COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION OF KENTUCKY

In the Matter of:

ELECTRONIC PROPOSED ADJUSTMENT OF	)	
THE WHOLESALE WATER SERVICE RATES OF	)	Case No. 2017-00199
CENTRAL CITY MUNICIPAL WATER & SEWER	)	

CITY OF CENTRAL CITY'S RESPONSES TO THE FIRST REQUEST FOR INFORMATION TO CENTRAL CITY FILED BY MUHLENBERG COUNTY WATER DISTRICT AND MUHLENBERG COUNTY WATER DISTRICT NO. 3

The City of Central City provides the following responses to the First Request for Information filed by Muhlenberg County Water District and Muhlenberg County Water District No. 3.

Respectfully submitted,

M. Todd Osterloh

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M. TODD OSTERLOH
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ATTORNEYS FOR CITY OF CENTRAL CITY

1. Provide Mr. McGhee's curriculum vitae.

Response: Please see attached document.

Witness: Michael W. McGhee

Michael W. McGhee, PE

Project Assignment

Current Position

1995 – Present **McGhee Engineering, Inc.** Guthrie, KY

President

- Founder and President of a Civil Engineering firm serving western Kentucky. Specialized expertise in water system engineering, wastewater system engineering, transportation, grading and drainage, project management, and project financing.

Education

University of Kentucky, Lexington, Kentucky, 1980

Bachelor of Science in Civil Engineering

- Broad Civil Engineering curriculum, concentration in structures.

University of Houston, Houston, Texas, 1984

Master of Business Administration

- Concentration in Finance.

Previous Professional Experience

1990-1995 ***Haworth, Meyer & Boleyn, Inc.*** Nashville, TN

Nashville Division Manager

- Responsible for the management of a consulting engineering firm branch office in Nashville providing transportation, water and wastewater design.

1987-1990 ***Espey, Huston & Assoc., Inc.*** Dallas, TX

Municipal & Environmental Engineering Manager

- Responsible for the management of all municipal and environmental engineering services for a ENR top 200 regional consulting engineering firm branch office in Dallas.

1985-1987 ***Espey, Huston & Assoc., Inc.*** Houston, TX

Engineering Project Manager

- Responsible for the management of Civil Engineering projects including water and wastewater design, highway and street design, drainage design, and construction administration services.

1983-1985 ***Ray Young Engineers, Inc.*** Houston, TX

Municipal & Environmental Engineering Manager

- Designed water and wastewater plants and distribution/collection systems.

1981-1983 ***Fluor Engineers, Inc.*** Houston, TX

Associate Structural Engineer

- Design of foundations and supporting structures for petrochemical plants.

Professional & Community Activities

Licensed Engineer in Kentucky, Tennessee and Pennsylvania. Member of the National Society of Professional Engineers, Kentucky Rural Water Association, American Water Works Association, Elkton Rotary Club, Southern Pennyrile Chamber Alliance.

WD 1

2. Describe Mr. McGhee's role in the renovation of Central City's water treatment plant that was completed in 2013 ("2013 renovation").

Response: Mr. McGhee served as engineering project manager for the water system expansion project.

Witness: Michael W. McGhee

3. Provide all studies, analyses, and reports regarding the projected use of water in Muhlenberg County that Central City had available when planning the 2013 renovation.

Response: Please see the attached documents that include (a) Water Supply Feasibility Study (Garver Engineers, 2003), (b) 2008 & 2009 Early Planning Assessments (McGhee), and (c) Central City Water Treatment Plant Expansion Study (Strand)

Witness: Michael McGhee

Water Supply Feasibility Study

for

Regional Water Committee
Muhlenberg County, Kentucky

GARVER ENGINEERS

February 25, 2003

WD 3a

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SECTION 1
INTRODUCTION

1.1 General

Muhlenberg County, Kentucky is located between the Green and the Pond Rivers in the Pennyrile area of Kentucky. Its county seat is Greenville, and the other principal city in the County is Central City. Other incorporated cities served by the Muhlenberg County based water systems include Drakesboro, Powderly, Sacramento, South Carrollton, and Bremen. The County has a (2000 census) population of 31,839, and virtually all of the County has water service through one of the four water utilities in the County: the City of Central City, the City of Greenville, Muhlenberg County Utility District No. 1 (District 1), and Muhlenberg County Utility District No. 3 (District 3).

The City of Greenville has its own water source and 1.0 MGD water treatment plant. The three other systems are served by the City of Central City, which has a raw water intake on the Green River and a 4.0 MGD water treatment plant.

1.2 New Regulations

The water supply industry has for a number of years been facing a series of new requirements imposed by federal and state regulators, and it appears that in the foreseeable future there will continue to be additional regulations. The Enhanced Surface Water Treatment Rule requires significant changes in water treatment practices. The Commonwealth of Kentucky is currently being vigorous in implementing new regulations and in planning for the future. Many water treatment plants, including the Central City and Greenville plants, will have trouble meeting these requirements without significant improvements—improvements that in the current case would be covered by the proposed new facility and that would have to be added to the existing facilities if a new facility were not built. Among the new requirements that are already in place or are anticipated within the next 5 to 10 years are:

- Increased control of disinfection byproduct formation
- Cryptosporidium and giardia removal
- Virus removal
- More stringent turbidity and particle removal
- Enhanced Total Organic Carbon removal

1.3 Greenville Water Production Facilities

The City of Greenville provides potable water service to some 2,025 customers. The core facilities of the Greenville 1.0 MGD water treatment plant were constructed almost three quarters of a century ago and the production facilities have undergone several upgrades over the years. The existing plant is in satisfactory working condition and produces a good quality of water at a reasonable cost.

The Greenville plant would be difficult to further expand, and with its granular filters the existing facility will be unable to meet anticipated future water quality standards being promoted by the state and federal governments. In addition, the small lakes that Greenville uses as water sources have severely limited capacities. During recent years in peak demand periods Greenville's raw water source has been inadequate to supply the demand and it has been necessary for Greenville to purchase water treated by Central City through District 1 in order to supplement the City's needs.

The problem of developing an adequate raw water source is a problem that Greenville must address as soon as possible. The problem of meeting future water quality standards is one that will require Greenville to build a new water treatment plant. The need for this is absolute, the only question concerning this problem is how long Greenville can wait.

Greenville has investigated several options for sources of water over the years and more recently considered building an intake on the Green River and constructing a raw water line to their treatment plant. It has been estimated that building a new intake and raw water line from the Green River would cost in excess of $3.2 million and adding upgrading of the Greenville plant to meet future regulatory requirements would increase the cost to in excess of $ 5.5 million. It should be noted that if Greenville does build its own 1.0 MGD treatment plant it would not have the additional 1.0 MGD of reserve capacity available for industrial use.

1.4 Central City Water Production Facilities

The Central City water treatment plant has a capacity of 4 million gallons of water per day (MGD) and processes raw water taken from the Green River. The original portion of the plant had a capacity of 2.0 MGD and was built along with the raw water intake in the early 1970's. Water usage increased significantly and during 1983 the plant capacity was increased to 4.0 MGD.

The raw water intake located on the Green River has a traveling water screen and three pumps with associated valves, piping and electrical equipment. Raw water is delivered to the treatment plant through a 20-inch raw water main that has a hydraulic capacity of 8 MGD. Potassium permanganate storage and feed equipment is located at the intake for taste and odor control.

The water treatment plant has two circular up-flow solids contact units that are used as flocculation and coagulation units. A single rectangular settling basin with tube settlers follows the flocculation and coagulation units and it has a two-hour detention time at 4.0 MGD. Four filters, each of which have a capacity of 1.0 MGD at 2 gallon per minute per square foot (gpm/ft^2) filtration rate, follow the settling basin. There are two clear wells that operate in series. The plant has three high service pumps and there are facilities for bulk storage of lime, liquid alum, ton cylinder chorine and fluorosilicic acid.

Major parts of the plant and intake are approximately thirty years old and ongoing maintenance is required, but the basic facility is sound and with proper maintenance is usable for many years to come.

Central City's treatment facility currently serves the City of Central City, the Muhlenberg County Water District No. 1, the City of Drakesboro, the Muhlenberg County No. 3 Water District and the City of Sacramento in McLean County. The water plant serves approximately 12,300 customers.

At times of highest usage the Central City water treatment plant is pumping between 75% and 80% of its rated capacity, thus the question of additional or replacement water treatment capacity has arisen for both of the County's water sources. During the first six months of 2002, the Central City plant produced over 3.7 million gallons of water on 21 different days and on 5 days during the month of July alone. Hours of production in July of 2002 averaged 20.4 hours per day (85%) and on 7 days the plant was operated around the clock. Operating at full or near full capacity is very risky and a violation of the permit with the Kentucky Division of Water. In addition to the problem of lack of treatment capacity, Central City's plant, because it is a granular filter process, like Greenville's plant, has the same issues that Greenville's plant faces in meeting regulatory requirements that are on the horizon and in providing high quality water to its customers.

If an industry were to locate in the County that required a large volume of water it would not be possible to serve it, and the industry probably would have to be turned away due to the lack of capacity. Already, there is a proposed development of a new electric generation plant near Central City and the opening of new coal mines that will require large amounts of water. In addition, the development of a regional industrial park near Graham in the County will also require enough capacity of water to be attractive to new industry.

Central City does not have enough water treatment capacity currently to handle the existing needs of its customers in accordance with existing regulations, let alone to handle the future needs of Muhlenberg County, without expansion of the existing facility. Given the fact that it will take a minimum of three years to get a new or expanded facility in operation, expansion and upgrade of the water treatment plant needs to commence as soon as possible.

1.5 Project Parameters

The Commonwealth of Kentucky, for a number of years, has been encouraging the consolidation of local water systems into more efficient regional systems. In furtherance of that goal the utilities of Muhlenberg County have formed the Muhlenberg County Regional Water Planning Committee (The Committee) to consider the possibility of complete regionalization of the County's water systems and this Report has been prepared in response to The Committee's order to study the matter.

It is the desire of The Committee to have a treatment plant that embodies the latest proven technological advances and that will provide treatment that will meet all current state and federal requirements and that will have the optimum ability to meet likely future requirements. Ultrafiltration system tests have shown that this technology is able to remove particulates above the pore size and to remove to below detection limits both *giardia* and *cryptosporidium*, two potential contaminants that are of especial interest. Ultrafiltration also achieves a very high level of removal of viruses in general and of fecal and total coliform. Granular filter systems cannot achieve the same levels of removal in most cases.

For these reasons the ultrafiltration process with pretreatment as required by Kentucky Division of Water has been selected as the process alternative to be used. The Kentucky Division of Water currently requires chemical addition, mixing, flocculation and settling prior to ultrafiltration. This requirement is currently under investigation. Based on the results of a pilot study now under way for another location and the pilot study that will have to be done for the Muhlenberg County system, it may be possible to do without the settling process. Since this decision has not been made, all calculations in this Report are based on including the settling process in the new plant.

During the year 2002, the water pumped from the plants averaged as follows:

System	Average Day Usage During the Year	Average Day Usage During Peak Month
Central City	2.93 MGD	3.33 MGD
Greenville	0.57 MGD	0.65 MGD
TOTAL	3.50 MGD	3.98 MGD

The U S Census Bureau growth projection for Muhlenberg County as a whole shows essentially zero growth out to the year 2020. The leaders of the utilities hope that the county will have some growth, and they want to have capacity in the new plant for at least 1.0% per year growth out to the year 2025 plus an allowance of 1.0 MGD for possible industrial use. In order to provide for peak day use the peak month average flow is multiplied by 1.25 to get the required plant capacity.

Using this process, the required plant size is 3.98 X 1.25 = 4.98 MGD (current average day usage in peak month), projected 25 years at 1.0% = 6.38 MGD, to which is added 1.0 MGD = 7.38 MGD. The proposed water production capacity has been rounded to 8.0 MGD with all four utilities participating. In order to show the situation for the three current customers if Greenville should elect not to join in, the required plant capacity for Central City's facilities would be reduced to 7.0 MGD under this non-unified alternative.

Because of the availability of the Central City water treatment plant as a possible basis for an enlarged system, two alternatives are being studied for the four parties:

- ***Option 1*** - reuse of the Central City plant with addition of ultrafiltration and enlargement to 8 MGD
- ***Option 2*** - construction of an entirely new ultrafiltration plant with a capacity of 8 MGD.

SECTION 2
ANALYSIS OF ALTERNATIVES

2.1 General

The two regional water treatment alternatives being studied for Muhlenberg County are:

- ***Option 1*** - reuse of the Central City plant with addition of ultrafiltration and enlargement to 8 MGD.

- ***Option 2*** - construction of an entirely new ultrafiltration plant with a capacity of 8 MGD.

At this time the precise plans of District 1 for pumping station installation and pipeline work to the south of Central City are still undetermined. If the Committee decides to move forward with this project it may be to the advantage of all concerned for District 1 to adjust its plans to suit the new situation. For this reason, there may need to be some moderate to small adjustments to the piping layout and costs presented herein. It should also be noted that because Greenville's storage tanks are at almost the same elevation as the District 1 Powderly tank it will be necessary for Greenville to construct a low head booster pumping station. The cost of this facility is not included in the calculation presented herein.

2.2 Option 1 – Reuse Central City Plant

2.2.1 Description

The proposed improvements associated with Option 1 are shown on Exhibit 1. Central City's existing intake would be modified and all possible transmission lines, storage tanks and other facilities would be reused. The City's water treatment plant would be expanded to 8 MGD capacity and improvements made including the addition of an ultrafiltration system. The total list of items of new work for this option is as follows:

a. Raw water intake B (existing intake) modifications
b. Modify Central City's existing water treatment plant including addition of an ultrafiltration system and expanding the facility capacity to 8 MGD as described below
c. Finished water line C (18" DIP)
d. Finished water line F (12" DIP)
e. Finished water line G (8" DIP)
f. District 3 connector line I (10" DIP)
g. Metering point for Greenville

The key elements of work associated with upgrading and expanding Central City's existing treatment facility include:

a. 8.0 MGD ultrafiltration system
b. installation, transfer pumps and internal piping for ultrafiltration
c. building for new facilities
d. additional flocculation capability
e. chemical feed improvements
f. site work
g. site piping
h. laboratory additions
i. clear well addition
j. high service pumps and appurtenances
k. miscellaneous minor repair, repainting, and refurbishing
l. electrical work and control
m. SCADA system

2.2.2 Advantages

The advantages of reusing the Central City plant as the starting point of the new treatment facility include:

a. A large amount of valuable—and not yet fully depreciated—facilities will not be abandoned, but will be reused, thus reducing the overall cost of the new treatment facility and its associated transmission, pumping, and metering facilities.

b. The availability of the filters in the existing plant (which will pass 8.0 MGD at 4 gpm/ft^2) means that if total organic carbon (TOC) removal, and taste and odor control are defined as needs during pilot testing or at some later date, the existing filters could be retrofitted as granular activated carbon filters to remove taste and odor and TOC.

c. The cost for new transmission and connector lines and metering will be significantly less for this option.

2.2.3 Disadvantages

a. The components of the existing plant are not brand new.

b. This project would abandon the Greenville water treatment facility.

2.2.4 Cost

The Opinion of Probable Cost for each portion of the various improvements associated with Option 1 is shown in the Appendix and the Opinion of Probable Cost for the total project is summarized below.

Estimate 1

Option 1 – Reuse Central City Plant (8.0 MGD)

Muhlenberg County Water System Improvements

Opinon of Probable Costs

Item	Probable Cost
Raw Water Intake "B" Modifications	$ 430,000
Water Treatment Plant Improvements & Expansion to 8.0 MGD	7,560,000
Finished Water Line "C" (18" DIP)	990,063
Finished Water Line "F" (12" DIP) & "G" (8" DIP)	1,095,925
District 3 Connector Line "I" (10" DIP)	135,825
Metering Point for Greenville	30,000
Subtotal	10,241,813
Contractors Overhead and Profit	1,536,272
Subtotal	11,778,085
Construction Contingency	1,177,915
Total Estimated Construction Cost	12,956,000
Non-Construction Costs	1,944,000
Total Estimated Project Cost	$14,900,000

2.3 Option 2 – New Plant

2.3.1 Description

The proposed improvements associated with Option 2 are shown on Exhibit 2. Central City's existing intake would be modified and all possible transmission lines, storage tanks and other facilities would be reused. A new 8 MGD water treatment plant would be constructed which would include an ultrafiltration membrane system. The total list of items of work for this option is as follows:

a. Raw water intake B modifications
b. Raw water line D (24" DIP)
c. New 8.0 MGD treatment plant B
d. Finished water line E (24" DIP)
e. Finished water line F (12" DIP)
f. Finished water line G (8" DIP)
g. Central City connector line H (16" DIP)
h. District 3 connector line I-1 (10" DIP)
i. District 3 connector line I-2 (8" DIP)
j. Greenville metering point
k. Central City metering points

The key elements of the new 8 MGD water treatment facility alternative include:

a. 8.0 MGD ultrafiltration system
b. installation, transfer pumps and internal piping for ultrafiltration
c. building for new facilities
d. pretreatment chemical storage, handling and feed equipment
e. pretreatment mixing
f. pretreatment flocculation
g. pretreatment settling
h. site work
i. site piping
j. laboratory and furnishings
k. clear well
l. high service pumps
m. backwash/wastewater treatment
n. chlorination system
o. electrical and control
p. SCADA system

2.3.2 Advantages

The advantages of an entirely new treatment facility include:

a. All of the components of the new plant will be brand new.

2.3.3 Disadvantages

The disadvantages of constructing an entirely new treatment facility include:

a. A large amount of valuable -- and not yet fully depreciated -- facilities in the Central City system will be abandoned, and yet must be paid for, so paying for these facilities will increase the overall cost of the new treatment facility and its associated transmission, pumping, and metering facilities.
b. The filters in the existing plant (which will pass 8.0 MGD at 4 gpm/ft^2) will not be available, and this means that if total organic carbon (TOC) removal, and taste and odor control are defined as needs during pilot testing or at some later date, it would be necessary to install activated carbon facilities at additional cost to remove taste and odor and TOC.
c. This project would abandon the existing water treatment facilities at both Greenville and Central City.
d. The cost for new transmission and connector lines and metering will be significantly greater for this option.

2.3.4 Cost

The Opinion of Probable Cost for each portion of the various improvements associated with Option 2 is shown in the Appendix and the Opinion of Probable Cost for the total project is summarized below.

Estimate 2

Option 2 – New 8.0 MGD Water Treatment Plant

Muhlenberg County Water System Improvements

Opinon of Probable Costs

Item	Probable Cost
Raw Water Intake "B" Modifications	$ 430,000
Raw Water Line "D" (24" DIP)	581,700
New 8.0 MGD Water Treatment Plant	11,330,000
Finished Water Line "E" (24" DIP)	1,488,875
Finished Water Line "F" (12" DIP) & "G" (8" DIP)	1,095,925
Central City Connector Line "H" (16" DIP)	394,800
District 3 Connector Line "I -1" (10" DIP)	120,388
District 3 Connector Line "I -2" ("8" DIP)	33,500
Metering Point for Greenville	30,000
Metering Points for Central City	30,000
Subtotal	15,535,188
Contractors Overhead and Profit	2,330,278
Subtotal	17,865,466
Construction Contingency	1,786,534
Total Estimated Construction Cost	19,652,000
Non-Construction Costs	2,948,000
Total Estimated Project Cost	$22,600,000

2.4 Non-Unified Alternative

One of the possibilities that may emerge from this study is that Greenville chooses not to join the other three utilities. If this should be the case, Greenville would, at the least, have to develop a new raw water source on the Green River, and in order to have a situation equivalent to the other three utilities Greenville would have to build a new 1.0 MGD ultrafiltration plant. The other three utilities would have to increase the amount of water available to them and would upgrade to ultrafiltration, but would only need to increase the plant size to 7.0 MGD. Under this scenario it would be the group of three who had the 1.0 MGD of industrial capacity, and Greenville would not be able to supply any significant amount of industrial water.

In order to allow the parties to contrast the likely costs of a non-unified approach Estimates 3.1, 3.2, and 3.3 have been developed to show, respectively:

- Estimate 3.1 - the estimated cost of a project for the current 3 parties that would increase the capacity to 7.0 MGD;
- Estimate 3.2 - the estimated cost to Greenville if Greenville develops a new raw water source but continues to use the existing treatment plant, and
- Estimate 3.3 - the estimated cost to Greenville if Greenville develops a new raw water source and builds a new 1.0 MGD ultrafiltration plant.

