splash pad



Location: Stockton Hills Water Company standpipe
Photographer: Yvonne M. Franklin, E.I.T.
Photograph Date: September 8, 2009.
Direction of View: up the ladder
Comments: Standpipe ladder and overflow piping.



Location: across from Stockton Hills Water Company Standpipe
Photographer: Yvonne M. Franklin, E.I.T.
Photograph Date: September 8, 2009
Direction of View: northeast at standpipe
Comments: standpipe shows signs of dirt and mold on outside

A sanitary survey is defined in Missouri Department of Natural Resources Public Drinking Water Regulation 10CSR 60-2.015 as "an on-site engineering inspection and review of a public water supply-its supply source(s), treatment of supply source(s), treatment facilities, and distribution system(s), for the purpose of evaluating their adequacy, reliability and safety for producing and distributing drinking water." The following items will be used as the basis for calculations to determine community public water system adequacy, reliability and safety.

Population

The latest United States Census will be used to determine population if appropriate. Previous US Census will be used to determine population trends if appropriate. Currently, Stockton Hills Water Company serves 147 residential connections. A portion of the homes are used as summer and weekend residences. The residential population is 355 persons or an average of 2.42 persons per household. Stockton Hills Water Company was originally developed to serve a maximum of 362 lots during 1971 through 1973. However, due to people purchasing multiple lots, the maximum number of lots that can be served in the future is 300. All future calculations will be based on the 300 lots being served year-round as residential homes.

A. Calculate the CURRENT POPULATION

   Based on data submitted by the public water supply during the sanitary survey inspection, the current population being served is approximately 355 persons at 147 residential connections. This is an average of 2.42 persons per household.

B. Calculate FUTURE POPULATION FOR DESIGN PURPOSES assume all 300 lots within the development have residential houses built on them.

   Population = 300 connections * (2.42 persons/connection)
   Population = 726 people

Average Daily Usage

Usage rates, water loss rates, unusual conditions, and population per service connections shall be based upon one or more of the alternatives listed below:

1. Historical data from the public water system, if available. This data shall be representative of climatic conditions that affect demand and source.

2. If such historical data from the public water system are not available, data from a comparable water system may be used.

3. If neither historical nor comparable water system data are available, the following information shall, as a minimum, be used for design purposes:

i. Population per service connection for permanent residential dwelling units including houses, mobile homes, condominiums, apartments, and multiplexes shall be approximately three (3.0) persons/dwelling unit; and

ii. Domestic water usage for residential dwelling units excluding lawn/garden irrigation usage shall be an average of 80 gallons per person per calendar day, except that for rural water districts this may be an average of 60 gallons per day.

4. Other usage criteria may be used in lieu of the criteria listed in the preceding item (3) if the engineer provides adequate justification.

Average Domestic Usage = 80 gallons per person per day for residential customers excluding lawn/garden irrigation usage.

A. Determine or calculate CURRENT (DOMESTIC) AVERAGE DAILY USAGE

Month – Year	Total Gallons Pumped	Total Gallons Billed Quarterly	Percent Water Loss
July 2008	454,900		
August 2008	674,000		
September 2008	657,000	1,559,000	12.7%
October 2008	684,600		
November 2008	501,000		
December 2008	533,500	1,315,000	23.5%
January 2009	682,700		
February 2009	493,200		
March 2009	628,400	1,293,000	28.3%
April 2009	644,200		
May 2009	574,400		
June 2009	635,300	1,212,000	34.7%
Total	7163,200	5,379,000	24.9%

$$\text{Current Average Daily Usage} = \frac{7{,}163{,}200 \text{ gal/year}}{365 \text{ day/year}} = 19{,}625 \text{ gpd}$$

$$\text{Average Daily Usage/connection} = \frac{19{,}625 \text{ gal/day}}{147 \text{ connections}} = 133.5 \text{ gpd/connection}$$

$$\text{Average Daily Usage/person} = \frac{133.5 \text{ gpd/connection}}{2.42 \text{ person/connection}} = 55.2 \text{ gpd/person}$$

All current calculations will be based on a water consumption of 55 gpd/person.

B. Calculate FUTURE AVERAGE DAILY USAGE FOR DESIGN PURPOSES

All future calculations shall be based on the following assumptions:

- the system is completely built to capacity of 300 connections/residences
- all residences will be year-round
- average daily consumption of water per person is 80 gallons per day.