It is interesting to note that the $3,205,000 estimated saving to the three if Greenville does not join them is almost identical to Greenville's cost for the now water source project without treatment plant.

Estimate 3.1

Reuse Central City Plant (7.0 MGD)

To Serve District 1, District 3 and Central City

Opinon of Probable Costs

Item	Probable Cost
Raw Water Intake "B" Modifications	$ 400,000
Water Treatment Plant Improvements & Expansion to 7.0 MGD	6,600,000
Finished Water Line "C" (16" DIP)	902,375
District 3 Connector Line "I" (10" DIP)	135,825
Subtotal	8,038,200
Contractors Overhead and Profit	1,205,800
Subtotal	9,244,000
Construction Contingency	926,000
Total Estimated Construction Cost	10,170,000
Non-Construction Costs	1,525,000
Total Estimated Project Cost	$11,695,000

Estimate 3.2

Greenville Only Excluding

Upgrade of Greenville's Existing Plant

Opinon of Probable Costs

Item	Probable Cost
Raw Water Line A	$1,842,800
Raw Water Intake	400,000
Subtotal	2,242,800
Contractors Overhead and Profit	335,200
Subtotal	2,578,000
Construction Contingency	257,000
Total Estimated Construction Cost	2,835,000
Non Construction Costs	425,000
Total Estimated Project Cost	$3,260,000

Estimate 3.3

Greenville Only Including

Upgrade of Greenville's Existing Plant

Opinon of Probable Costs

Item	Probable Cost
Raw Water Line A	$1,842,800
Raw Water Intake	400,000
1.0 MGD Ultra-filtration Treatment Plant	1,600,000
Subtotal	3,842,800
Contractors Overhead and Profit	576,200
Subtotal	4,419,000
Construction Contingency	440,000
Total Estimated Construction Cost	4,859,000
Non Construction Costs	726,000
Total Estimated Project Cost	$5,585,000

2.5 Recommended Option

The recommended option for construction is Option 1, Reuse the Existing Central City Facilities to the maximum possible extent. This option has the major advantage of being an estimated $ 7,700,000 less expensive than Option 2, which is to create a completely new facility (except for reusing Central City's raw water intake).

The recommended option does have the moderate disadvantage that some equipment will not be brand new and will have a shorter life before repairs are required, but this is a minor item when compared to the overall cost saving. It should be noted that it is likely that all additional cost over the lowest cost (recommended) option will likely have to be repaid directly by the water users in Muhlenberg County since the financing possibility presented in Section 5, assumes a high level of grant funding which still will not cover the entire project cost.

Ownership can be accomplished with either of the options presented herein, and there does not appear to be a financial reason for choosing one option over the other. In the case of either option, depreciation issues will have to be satisfactorily resolved and, in the case of either option, a contract between all of the parties that covers all forseeable aspects of ownership, operation, billing, and financing will have to be created and entered into. The crucial aspect of this agreement is that all parties shall be satisfied that the agreement is fair to all.

EXHIBIT 1

WATER SYSTEM IMPROVEMENTS
FOR MUHLENBERG COUNTY, KENTUCKY

OPTION 1 - REUSE CENTRAL CITY PLANT

SCALE 1" = 3,000'

0 1,500 3,000'

GARVER ENGINEERS

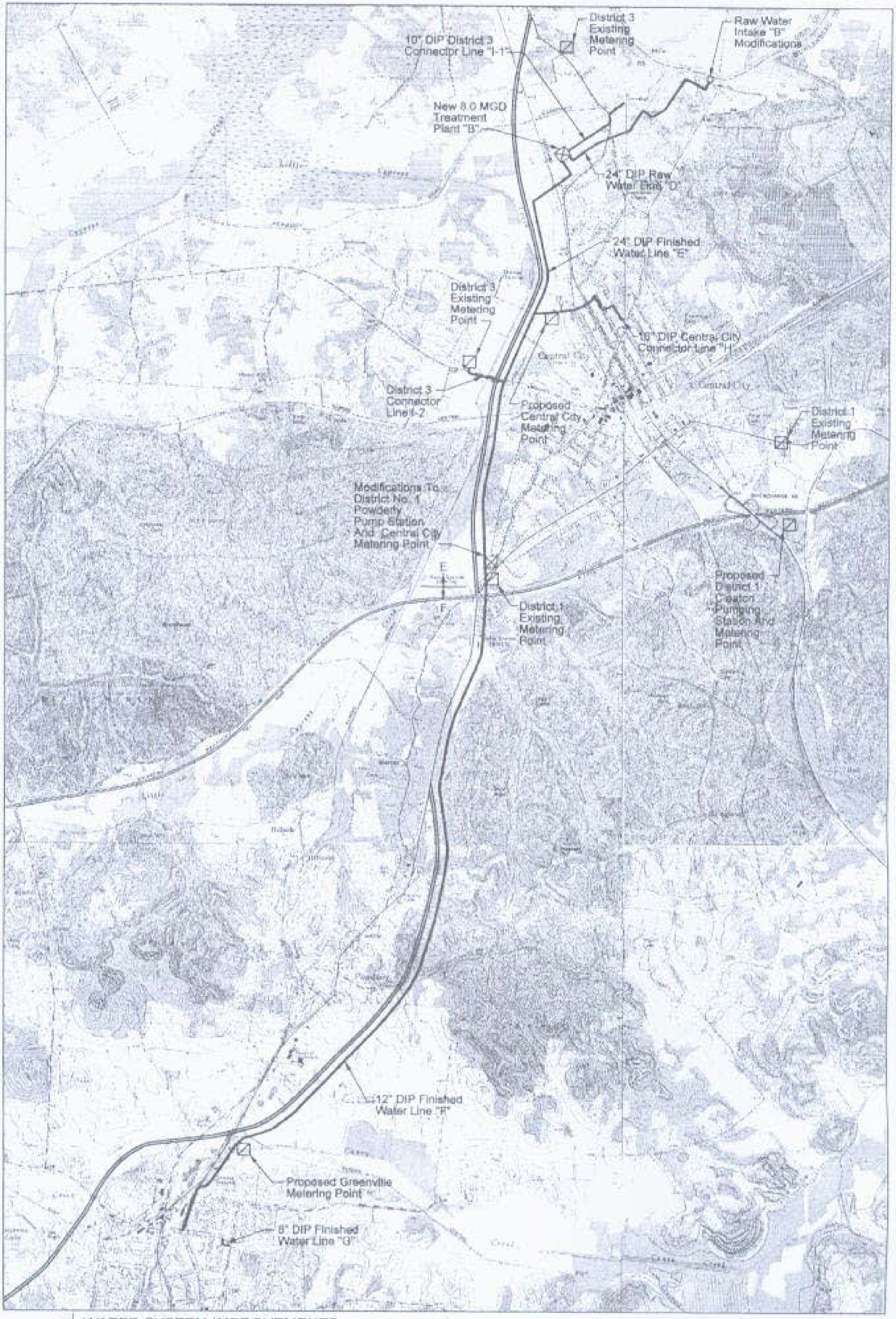

EXHIBIT 2

WATER SYSTEM IMPROVEMENTS
FOR MUHLENBERG COUNTY, KENTUCKY

OPTION 2 - NEW PLANT

SCALE: 1" = 3,000

0 1,500 3,000

GARVER ENGINEERS

SECTION 3

METERING FOR ALTERNATE SITUATIONS

3.1 General

Metering of water sold to the various entities could be accomplished by the following methodology for each alternative.

3.2 Option 1 – Reuse Central City Plant

1. The flow leaving the Central City treatment plant would be metered.
2. Flow to District No. 3 would be metered at the existing main metering point on US Highway 431.
3. Flow to District No. 3 at the small pumping station on State Route 70 would continue to be metered at that point.
4. Flow to District No. 1 from Central City would be metered at the existing US Highway 62 E connection point.
5. Flow to District No. 1 from Central City would be metered at the new Cleaton Pumping Station.
6. The District No. 1 Powderly Pumping Station would pump to the District and through it to Greenville. All the flow passing through the Pumping Station would be metered at that point.
7. The flow to Greenville would be metered at an appropriate point north of Greenville.

3.3 Option 2 - New Plant

1. The flow leaving the new treatment plant would be metered.
2. A direct connection would be made to District No. 3 through new connector line I, and the flow would be metered at the existing main metering point located on US Highway 431.

3. Flow to District No. 3 at the small pumping station on State Route 70 would flow through a new connector line and would continue to be metered at that point.
4. The flow through Central City Connector Line H would be metered to that part of the city.
5. The flow to Central City from the connection adjacent to the District No. 1 Powderly Pumping Station would be metered at that point (the flow into Central City from both connections would include the flow that would go back out at the two eastern connections to District No. 1).
6. The flow to District No. 1 from Central City would be metered at the existing US Highway 62 East connection point.
7. The flow to District No. 1 from Central City would be metered at the new Cleaton Pumping Station.
8. The District No. 1 Powderly Pumping Station would pump to the District and through it to Greenville. All the flow passing through the Pumping Station would be metered at that point.
9. The flow to Greenville would be metered at an appropriate point north of Greenville.

SECTION 4
OPERATING/OWNERSHIP OPTIONS

4.1 Options

The basic methods for handling ownership and operation of the water source/treatment/transmission system (water supply) are ownership and operation by Central City or ownership and operation by a Commission. Under the first option, Central City remains owner of the treatment plant, intake, and transmission lines and tanks inside Central City and the other parties buy water at wholesale from Central City.

Under the second option, a Commission would have to be formed and it would then have to purchase all interest in the Central City treatment plant, the Central City intake, and three tanks and the main transmission lines in Central City plus new transmission lines in Central City, between Central City and Greenville, and all new additions to the existing Central City treatment plant and intake.

In either case, the cornerstone of the system will be a contractual agreement between the parties that sets out all parameters and that guarantees fair and equitable treatment to all parties. The positive and negative features of the two alternatives are discussed below.

4.2 Ownership by Central City

4.2.1 Advantages

An obvious advantage of this method is its simplicity. Three of the four potential parties are already linked in this arrangement—and have been linked for many years—and simply by adding one additional party the new arrangement would be completed.

There would be less legal and administrative expense and less time consumed if the parties elect to continue with the existing ownership and operating agreement.

It is possible that as four separate but cooperating utilities the parties would be eligible for a larger amount of grant money than they would be eligible for as a single entity.

No cost would be incurred in transferring Central City's appropriate assets to the new entity.

The people of Central City would not be required to give up assets that they have owned for many years.

4.2.2 Disadvantages

The wholesale customers could feel that they are less than equal partners in the venture, however two of them have already been in the relationship for many years and it has been satisfactory and there is no reason to believe that it will not continue to be so.

4.3 Ownership by a Commission

4.3.1 Advantages

All of the parties would see themselves as equals.

4.3.2 Disadvantages

Central City's citizens would be likely to have a difficult time accepting the loss of so many of their City's long-time assets.

The cost of setting up the new entity would be significant, and the time required to do so would also be significant, thus slowing down the project.

The commission would have to purchase from Central City all of the facilities that will be reused and this would add several millions of dollars to the cost of the project.

It is possible that as one entity, rather than as four separate cooperating utilities, the commission would not be eligible for as much grant money as the four separate utilities would be.

4.4 Recommendation

We recommend that Greenville enter existing agreement and become a wholesale customer along with Districts 1 and 3. The new amortization and operating costs will be added onto the existing agreement to determine a new, uniform wholesale water purchase rate for all customers. The Cost Allocation Calculations in Section 5 are based on this option.

This recommendation is made because:

1. The recommended option for carrying out the project is to utilize to the fullest possible extent the existing Central City facilities.

2. Three of the four potential parties to the agreement (and all three are parties to the agreement if Greenville does not choose to join) are already bound by an existing agreement and an existing wholesale water rate ($1.25 per thousand gallons).

3. Utilization of the existing wholesale sale/purchase approach will be by far the easiest option to implement.

4. It will be possible to implement this option much more quickly than the other option, and time is important because both of the water supplies involved have the problem of inadequate supply or treatment capacity.
5. This alternative avoids increasing the project cost in order to pay Central City for its assets that would have to be taken over by a commission.
6. This approach achieves the goal of having the same wholesale water purchase rate per 1,000 gallons for all customers, thus making the cost totally proportional to the amount of water required.

SECTION 5
COST ALLOCATION

5.1 General

The two major elements that comprise the cost to be allocated are operation of the system and amortization of the cost of all of the components of the system. In this particular situation, each of the two elements has two parts.

In the case of operation, the two parts are payment for the new operating costs associated with the higher level of treatment that will be achieved by the new treatment plant and payment for the ongoing operating costs of the existing facilities that will become the foundation of the new system. Unlike the other parties, Greenville will experience a decrease in operating cost since it will no longer have to operate its existing water treatment plant. It is estimated that this decrease will be greater than the corresponding cost that Greenville will pay as its share of the ongoing operating costs of the reused Central City water treatment plant.

In the case of amortization, the two elements are amortization of the new facilities that will be built and amortization of the existing facilities that will be incorporated into the new system.

Central City and District 1 and District 2 have been paying the costs of amortization and operation of the existing facilities for many years, and the method for sharing these costs between them is the wholesale charge of $1.25 for each 1,000 gallons of water purchased. In order to pay for the new operating costs and for amortization of the new facilities there will have to be an increase to this $1.25 rate.

If Greenville joins the other three parties in the system and becomes a wholesale customer, the financial agreement will be such that the wholesale cost per 1,000 gallons of water purchased by Greenville will be the same as the wholesale cost to the other customers.

In order to determine the addition to the basic $1.25 rate that will be required to pay for the new operation and amortization costs, in the calculations that follow the cost of operation and amortization of the new facilities has been divided between all of the customers on the basis of water purchased.

The two Districts are already paying the basic $1.25 charge and a description of how Greenville's addition as a customer will affect this rate is also included in this discussion. In each case the annual cost of the system will be considered in two parts, the cost of the new facilities and operation and the cost of the existing facilities and operation.

5.2 Recommended Option

A contract, which has been in force for many years, exists between Central City, District 1, and District 3. Under this contract the two Districts purchase water from Central City for $1.25 per 1000 gallons. This amount covers amortization of all of the facilities that are jointly used and the operation of the water treatment plant and associated overhead costs. The new wholesale water charge to the two Districts will include an amount added to the current wholesale price to cover the additional operating and amortization costs generated by this project. The rate for Greenville will be based on Greenville's share of the new amortization and operation costs and Greenville's share of the cost of the existing treatment facility.

In order to calculate Greenville's percentage of water sold the amount of water pumped at the Greenville plant has been used. The result sought is to calculate the same cost per thousand gallons for each wholesale customer, including costs for the existing facilities and the new rate to cover amortization of the work under this project plus the new operating costs.

Based on all of the above, we recommend that the cost split be based on a wholesale purchase approach with each of the purchasers paying the same cost per thousand gallons. The actual rate will be determined by the amount

of grant that can be obtained and by the final project design and cost. It currently appears that this cost will be some where in the range of $1.60 to $1.90 per 1,000 gallons.

5.3 Sample Annual Cost Calculation

We recommend that all costs be shared on the basis of water used, so this calculation is based on splitting all costs on the basis of the amount of water used by each party during the year.

The actual figures for water used by each party during the year 2002 are as follows:

Existing Customers

Utility	Total Use (Gallons)	Percent of Grand Total
Central City	209,899,600	21.83
District 1	523,489,300	54.46
District 3	227,899,800	23.71
Grand Total	961,288,700	100.00

Greenville Plus
Existing Customers

Utility	Total Use (Gallons)	Percent of Grand Total
Central City	209,899,600	17.98
District 1	523,489,300	44.85
District 3	227,899,800	19.52
Greenville	206,027,718	17.65
Grand Total	1,167,316,418	100.00

The percentages of Grand Total shown immediately above are the percentages used throughout the following example to calculate the split of the new costs. In preparing the following series of Tables, a number of assumptions have been made, and they are explained below and terms that have been used are defined below.

It should be noted that all of the figures in the Tables that follow are approximate and must be confirmed or adjusted as necessary by the parties' accountants and must be adjusted as cost estimates are refined and possible grant participation and bond interest rates are established.

5.4 Terms and Assumptions - with no grant funds

1. There will be no grant funds.

2. The existing wholesale rate will be adjusted by adding the marginal cost of the additional water to be treated for Greenville and the new total will be split among the customers based on the amount of water each will purchase.

3. Greenville will no longer have to pay for operation of its treatment plant and water sources and will have an annual saving estimated to be $115,907 per year (based on Central City operating cost per 1000 gallon with the assumption that Greenville will not be able to end all of its overhead costs for which an allowance of $30,000 per year has been made.) These assumptions will have to be verified.

4. All of the parties will pay their share of the operating cost addition due to the higher level of treatment that will be achieved. This will be part of the new wholesale rate.

5. All of the parties will pay their share of the amortization cost for the new facilities. This will be part of the new wholesale rate.

COST COMPILATION for TABLE 5.1-1

The current wholesale rate of $1.25 per thousand gallons covers all of the purchasers' costs of buying water. If Greenville becomes a wholesale purchaser the only additional annual cost will be the marginal cost of producing the water Greenville purchases. The current marginal cost of the water produced is for chemicals and power, and in the most recent audit these costs amounted to $126,723 for 961,288,700 gallons, or 13.18 cents per thousand gallons. Since Greenville will use 206,027,000 gallons per year, the additional cost will be $27,160 per year.

Since Greenville will be sharing in the fixed costs as well as the marginal costs, the existing $1.25 wholesale rate will be adjusted downward for all customers, including Greenville, if Greenville joins. It will then have to be adjusted upward to add to all of the customers the marginal cost of treating the water for Greenville (the marginal cost for the existing customers is already covered in the $1.25). It will have to be further adjusted upward for all customers to cover the operating and amortization costs for the new facilities.

In order to spread the current $1.25 rate over Greenville as well as the other customers the rate needs to be adjusted by the ratio of the new amount of water that will be produced to the existing amount so the income will only be redistributed not increased. Then the marginal cost attributable to Greenville will be spread over all customers. The calculations are as follows:

1. Adjustment to Current Wholesale Rate By Adding Greenville:
    a. Existing rate redistribution by adding Greenville =

       = $1.25 per 1000 gallons x [961,288,700 /1,167,316,418] =

       = **$1.03 per 1000 gallons**

b. Addition of Greenville's marginal costs:

= $27,160/ 1,167,316 = **$0.02** per thousand gallons

c. Total Cost for Existing Operation = $1.03 + $0.02 **= $1.05 per 1000 gallons**

In order to get the new total wholesale rate, the cost of amortizing the new facilities and the added operating cost must be determined on a per thousand gallons basis. The calculation is as follows:

2. New Amortization and Operating Cost per 1000 Gallons (Assuming No Grant Funds):

a. Total Project Cost = $14,900,000	
b. Annual amortization cost assuming no grant funds and payback at 5% over 38 years =	$ 883,335
c. Additional annual operating cost =	125,000
d. Total annual amortization and operating Cost for new facilities =	$ 1,108,355
e. Total amortization and operating cost for new facilities per 1000 gallons = = $ 1,108,355 / 1,167,316 =	**$ 0.86**

3. New Wholesale Rate per 1000 Gallons (Assuming No Grant Funds):

a. Current rate adjustment by adding Greenville =	$ 1.05
b. Amortization and operating cost for new facilities =	0.86
c. New Total Wholesale Rate per 1000 Gallons =	$ 1.91

Use New Wholesale Rate of $ 1.90 per 1000 Gallon

The above figures or their counterparts for differing situations are used in the calculations that follow.

TABLE 5.1-1

CUSTOMER MONTHLY INCREASE

ALL FOUR UTILITIES

OPTION 1 – REUSE CENTRAL CITY'S PLANT

WITH NO GRANT FUNDS

	CENTRAL CITY	DISTRICT 1	DISTRICT 3	GREENVILLE
ANNUAL WATER USED (GALLONS)	209,899,600	523,489,300	227,899,800	206,027,718
NEW ANNUAL COST @ $1.90 PER 1000 GALLON	$ 398,809	$ 994,629	$ 433,009	$ 391,452
LESS CURRENT ANNUAL COST @ $1.25 PER 1000 GALLON	- $ 262,375	- $ 654,362	- $ 284,875	0
LESS GREENVILLE'S CURRENT REDUCED OPERATING COST	0	0	0	- $ 115,907
TOTAL ADDITIONAL ANNUAL COST	$ 136,428	$ 340,267	$ 148,134	$ 275,545
CUSTOMERS	2,267	5,982	2,031	2,025
AVERAGE CUSTOMER MONTHLY INCREASE	$ 5.02	$ 4.74	$ 6.08	$ 11.34

TABLE 5.1-2

CUSTOMER MONTHLY INCREASE

NON UNIFIED ALTERNATIVE

DISTRICT 1, DISTRICT 3, CENTRAL CITY

WITH NO GRANT FUNDS

USE CENTRAL CITY PLANT @ $11,695,000 TOTAL PROJECT

CURRENT OPERATING COST $571,394 + $109,386 = $680,780

NEW OPERATING COST $93,750

ASSUME NO GRANTS.
PAYBACK of $11,695,000 @ 5.0%/38 YEARS = $693,329

TOTAL NEW ANNUAL COST IS $787,079

	CENTRAL CITY	DISTRICT 1	DISTRICT 3
PERCENT OF TOTAL	**21.83**	**54.46**	**23.71**
ANNUAL COST OF NEW EXPENSES	$171,819	$428,643	$186,616
AVERAGE CUSTOMER MONTHLY INCREASE	$6.32	$5.97	$7.66
CUSTOMERS	2267	5982	2031

TABLE 5.1-3

CUSTOMER MONTHLY INCREASE

NON UNIFIED ALTERNATIVE

GREENVILLE ALONE - NO TREATMENT PLANT

WITH NO GRANT FUNDS

USE GREENVILLE'S EXISTING PLANT @ $3,260,000 TOTAL PROJECT

NEW OPERATING COST = $10,000

ASSUME NO GRANT.
PAYBACK of $3,260,000 @ 5.0%/38 YEARS = $153,267

TOTAL ANNUAL NEW COST IS $203,267

	GREENVILLE
PERCENT OF TOTAL	**100**
NEW ANNUAL COST	$203,267
AVERAGE CUSTOMER ADDITIONAL MONTHLY COST	$8.36
CUSTOMERS	2025

TABLE 5.1-4

CUSTOMER MONTHLY INCREASE

NON UNIFIED ALTERNATIVE

GREENVILLE ALONE – WITH TREATMENT PLANT

WITH NO GRANT FUNDS

NEW GREENVILLE PLANT @ $5,585,000 TOTAL PROJECT

NEW OPERATING COST = $30,000

ASSUME NO GRANT.
PAYBACK of $5,585,000 @ 5.0%/38 YEARS = $331,102

TOTAL ANNUAL NEW COST IS $361,102

	GREENVILLE
PERCENT OF TOTAL	**100**
NEW ANNUAL COST	$361,102
AVERAGE CUSTOMER ADDITIONAL MONTHLY COST	$14.86
CUSTOMERS	2025

5.5 Terms and Assumptions - with grants

1. Grants totaling $6,000,000.00 will be obtained.

2. The existing wholesale rate will be adjusted by adding the marginal cost of the additional water to be treated for Greenville and the new total will be split among the customers based on the amount of water each will purchase.

3. Greenville will no longer have to pay for operation of its treatment plant and water sources and will have an annual saving estimated to be $115,907 per year (based on Central City operating cost per 1000 gallon with the assumption that Greenville will not be able to end all of its overhead costs for which an allowance of $30,000 per year has been made.) These assumptions will have to be verified.

4. All of the parties will pay their share of the operating cost addition due to the higher level of treatment that will be achieved. This will be part of the new wholesale rate.

5. All of the parties will pay their share of the amortization cost for the new facilities. This will be part of the new wholesale rate.

COST COMPILATION for TABLE 5.2-1

The current wholesale rate of $1.25 per thousand gallons covers all of the purchasers' costs of buying water. If Greenville becomes a wholesale purchaser the only additional annual cost will be the marginal cost of producing the water Greenville purchases. The current marginal cost of the water produced is for chemicals and power, and in the most recent audit these costs amounted to $126,723 for 961,288,700 gallons, or 13.18 cents per thousand gallons. Since

Greenville will use 206,027,000 gallons per year; the additional cost will be $27,160 per year.

Since Greenville will be sharing in the fixed costs as well as the marginal costs, the existing $1.25 wholesale rate will be adjusted downward for all customers, including Greenville, if Greenville joins. It will then have to be adjusted upward to add to all of the customers the marginal cost of treating the water for Greenville (the marginal cost for the existing customers is already covered in the $1.25), and it will have to be further adjusted upward for all customers to cover the operating and amortization costs for the new facilities.

In order to spread the current $1.25 rate over Greenville as well as the other customers the rate needs to be adjusted by the ratio of the new amount of water that will be produced to the existing amount so the income will only be redistributed not increased. Then the marginal cost attributable to Greenville will be spread over all customers. The calculations are as follows:

1. Adjustment to Current Wholesale Rate By Adding Greenville:
   a. Existing rate redistribution by adding Greenville =

      = $1.25 per 1000 gallons x [961,288,700 /1,167,316,418] =

      = **$1.03 per 1000 gallons**
   b. Addition of Greenville's marginal costs:

      = $27,160/ 1,167,316 = **$0.02** per thousand gallons
   c. Total Cost for Existing Operation = $1.03 + $0.02 **= $1.05 per 1000 gallons**

In order to get the new total wholesale rate, the cost of amortizing the new facilities and the added operating cost must be determined on a per thousand gallons basis.

The calculation is as follows:

2. New Amortization and Operating Cost per 1000 Gallons (Assuming $ 6,000,000 Grants):

a.	Total Project Cost = $14,900,000	
b.	Loan amount assuming $ 1,500,000 grant for each of four parties = $ 8,900,000	
c.	Annual amortization cost assuming 40% grant funds and payback at 5% over 38 years =	$ 527,630
c.	Additional annual operating cost =	125,000
d.	Total annual amortization and operating Cost for new facilities =	$ 652,630
e.	Total amortization and operating cost for new facilities per 1000 gallons = = $ 652,630 / 1,167,316 =	**$ 0.56**

3. New Wholesale Rate per 1000 Gallons(Assuming No Grant Funds):

a.	Current rate adjustment by adding Greenville =	$ 1.05
b.	Amortization and operating cost for new facilities =	0.56
c.	New Total Wholesale Rate per 1000 Gallons =	$ 1.61

Use New Wholesale Rate of $ 1.60 per 1000 Gallon

The above figures or their counterparts for differing situations are used in the calculations that follow.

TABLE 5.2-1

CUSTOMER MONTHLY INCREASE

ALL FOUR UTILITIES

OPTION 1 – REUSE CENTRAL CITY'S PLANT

WITH $6,000,000 GRANT

	CENTRAL CITY	DISTRICT 1	DISTRICT 3	GREENVILLE
ANNUAL WATER USED (GALLONS)	209,899,600	523,489,300	227,899,800	206,027,718
NEW ANNUAL COST @ $1.60 PER 1000 GALLON	$ 335,839	$ 837,583	$ 364,639	$ 329,644
LESS CURRENT ANNUAL COST @ $1.25 PER 1000 GALLON	- $ 262,375	- $ 654,362	- $ 284,875	0
LESS GREENVILLE'S CURRENT REDUCED OPERATING COST	0	0	0	- $ 115,907
TOTAL ADDITIONAL ANNUAL COST	$ 73,464	$ 183,221	$ 79,764	$ 213,737
CUSTOMERS	2,267	5,982	2,031	2,025
AVERAGE CUSTOMER MONTHLY INCREASE	$ 2.70	$ 2.55	$ 3.27	$ 8.80

TABLE 5.2-2

CUSTOMER MONTHLY INCREASE

NON UNIFIED ALTERNATIVE

DISTRICT 1, DISTRICT 3, CENTRAL CITY

BEST CASE WITH GRANT OF APPROXIMATELY 40%

USE CENTRAL CITY PLANT @ $11,695,000 TOTAL PROJECT

CURRENT OPERATING COST $571,394 + $109,386 = $680,780

NEW OPERATING COST $93,750

ASSUME GRANTS OF $1.5 MILLION FOR EACH OF THE 3 PARTIES,
SO NET AMOUNT TO BORROW IS $7,195,000, PAYBACK @ 5.0%/38 YEARS = $426,550

TOTAL NEW ANNUAL COST IS $520,300

	CENTRAL CITY	DISTRICT 1	DISTRICT 3
PERCENT OF TOTAL	**21.83**	**54.46**	**23.71**
ANNUAL COST OF NEW EXPENSES	$113,581	$283,355	$123,363
AVERAGE CUSTOMER MONTHLY INCREASE	$4.18	$3.95	$5.06
CUSTOMERS	2267	5982	2031

TABLE 5.2-3

CUSTOMER MONTHLY INCREASE

NON UNIFIED ALTERNATIVE

GREENVILLE ALONE - NO TREATMENT PLANT

BEST CASE WITH GRANT OF APPROXIMATELY 40%

USE GREENVILLE'S EXISTING PLANT @ $3,260,000 TOTAL PROJECT

NEW OPERATING COST = $10,000

ASSUME GRANT OF $1.5 MILLION
SO NET AMOUNT TO BORROW IS $1,760,000, PAYBACK @ 5.0%/38 YEARS = $104,340

TOTAL ANNUAL NEW COST IS $114,340

	GREENVILLE
PERCENT OF TOTAL	**100**
NEW ANNUAL COST	- $114,340
AVERAGE CUSTOMER ADDITIONAL MONTHLY COST	$4.71
CUSTOMERS	2025

TABLE 5.2-4

CUSTOMER MONTHLY INCREASE

NON UNIFIED ALTERNATIVE

GREENVILLE ALONE – WITH TREATMENT PLANT

BEST CASE WITH GRANT OF APPROXIMATELY 40%

NEW GREENVILLE PLANT @ $5,585,000 TOTAL PROJECT

NEW OPERATING COST = $30,000

ASSUME GRANT OF $2.25 MILLION
SO NET AMOUNT TO BORROW IS $3,335,000, PAYBACK @ 5.0%/38 YEARS = $197,713

TOTAL ANNUAL NEW COST IS $227,713

	GREENVILLE
PERCENT OF TOTAL	**100**
NEW ANNUAL COST	- $227,713
AVERAGE CUSTOMER ADDITIONAL MONTHLY COST	$9.37
CUSTOMERS	2025

APPENDIX I

OPINION OF PROBABLE COST
OPTION I – REUSE CENTRAL CITY PLANT WITH ADDITION OF ULTRAFILTRATION AND ENLARGEMENT TO 8.0 MGD
MUHLENBERG COUNTY, KENTUCKY

ITEM	TOTAL COST
1. 8.0 Ultrafiltration Membrane System	$ 2,760,000
2. Membrane Installation, Transfer Pumps and Piping for Ultrafiltration System	1,250,000
3. Building for New Facilities	500,000
4. Additional Flocculation Capability	250,000
5. Chemical Feed Improvements	200,000
6. Site Work	75,000
7. Site Piping and Valves	200,000
8. Laboratory Addition	50,000
9. Clearwell Addition	550,000
10. High Service Pump & Enclosure	675,000
11. Miscellaneous Minor Repair, Repainting, and Refurbishing	150,000
12. Electrical Work	550,000
13. Instrumentation & Controls	350,000
TOTAL CONSTRUCTION COST	$ 7,560,000

OPINION OF PROBABLE COST
OPTION 2 – NEW 8.0 MGD ULTRAFILTRATION PLANT
MUHLENBERG COUNTY, KENTUCKY

ITEM	TOTAL COST
1. 8.0 Ultrafiltration Membrane System	$ 2,760,000
2. Membrane Installation, Transfer Pumps	
3. and Piping for Ultrafiltration System	1,250,000
4. Building for New Facilities	1,000,000
5. Pretreatment Chemical Storage, Handling	
6. and Feed Equipment	450,000
7. Pretreatment Mixing	150,000
8. Pretreatment Flocculation	495,000
9. Pretreatment Settling	475,000
10. Site Work	325,000
11. Site Piping and Valves	300,000
12. Laboratory and Furnishing	150,000
13. Clearwell	1,350,000
14. High Service Pumps	650,000
15. Backwash/Wastewater Treatment	350,000
16. Chlorination System	225,000
17. Electrical Work	1,050,000
18. Instrumentation & Controls	350,000
TOTAL CONSTRUCTION COST	$ 11,330,000

OPINION OF PROBABLE COST
VARIOUS WATER LINE PROJECTS
MUHLENBERG COUNTY, KENTUCKY

Raw Water Line A

1. 12-inch D.I.P.	54,500 LF @ $30.50/LF	$1,662,250
2. Highway bore	300 LF @ $100.00/LF	30,000
3. Street repair and miscellaneous	LUMP SUM	85,500
4. Valves	LUMP SUM	65,000
	SUBTOTAL	$1,842,800

Finished Water Line C

1. 18-inch D.I.P.	15,250 LF @ $50.25/LF	$766,313
2. Highway and railroad bore	250 LF @ $275.00/LF	68,750
3. Street repair and miscellaneous	LUMP SUM	95,000
4. Valves & Appurtenances	LUMP SUM	60,000
	SUBTOTAL	$990,063

Raw Water Line D

1. 24-inch D.I.P.	6500 LF $69.50/LF	$451,750
2. Highway and railroad bore	150 LF @ $300.00/LF	45,000
3. Street repair and miscellaneous	LUMP SUM	50,000
4. Valves & Appurtenances	LUMP SUM	35,000
	SUBTOTAL	$ 581,700

Finished Water Line E

1. 24-inch D.I.P.	17,250 LF @ 69.50/LF	$1,198,875
2. Highway and railroad bore	200 LF @ 300.00/LF	60,000
3. Street repair and miscellaneous	LUMP SUM	125,000
4. Valves & Appurtenances	LUMP SUM	75,000
5. Connect to District 3 and Central City and meter	LUMP SUM	30,000
	SUBTOTAL	$1,488,875

Finished Water Line F and G

1. 12-inch D.I.P.	28,250 LF @ $30.50/LF	$861,625
2. 8-inch D.I.P.	800 LF @ $21.00/LF	16,800
3. Highway and railroad bore	100 LF @ $150.00/LF	15,000
4. Street repair and miscellaneous	LUMP SUM	100,000
5. Valves & Appurtenances	LUMP SUM	65,000
6. Connect to existing lines	LUMP SUM	10,000
5. Modifications to existing pump station	LUMP SUM	25,000
	SUBTOTAL	$1,095,925

Central City Connector Line H

1. 16-inch D.I.P.	6400 LF @ $44.50/LF	$284,800
2. Highway and railroad bore	150 LF @ $175.00/LF	30,000
3. Street repair and miscellaneous	LUMP SUM	45,000
4. Valves & Appurtenances	LUMP SUM	25,000
5. Connect to existing lines	LUMP SUM	10,000
	SUBTOTAL	$394,800

District 3 Connector Line I

1. 10-inch D.I.P.	3700 LF @ $27.25/LF	$100,825
2. Street repair and miscellaneous	LUMP SUM	20,000
3. Valves & Appurtenances	LUMP SUM	15,000
	SUBTOTAL	$135,825

District 3 Connector Line I-1

1. 10-inch D.I.P.	2950 LF @ $27.25/LF	$ 80,388
2. Highway and railroad bore	100 LF @ $150.00/LF	15,000
3. Street repair and miscellaneous	LUMP SUM	15,000
4. Valves & Appurtenances	LUMP SUM	10,000
	SUBTOTAL	$120,388

District 3 Connector Line I-2

1. 8-inch D.I.P.	500 LF @ $21.00/LF	$ 10,500
2. Highway and railroad bore	100 LF @ $100.00/LF	10,000
3. Street repair and miscellaneous	LUMP SUM	5,000
4. Valves & Appurtenances	LUMP SUM	8,000
	SUBTOTAL	$33,500

BASIS FOR COST ESTIMATING

Pipe and gate valve costs were estimated using Means 2002 adjusted using the average of Owensboro and Bowling Green figures, which results in 0.8975 x national average, with the result rounded to nearest 25 cents):

24-inch	$69.50/lf
20-inch	$55.50/lf
20-inch	$55.50/lf
18-inch	$50.25/lf
16-inch	$44.50/lf
12-inch	$30.50/lf
10-inch	$27.25/lf
8-inch	$21.00/lf
Gate valve-12"	$1,000ea
Gate valve-16"	$2,000ea
Gate valve-18"	$2,750ea
Gate Valve 20"	$3,275ea
Gate Valve 24"	$5,000ea
Air release valve	$2,500ea

Costs for other elements are based on bid tabulations for similar projects or manufacturers pricing estimates.

Recent Water Plant Costs

February 5, 2008

Owner	Capacity (MGD)	Year Completed	Construction Cost	New, Expansion or Retrofit	Major Components	Cost Per Gallon of Capacity
Logan Todd RWC	10	2003	$24,960,600	New	Raw water basin, flocculation & sedimentation basins, membrane filters, clearwells, high service pump station, administration building, laboratory	$2.50
Madisonville, KY	8	2008	$12,500,000	Retrofit (8➔8)	Retrofit of an existing 8 MGD conventional plant with membrane filtration, no capacity increase.	$1.56
Adair County, KY	5	2008	$12,500,000	New	Intake, flocculation & sedimentation basins, conventional filters, clearwell, high service pump station, administration building, laboratory	$2.50
Dickson Co., TN	5	2003	$15,000,000	New	Intake, direct membrane filtration, clearwell, high service pump station, administration building, laboratory	$3.00
Paintsville, KY	6	2010	$25,000,000	New	Raw water intake, transmission line, flocculation & sedimentation basins, membrane filters, UV disinfection, clearwells, high service pump station, administration building, laboratory	$4.17
Kentucky American Water Co. (Lexington)	20	2010	$160,000,000	New	New water plant and 31 miles of transmission pipeline	$8.00

Central City Water & Sewer System
Water Plant Expansion

May 6, 2008

Preliminary Cost Analysis

Approximate Cost to Expand Plant to 8 MGD

4 MGD Retrofit:	4 MGD x $1.50 =	$6,000,000
4 MGD New Capacity	4 MGD x $3.00 =	$12,000,000
Subtotal – Plant Construction		$18,000,000
Distribution Improvements		$6,000,000
Total Construction		$24,000,000
Project Development Costs & Contingency – 25%		$6,000,000
Total Estimated Project Cost		$30,000,000

Financing Cost

Assuming:	Grant Funds	$5,000,000
	Loan Funds	$25,000,000
	Total	$30,000,000

Wholesale Cost of Water

Current Average Water Sales		3,500,000 GPD
Debt Service on $25M	4.5%, 40 Years, 1.10 CR	$1,495,000
Estimated Additional O&M		$100,000
Total Additional Annual Cost		$1,595,000
Average Wholesale Cost of Water Increase		$1.25 per 1,000 gallons

Water Bill Impact (Allowing for 20% Water Loss)

1,000 gallon per month user	$1.56
2,000 gallon per month user	$3.13
5,000 gallon per month user	$7.81
10,000 gallon per month user	$15.63
100,000 gallon per month user	$156.25

Central City Water & Sewer System May 12, 2008
Water Plant Expansion

Preliminary Cost Analysis

Approximate Cost to Expand Plant to 6 MGD

4 MGD Retrofit:	4 MGD x $1.50 =	$6,000,000
2 MGD New Capacity	2 MGD x $3.00 =	$6,000,000
Subtotal – Plant Construction		$12,000,000
Distribution Improvements		$4,000,000
Total Construction		$16,000,000
Project Development Costs & Contingency – 25%		$4,000,000
Total Estimated Project Cost		$20,000,000

Financing Cost

Assuming:	Grant Funds	$4,000,000
	Loan Funds	$16,000,000
	Total	$20,000,000

Wholesale Cost of Water

Current Average Water Sales		3,500,000 GPD
Debt Service on $16M	4.5%, 40 Years, 1.10 CR	$957,000
Estimated Additional O&M		$75,000
Total Additional Annual Cost		$1,032,000
Average Wholesale Cost of Water Increase		$0.81 per 1,000 gallons

Water Bill Impact (Allowing for 20% Water Loss)

1,000 gallon per month user	$1.01
2,000 gallon per month user	$2.02
5,000 gallon per month user	$5.05
10,000 gallon per month user	$10.10
100,000 gallon per month user	$101.00

CENTRAL CITY

Kentucky

UNBRIDLED SPIRIT

Municipal Water & Sewer System

Water System Expansion & Rehabilitation

Preliminary Engineering Report

June 24, 2009

McGHEE ENGINEERING

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Project Budget

Item	Total
Construction	
Renovate River Water Pump Station	$ 700,000
Expand Water Plant to 7 MGD	$ 11,500,000
1 MG Elevated Water Storage Tank	$ 2,000,000
Renovate Existing Water Storage Tanks	$ 600,000
Distribution System Improvements	$ 1,700,000
SUBTOTAL - Construction	$ 16,500,000
Non-Construction Items	
Administrative	$ 60,000
Legal Costs	$ 60,000
Land & ROW	$ 10,000
GIS Data Acquisition and Implementation	$ 220,000
Preliminary Engineering	$ 450,000
Additional Services - Geotechnical, Environmental, Special Studies	$ 150,000
Design Engineering	$ 810,000
Construction Phase Engineering Services	$ 350,000
Construction Inspection	$ 740,000
Start-Up Services & O&M Manuals	$ 150,000
SUBTOTAL - Non-Construction	$ 3,000,000
Contingency	$ 1,650,000
TOTAL ESTIMATED PROJECT COST	$ 21,150,000

Project Financing

2008 KIA Coal Severance Grant	$ 1,550,000
USDA Rural Development/CDBG Grant	$ 6,500,000
USDA Rural Development Loan	$ 13,100,000
TOTAL	$ 21,150,000

- Approximately 50% of the KIA funds should be available to draw by September 1, 2009.
- Any combination of RD, CDBG, or other grant totaling $6,500,000.
- Assumes RD loan at 3.75%, 40 years.
- Still need to request KIA funds in 2010 legislative session.