Future Average Daily Usage = 726 residents x (80 gpd/person) = 58,080 gpd

Maximum Daily Usage

Maximum Daily Usage shall be the maximum pumpage day during the latest three-year period for public water supplies that have adequate records to determine this number. An exception may be made and a smaller maximum day usage determined if the three-year maximum pumpage day was due to high consumption that will not occur again due to changes in the system or caused by unusual operations (Insurance Services Office, Inc. (ISO) Fire Suppression Rating Schedule (FSRS), August 1998 Edition, Part 602).

Maximum Daily Usage may be calculated as Average Domestic Usage plus Maximum Irrigation Usage.

Maximum Irrigation Usage can be based on 0.8 inches of water applied to all lawn/garden areas in one week assuming an even daily distribution through the week (SWRO policy).

Maximum Daily Usage may be calculated as (1.5)*(Average Daily Usage), per ISO FSRS, Part 602.

A. Determine or calculate the CURRENT MAXIMUM DAILY USAGE

The third method will be used to determine the maximum daily usage: (1.5)*(Average Daily Usage).

Current Maximum Daily Usage = (1.5)*(19,625) = 42,600 gpd

B. Calculate FUTURE MAXIMUM DAY USAGE FOR DESIGN PURPOSES

Future Maximum Daily Usage = (1.5)*(58,080 gpd) = 87,120 gpd

Instantaneous Peak Flow

Instantaneous Peak Flow = Domestic Instantaneous Peak Flow plus Irrigation Instantaneous Peak Flow.

Domestic Instantaneous Peak Flow is the greater of 1 gpm per connection or gpm = 12 (no. of connections)$^{0.515}$ (as per MDNR-PDWP policy).

A. Current Domestic Instantaneous Peak Flow

DIPF1 = (1 gpm/connection)*(147connections) = 147 gpm

DIPF2 = 12(147 connections)$^{0.515}$ = 156.8 ~ 157 gpm

The second method has the larger domestic instantaneous peak flow and will be used for subsequent calculations.

B. Future Domestic Instantaneous Peak Flow

DIPF1 = (1 gpm/connection)*(300 connections) = 300 gpm

DIPF2 = 12(300 connections)$^{0.515}$ = 226 gpm

Average Irrigation Usage can be based on nine inches per year application to lawns/gardens for estate housing (≧ $500,000 retail cost per house and lot) and four inches per year application to lawn/gardens for middle class housing (< $500,000 retail cost per house and lot) (SWRO policy).

For lawn watering, the following estimates may be used:

Housing Type	Sprinkler Type	Flow per House
Moderate/Middle Class	End of Hose	1.25 gpm
Estate	Automatic	2 gpm

Irrigation Instantaneous Peak Flow can be calculated as 1.25 gpm/residential connection for middle class housing, 2.0 gpm/residential connection for estate housing (as per MDNR-SWRO policy).

C. Current Irrigation Instantaneous Peak Flow

IIPF = (1.25 gpm/residential connection)*(147 connections) = 183.75 ~184 gpm

D. Future Irrigation Instantaneous Peak Flow

IIPF2 = (1.25 gpm/residential connection)*(300 connections) = 375 gpm

E. Calculate CURRENT INSTANTANEOUS PEAK FLOW

CIPF = 157 gpm + 184 gpm = 341 gpm

Calculate FUTURE INSTANTANEOUS PEAK FLOW FOR DESIGN PURPOSES

FIPF = 300 gpm + 375 gpm = 675 gpm

An evaluation of the well and storage capacity must be completed to determine if instantaneous peak flow can be met by this system.

Fire Flow (based on ISO FSRS, August 1998)

No fire flow is provided for this development at this time. However, if fire flow were to be made available in the future, the following should be considered:

The minimum allowable flow to be considered fire flow by Missouri Department of Natural Resources Public Drinking Water Branch is 250 gpm or one standard hose stream while maintaining a minimum residual pressure of 20 pounds per square inch (20 psi) and maintaining this flow for a minimum of two hours. Mains with fire hydrants that cannot maintain this flow pressure and duration are in violation of Design Guide, Part 8.1.5. This fire flow (250 gpm, 20 psi residual, two-hour duration) corresponds to ISO Class 8 minimum.

Fire hydrants on mains smaller than six inches in diameter are in violation of Design Guide, Part 8.1.2. This applies to all public water supplies that provide fire protection.

Pressure

Required Minimum	20 psig, PDWP Regulation 10 CSR 60-4.080(9)
Recommended Maximum Working	100 psig, Design Guide, Part 8.1.1
Recommended Minimum Working	35 psig, Design Guide, Part 8.1.1
Recommended Normal Working	60 psig, Design Guide, Part 8.1.1
Conversion factor psi to feet water	$\frac{33.90 \text{ feet of water @ } 39.1^\circ \text{ F}}{\text{atmosphere}} * \frac{\text{atmosphere}}{14.696 \text{ psi}} = \frac{2.307 \text{ ft } H_2O}{\text{psi}}$

from Chemical Engineers Handbook 4th Edition, page 1-23

Elevations

Elevations are approximated from 7.5 minute USGS topographic maps that show contours at 20-foot vertical intervals. These elevations are useful for preliminary engineering calculations but are not sufficiently accurate for use in final design.

The approximate elevation at the well head appears to be 1,063 feet above Mean Sea Level (MSL) and is also the highest elevation within the system.

The approximate elevation at the lowest level of the distribution system appears to be 910 feet MSL at the ground surface. This provides a distribution system elevation difference of approximately 153 feet.

At this time, Stockton Hills Water Company does not have any undeveloped land to be considered for future development. The highest point within the subdivision is located near the well house with an estimated mean sea level of 1,305 feet.

Hydraulics

Friction loss will be based on Hazen Williams C Factor of 130 for PVC pipe and 100 for cast/ductile iron pipe and steel pipe (based on AWWA, M22 Sizing Water Service Lines and Meters).

Hazen Williams equation (from Handbook of PVC Pipe Design and Construction, UniBell Pipe Association, 1982)

$$f := 0.2083\left(\frac{100}{C}\right)^{1.852}\cdot\frac{Q^{1.852}}{d_i^{4.865}}$$

Where f = friction loss (ft of H_2O/100 ft), Q = flow rate (gpm)
di = pipe internal diameter (inches), C = flow coefficient

Wells

The total developed groundwater source capacity shall equal or exceed the design maximum day demand (Design Guide 3.2.1.1)

Number of Sources (Design Guide 3.2.1.2)

Public drinking water systems serving 500 or more people shall have more than one well and shall be capable of meeting design maximum day demand with the largest producing well out of service.

Stockton Hills Water Company currently serves less than 500 people; therefore, this does not apply at this time. However, the water company will reach 500 people with the 207th connection (house). It would be very beneficial for this system to begin planning for this second well.

Unless yield and drawdown tests indicate a higher long term aquifer withdrawal can be sustained, the normal capacity of each well for routine use will be calculated as operating eight hours out of a 24 hour day.

Using information about the wells (flow rate, pump setting, pump size, static water level, etc.) the estimated pump efficiency can be calculated. The recommended operating pressure range is 40 to 60 psig.

The public water supply is served by one well. The file for this facility and information provided by the pump installer indicated that the well was drilled in 1971 to a total depth of 525 feet, with 305 feet of six-inch steel casing. The well pump was replaced July 2009 with a submersible pump that produces 26 gallons per minute. This well is provided with shutoff and check valves, pressure gauge, drawdown tube and gauge, master meter, screened casing vent, chlorine injection, and sampling taps.

At 26 gpm and a normal eight hours operating period, the estimated normal capacity of this well would be

(26 gpm)*(8 hr/day)*(60 min/hr) = 12,480 gallons per day

This is less than the calculated current (19,625 gpd) daily usage, the current maximum day usage 29,438 gpd), the future average daily usage (58,080 gpd), and the future maximum (87,120 gpd) daily usage. Therefore, a second well should be planned to meet the all of these requirements as operating eight hours out of a 24 hour day.

For systems serving less than 500 people, the need for the second well is highly recommended but not required. As this system approaches the 207th connection, then the following could be used as a preliminary design for the construction of a second well.