Water System Budget Impact

Current Average Water Sales	3,500,000 GPD
Debt Service on $13.1M, 3.75%, 40 Yr, 1.10 Cvg.	$701,200
Estimated Additional O&M	$100,000
Estimated Additional Annual Depreciation	$528,750
Total Additional Annual Cost	$1,329,950
Average Wholesale Cost of Water Increase	$1.04 per 1,000 Gal

User Rate Impact

Rank			City Name	Date of Last Incr.	Minimum Bill	Minimum (Gal.)	1000 Gallons	2000 Gallons	3000 Gallons	4000 Gallons	5000 Gallons	10000 Gallons
O	I	F	INSIDE CITY RATES									
1			Central City Water & Sewer - Original	7/1/02	$ 3.25	1000	$ 3.25	$ 5.30	$ 7.35	$ 9.40	$ 11.45	$ 19.95
	1		Central City Water & Sewer - Interim	9/20/08	$ 4.06	1000	$ 4.06	$ 6.62	$ 9.18	$ 11.74	$ 14.30	$ 24.95
2	2	1	Earlington Water & Sewer System	7/2/02	$ 6.50	2000	$ 6.50	$ 6.50	$ 9.30	$ 12.10	**$ 14.60**	$ 24.10
3	3	2	Nortonville Water Works	5/1/95	$ 9.00	2000	$ 9.00	$ 9.00	$ 11.25	$ 13.50	**$ 15.75**	$ 27.00
4	4	3	Hopkinsville Water Environmental Authority	7/1/07	$ 7.41	2244	$ 7.41	$ 7.41	$ 9.91	$ 13.21	**$ 16.51**	$ 33.02
5	5	4	HWEA-Pembroke	7/1/07	$ 9.45	2244	$ 9.45	$ 9.45	$ 11.61	$ 14.47	**$ 17.33**	$ 31.64
		5	Central City Water & Sewer - Final	n/a	$ 4.47	1000	$ 4.47	$ 7.74	$ 11.01	$ 14.28	$ 17.55	$ 32.15
6	6	6	Kuttawa Water Department	1/1/06	$ 8.00	1000	$ 8.00	$ 10.72	$ 13.44	$ 16.16	**$ 18.88**	$ 32.08
7	7	7	HWEA-Crofton	7/1/07	$ 11.91	2244	$ 11.91	$ 11.91	$ 14.44	$ 17.78	**$ 21.12**	$ 37.83
8	8	8	Dawson Springs Water & Sewer System	1/1/08	$ 10.27	2000	$ 10.27	$ 10.27	$ 14.06	$ 17.79	**$ 21.52**	$ 37.52
9	9	9	Salem Municipal Water System	1/1/08	$ 10.30	2000	$ 10.30	$ 10.30	$ 14.64	$ 18.98	**$ 23.32**	$ 41.47
10	10	10	Princeton Water/Wastewater	11/1/06	$ 7.98	1122	$ 7.98	$ 13.34	$ 16.02	$ 18.70	**$ 24.06**	$ 41.44
11	11	11	Greenville Utilities Commission	1/1/08	$ 8.20	1000	$ 8.20	$ 12.60	$ 16.60	$ 20.60	**$ 24.60**	$ 42.85
12	12	12	Cadiz Municipal Water	1/1/08	$ 12.00	2000	$ 12.00	$ 12.00	$ 16.42	$ 20.84	**$ 25.26**	$ 42.56
13	13	13	Guthrie Water Works	7/12/05	$ 16.50	2000	$ 16.50	$ 16.50	$ 20.00	$ 23.50	**$ 27.00**	$ 44.50
14	14	14	White Plains Water Department	1/1/08	$ 12.25	1000	$ 12.25	$ 16.00	$ 19.75	$ 23.50	**$ 27.25**	$ 46.00
15	15	15	Madisonville Light & Water	11/17/03	$ 8.66	1000	$ 8.66	$ 13.31	$ 17.96	$ 22.61	**$ 27.26**	$ 50.51
16	16	16	Drakesboro Water Department	6/7/03	$ 16.28	2000	$ 16.28	$ 16.28	$ 20.59	$ 24.90	**$ 29.21**	$ 50.76
17	17	17	Morton's Gap Water Department	12/3/07	$ 14.75	2000	$ 14.75	$ 14.75	$ 19.80	$ 24.85	**$ 29.90**	$ 53.70
18	18	18	Oak Grove Water Department	1/1/08	$ 14.64	2000	$ 14.64	$ 14.64	$ 20.03	$ 25.42	**$ 30.81**	$ 57.76
19	19	19	Grand Rivers Water System	6/14/03	$ 14.00	0	$ 17.50	$ 21.00	$ 24.50	$ 28.00	**$ 31.50**	$ 49.00
20	20	20	Hanson Water System	4/25/05	$ 16.00	2000	$ 16.00	$ 16.00	$ 21.50	$ 27.00	**$ 32.50**	$ 58.00
21	21	21	Eddyville Water Department	7/1/04	$ 21.12	2000	$ 21.12	$ 21.12	$ 25.69	$ 30.26	**$ 34.83**	$ 57.69
22	22	22	Smithland Water & Sewer System	12/1/03	$ 19.08	2000	$ 19.08	$ 19.08	$ 24.54	$ 30.00	**$ 35.46**	$ 60.06
23	23	23	Elkton Water Works - 1/9/09	2/13/07	$ 21.27	2000	$ 21.27	$ 21.27	$ 26.02	$ 30.77	**$ 35.52**	$ 57.67
24	24	24	Marion Water Department	7/1/07	$ 16.36	1500	$ 16.36	$ 19.37	$ 25.39	$ 31.41	**$ 37.43**	$ 61.48
25	25	25	Fredonia Water Department	10/11/04	$ 18.38	2000	$ 18.38	$ 18.38	$ 25.40	$ 32.44	**$ 39.45**	$ 70.14
26	26	26	Trenton Water Works	1/15/03	$ 24.48	1000	$ 24.48	$ 28.96	$ 33.44	$ 37.92	**$ 42.40**	$ 64.80
			Average Charge for Water-Inside City				$ 12.50	$ 13.92	$ 17.85	$ 21.86	$ 25.96	$ 44.67

Wholesale Rate Impact

Rank			Supplier Name	Date of Last Incr.	Rate $/1000 Gal
O	I	F	WHOLESALE		
1			Central City Water & Sewer - Original	9/9/96	$ 1.25
2	1	1	Dawson Springs W&S System	1/1/08	$ 1.31
3	2	2	South Hopkins Water District	2/7/96	$ 1.67
	3		Central City Water & Sewer - Interim	9/20/08	$ 1.57
4	4	3	Princeton Water/Wastewater	11/1/06	$ 1.77
5	5	4	Madisonville L&W Nebo/N. Hop	8/27/03	$ 1.89
6	6	5	Madisonville L&W Hanson	8/27/03	$ 1.94
7	7	6	Kuttawa Water Department	1/1/06	$ 2.07
8	8	7	Crittenden/Livingston WD	11/6/03	$ 2.20
		8	Central City Water & Sewer - Future	n/a	$ 2.48
9	9	9	Hopkinsville WEA	7/1/07	$ 2.81
10	10	10	Logan-Todd RWC	2/1/07	$ 3.31
11	11	11	Eddyville Water Department	7/1/04	$ 3.50
			Average Charge for Water (Future)		$ 2.38

Central City Water & Sewer System

June 24, 2009

Water Plant Expansion

Planning Phase Cost Estimate

Item	Total
Renovate River Water Pump Station	$700,000
Expand Water Plant to 7 MGD	$11,500,000
1 MG Elevated Water Storage Tank	$2,000,000
Renovate Existing Water Storage Tanks	$600,000
Distribution System Improvements	$1,700,000
SUBTOTAL - Construction	**$6,500,000**
Administrative	$60,000
Legal Costs	$60,000
Land & ROW	$10,000
GIS Data Acquisition and Implementation	$220,000
Preliminary Engineering	$450,000
Additional Services - Geotechnical, Environmental, Special Studies	$150,000
Design Engineering	$810,000
Construction Phase Engineering Services	$350,000
Construction Inspection	$740,000
Start-Up Services & O&M Manuals	$150,000
SUBTOTAL - Non-Construction	$3,000,000
Contingency	$1,650,000
TOTAL ESTIMATED PROJECT COST	**$21,150,000**

Financing Sources

2008 State Budget Grant	$1,550,000
USDA Rural Development Grant	$6,500,000
USDA Rural Development Loan	$13,100,000
TOTAL	**$21,150,000**

Wholesale Cost of Water

Current Average Water Sales		3,500,000 GPD
Debt Service on $13.1M	3.75%, 40 Years, 1.10 CR	$701,200
Estimated Additional O&M		$100,000
Estimated Additional Annual Depreciation		$528,750
Total Additional Annual Cost		$1,329,950
Average Wholesale Cost of Water Increase		$1.04 per 1,000 gallons

Water Bill Impact (Allowing for 15% Water Loss)

1,000 gallon per month user	$1.22
2,000 gallon per month user	$2.44
5,000 gallon per month user	$6.10
10,000 gallon per month user	$12.20
100,000 gallon per month user	$122.00

Report

Water Treatment Plant Preliminary Engineering Report

Central City, KY

August 2009

WD 3c

Report for

Central City, Kentucky

Water Treatment Plant Preliminary Engineering Report

Prepared by:

STRAND ASSOCIATES, INC.®
325 West Main Street, Suite 710
Louisville, KY 40202
strand.com

August 2009

STRAND
ASSOCIATES, INC.
ENGINEERS

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EXECUTIVE SUMMARY

This preliminary design report evaluates the existing Central City Water Treatment Plant, and recommends capacity and treatment upgrades for the existing Central City Water Treatment Plant. The river water pump station and treatment plant capacity will be expanded from 4-million gallons per day to 7-million gallons per day with provisions provided to expand to the ultimate capacity of 10.5-million gallons per day. The existing contact clarification process will be replaced with a conventional rapid mix, flocculation, and sedimentation process.

EXISTING RIVER WATER PUMPING STATION

The existing river water pumping station consists of the following components:

1. Three new river water pumps.
2. New electrical and chemical feed building.
3. Miscellaneous mechanical, structural, and electrical modifications and improvements.

EXISTING WATER TREATMENT PLANT

The existing water treatment plant consists of the following components:

1. Two new rapid mix tanks.
2. Conversion of the existing sedimentation basin into two (and one future) four-stage tapered flocculation basin trains.
3. New two-train sedimentation basin.
4. Improvements to existing filters including new controls and valves.
5. Filter building expansion and additional filter capacity.
6. New Powdered Activated Carbon, sodium hypochlorite, and coagulant feed rooms.
7. Additional clearwell capacity.
8. New high service pumping station and motor control center room.
9. New supervisory control and data acquisition system.
10. Miscellaneous mechanical, structural, and electrical modifications and improvements.

The opinion of probable construction cost for these improvements is $12,200,000. Construction is anticipated to be completed by November 2011.

SECTION 1
INTRODUCTION

1.01 BACKGROUND

The Central City Water Treatment Plant (WTP) serves customers in the city as well as provides water to customers in the City of Drakesboro, Muhlenburg County Water District No. 1, Muhlenburg County Water District No. 3, and the City of Sacramento in McLean County with an equivalent population of approximately 33,800. Figure 1.01-1 displays the general service area.

1.02 PURPOSE AND SCOPE

The purpose of this preliminary engineering report is to discuss the necessary design elements for immediately expanding the existing river water pumping station and WTP from 4-million gallons per day (mgd) to 7 mgd with an ultimate planned capacity of 10.5 mgd.

This report shall be used to meet the requirements, as described in the Kentucky Administration Regulations Requirement: Chapter 8:100, for preliminary design approval before final design commences.

The remaining sections of the preliminary design report will focus on the following components:

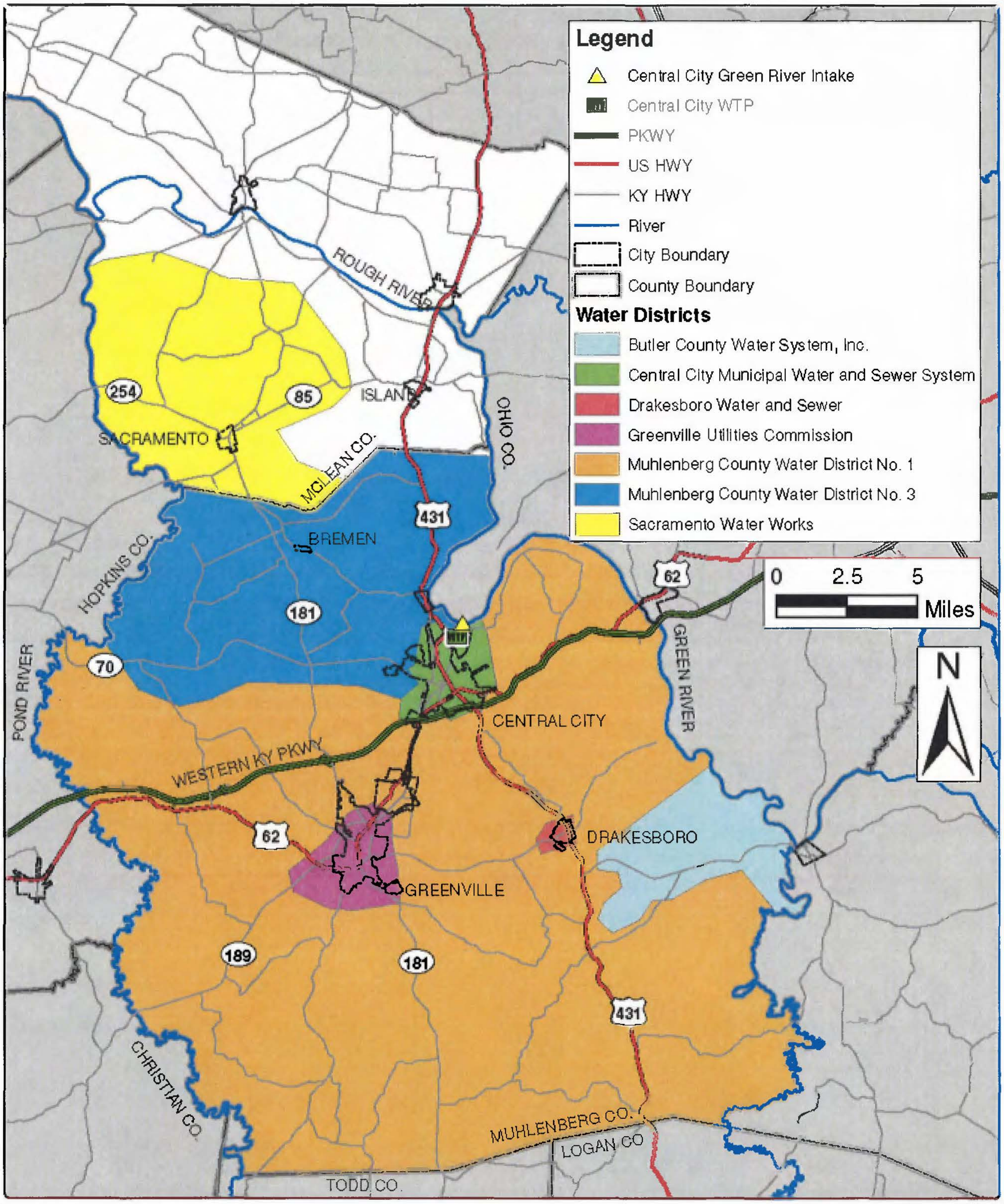
Section 2	Background
Section 3	Treatment Goals and Regulations
Section 4	River Water Quality
Section 5	Existing Water Treatment Plant Performance
Section 6	Treatment Alternatives
Section 7	Recommended Treatment Train Alternative
Section 8	Intake and Pumping Facilities
Section 9	Structural, Architectural, and HVAC Improvements
Section 10	Plant Utilities
Section 11	Instrumentation, Controls and Supervisory Control and Data Acquisition (SCADA)
Section 12	Permit Requirements
Section 13	Staffing
Section 14	Schedule and Construction Cost

Using the existing data and water treatment experience, this report will identify the major treatment issues and applicable water treatment technologies to meet the goals of Central City and the Safe Drinking Water Act (SDWA).

This report evaluates a number of treatment alternatives and presents a treatment option preferred for Central City, Kentucky.

1.03 DEFINITIONS

ACH	air changes per hour
AMSL	above mean sea level
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers



CENTRAL CITY POTABLE WATER SERVICE AREA

WATER TREATMENT PLANT PRELIMINARY DESIGN REPORT
CENTRAL CITY, KENTUCKY

STRAND ASSOCIATES, INC. ENGINEERS

FIGURE 1.01-1
5109.001

AWWA	American Water Works Association
BEP	Best Efficiency Point
CaCO3	calcium carbonate
CMU	concrete masonry unit
DBP	disinfection byproducts
D/DBP	Disinfectants/Disinfection By-Products
DHS	Department of Homeland Security
DOC	dissolved organic carbon
EC	enhanced coagulation
ESWTR	Enhanced Surface Water Treatment Rule
FEMA	Federal Emergency Management Agency
ft^2	square feet
ft^3	cubic feet
gpm	gallons per minute
gpm/ft^2	gallons per minute per square feet
GAC	granulated activated carbon
HBC	Dept. of Housing, Buildings, and Construction
HMI	Human-Machine Interface
hp	horsepower
HVAC	Heating, ventilation, and air conditioning
IDSE	Initial Distribution System Evaluation
IESWTR	Interim Enhanced Surface Water Treatment Rule
KDOW	Kentucky Division of Water
KPDES	Kentucky Pollutant Discharge Elimination System
LAN	Local Area Network
lbs	pounds
LCR	Lead and Copper Rule
LT2ESWTR	Long-Term 2 Enhanced Surface Water Treatment Rule
MCC	motor control center
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MRDL	maximum residual disinfectant level
mg/L	milligrams per liter
mgd	million gallons per day
MDBRs	Microbial and Disinfection Byproducts Rules
NPDWR	National Primary Drinking Water Regulations
NSDWR	National Secondary Drinking Water Regulations
NTU	nepholometric turbidity unit
PAC	powdered activated carbon
pcf	per square feet
pc/L	picocuries per liter
PLC	programmable logic controller
psi	pounds per square inch
PSW	Partnership for Safe Water
RTU	Remote Telemetry Units
SCADA	supervisory control and data acquisition
SCC	Supervisory control center
SDWA	Safe Drinking Water Act
SMACNA	Sheet Metal and Air-Conditioning Contractors National Association
SOC	synthetic organic compounds

SUVA	specific ultraviolet absorbance
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
TDH	total dynamic head
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
TTHM	total trihalomethane
TVSS	Transient Voltage Surge Suppressor
UCMR2	Unregulated Contaminant Monitoring Regulation (second cycle)
UPS	Uninterruptible Power Supply
USACE	US Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	ultraviolet
VFD	variable frequency drive
WTP	water treatment plant

SECTION 2
BACKGROUND

2.01 BACKGROUND

Central City has been withdrawing and treating water from the Green River for over 50 years. The original WTP and river water pumping station was located adjacent to the Green River. In 1969, plans for a new treatment plant were developed. The original WTP was subsequently abandoned and the river water pumping station was modified to pump to a new 2 mgd lime-softening WTP. In 1982, plans were developed to expand the WTP to 4 mgd. Some time later, the plant was converted from a lime-softening plant to a conventional treatment process.

2.02 EXISTING PLANT CAPACITY

From the 2005 to 2007, the average daily water treatment flow increased from 3.30 mgd to 3.54 mgd, which is an increase of approximately 0.12 mgd per year. The maximum daily treated water flow has increased beyond the design capacity of the WTP. WTP operators have stated that during the maximum daily flows and seasonal Green River water quality changes, process adjustments, such as more frequent filter backwashes and increasing coagulant/polymer feed, must be made to treat the water. Table 2.02-1 shows the average and maximum raw water treated at the Central City WTP.

Year	Average Daily Flow	Maximum Daily Flow
2005	3.30 mgd	4.15 mgd
2006	3.32 mgd	4.23 mgd
2007	3.54 mgd	4.26 mgd

Table 2.02-1 Green River Average and Maximum Daily Flows

The existing WTP will be expanded to 7 mgd so that Central City can meet projected maximum day demands and provide additional capacity for future growth.

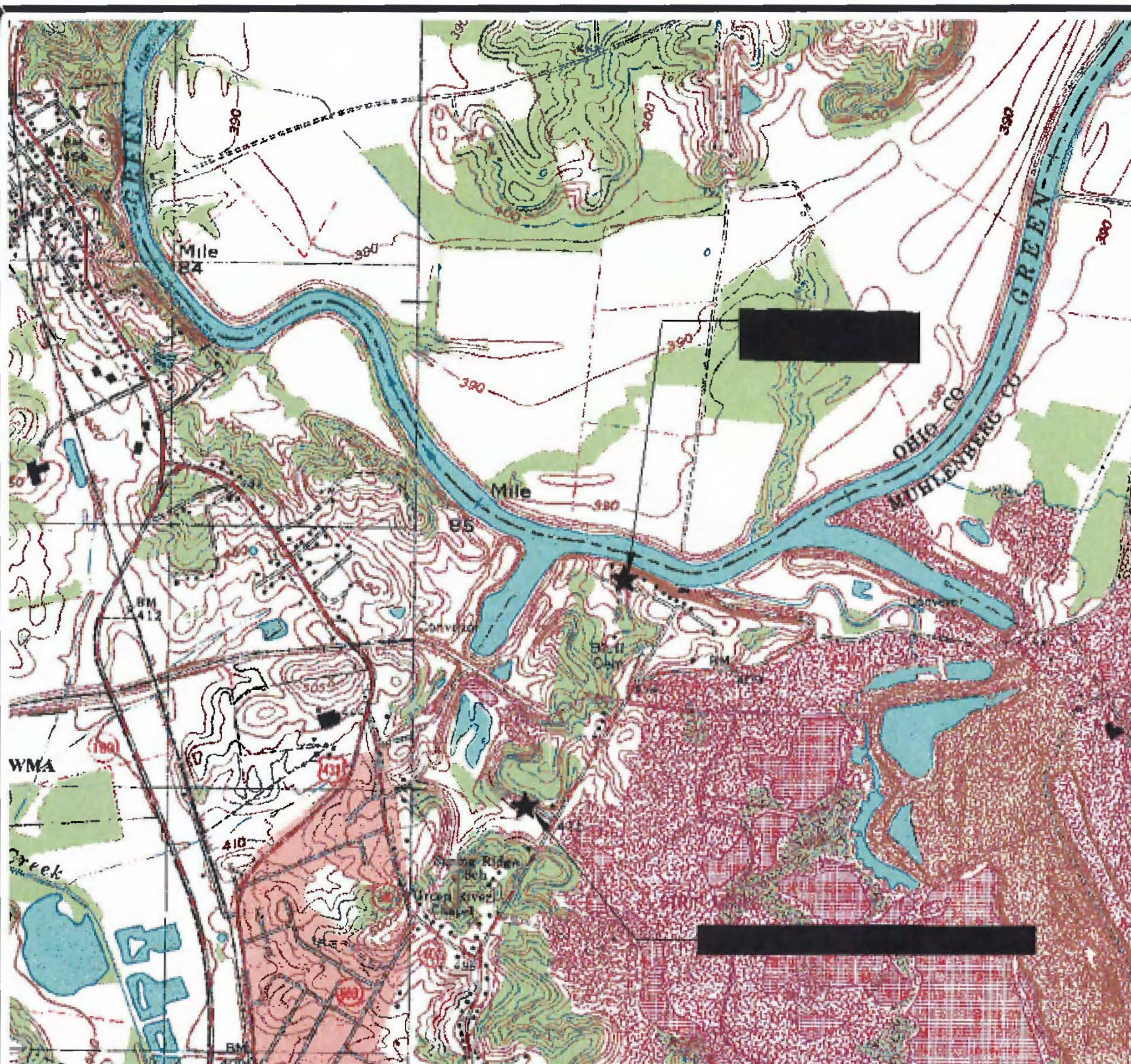
2.03 EXISTING PLANT OPERATIONS

The existing WTP operates on a 24-hour basis to provide adequate water volume to keep distribution storage tanks filled within their set operating ranges. The existing plant is barely meeting current system demands, and is operating beyond its original design capacity.

2.04 WATER SOURCE

Central City WTP will continue to use the Green River as its water source. An analysis of the Green River water quality is in Section 4.

The location of the river water intake is at north latitude 37°19'27.92", west longitude 87°6'54.56". The WTP is located at north latitude 37°19'2.56", west longitude 87°7'8.57". The location of the river water intake and WTP are displayed on a United States Geological Survey (USGS) topographical map in this report. See Figure 2.04-1.



WATER TREATMENT PLANT AND
RIVER WATER PUMPING STATION LOCATION MAP

WATER TREATMENT PLANT PRELIMINARY DESIGN REPORT
CENTRAL CITY, KENTUCKY

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 2.04-1
5109.001

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SECTION 3
TREATMENT GOALS AND REGULATIONS

3.01 TREATMENT GOALS AND OBJECTIVES

A. Safe Drinking Water Act

The general goals of drinking water treatment are to produce water that is microbiologically and chemically safe, aesthetically pleasing, and reasonably priced. The SDWA and its amendments establish regulatory guidelines that are used to determine the amount of treatment required to meet these goals.

Microbiologically safe is defined as free from disease-causing bacteria, viruses, and intestinal parasites such as Giardia and *Cryptosporidium*. To achieve this, the WTP uses multiple barriers consisting of coagulation, flocculation, sedimentation, and filtration to remove the organisms along with disinfection to render organisms incapable of producing sickness in humans.

Chemically safe refers to maintaining concentrations of inorganic and organic constituents in the water below levels known to create an acute or chronic health risk. For example, specific chemicals, such as nitrate, when present in the water above 10 milligrams per liter (mg/L), can cause acute illnesses to a susceptible part of the population served. Other chemicals, such as pesticides or disinfection by-products (DBP), are strongly suspected of increasing cancer risks. Alternative treatment technologies or methods, such as granular activated carbon (GAC), ultraviolet (UV) disinfection, or membrane filtration are often used to address this type of risk.

Aesthetically pleasing means the water is free from all taste, color, and odor-causing compounds including those originating in the watershed, those resulting from treatment practices such as disinfection, and those attributable to materials of construction and modes of operation of the distribution system.

Finally, reasonably priced is generally understood to mean that the treatment facility must effectively meet treatment goals and efficiently use resources, especially with respect to energy, chemicals, and staffing.

B. Drinking Water Regulations

The following sections of this report will address the following drinking water regulations:

1. Total Coliform Rule
2. National Primary Drinking Water Regulations
3. National Secondary Drinking Water Regulations
4. Commonwealth of Kentucky Regulations
5. Surface Water Treatment Rules
    a. Surface Water Treatment Rule
    b. Interim Enhanced Surface Water Treatment Rule
    c. Long-Term 2 Enhanced Surface Water Treatment Rule
6. Disinfectants/Disinfection By-Products Rule
    a. Total Trihalomethanes Rule

b. Stage 1 Disinfectants/Disinfection By-Products Rule
c. Phase 2 Disinfectants/Disinfection By-Products Rule

7. Lead and Copper Rule (LCR)

The United States Environmental Protection Agency (USEPA) regulates drinking water contaminants through the National Primary Drinking Water Regulations and the National Secondary Drinking Water Regulations. The USEPA also tracks unregulated contaminants. These regulations are discussed in more detail in Subsection 3.02.

The Microbial and Disinfection Byproducts Rules (MDBPs) are a set of regulations continuously developed by the USEPA to address microbial pathogens and disinfectants/disinfection byproducts in public drinking water. Together these rules fill thousands of pages and tables, which can be found on the USEPA Web site. Subsection 3.03 briefly summarizes those rules that are most applicable to the Central City WTP.

C. <u>The Partnership for Safe Water</u>

The Partnership for Safe Water (PSW) is not a regulation but an agreement developed by the USEPA, the American Water Works Association (AWWA), the AWWA Research Foundation, the Association of Metropolitan Water Agencies, the Association of State Drinking Water Administrators, and the National Association of Water Companies. PSW is voluntary for surface water utilities to "identify areas that will enhance the water system's ability to prevent entry of *Cryptosporidium*, Giardia, and other microbial contaminants into treated water and to voluntarily implement those actions that are appropriate for the system."

PSW was developed in 1995 as an interim measure that utilities could take in anticipation of delays in the then upcoming Enhanced Surface Water Treatment Regulations. In essence, the PSW is an agreement by the water utility to assess itself and make improvements that will allow it to maintain finished water turbidity at or lower than 0.1 nepholometric turbidity unit (NTU) at least 95 percent of the time. This level of turbidity has, by virtue of PSW, become the standard of a "well run" drinking water utility and the USEPA maximum contaminant level goal (MCLG) for turbidity removal.

3.02 TOTAL COLIFORM RULE

The Total Coliform Rule (TCR) is the latest version of one of our oldest drinking water regulations. Total coliform testing is commonly used in drinking water treatment to determine the effectiveness of source water, treatment, and distribution system barriers to bacterial contamination. Coliform bacteria are organisms that have one or more biochemical reactions similar to *Escherichia coli* (*E. coli*) that are commonly found in the digestive tract of warm-blooded animals. The total coliform test is a test for bacteria with similar biochemistry to *E. coli* which are capable of growing at 35°C. The total coliform group includes several genera of bacteria belonging to the family *Enterobacteriaciae*. Some of these bacteria are not pathogenic. The TCR that limits this bacterial contaminant was effective in December 1990.

The number of samples that must be collected during routine monitoring is based on the population served, as summarized in Table 3.02-1. A state-approved sampling location and monitoring plan must be developed by every public water system.

Population Served	Samples per Month	Population Served	Samples per Month
25 to 1,000	1	59,001 to 70,000	70
1,001 to 2,500	2	70,001 to 83,000	80
2,501 to 3,300	3	83,001 to 96,000	90
3,301 to 4,100	4	96,001 to 130,000	100
4,101 to 4,900	5	130,001 to 220,000	120
4,901 to 5800	6	220,001 to 320,000	150
5,801 to 6,700	7	320,001 to 450,000	180
6,701 to 7,600	8	450,001 to 600,000	210
7,601 to 8,500	9	600,001 to 780,000	240
8,501 to 12,900	10	780,001 to 970,000	270
12,907 to 17,200	15	970,001 to 1,230,000	300
17,201 to 21,500	20	1,230,001 to 1,520,000	330
21,501 to 25,000	25	1,520,001 to 1,850,000	360
25,001 to 33,000	30	1,850,001 to 2,270,000	390
33,001 to 41,000	40	2,270,001 to 3,020,000	420
41,001 to 50,000	50	3,020,001 to 3,960,000	450
50,001 to 59,000	60	3,960,001 or more	480

Table 3.02-1 Total Coliform Rule

Compliance with the TCR is based on the presence/absence of total coliforms rather than coliform densities, as follows:

A. No more than 5 percent of the valid samples collected each month can yield a positive result for total coliforms, if 40 or more samples are analyzed per month. No more than one sample per month can test positive if fewer than 40 samples are analyzed each month.

B. No valid repeat sample can produce a positive result for fecal coliforms or *E. coli*.

C. No valid repeat sample can produce a positive result for total coliforms if the original routine sample produced a positive result for fecal coliforms or *E. coli*.

D. If any routine or repeat sample is total coliform-positive, the total coliform-positive culture must be analyzed to determine if fecal coliforms are present. *E. coli* analysis may be performed in lieu of fecal coliform analysis. Fecal coliform or *E. coli* testing can be avoided if total coliform-positive samples are assumed to be positive for fecal coliform or *E. coli*.

The state must be notified within 24 hours if a violation occurs.

If total coliforms are detected in any sample, at least three repeat samples, depending on the population served, must be collected for each coliform-positive sample.

If total coliforms are detected in any repeat sample, another set of repeat samples must be collected on the same day and from the same location within 24 hours of notification of a total coliform-positive repeat sample. The utility must repeat this process until either total coliforms are not detected in a set of repeat samples or until the monthly maximum containment level (MCL) has been violated.

Central City is in compliance with the TCR.

3.03 NATIONAL PRIMARY DRINKING WATER REGULATIONS

The National Primary Drinking Water Regulations (NPDWR) are intended to protect public health by limiting the concentrations of contaminants in drinking water. These are legally enforceable standards that apply to public water systems.

The list of regulated contaminants includes microorganisms, disinfection byproducts, disinfectants, inorganic chemicals, organic chemicals, and radionuclides.

A comprehensive list is available through USEPA; however, Table 3.03-1 lists the synthetic organic compounds (SOC) discussed in Section 3 found in Central City's raw water. None of these contaminants are present at levels that exceed the MCL for treated water.

Synthetic Organic Compounds	Maximum Contaminant Levels (mg/L)
Simazine	0.004
Atrazine	0.003
Di(2-ethylhexyl) phthalate	0.006

Table 3.03-1 Maximum Contaminant Levels for Regulated Synthetic Organic Compounds Present in Central City Raw Water

3.04 NATIONAL SECONDARY DRINKING WATER REGULATIONS

Unlike the NPDWRs, the National Secondary Drinking Water Regulations are not enforceable. They are USEPA recommendations on contaminants that may cause aesthetic or cosmetic affects in drinking water.

Table 3.04-1 lists some of the NSDWRs of concern. In the summer of 2007, manganese concentrations exceeded the manganese secondary drinking water standard on occasion. However, other than this period, within the last three years, data has shown the manganese concentrations are below the secondary drinking water standard. Iron and total dissolved solids are present at much lower concentrations than the secondary drinking water standards.

Parameter	Secondary Standard (mg/L)
Iron	0.3
Manganese	0.05
Total Dissolved Solids	500 mg/L

Table 3.04-1 Secondary Standards of Aesthetic Parameters of Concern In Central City

3.05 COMMONWEALTH OF KENTUCKY REGULATIONS

The Commonwealth of Kentucky has implemented state requirements for synthetic organic chemicals (401 KAR 8:400), volatile organic chemicals (401 KAR 8:420) and inorganic chemical sampling, analytical techniques, and maximum contaminant levels (401 KAR 8:250). Table 3.05-1 lists additional water quality parameters that are monitored at the Central City WTP based on these regulations. None of these contaminants are present at levels that exceed the MCL for treated water.

Kentucky Administrative Regulation	Parameter	MCL (mg/L)	Optimum Concentration* (mg/L)
401 KAR 8:400	Aldicarb	0.003	N/A
401 KAR 8:400	Aldicarb sulfoxide	0.004	N/A
401 KAR 8:400	Aldicarb sulfone	0.003	N/A
401 KAR 8:250	Nickel	0.1	N/A
401 KAR 8:250	Sodium	N/A	20

*401 KAR 8:250, Section 15 requires special monitoring for sodium for community public water systems.

Table 3.05-1 Monitored Water Quality Parameters per Kentucky Administrative Regulations

The following Kentucky regulations generally follow the national regulatory standards.

A. Microbiological monitoring (401 KAR 8:200).
B. Inorganics (401 KAR 8:250).
C. Lead and copper (401 KAR 8:300).
D. Corrosivity monitoring (401 KAR 8:350).
E. Disinfectant results, DBPs, and disinfection by-product precursors (401 KAR 8:550).
F. Radionuclides (401 KAR 8:550).
G. Secondary standards (401 KAR 8:600).

3.06 SURFACE WATER TREATMENT REGULATIONS

A. The Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) is primarily a microbiological regulation and codifies the use of the multiple barrier concept, discussed earlier, for control of pathogenic organisms. The SWTR became effective in December 1990 and required water suppliers to use all but the most pristine water sources to provide filtration of their surface water (or groundwater under the direct influence of surface water). It also required all systems having a surface water source to provide some level of disinfection.

In further defining the physical barrier of filtration, the SWTR reduced the MCL for finished water turbidity from 1 NTU to 0.5 NTU (95 percent of the time, measured daily) and set a limit of 5 NTU on the maximum finished water turbidity. Central City meets this portion of the rule, as the average treated water turbidity is 0.07 NTU.

As an additional barrier to organisms, the SWTR required a measurable disinfectant residual be present to the farthest ends of the distribution system. The measurable residual was defined as a minimum of 0.2 mg/L of free or combined chlorine. Central City provides a measurable disinfectant residual.

The SWTR required 99.9 percent (3 log) for the combination of removal and inactivation of Giardia cysts and 99.99 percent (4 log) for the combination of removal and inactivation of viruses. As defined by the USEPA, Central City is a "well-operated" conventional surface WTP based on finished water quality and, therefore, receives credit for 99.7 percent (2 ½-log) removal of Giardia cysts and 99 percent (2 log) removal of viruses.

The remaining inactivation credits, ½ log of inactivation for Giardia cysts and 2 log of inactivation for viruses, can be accomplished through disinfection using chlorine, chloramines, ozone, or chlorine dioxide.

The credit is based on achieving the product of disinfectant concentration and contact time, known as CT. The concentration (C) is the active disinfectant residual concentration exiting the reactor used for primary disinfection and the time (T) is the time it takes for 10 percent of the influent flow to exit the reactor (T_{10}). T_{10} can be determined using tracer testing in the plants using different flow rates. Tables of CT values required for each of the disinfectants at different temperatures, and in some cases, different pH values, are published in the Guidance Manual for *Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*, AWWA, Denver, Colorado, 1991, and the Interim Enhanced Surface Water Treatment Rule (IESWTR) Guidance Manual.

Based on the existing drawings and MOR data, an average clearwell depth of 3.3 feet would need to be maintained to achieve the ½ log inactivation. The Central City WTP should be in compliance with this rule.

B. The Interim Enhanced Surface Water Treatment Rule

The IESWTR became effective in February 16, 1999, and applies to public water systems that use surface water and serve at least 10,000 people. Major components of this rule include the following criteria:

1. It establishes a MCLG of zero for *Cryptosporidium*.

2. It requires at least 99 percent (2 log) removal of *Cryptosporidium*. Central City complies with the SWTR and the strengthened turbidity performance standards of the IESWTR. Therefore, the plant meets the regulation's credit that systems using conventional filtration are achieving 2 log removal of *Cryptosporidium*.

3. It strengthens turbidity performance requirements such that the turbidity must not exceed 0.3 NTU in at least 95 percent of the measurements and must not exceed 1.0 NTU at any time, based on measurements of the combined filtered water taken at four-hour intervals.