The minimum capacities needed (in addition to the existing well) to meet the above requirements for operating eight out of a 24-hour day are the following:

Current Daily Usage: $\frac{19{,}625 \text{ gpd} - 12{,}480 \text{ gpd}}{(8 \text{ hr/day}) * (60 \text{ min/hr})} = 14.9 \text{ gpm}$

Current Maximum Daily Usage: $\frac{29{,}438 \text{ gpd} - 12{,}480 \text{ gpd}}{(8 \text{ hr/day}) * (60 \text{ min/hr})} = 35.3 \text{ gpm}$

Future Average Daily Usage: $\frac{58{,}080 \text{ gpd} - 12{,}480 \text{ gpd}}{(8 \text{ hr/day}) * (60 \text{ min/hr})} = 95.0$ gpm

Future Maximum Daily Usage: $\frac{87{,}120 \text{ gpd} - 12{,}480 \text{ gpd}}{(8 \text{ hr/day}) * (60 \text{ min/hr})} = 155.5$ gpm

To maintain this flow, the well capacity needs to be 150% of the pump flow needed (based on Missouri Department of Natural Resources Water Resources Center). The minimum design requirements will be calculated for the future maximum daily usage well.

1.50 x 155.5 gpm = 233.25 gpm ~ 233 gpm

The minimum distance of pump setting minus well operation level is 60 feet (i.e. no less than 60′ of water over the pump at all times). This provides adequate net positive suction head for most pumps.

The pump total dynamic head (TDH) is operating at a depth plus 138.6′ (equal to 60 psig at the surface):

TDH = (.55)*(pump horsepower)*(3,960)/ gpm try a 30-Hp pump in an eight-inch well based on pump sizes and pump efficiency.

TDH = (.55)*(30-Hp)*(3,960)/233 gpm = 280.4 ~ 280 feet

The pump set depth = 280′ – 138.6′ + 60′ = 201.4 feet < 1000 feet maximum pump depth.

An eight-inch diameter well is recommended. Note that well diameters have little effect on actual well yield but limit the size of pumps that can be installed. The six-inch well is normally limited to five-hp pumps as the next normal size up (7½-hp) generally have a dimension greater than 5½-inch. Installations that have larger pumps in six-inch holes have a higher risk of problems during installation and removal. Also, note that three-phase power is required for virtually all standard pumps above 7½-hp.

Evaluate the well to see if the 30-Hp pump is sufficient to meet the instantaneous peak flow of 341 (current) and 675 (future) gpm, respectively. Assume 55% efficiency on the pump.

Assume 55% efficiency. Determine pump capacity at the upper pressure range of 60 psi.

TDH = (60 psi) x (2.307 ft H_2O/psi) = 138.42 ft

$$(30\text{-Hp})(0.55) = \frac{(\text{gpm})(138.42 \text{ ft})}{3{,}960}$$

gpm = 472 gpm

Evaluate the pump at the lower pressure range of 40 psi.

TDH = (40 psi) x (2.307 ft H2O/psi) = 92.28 ft

$$(30\text{-Hp})(0.55) = \frac{(\text{gpm})(92.28\text{ ft})}{3{,}960}$$

gpm = 708 gpm each

The well pump will meet both the current (341 gpm) and future (675 gpm) instantaneous peak flows while operating within a 40 psi – 60 psi range.

Storage

Public water supplies that do not provide the fire protection shall have sufficient finished water storage to meet the minimum design operating pressure and flow for the diurnal flow pattern on the design maximum usage day with all well pumps, treatment plants, high service pumps, booster pumps, or other equipment that affect pressure and flow in operation. For standpipes, the volume above the elevation, which provides 20 psig at the tower base, shall be counted as nominal (useable) capacity.

The storage system consists of a standpipe 10 feet in diameter by 70 feet in height and has a gross capacity of 40,536 gallons.

Tank Volume = Pi * $(10\text{ ft}/2)^2$ * 69 ft * 7.48 gal/ft^3 = 40,536 gallons

The actual volume of this tank is believed to be less than this since the overflow is about one foot below the top of the tank and the outlet pipe is probably above the bottom of the tank.

Nominal Capacity (assume overflow is set at 69 feet. The elevation at which 20 psi pressure is maintained in the distribution system is approximately 43.14 feet, assuming a 3 feet pipe bury depth.

$$20\text{ psi} * \frac{2.307\text{ ft}}{\text{Psi}} - 3\text{ ft} = 43.14\text{ ft}$$

$$\text{Nominal Capacity} = \text{pi} * \frac{(10\text{ ft})^2}{4} * (69 - 43.14\text{ ft.}) * \frac{7.48\text{ gal}}{ft^3} = 15{,}192\text{ gallons}$$

To provide the future design average daily flow in total storage tank volume, an additional volume as calculated below would be needed:

58,080 gal. – 40,536 gal. = 17,544 gallons

To provide the current design average daily flow in usable storage, an additional volume of usable storage as calculated below would be needed:

19,625 gal. – 15,192 gal. = 4,433 gal.