4. It establishes a disinfection profiling requirement for surface water systems with either of the following criteria:

   a. Total trihalomethane (TTHM) levels of at least 80 percent of the MCL as an annual average.

   b. Haloacetic acid (HAA5) levels of at least 80 percent of the MCL as an annual average.

As shown in Table 3.06-1, the annual average does not meet the above criteria and Central City is not required to submit disinfection profiling.

	TTHM (μg/L)	HAA5 (μg/L)
MCL	80	60
80% of MCL	64	48
Average Distribution System Water Quality	50.5	37.5

Table 3.06-1 Central City Disinfection By-Products

C. Long-Term 2 Enhanced Surface Water Treatment Rule

The Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) is designed to complete the Enhanced Surface Water Treatment Rule that began in the IESWTR. Under the old rules, public water systems that use filtration on a surface water source were required to achieve at least a 99 percent (2-log) removal of *Cryptosporidium*. The LT2ESWTR focuses on the reduction of disease associated with *Cryptosporidium* and other pathogenic microorganisms in drinking water by targeting public water systems that are at higher risk to *Cryptosporidium* contamination. The final rule provides a balance between the reduction and/or deactivation of pathogenic microorganisms and the minimization of DBP formation in drinking water. The final rule became effective January 5, 2006.

The LT2ESWTR applies to all systems that use surface water or groundwater under the direct influence of surface water. This rule sets requirements for monitoring and treatment based on the public water system customer base and the level of pathogenic microorganisms found in the source water. Disinfection profiling requirements are established within the regulation to maintain the balance protection from pathogenic microorganisms against the reduction of Disinfectants/Disinfection By-Products (D/DBP).

1. Monitoring Requirements for Filtered Systems

Systems serving between 10,000 and 49,999 people (Schedule 3 category) are required to submit their *Cryptosporidium* Monitoring Plan by January 1, 2008, and start sampling the water source for *Cryptosporidium* in April 2008. The City reports it has started this monitoring.

Systems may grandfather *Cryptosporidium* data in lieu of collecting two years of similar data in the future. USEPA will review and determine which data can be grandfathered, if applicable. Systems that do not grandfather or collect additional *Cryptosporidium* data will automatically be regulated as a Bin 4 facility. Under this classification, facilities will be required to provide 5.5-log reduction of *Cryptosporidium* at all times.

2. *Cryptosporidium* Treatment

Under the rule, public water systems that are filtered or unfiltered, but require filtration are classified into bins based on the existing treatment technologies employed at the WTP and the *Cryptosporidium* level detected in the source water. The bin classification then establishes the level of additional treatment required by the proposed rule. Table 3.06-2 shows the level of treatment required for filtered systems.

Source Water *Cryptosporidium* concentration (oocyst/L)	Bin Classification	Additional Treatment Requirements			
		Conventional Filtration	Direct Filtration	Slow Sand or Diatomaceous Earth Filtration	Alternative Filtration Technologies
< 0.075	Bin 1	No additional treatment	No additional treatment	No additional treatment	No additional treatment
0.075 and < 1.0	Bin 2	1 log treatment	1.5 log treatment	1 log treatment	([1])
1.0 and < 3.0	Bin 3	2 log treatment	2.5 log treatment	2 log treatment	([2])
≥ 3.0	Bin 4	2.5 log treatment	3 log treatment	2.5 log treatment	([3])

[1] As determined by the state such that the total *Cryptosporidium* removal and inactivation is at least 4.0 log.
[2] As determined by the state such that the total *Cryptosporidium* removal and inactivation is at least 5.0 log.
[3] As determined by the state such that the total *Cryptosporidium* removal and inactivation is at least 5.5 log.

Table 3.06-2 Level of Treatment Required for Filtered Systems

3. Uncovered Finished Water Storage Facility

Systems serving between 10,000 and 49,999 people (Schedule 3 category) are required to notify USEPA of any uncovered treated water storage facilities. The Central City WTP has a covered clearwell for finished water storage and all new clearwells will be covered; therefore, this issue is not applicable.

The rule also provides a "microbial toolbox" that establishes acceptable management and treatment options and the log removal credit associated with each option. These options range from the implementation of a watershed control program, which receives 0.5-log credit, to the installation of membrane treatment technology, which requires a challenge test or direct integrity test to establish log credit. The "microbial toolbox" can be found in Table IV.D-1 on pages 684 to 685 of the Federal Register (Vol. 71 No. 3, 2006).

Central City has recently begun testing the *Cryptosporidium* level in the source waters to establish the Central City WTP bin classification.

D. Stage 1 Disinfectants and Disinfection Byproducts Rule

The Stage I D/DBP Rule was enacted to reduce health risk because of disinfection practice. To accomplish the goals of this rule, USEPA established maximum residual disinfectant levels (MRDLs) for disinfectants including chlorine, chloramine, and chlorine dioxide as shown in Table 3.06-3. USEPA also enacted and reduced previous MCLs for DBPs including TTHM, HAA5, bromate (an ozone by-product), and chlorite (a chlorine dioxide byproduct) as shown in Table 3.06-4.

Compound or Group	MRDL (mg/L)
Chlorine	4.0
Chloramine	4.0
Chlorine Dioxide	0.8

Table 3.06-3 MRDL for Disinfectants

In addition, USEPA enacted a treatment technique, enhanced coagulation (EC), intended to reduce DBPs by reducing organic materials that could react with disinfectants to form DBPs. EC defines a requirement for the removal of total organic carbon (TOC) in the coagulation, flocculation, and sedimentation portion of a conventional treatment plant.

Compound or Group	MCL (µg/L)
TTHM	80
HAA5	60
Bromate	10
Chlorite	1,000

Table 3.06-4 MCL for DBPs

A system does not have to implement enhanced coagulation if any of the following are true:

1. Source water TOC is less than 2.0 mg/L.

2. Treated water TOC is less than 2.0 mg/L.

3. Source water TOC <4.0 mg/L, raw water alkalinity >60 mg/L as calcium carbonate (CaCO3), distribution system TTHM and HAA5 concentrations are less than or equal to 40 mg/L and 30 mg/L, respectively.

4. Distribution system TTHM and HAA5 concentrations are less than or equal to 40 mg/L and 30 mg/L, respectively, and the system uses only free chlorine for disinfection.

5. Source water specific ultraviolet absorbance (SUVA) is less than 2.0 L/mg-m. SUVA is calculated by dividing UV absorbance (m-1) at 254 nm by the concentration (mg/L) of dissolved organic carbon (DOC).

6. Treated water SUVA is less than 2.0 L/mg-m.

If none of the six conditions are met, Step 1 of EC takes effect. Step 1 establishes targets for additional precursor removal to be achieved based on raw water TOC and alkalinity. These targets are shown in Table 3.06-5. If a utility can satisfy the TOC percent removals specified in Step 1, the EC criterion for Stage 1 is satisfied. If a system is unable to meet the Step 1 TOC removal requirements, an alternative percent TOC removal requirement may be selected.

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as CaCO3)		
	0 to 60	>60 to 120	>120
>2.0 to 4.0	35%	25%	15%
>4.0 to 8.0	45%	35%	25%
>8.0	50%	40%	30%

Table 3.06-5 Enhanced Coagulation TOC Removal Requirements for Step 1

The required organic carbon reduction is 25 percent based on the Green River TOC and alkalinity concentrations. Table 3.06-6 shows that the TOC reduction achieved has been greater than that required.

Raw Water Quality	
Average Total Organic Carbon (mg/L)	3
Average Alkalinity (mg/L as CaCO3)	106.3
Treated Water Quality	
Average Total Organic Carbon (mg/L)	1.8
Total Organic Carbon Reduction Achieved	39%
Total Organic Carbon Reduction Required	25%

Table 3.06-6 Total Organic Carbon Achieved

E. Stage 2 Disinfectants and Disinfection Byproducts Rule

Stage 2 D/DBP Rule, similar to the LT2ESWTR, uses the data from the Information Collection Rule to reduce risk of D/DBP formation from disinfection practices. Stage 2 was promulgated on January 6, 2006. This rule tightens the compliance monitoring requirements for TTHM and HAA5. This rule applies to community and nontransient, noncommunity water systems with a primary or residual disinfectant other than UV light.

This rule first requires utilities to define the higher risk areas within their own distribution systems by conducting an Initial Distribution System Evaluation (IDSE). Compliance can be attained by one of the following four methods.

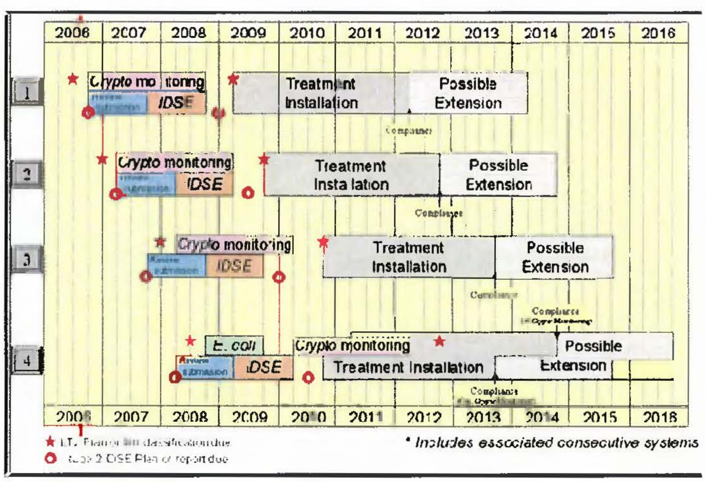
1. Systems serving less than 500 persons may qualify for a Very Small System Waiver.

2. Systems with proper Stage 1 D/DBP Rule data [TTHM less than or equal to 40 micrograms per liter (µg/L) and HAA5 less than or equal to 30 µg/L] may qualify for 40/30 Certification.

3. Systems may conduct a system specific study using either existing monitoring results or a properly constructed computer model.

4. Systems may conduct standard monitoring.

The Stage 2 D/DBP rule is being implemented on a staggered schedule based on system size, as shown in Figure 3.06-1.



Note: 1, 2, 3, and 4 on left-hand side of figure indicates schedule based on system size.

Figure 3.06-1 LT2ESWTR and D/DBP Phase II Regulatory Timeline

Central City WTP was categorized as a Schedule 3 facility and has begun conducting standard monitoring.

Upon completion of the IDSE, each system required to conduct additional testing will conduct final testing at the locations selected during the IDSE according to the schedule provided above. Ultimately, water treatment changes may be required in systems that are found to exceed the locational running annual average. The MCL at each monitoring site for TTHMs will be 80 μg/L and for HAA5 will be 60 μg/L.

3.07 LEAD AND COPPER RULE

The intent of the Lead and Copper Rule (LCR) is to maintain lead and copper concentrations at the tap below action levels of 15 and 1,300 μg/L, respectively. The LCR took effect in January 1992 with corrections in June 1992.

A. Initial Monitoring

Initial monitoring of targeted high-risk taps to determine compliance with the lead and copper action levels began by January 1992 and was completed by January 1993. The 90th percentile values (when the results are ordered in ascending value) were used for determining compliance with the lead and copper action levels.

B. Source Water Monitoring and Treatment

If the lead or copper action levels were exceeded, source water monitoring is required to determine if source treatment is necessary to remove lead or copper from the source water. Source water monitoring was to be completed by July 1994. The state may have required modifications to provide source treatment. The state was to have accepted the recommended source treatment or designated other treatment by January 1995. The affected water supplier was then required to install the required source treatment by January 1997. The state must have also established maximum entry point concentrations for lead and copper for each system.

C. Large Systems

For large systems (>50,000 population served), compliance with the LCR is based on implementation of optimal corrosion control treatment. Corrosion control is considered to be optimized if the difference between the lead level measured in the 90th percentile at the tap and in the finished water entering the distribution system is less than 5 μg/L for two consecutive 6-month monitoring periods, as long as the 90th percentile lead concentration is less than 15 μg/L.

If optimal treatment was not demonstrated to the state's satisfaction, large systems were required to complete corrosion control studies and recommend optimal treatment by July 1994. The state was to accept the recommended treatment or designate other optimal corrosion control treatment by January 1995. The affected water supplier must then have installed the required optimal corrosion control treatment by January 1997.

Post-treatment monitoring for source water treatment and/or optimal corrosion control treatment should have been completed and the results submitted to the state by January 1998.

If post-treatment monitoring determined that the lead or copper action levels were not exceeded after the implementation of source water and/or optimal corrosion control treatment, the state was to establish optimal water quality parameters for each system. Water suppliers must demonstrate continued compliance with the lead and copper action levels by maintaining water quality parameters at levels established by the state. The number of tap samples collected during each 6-month monitoring period may be reduced if water quality parameters are maintained at levels established by the state for two consecutive 6-month monitoring periods.

If post-treatment monitoring determined that the lead or copper action levels are exceeded after the implementation of source water and/or optimal corrosion control treatment, lead service connection replacement and public education are required. Lead service connections must be replaced at an annual rate of 7 percent of the initial total number of lead service connections.

D. Small and Medium Systems

Small and medium systems exceeding the action levels must start corrosion control. For small and medium systems, lead and copper action levels are substitute measurements for optimal corrosion control. These systems are considered to have optimized corrosion control if they continue to meet the lead and copper action levels. However, a system must recommence completion of corrosion control treatment steps if it exceeds the action level during any future monitoring period.

Central City is in compliance with the Lead and Copper Rule.

3.08 FUTURE REGULATIONS

A number of regulations are being prepared and reviewed by the USEPA and the Department of Homeland Security (DHS). A short summary of the contemplated rules is provided as follows.

A Radon Rule

The radon rule is expected to apply to groundwater systems or systems that mix surface and groundwater. It will limit the amount of radon permitted to enter the distribution system to 300 picocuries per liter (pc/L) unless an individual state implements a multimedia radon reduction program. The amount of radon permitted in a state that implements multimedia reduction is increased to 4,000 pc/L.

B. Total Coliform Rule Revisions

Proposed revisions to the existing rule or a new rule are currently being evaluated. The scope and requirements of the rule are not currently defined.

C. Atrazine, Perchlorate, Methyl Tertiary-Butyl Ether

These SOCs are currently being considered for regulation. The requirements and timing of any regulation is uncertain.

D. Unregulated Contaminant Monitoring Regulation

The second cycle of Unregulated Contaminant Monitoring Regulation (UCMR2) was promulgated as of January 4, 2007. Public water systems are required to monitor a list of 25 contaminants every five years. UCMR 2 monitoring will occur during 2008 to 2010.

E. Chemical Facility Anti-Terrorism Standards (6 CFR Part 27)

The DHS has drafted legislation that will require additional security measures to protect facilities that manufacture, store, use, and distribute chemicals that represent a high risk to the nation's security. Chlorine gas and chlorine dioxide is listed as a potential high risk chemical within this regulation. The final rule was published in the Federal Register on April 9, 2007.

This regulation does not apply to Central City WTP because Central City uses hypochlorite for disinfection.

SECTION 4
RIVER WATER QUANTITY AND QUALITY

4.01 INTRODUCTION

Central City has been utilizing the Green River as a water source for its existing treatment facility since 1970. This section presents information on the Green River.

4.02 GREEN RIVER

A. Yield

On March 2, 1982, Central City Municipal Water and Sewer was issued a permit to withdraw 4 mgd from the Green River. The current treatment plant is designed to withdraw 4 mgd. A revised permit will be required to expand treatment plant capacity.

B. River Water Quality

The available river water quality data (2005 to 2007) for Green River is presented in the following tables. Table 4.02-1 presents select inorganic parameters. A more complete list is included in the Appendix A.

	Alkalinity (mg/L)	Hardness (mg/L)	Iron (mg/L)	Manganese (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Organic Carbon* (mg/L)	Turbidity (NTU)
Average	111	165	0.23	0.49	7.8	226 (08/15/06) 282 (08/08/07)	3.0	24.5
Minimum	52	84	-	-	6.9	-	1.5	1.7
Maximum	204	270	-	-	8.6	-	4.5	370

*TOC data based on monthly TOC samples.

Table 4.02-1 Select Green River Average Daily Inorganic Water Quality Parameters

Table 4.02-2 presents available lab results of the National Primary, Secondary, and state required monitored constituents for which a detect was found.

	Atrazine (mg/L)	Di (2-Ethylhexyl) Phthalate (mg/L)	Simazine (mg/L)
06/08/05	-	0.0012	-
05/17/07	0.00056	-	-
05/09/08	0.00073	-	0.00015

Table 4.02-2 Green River Organic Water Quality Parameters

Table 4.02-3 presents the five highest daily river water turbidities measured at Green River.

2005*		2006		2007	
Date	Turbidity (NTU)	Date	Turbidity (NTU)	Date	Turbidity (NTU)
9/1/2005	211	9/25/2006	252.00	12/11/2007	370.00
9/2/2005	135	9/26/2006	238.00	12/12/2007	171.00
5/2/2005	121	1/26/2006	210.00	1/10/2007	164.00
5/3/2005	118	9/27/2006	143.00	12/13/2007	164.00
3/29/2005	115	5/30/2006	129.00	3/4/2007	131.00

*July 2005 and November 2005 turbidity data not available.

Table 4.02-3 Green River Highest Daily Turbidity Measurements

C. Discussion

The following is an overall summary of the water quality, with respective ranges:

1. Green River has moderately low turbidity with an average turbidity of 23.4 nephelometric turbidity unit (NTU). However, daily turbidity spikes can be as high as 370 NTU.

2. The water is relatively hard with moderate levels of alkalinity.

3. The total dissolved solids data is limited, but is within normal levels. Total organic carbon levels are also moderately low. (See Section 3–Treatment Goals and Objectives for additional discussion).

4. Iron and manganese are high enough to cause significant aesthetic concerns. (See Section 3-Treatment Goals and Objectives for additional discussion)

5. The data indicates the detection of a few synthetic organic chemicals, Atrazine, Di (2-Ethylhexyl) Phthalate, and Simazine. These chemicals are currently regulated, but appear to be sporadically present at relatively low concentrations.

6. Atrazine has been detected for the last two years in May. However, neither sample is near the regulated MCL. Atrazine is a widely used herbicide for control of broadleaf and grassy weeds.

4.03 CONCLUSIONS

A. Quantity

A revised permit to withdraw public water will be required to expand treatment plant capacity.

B. Quality

Water quality data indicates the Green River water, when treated, should result in relatively noncorrosive, moderately hard water. This data indicates that treatment should include reduction of turbidity, TOC, iron, manganese, synthetic organic compounds (especially Atrazine) and inactivation of virus, bacteria, and cysts. Treatment requirements will be discussed in more detail in later sections of this report.

SECTION 5
EXISTING WATER TREATMENT PLANT PERFORMANCE

5.01 DESCRIPTION OF EXISTING WATER TREATMENT FACILITIES

The Central City Treatment Plant is a modified lime-softening water treatment facility currently operated as a conventional treatment plant with two-stage sedimentation. The source of supply to the facility is the Green River. The water treatment processes include a screened intake, river water pumps, chemical treatment, rapid mix, contact clarifiers, sedimentation, granular media filtration, chlorine disinfection, buried clearwell storage, and high service pumps. The current WTP was placed into service in 1970 and is rated for 4 mgd. The river water pumping station is located at the old WTP site adjacent to the Green River. Figure 2.04-1 in Section 1 shows the locations of the WTPs and River Water Pumping Station on a topographical map.

The US Army Corps of Engineers (USACE) controls water levels on the Green River. The River Water Pumping Station is located at about Green River Mile 84, upstream of Lock 2 at River Mile 63. On September 8, 2008, the water elevation at Lock 2 was at 364.1 feet, which is 1.1 feet above the low (normal) pool elevation of 363.0 feet. The Ordinary High Water Level for the Green River is 376.0. The Ordinary High Water Level is the point on the bank at which natural vegetation shifts from predominately aquatic species to terrestrial species.

The 100-year flood elevation for the WTP is 397 feet above mean sea level (AMSL). Modifications made to the facility in areas below the 100-year floodplain elevation of 397-feet elevation, as indicated in Federal Emergency Management Agency (FEMA) Flood Maps, will require a Chapter 30 permit from the USACE. Based on elevations from past plan sets developed by others, the lowest elevations in the area of the WTP are 465 feet.