To provide the future design average daily flow in usable storage, an additional volume of usable storage as calculated below would be needed:

58,080 gal. – 15,192 gal. = 42,888 gal.

Mains

Evaluate the existing mains to meet instantaneous peak flow and pressure.

Based on information from plans provided during the inspection, the water mains within the subdivision range from five-inch to two-inch PVC pipes. This system will not be able to support fire flows unless the mains are upgraded to six inches or larger, therefore, fire flow analysis will not be given.

The cross section area for five-inch diameter SDR 21 Pressure Class 200 PVC pipe (the inside diameter for this type of pipe is 5.033") is as follows:

$((5.033 \text{ in} * 1 \text{ ft}/12 \text{ in})/2)^2 * \text{pi} = 0.1382 \text{ ft}^2$

The current instantaneous peak flow with irrigation is 341 gpm

$$341 \text{ gpm} * \frac{1 \text{ min}}{60 \text{ sec}} * \frac{1 \text{ ft}^3}{7.48 \text{ gal}} = 0.760 \text{ ft}^3/\text{sec}$$

$$\text{Average velocity} = \frac{0.760 \text{ ft}^3/\text{sec}}{0.1382 \text{ ft}^2} = 5.50 \text{ ft/sec}$$

2.5 ft/sec < 5.50 ft/sec < 10 ft/sec => OK

The future instantaneous peak flow with irrigation is 675 gpm

$$675 \text{ gpm} * \frac{1 \text{ min}}{60 \text{ sec}} * \frac{1 \text{ ft}^3}{7.48 \text{ gal}} = 1.504 \text{ ft}^3/\text{sec}$$

$$\text{Average velocity} = \frac{1.504 \text{ ft}^3/\text{sec}}{0.1382 \text{ ft}^2} = 10.88 \text{ ft/sec}$$

2.5 ft/sec <10 ft/sec < 10.88 ft/sec => not OK

The five-inch Class 200 PVC pipe is capable of meeting only the current instantaneous peak flow with irrigation. Therefore, the minimum pipe size must be greater than five inches to meet the future instantaneous peak flow of 675 gpm.

The cross section area for four-inch diameter Class 200 PVC pipe (the inside diameter for this type of pipe is 4.072") is as follows:

$((4.072 \text{ in} * 1 \text{ ft}/12 \text{ in})/2)^2 * \text{pi} = 0.0904 \text{ ft}^2$

The current instantaneous peak flow with irrigation is 341 gpm (0.760 ft^3/sec).

$$\text{Average velocity} = \frac{0.760 \text{ ft}^3/\text{sec}}{0.0904 \text{ ft}^2} = 8.41 \text{ ft/sec}$$

2.5 ft/sec < 8.41 ft/sec < 10 ft/sec => OK

The four-inch Class 200 PVC pipe is capable of meeting the current instantaneous peak flow with irrigation.

The cross section area for three-inch diameter Class 200 PVC pipe (the inside diameter for this type of pipe is 3.166") is as follows:

$((3.166 \text{ in} * 1 \text{ ft}/12 \text{ in})/2)^2 * \text{pi} = 0.0550 \text{ ft}^2$

The current instantaneous peak flow with irrigation is 341 gpm (0.760 ft^3/sec)

$$\text{Average velocity} = \frac{0.760 \text{ ft}^3/\text{sec}}{0.0550 \text{ ft}^2} = 13.82 \text{ ft/sec}$$

2.5 ft./sec < 10 ft./sec < 13.82 ft/sec = > Not OK. Increase minimum pipe sizing to 4" Class 200 PVC

Using pipe smaller than four inches (SDR-21 PC 200) to meet the instantaneous peak flow with irrigation would create water hammer within the distribution system. It is recommended that a minimum pipe size of four-inch Class 200 PVC or larger be used to prevent water hammer within the system, if irrigation occurs at a frequent level by the majority of homeowners.

The current maximum daily demand of this system is 29,438 gallons per day or 20.44 gpm. The existing distribution system consists of approximately 2,450 lineal feet of 5" PVC; 3,950 lineal feet of 4" PVC; 8,650 lineal feet of 3" PVC; 7,850 lineal feet of 2½" PVC; and 9,230 lineal feet of 2" PVC pipe.