Elevations reported in this section are based on feet AMSL unless otherwise indicated.

5.02 EXISTING TREATMENT CAPACITY AND PERFORMANCE

A. Treatment Capacity and Performance

The following is a summary of the unit operations at the Central City WTP and evaluation of each unit's ability to provide reliable drinking water. This section will identify issues with treatment capacity and performance to develop an array of future improvements. Discussion of river water intake and pumping facilities is addressed in Section 8.

1. Rapid Mix

The existing rapid mix system consists of one constant speed (100 revolutions per minute), vertical impeller rapid mixer that agitates a tank with approximate dimensions of 7 feet by 12 feet by 10.5 feet [WxLxH with side water depth (SWD) of 9 feet]. River water enters the rapid mix tank through a 16-inch pipe in the tank sidewall. Coagulated water leaves the rapid mixer over a weir and is then transferred to a splitter box. The existing rapid mixer consists of one 2 horsepower (hp) vertical mixer with an impeller of unknown dimension and size, installed on a single shaft.

Figure 5.02-1 displays the rapid mix system.

Figure 5.02-1 Existing Rapid Mix Basin

At the design flow rate of 4 mgd, the hydraulic detention time in the rapid mixer is approximately two minutes.

Coagulant, polymer, and activated carbon slurry are fed into the rapid mix.

To meet Ten State Standards (2003 Edition), the existing rapid mixer should be designed with a maximum detention time of no more than 30 seconds. The 2007 edition requires mixing equipment capable of imparting a minimum velocity gradient (G) of at least 750 s^{-1}. The 2003 edition does not reference a specific G value.

The following is a summary of concerns related to the existing rapid mixing system based on discussions with operators and observations of the equipment:

a. It may be beneficial that a variable speed drive be provided to vary mixing energy to match changing water quality and rate of flow conditions.

b. Chemicals are being drip-fed into the top of the tank. Moving the chemical injection point closer to the impeller may provide better mixing and more efficient chemical use.

c. There is no redundant rapid mix system or bypass to allow the existing rapid mix basin and equipment to be taken out of service.

d. Regular jar testing should be performed to optimize the addition of coagulant, polymer, and carbon and mixing speed.

e. The hydraulic detention time in the rapid mixer is much longer than what is recommended. Additional mixing time may shear newly formed coagulated particles.

f. Corrosion was observed on the catwalk above the rapid mixing tank.

g. Typical velocity gradients range from 300 s^{-1} to 1600 s^{-1}. (Kawamura, 1991) However, no records are available to determine the type of impeller that is utilized in the basin. Therefore, the existing velocity gradient cannot be determined.

4. Contact Clarifier

Central City WTP operates two contact clarifiers. Coagulated water from the rapid mixing system enters a splitter box that distributes the flow to each contact clarifier. Figure 5.02-2 displays these facilities.

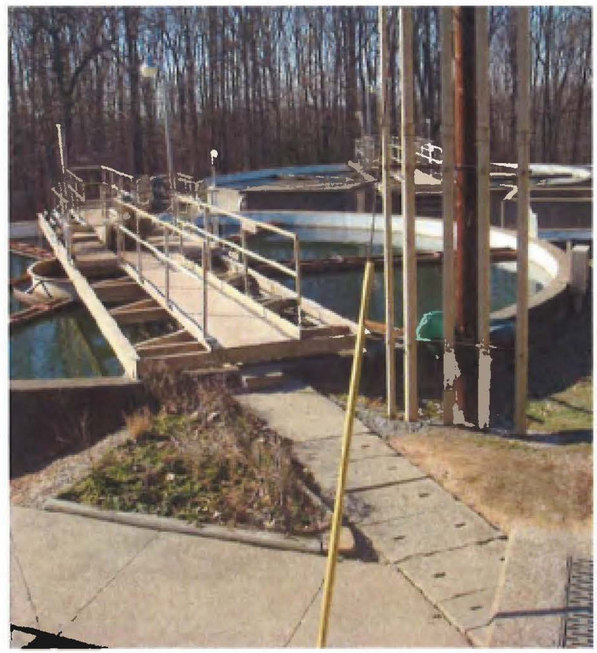


Figure 5.02-2 Existing Contact Clarifiers

Coagulated water from the splitter box is discharged to the center of the contact clarifier. A vertical turbine mixer slowly mixes the coagulated water in the flocculation zone located in the center of the contact clarifier for a period of about 26.5 minutes (at a design flow rate of 4 mgd or 2 mgd per clarifier). The speed of the vertical turbine mixer can be adjusted by variable frequency drive (VFD) to facilitate the formation of larger settable particles or “floc”. The flocculated water passes under a baffle to a settling zone within the clarifier, where the flocculated particles settle to the clarifier bottom.

Clarified water passes through submerged orifices in radial launders and exits the units.

Settled flocculated particles or sludge is pushed toward a centrally located sludge collection pit by slowly rotating sludge rakes. The rotational speed of the sludge rake arms can be varied to minimize the resuspension of settled particles.

Sludge is removed from the sludge collection pit by manually operating sludge valves. The sludge valves are located in a separate building between the contact clarifiers. The sludge is discharged to a common outfall pipe to a ditch leading to Devil’s Lake and eventually Green River.

Table 5.02-1 lists the calculated operating parameters of the clarifiers, based on a design flow of 4 mgd and existing record drawings.

TABLE 5.02-1

EXISTING CLARIFIER OPERATING PARAMETERS

Parameter	Units	Existing	10 States Standards (2003)
Contact Clarifier Units	No.	2	2 minutes
Design flow/clarifier	mgd	2	N/A
Clarifier diameter, each[1]	ft	48	N/A
Flocculation zone average diameter, each [1]	ft	17.5	N/A
Contact clarifier area, each[2]	ft^2	1,700	N/A
Effluent launder length, each[1]	ft	102	N/A
Side water depth[1]	ft	12.25	N/A
Total volume, each	gal	166,000	N/A
Flocculation zone volume, each	gal	36,800	N/A
Flocculation zone detention time	min	26.5	>30 minutes
Total detention time	hr	2	2 to 4 hours
Launder loading rate	gpm/ft	6.8	<10
Upflow rate[3]	gpm/ft^2	0.9	<1

[1] Based on 1982 record drawings. Zone is conical in shape.
[2] Total surface area–baffled zone area.
[3] Based on total area-average area provided by flocculation zone.

The following is a list of major standards for solid contactors provided in the Ten State Standards (2003 Edition).

a. A minimum of two contact clarifier units are required.

b. Flocculation mixers should be adjustable speed.

c. Hydraulic residence time in the flocculation zone should not be less than 30 minutes.

d. The total hydraulic residence time in the contact clarifier should be two to four hours.

e. The weirs should be designed for no more than 10 gallons per minute (gpm) per foot of weir length for units used as clarifiers.

f. Upflow rates should be no more than 1 gpm per square foot for units used as clarifiers.

Several issues with the contact clarifiers were revealed through discussions with operational staff and observations of the equipment. The following is a summary of concerns related to the contact clarifiers.

a. In the past, automatic valve actuators operated sludge valves to remove sludge from the contact clarifiers. The valve actuators were programmed to remove sludge based on elapsed time. At some point, the automatic valve actuators quit working. Now, the valves are operated manually and sludge is removed based on observation.

b. The volume and concentration of sludge removed from contact clarifier cannot be determined.

c. The original clarifier drives and vertical mixer drives were belt driven. After some time the belts began to slip, and the drive units were replaced with direct drive motors. It is not certain whether or not the over-torque limit switches are properly functioning to shutdown and/or alarm when there is an obstruction preventing the rake arms from turning.

d. The operators have observed sludge resuspending and passing through the effluent orifices while restarting the contact clarifiers after a nightly shutdown.

e. The operators have said that during certain times of the year, it is difficult to prevent flocculated particles from leaving the contact clarifier. In the summer, afternoon temperatures rise and effluent turbidity rises accordingly. In the winter, the flocculated particles do not settle. In response to these seasonal water quality changes, polymer is now fed at two applications points, at the river water pumping station and at the rapid mixing chamber. Even with the polymer addition, the loss of sludge from the units continues to occur.

f. During the site visit, algae growth was visible throughout the tank.

g. Existing flocculation zone provides less than the detention time recommended.

h. If one of the contact clarifiers were taken out of service for maintenance, plant capacity is reduced to 2 mgd.

i. Corrosion can be observed on the walkways and mechanism arms.

j. There are no handrails installed at the perimeter of the contact clarifiers.

5. Sedimentation

The sedimentation basin receives flocculated and settled water from the contact clarifiers through an influent trough. There is one sedimentation basin train. As flocculated water passes through the length of the basin, flocculated particles, or sludge settles to the bottom of the basin before flowing up through tube settlers. Settled water (above the tube settlers) flows over v-notch weirs into seven effluent weirs launders and into a common header out of the sedimentation basin.

The basin has a sloped bottom slab with valves to drain sludge. However, there is no sludge collection equipment installed on the sedimentation basin to remove sludge. According to the operators, the sedimentation basins are taken out of service approximately every three months to remove settled sludge. The amount of sludge removed cannot be determined.

In 2002, approximately 1,375 square feet (ft^2) of 2-feet deep tube settlers were installed at the end of the sedimentation basin, and a 24-inch bypass pipe was installed to connect sedimentation basin influent and effluent piping.

Table 5.02-2 lists the calculated operating parameters based on a design flow of 4 mgd and existing record drawings.

TABLE 5.02-2

EXISTING SEDIMENTATION OPERATING PARAMETERS

Parameter	Units	Existing	10 States Standards (2003)
Sedimentation basins	No.	1	N/A
Basin dimensions (L x W)[1]	ft x ft	120 x 40	N/A
Side water depth[1]	ft	10.5	N/A
Basin surface area[1]	ft^2	4,800	N/A
Total volume	gal	377,000	N/A
Effluent weir length[1]	ft	221	N/A
Tube settler cross-sectional area[2]	ft^2	1,375	N/A
Basin detention time	hr	2.26	4 hours without tube settlers
Effluent weir loading rate	gpd/ft	18,100	<20,000
Surface overflow rate	gpm/ft^2	0.58	<0.5
Horizontal basin velocity	ft/min	0.88	<0.5
Tube settler loading rate[2]	gpm/ft^2	2	<2

[1] Based on 1982 record drawings.
[2] Based on drawings provided by manufacturer.

The following is a list of major standards for sedimentation basins provided in the Ten State Standards (2003 Edition):

a. The hydraulic detention time should be a minimum of four hours without tube settlers. Reduced detention time may be approved when equivalent effective settling is demonstrated or when overflow rate is not more than 0.5 gallons per minute per square feet (gpm/ft^2).

b. A maximum rate of 2 gpm/ft^2 of cross-sectional area is required for tube settlers.

c. The rate of flow over the outlet weirs should not exceed 20,000 gallons per day per foot.

d. The velocity through the settling basin should not exceed 0.5 feet per minute.

e. Basins should be designed to maintain velocities suitable for settling the basin and to minimize short-circuiting.

f. An overflow pipe should be provided to establish the maximum water level desired on the top of the filters.

g. Adequate sludge collection equipment that ensures proper basin coverage shall be provided.

h. Basins must be provided with a means for dewatering.

i. Flushing lines or hydrants shall be provided.

j. Permanent ladder should be provided on the inside walls of basins above the water level.

k. Guardrail/handrail should be provided.

The following is a summary of concerns related to the sedimentation basins.

a. The velocity through the settling basin is 75 percent greater than the recommended standard. High velocities through the settling basin can reduce effective settling.

b. No baffles have been provided in the tanks to minimize hydraulic short-circuiting. While this is not required, baffles can mitigate high velocities through the tank.

c. Sludge removal rates and concentrations cannot be determined.

d. The sedimentation basins need to be taken out of service to remove sludge.

6. Filtration

The Central City WTP operates four mixed media conventional filters. Settled water from the sedimentation basin enters at the top of the filters from a common 24-inch influent pipe. Settled water is then filtered through a mixed media layer, and filtered water is collected by filter blocks located at the bottom of the filter. According to the operators, the filter media was replaced within the last three years. Filtered water is then conveyed through an 18-inch filter effluent pipe to the clearwell. Each filter has an on-line turbidimeter that records the turbidity of the filter effluent.

The filters are backwashed periodically according to a schedule. However, the operators also monitor the pressure differential through the filter media and the filter effluent turbidity on each filter to determine if a filter needs to be backwashed sooner. A wash water pump discharges water from the clearwell through a common 18-inch wash water pipe header to backwash each filter. According to the operators, a valve is installed for each filter to control the wash water rate to each filter. Wash water is conveyed at the bottom of the filters to fluidize the filter media and to a revolving arm surface wash system. Backwash waste is conveyed through a 20-inch drain pipe to the outfall.

Table 5.02-3 lists the calculated design parameters based on a design flow of 4 mgd and existing record drawings.

Each filter also has an orifice plate installed to record the wash water flow to each filter. According to the operators, the orifice plates do not accurately measure flow and are not used for reporting purposes. Backwash waste volume is tracked based on the wash water pump flow rate.

After a backwash cycle is complete, the filter effluent is diverted to the 20-inch drain until the turbidity is below 0.2 NTU (Filter-to-Waste).

The filter controls are all hydraulically actuated valves.

TABLE 5.02-3

EXISTING FILTER DESIGN CRITERIA

Parameter	Units	Existing	10 State Standards (2003)
Filter units	No.	4	>2
Design flow, each (3 in service)	gpm	926	N/A
Dimensions (L x W)[1]	ft	18.5 x 19.5	N/A
Filter box depth[1]	ft	11.58	>8.5
Filter area, each[1]	ft^2	360	N/A
Filter loading rate (3 in service)	gpm/ft^2	2.57	<5
Filter media, depth–type[1]	ft	2.5 - sand/anthracite	2 to 2.5
Support media, depth-type[1]	ft	1 - gravel	N/A
Wash water pumps	No.	1	2
Wash water pump flow rate[2, 3]	gpm	~6,000	N/A
Total wash water loading rating[2]	gpm/ft^2	~16.67	>15
Backwash time, minimum[2]	min	N/A	>15
Influent pipe diameter[1]	inch	24	N/A
Influent pipe velocity[4]	fps	1.33	<2

[1] Based on 1982 record drawings.
[2] Based on discussions with operators.
[3] Actual capacity may be greater.
[4] Assumes 3 filters in service at 4 mgd.

The following is a list of major standards for filters provided in the Ten State Standards (2003 Edition).

a. At least two units should be provided.

b. The units should be designed so that there is enough filter capacity to take one filter out of service and meet the plant design capacity (4 mgd).

c. The filter box depth should be a minimum of 8.5 feet.

d. Maximum velocity of treated water to filters should be 2 feet per second.

e. Surface wash rates for revolving arm surface wash systems should be 0.5 gallons per minute per square foot (gpm/ ft^2).

f. A minimum of 15 gpm/ft^2 should be provided for backwash; 20 gpm/ft^2 is recommended.

g. Wash water pumps should be installed in duplicate unless an alternate means of obtaining wash water is available. Central City can backwash with system water, if needed.

h. Filters should be backwashed for a minimum of 15 minutes.

i. A rate-of-flow indicator, preferably with a totalizer on the main wash water line, should be located so that it can be easily read by the operator during the washing process.

The following is a summary of concerns related to the filters.

a. The hydraulic valve actuators appear to be in poor repair and operators have experienced difficulties with them. The filter controls are currently being replaced.

b. Backwash flow cannot be measured accurately.

c. There is no redundant wash water pump, but it may be possible to backwash from the water distribution system.

d. During certain times of the year, the filter effluent turbidity rises because of water quality changes on the Green River resulting in a rising sludge blanket in the contact clarifiers. When these rises occurred, the operators proactively increased the prechlorination rate, adjusted polymer and coagulant addition, and decreased elapsed time between backwash cycles to as little as 20 hours. Such actions have prevented finished water turbidity violations.

7. Clearwell Storage and Disinfection

Central City WTP has a total clearwell volume of approximately 409,000 gallons. According to record drawings, the normal water surface elevation is 489.25 feet and the finished floor elevation is 477.8, which calculates to a maximum depth of about 11.5 feet. According to the operators, the additional baffling was placed within the last five years in the clearwell to prevent hydraulic short-circuiting. The amount of total storage is about 10 percent (409,000 gallons) of the rated 4 mgd treatment capacity. Kentucky Division of Water (KDOW) requires facilities to have approximately 15 percent of rated capacity (600,000 gallons at a 4 mgd production rate) clearwell storage for adequate hydraulic storage for standby and emergency use.

Central City should be able to provide 0.5 log removal of Giardia required by the USEPA with approximately 3.3 feet depth based on a CT value (C is the residual disinfection concentration in mg/L; and T is the time [minutes] that water is in contact with the disinfectant) of 41 assuming the following parameters:

a. 0.5 baffling factor
b. 5 degrees Celsius temperature
c. pH 8
d. 2 mg/L chlorine dose

Although only 3.3 feet is required for log credits, greater depth is likely required to operate the high service and backwash pumps. CT calculations for the existing plant capacity and design capacity based on design by McGhee Engineering, Inc. are provided in Appendix B.

Total clearwell volume is less than 15 percent of rated capacity of the treatment as required by KDOW.

8. Chemical Treatment

The following is a summary of Central City's chemical feed systems used to treat water prior to distribution. Central City currently injects the following chemicals into the water treatment process:

a. Potassium permanganate for taste and odor control, and oxidation.
b. Two polymers for coagulation aid.
c. Aluminum-Chlorohydrate-based proprietary solution for coagulation.
d. Powdered Activated Carbon (PAC) for taste and odor control.
e. Corrosion inhibitor for corrosion control in water distribution system.
f. Sodium Hypochlorite for disinfection.

g. Hydrofluorosilicic Acid (dentifrice).

5.03 BULK STORAGE

Table 5.03-1 summarizes the amount of chemicals used for 2006 and 2007 along with the existing storage capacity. All bulk storage tanks appear to provide at least the required 30 days storage capacity.

Chemical	units	2006/2007 Average Monthly Use[5]	Available Bulk Storage (lbs/gal)
Potassium Permanganate[1]	lbs	1,700	N/A
Polymer (CedarFloc 526)[2]	gal	186	N/A
Polymer (CedarFloc 550)[2]	gal	25	N/A
Coagulant (UltraFloc 9154)	gal	1,600	5,000
Powder Activated Carbon[3]	lbs	0 to 3,000; 830 (average)	N/A
Sodium Hypochlorite	gal	2,950	6,000
Corrosion Inhibitor (Calciquest)	gal	1,100	5,000
Hydrofluorosilicic Acid[4]	gal	340	N/A

[1]Potassium permanganate is delivered in 5-gallon buckets.
[2]Polymer is delivered in 450-lb drums.
[3]Carbon is stored in 40-lb bags.
[4]Hydrofluorosilicic Acid is delivered in drums.
[5]Average river water pumping rate in 2007 = 3.5 mgd average day demands

Table 5.03-1 Reported Chemical Usage

Numerous chemical containment issues were observed during a visit to the treatment plant. Chemical containment should be addressed throughout the treatment plant.

5.04 POTASSIUM PERMANGANATE FEED SYSTEM

Central City is currently feeding potassium permanganate to the river water wetwell to oxidize the river water before entering the treatment plant. Potassium permanganate is a strong oxidizer. According to the operators, the potassium permanganate feed rate is adjusted to aid in the removal of iron and manganese and to prevent algae growth at the treatment plant.

The potassium permanganate feed equipment is located in a 6-foot by 10-foot prefabricated insulated fiberglass enclosure near the river water pumping station at the old water treatment site. Dry potassium permanganate is fed into a volumetric dry chemical feeder manufactured by Acrison, which fluidizes the dry chemical before pumping the fluidized chemical to the intake well.

The following list summarizes concerns related to the potassium permanganate feed system.

A. Operators have mentioned they believe moisture is causing dry permanganate to cake on the augur. This added weight is believed to have caused the augur to break on multiple occasions.

B. Ten States Standards (2003) recommends a scale for recording dry chemical use.

5.05 POLYMER FEED SYSTEM AT THE RIVER WATER PUMPING STATION

Central City is currently feeding polymer to the river water wetwell to aid in solids removal at the treatment plant. The polymer has some toxicity. According to the manufacturer, the purpose of the polymer is "to neutralize the charge of the water." Historically, the operators have experimented with different combinations of polymers and coagulant, and currently, the operators adjust the feed rate of this polymer and coagulant to improve the operation of the contact clarifiers.