Friction loss = f5 + f4 + f3 + f2½ + f2

f5 = $0.2083*(100/130)^{1.852}*Q^{1.852}/5.033^{4.865}$; where d_i=4.151″, C = 130; 2,450 ft
f = $0.00004931Q^{1.852}$ (ft of H_2O/100 ft)

f4 = $0.2083*(100/130)^{1.852}*Q^{1.852}/4.072^{4.865}$; where d_i=4.151″, C = 130; 3,950 ft
f = $0.0001382Q^{1.852}$ (ft of H_2O/100 ft)

f3 = $0.2083*(100/130)^{1.852}*Q^{1.852}/3.166^{4.865}$; where d_i = 3.166″, C = 130; 8,650 ft
f = $0.0004704Q^{1.852}$ (ft of H_2O/100 ft)

f2½ = $0.2083 * (100/130)^{1.852} * Q^{1.852}/2.601^{1.852}$; where d_i = 2.149″, C = 130; 7,850 ft
f = $0.001225Q^{1.852}$ (ft of H_2O/100 ft)

f2 = $0.2083 * (100/130)^{1.852} * Q^{1.852}/2.149^{1.852}$; where d_i = 2.149″; C = 130; 9,230 ft
f = $0.003099Q^{1.852}$ (ft of H_2O/100 ft)

Assume the system is maintaining a minimum pressure of 40 psi at the well house.

Friction Loss =

$$\frac{0.00004931Q^{1.852} * 2450}{100} + \frac{0.0001382Q^{1.852} * 3950}{100} + \frac{0.0004704Q^{1.852} * 8650}{100} + \frac{0.001225Q^{1.852} * 7850}{100} + \frac{0.003099Q^{1.852} * 9230}{100}$$

where Q = 20.44 gpm

Friction loss = 0.323 ft + 1.458 ft + 10.877 ft + 25.705 + 76.460 = 114.823 ft

Pressure loss = $\frac{114.823}{2.307 \text{ ft/psi}}$ = 49.77 psi

Residual Pressure within the system = 40 psi – 49.77 psi = - 9.77 psi

This is below the minimum requirement of 20 psi. It should be noted that the total lineal feet of 14,288 and the maximum daily usage were used to determine the friction loss which might not be accurate since the system does have looping which reduces the pressure loss. However, this method is considered more conservative and illustrates the distribution cannot support this rate of flow at the given distance–it is considered inadequate.

Increasing the minimum size of the piping to four-inch mains will decrease water hammer and maintain pressure within the system more adequately, especially if the majority of the residents were watering their yards.

Disinfection

Missouri Department of Natural Resources Regulation 10 CSR 60-4.055 and the accompanying Guidance Manual require 4-LOG (99.99%) virus inactivation.

Terms used are:

CT = disinfection residual concentration multiplied by the adjusted contact time.
T_{10} = adjusted contact time (minutes) or an approximation of the time at which 90% of the water has been in contact with the disinfectant for this much time or more and 10% of the water has been in contact with the disinfectant for this much time or less.
T_{10}/T = Rule of Thumb fraction = 0.3 for single or multiple unbaffled inlets and outlets, no intrabasin baffles (poor baffling condition). T is average contact time.
$CT_{99.99}$ = CT value at which 99.99% (or 4.0 LOG) of viruses are inactivated by free chlorine.

1. For 99.99% virus inactivation $(CT_{10} / CT_{99.99}) = 1$ or $CT_{10} = CT_{99.99}$

2. Minimum allowable free chlorine residual = 0.5 mg/L at the well. Maximum is 4.0 mg/L but never used because of taste/odor.

3. Calculate tank size for 15°C well water temperature, $CT_{99.99} = 4$, 0.5 mg/L free chlorine residual, 27 gpm pump rate

   $T_{10}/T = 0.3$
   (0.5 mg/L) $T_{10} = 4$
   $T_{10} = 8$
   $8/T = 0.3$
   T = 26.67 minutes
   Tank Volume = (26 gpm)*(26.67 min) = 693.42.09 gallons

For the recommended 30 minutes of chlorine contact time, the required storage volume is 780 gallons ((26 gpm) * 30 minutes = 730 gallons)

(730 gallons) / (7.48 gallons/ft^3) = 104..28 ft^3

104.28 ft^3 / (pi*(10/2)^2) = 1.33 feet or 16"

With pumping rate of 26 gpm, the water level inside the tank should be maintained 1.33 feet (16 inches) above the outlet pipe at all times to provide adequate chlorine contact.

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