This polymer feed system is located in a 12-foot by 12-foot pole barn near the river water pumping station at the old water treatment site. A mechanical diaphragm pump pumps polymer from a 55-gallon drum to the river water pump discharge line.

5.06 POLYMER FEED SYSTEM AT THE WATER TREATMENT PLANT

Central City is currently feeding a second polymer to the rapid mixing tank to aid in solids removal. The polymer has some toxicity. According to the manufacturer, the purpose of the polymer is "to provide ballast for coagulated particles". Historically, the operators have experimented with different combinations of polymers and coagulant, and currently, the operators adjust the feed rate of this polymer and coagulant to improve the operation of the contact clarifiers.

This polymer feed system is located in a chemical room adjacent to the laboratory in the water treatment building. A belt-driven mechanical diaphragm pump discharges polymer from a small open-top tank to the rapid mixing tank. The belt-driven mechanical diaphragm pump appeared to function properly. A chemical spill containment curb is provided in this chemical room.

Based on Strand's observations, the chemical feed pump appears to have aged and may need replacing.

5.07 COAGULANT FEED SYSTEM

Central City is currently feeding coagulant to the rapid mixing tank to aid in solids removal. According to the manufacturer, the coagulant is an aluminum-chlorohydrate based coagulant. Historically, the operators have experimented with different combinations of polymers and coagulant, and currently, the operators adjust the feed rate of the polymers and coagulant to improve the operation of the contact clarifiers.

The coagulant feed system is located on the second and third floors in the WTP building. Two 2,500 gallon fiberglass tanks installed on the third floor provide chemical bulk storage for the coagulant. PAC is also stored in this room, and there did not appear to be any chemical containment around the coagulant bulk storage tanks.

A manual valve on the second floor controls the flow from the bulk tank to the open-top day tank. The day tank is located in a chemical room adjacent to the laboratory on the second floor. A float switch and an alarm have been provided on the day tank to alert the operators when the tank is full. A belt-driven mechanical diaphragm pump discharges coagulant from a 250-gallon day tank to the rapid mixing tank. The belt-driven mechanical diaphragm pump appeared to function properly. A chemical spill containment curb is provided in this chemical room.

The following list summarizes concerns and comments related to the coagulant feed system.

A. The operators have commented there is no external level indication for the bulk tanks, and the tank level must be checked by dipping a stick in the tank. The chemical bulk tanks should have external level indication.

B. Chemical containment should be provided around the bulk tanks. It may be necessary to separate the coagulant and PAC bulk storage based on their chemical compatibility.

C. Ten States Standards (2003) recommends an installed redundant chemical feed pump for coagulant feed systems. The coagulant feed system does not have an installed redundant chemical feed pump.

D. The chemical feed pump appears to have aged and may need replacing.

E. The operators have said that at times the day tank has overflowed. The current equipment to transfer chemical to the day tank should be improved.

5.08 POWDER ACTIVATED CARBON FEED SYSTEM

Central City is periodically feeding PAC to the rapid mixing tank to address seasonally taste and odor problems.

The PAC system is located on third floor in the WTP building. PAC is fed into a volumetric dry chemical feeder manufactured by Acrison, which fluidizes the dry chemical before pumping the fluidized chemical to the rapid mixing tank. The volumetric dry chemical feeder appeared to be functioning properly. PAC is a combustible dust.

The following is a summary of concerns related to the PAC feed system.

A. The operators have commented that carbon dust from this system is a problem throughout the treatment plant.

B. Ten States Standards (2003) recommends a scale for recording dry chemical use.

5.09 SODIUM HYPOCHLORITE FEED SYSTEM

Central City is currently feeding sodium hypochlorite at the influent trough to the sedimentation basins (prechlorination) and at the 24-inch filter effluent pipe before the clearwells (postchlorination). Sodium hypochlorite provides disinfection and disinfection residual.

The sodium hypochlorite feed system is located in two rooms in the chemical building at the WTP. The chemical building also houses the fluoride feed system and corrosion inhibitor feed system. Sodium hypochlorite is stored in two 3,000-gallon bulk storage tanks. A transfer pump discharges hypochlorite from the bulk storage tanks to a 200-gallon day tank. The sodium hypochlorite bulk tank, day tank, and transfer pump are stored in the same room. A chemical containment wall has been provided. Four mechanical diaphragm pumps are provided for pumping hypochlorite from the day tank to the two application points. Two pumps are provided for prechlorination and two pumps are provided for postchlorination. The chemical feed pumps are placed on the floor in a smaller room separate to the chemical storage tanks. Chemical containment in this room is provided by a curb.

The operators mentioned that over time, the pump feed rates are increased to maintain the desired chlorine residuals at the application points. Also, the operators observed that, during the summer months, the mechanical diaphragm pumps have even stopped pumping. Sodium hypochlorite tends to off gas at relatively low temperatures, which can decrease the concentration of chlorine in the solution. This off-gassing can be mitigated by providing temperature-controlled storage.

The following is a summary of concerns related to the sodium hypochlorite feed system.

A. Chemical containment should be addressed in the chemical storage room. The operators have commented that when chemical spills occurred the chemical containment curb leaked.

B. Pump vapor locking should be investigated further.

5.10 FLUORIDE FEED SYSTEM

Central City is currently feeding fluorosilicic acid (fluoride) at the 24-inch filter effluent pipe before the clearwells. Fluoride is fed for prevention of dental cavities. Fluoride is a highly corrosive and toxic chemical.

The fluoride feed system is located in the chemical building at the WTP. Fluoride is stored in 55-gallon drums. A mechanical diaphragm pump has been provided for pumping fluoride from the day tank to the application point.

The 55-gallon drums lack level indication. A drum-scale should be used to record daily chemical use.

5.11 CORROSION INHIBITOR FEED SYSTEM

Central City is currently feeding corrosion inhibitor at the 24-inch filter effluent pipe before the clearwells. Corrosion inhibitor is fed to prevent corrosion in the water distribution system.

The corrosion inhibitor feed system is located in the chemical building at the WTP. The corrosion inhibitor is stored in the same room as the fluoride feed system in a 5,000-gallon bulk storage tank. An 8-inch tall concrete curb provides partial containment against spills. Chemical is transferred by gravity through the operation of valves to a 55-gallon open top day tank. A mechanical diaphragm pump is provided for pumping corrosion inhibitor from the drums to the application point.

Ten State Standards (2003) requires a day tank scale or level indication on the day tank. The operators have commented that the current balance-type scale is inadequate for their needs.

SECTION 6
TREATMENT ALTERNATIVES

6.01 EXISTING TREATMENT PROCESS

The Central City Treatment Plant is a modified lime-softening water treatment facility currently operated as a conventional treatment plant with two-stage sedimentation. The plant has not utilized its lime-softening equipment in the last ten years. Water treatment begins at the River Water Pumping Station. Rotating, mechanical screens remove debris from the Green River as it enters the river water pumping station wet well. Potassium permanganate and polymer are fed at the river water pumping station, giving the chemicals time to react in the approximately 3,000 feet of river water force main to the treatment plant.

River water enters the treatment plant and is fed to the rapid mixing tank, where a coagulant, a polymer, and PAC are added and mixed with the river water.

Coagulated water from the rapid mixing system enters a splitter box, which distributes the flow to two contact clarifiers. The contact clarifiers contain a centrally-located flocculation zone which promotes the formation of larger settable particles or "floc." Flocculated particles or sludge settles to the bottom of the clarifiers, and clarified water passes through submerged orifices in radial launders and exits the units. Sludge is removed by manual operation of sludge valves.

The sedimentation basin receives flocculated and settled water from the contact clarifiers. Flocculated particles or sludge settles to the sedimentation basin floor, and settled water passes over weirs and exits the sedimentation basin. Tube settlers were installed at the end of the sedimentation basin to increase the capacity of the sedimentation basin for removing settleable particles. The sedimentation basin is bypassed and taken out of service periodically to remove settled sludge.

Settled water from the sedimentation basin enters a common influent header, which distributes flow to the top of four mixed media conventional filters. The filters are backwashed periodically to remove filtered particles.

Filtered water is fed into the clearwell. Sodium hypochlorite is fed to the clearwell influent to meet the necessary chlorine contact time requirements. Fluoride and a corrosion inhibitor are also fed at the same application point.

See Section 5–Existing WTP Performance for additional discussion.

6.02 OTHER GREEN RIVER TREATMENT PLANTS

As part of the existing WTP analysis, a survey was conducted of other WTPs utilizing the Green River as a water source. This survey focused on the following areas of concern:

1. Treatment processes and procedures currently used.
2. Treatment challenges that are experienced.
3. Methods used to overcome treatment challenges.
4. Recommendations for improved performance.

A. Survey of Green River Water Treatment Plants

The following is a summary of these discussions.

1. Butler County Water Treatment Plant

Strand contacted David Maciel, Manager of Operations, at the Butler County Water System Inc. Butler County Water System, Inc. operates the Butler County WTP located in Morgantown, upstream of the Central City WTP. The Butler County WTP has a design capacity of about 1.3 mgd. Currently, the treatment plant is operating about 16 hours per day and is producing an average drinking water flow about 0.9 to 1 mgd. The Butler County WTP consists of a rapid mix tank, two contact clarifiers with surface mounted tube settlers, three mixed media conventional filters, and a clearwell.

During the spring, the Green River water quality can change, causing the filter run time to decrease from 50 hours to 15 hours between backwashes. During this time, the chlorine dose to the filters was increased, which seemed to alleviate the problem.

During the daily WTP startup, the operators observe a slight increase of solids leaving the contact clarifiers. After the contact clarifiers stabilize (30 minutes to an hour), the contact clarifier effluent returns to normal.

David Maciel did not offer any recommendations for treatment improvements.

2. Morgantown Water Treatment Plant

Strand contacted Dwayne Colter, Superintendent, at Morgantown Utilities. Morgantown Utilities operates the water, wastewater, and natural gas utilities for Morgantown, Kentucky. The Morgantown WTP is located in Morgantown upstream of the Central City WTP. The Morgantown WTP has a design capacity of about 0.68 mgd. Currently, the treatment plant is operating 14 to 16 hours per day and is producing an average drinking water flow of about 0.46 mgd. The treatment process consists of a flash mixer, one clarifier with tube settlers, one contact clarifier, three mixed media conventional filters, a clearwell, sludge ("mud") lagoon, and a discharge lagoon.

In the past, the plant experienced some difficulty with high solids loading of the filters. Morgantown WTP has experimented with different combinations of polymers and coagulants. The current coagulant seems to effectively settle particles. However, the current coagulant produces a larger amount of solids. Dwayne mentioned that the "mud" lagoon must be pumped out every six months.

Dwayne Colter did not offer any recommendations for treatment improvements.

3. Ohio County Water Treatment Plant

Strand contacted Walt Beasley, General Manager, at the Ohio County Water District. The District operates the Ohio County WTP located in Cromwell, upstream of the Central City WTP. The Ohio County WTP has a design capacity of about 2 mgd. Currently, the treatment plant is operating at design capacity, 24 hours per day. The Ohio County WTP consists of a flash mixer, two flocculation mixers, two settling basins with two tube settlers, two filters, and a clearwell. The Ohio County Water District is in the process of building a brand new Membrane WTP at another location.

The following reasons were given for building a Membrane WTP:

a. The existing WTP is currently producing water at design capacity, and the treatment plant site lacked space for additional treatment capacity expansion.

b. Currently, the Ohio County Water District has purchased as much as 2.3 mgd from the Perdue Farms WTP. The current contract is nearing completion.

c. The new treatment plant site has been designed for double the existing water treatment capacity (4 mgd) and will have space for expansion in the future.

d. The existing treatment plant equipment is near the end of its useful life.

e. Membrane treatment may reduce the potential for the formation of THM and DBP.

f. Membrane treatment represents the latest in water treatment plant technology.

Although a new Membrane WTP is being built, Walt Beasley says the existing conventional WTP consistently produces quality drinking water with very few problems. Seasonal changes in water quality did not greatly affect treatment plant performance. In addition, none of the Green River water samples tested positive for the presence of Cryptosporidium and/or Giardia.

4. Green River Valley Water Treatment Plant

Strand contacted David Mathews at the Green River Valley Water District. The District operates the Green River Valley WTP located in Munfordville, upstream of the Central City WTP. Plant capacity is 6 mgd. Currently, the plant is operated 24 hours per day and produces an average drinking water flow of 4 to 4.5 mgd. Most of the time, the Green River Valley WTP treats water from the Rio Verde Spring, and the Green River is a secondary source of water. The Green River Valley WTP consists of two rapid mixers, two flocculation trains, six sedimentation basins with tube settlers, six mixed media conventional filters, and give clearwells.

Although the main source of water is the Rio Verde Spring, high turbidity during the spring rains have reduced the filter run times from 80 hours between backwashes to as little as 20 hours. This phenomenon is uncommon. For the most part, seasonal water quality changes do not affect treatment operation.

David Mathews suggested that variable speed pumps and 24-hour operation was a key to stabilizing their treatment processes during poor water quality spikes, such as after a significant rain event. The variable speed pumps could be slowed temporarily to prevent overloading of their treatment processes.

5. Greensburg Water Treatment Plant

Strand contacted Gordon Price at Greensburg Municipal Water and Sewer. Greensburg operates the Greensburg WTP located in Greensburg upstream of Central City WTP. The Greensburg WTP has a design capacity of 1.44 mgd. Currently, the treatment plant is operated 20 hours a day and is producing an average drinking water flow of 1 mgd. Approximately, 72 percent of the drinking water produced is sold to Green Taylor Water. The plant consists of one rapid mixer, one flocculator, one sedimentation basin with tube settlers, two mixed media filters, and one clearwell.

Gordon Price commented the treatment plant produced a consistent drinking water with very little or no operational changes because of seasonal water quality changes on the Green River.

Gordon Price did not offer any recommendations for treatment improvements.

6. Perdue Farms, Inc.

Strand contacted David Jurgens at Perdue Farms, Inc. Perdue Farms operates the Perdue Farms WTP located in Beaver Dam (upstream of Central City WTP). The plant has a design capacity of 3 mgd. The primary function of the treatment plant is to provide potable water for the Perdue Farms chicken processing facilities. Perdue Farms also has a contract to sell water to the Ohio County Water District. Currently, the treatment plant is operated 24 hours per day. During the week while processing chicken, the WTP produces an average of 2.3 to 2.6 mgd. On the weekend during plant shutdown, it produces an average of 0.75 to 1.3 mgd. The source of water supply is the Green River. The WTP consists of a rapid mixing system, two superpulsators (a type of contact clarifier), two mixed media filters, and a clearwell with minimal storage capacity (100,000 gallons).

David Jurgens commented the current WTP lacks the treated water storage to accommodate the fluctuations in treated water demand from weekend to week day. At the beginning of the work week, the treated water flow must increase to about double the weekend treated water flow. During this time, the solids concentration from the superpulsators to the filters can increase. David Jurgens has found the key to preventing solids loss out of the superpulsators is to ramp up the flow slowly over an hour or two, which is sometimes impossible because of the lack of treated water storage.

David Jurgens recommended that variable speed drive pumps and additional clearwell storage should be included to provide additional treatment process flexibility.

B. Summary of Green River Water Treatment Plants

The following list are observations made of the Green River WTPs:

1. All treatment plants use a form of conventional treatment.

2. None of the treatment plants soften.

3. Three out of six plants utilize contact clarifiers for flocculation and partial sedimentation, similar to the existing Central City WTP.

4. Three out of six plants utilize separate flocculation and sedimentation.

5. All treatment plants with contact clarifiers experience an increase in contact clarifier effluent solids concentrations when treated water flow change, especially during morning startup of equipment.

6. All treatment plants with contact clarifiers experience difficulty with water quality changes on the Green River, which require increased filter backwash frequencies.

7. All treatment plants with contact clarifiers have the ability to slowly increase and decrease flows to the contact clarifiers. This has helped maintain stability of these processes.

8. One out of the three contact clarifier WTP has experimented with combinations of polymers and coagulants to increase the settleability of the sludge.

9. All treatment plants with separate flocculation and sedimentation did not generally experience seasonal process upsets because of water quality changes on the Green River.

10. All treatment plants experienced an increase in frequency of filter backwashes when the turbidity on the river increased during a significant rain event.

11. None of the treatment plants have found the presence of Cryptosporidium or Giardia on the Green River.

6.03 TREATMENT ALTERNATIVES

A preliminary evaluation was conducted to consider whether the existing treatment site could be used or a new treatment site would be required to accommodate projected demands. Given the relatively good condition of many of the structures and equipment and the available land on site, the existing plant facilities with accompanying improvements should be able to operate and accommodate demands in excess of 10 mgd. Therefore, the alternatives reviewed all contemplated expansion at the existing treatment site. The three alternatives considered are Alternative 1: Conventional Treatment Plant with Additional Contact Clarifiers, Alternative 2: Conventional Treatment Plant with Separate Flocculation and Sedimentation, and Alternative 3: Conventional Treatment Plant with Contact Clarifiers and a Membrane Filtration Polisher.

A. Alternative 1: Conventional Treatment Plant with Additional Contact Clarifiers

This alternative requires new rapid mixing equipment and tank, two new contact clarifiers, modifications/replacement of existing contact clarifier units, miscellaneous improvements to existing filters, additional filtration capacity, additional clearwell volume, residuals handling, additional piping, and several miscellaneous improvements to the existing chemical feed systems.

The advantage of this alternative is that the operators are familiar with contact clarifier operation.

The disadvantages of this alternative include the following:

1. The existing contact clarifiers become unstable when the flow rates changes.
2. The original contact clarifiers were designed for lime-softening and require modifications for stable conventional treatment operation.
3. Seasonal water quality changes on the Green River affect the ability of contact clarifiers to settle out sludge.
4. Contact clarifiers require significant amounts of polymer and coagulant to form settleable sludge.
5. Conventional filters do not provide a physical barrier for removal of Cryptosporidium.

B. Alternative 2: Conventional Treatment with Separate Flocculation and Sedimentation

This alternative requires two new rapid mix tanks and mixers, the conversion of the existing sedimentation basin to a four-stage tapered flocculation basin, the construction of two new sedimentation basins, miscellaneous improvements to existing filters, additional filtration capacity, additional clearwell volume, modification of the existing contact clarifiers to as an optional pretreatment step, piping modifications, and several miscellaneous improvements to existing chemical feed systems.

The advantages of this alternative are listed below:

1. This alternative is the most common type of treatment plant.
2. This alternative is reported to be comparatively easier to operate on the Green River.

3. This alternative has been proven to provide stable treatment for a variety of flow rates and water quality conditions.

4. The alternative is inexpensive to operate as compared to other treatment options, such as Membrane Treatment.

5. This alternative may reduce chemical usages as compared to contact clarifiers.

The disadvantage of this alternative is that conventional filters do not provide a physical barrier for removal of Cryptosporidium.

C. Alternative 3: Conventional Treatment with Contact Clarifiers and Membrane Filtration Polishing Filter

This alternative would require loading the existing treatment facilities at a higher rate for increased capacity followed by membrane filtration.

The advantages of this alternative include the following:

1. Membrane filtration provides a physical barrier for removal of Cryptosporidium.

2. Membrane filtration may reduce the potential to form (DBPs).

3. Membrane filtration has the potential to meet future, more stringent regulatory treatment standards.

4. Membrane filtration may reduce polymer and coagulant use.

The disadvantages of this alternative include the following:

1. Membrane filtration is considerably more complex to operate.

2. Membrane filtration requires more chemical use and storage for filter cleaning.

3. Membrane filters have historically required a large membrane replacement budget.

4. Membrane filters may require a higher operator classification, Class IVB versus IVA.

5. Membrane filtration requires a large amount of support equipment for operation in addition to operating existing equipment.

6. Membrane filtration will require pilot plant testing.

At the time of writing this report, Cryptosporidium has not been found on the Green River. If further sampling results indicate the presence of enough Cryptosporidium to require additional treatment than offered by conventional means, UV radiation equipment can be used for additional treatment.

A present worth evaluation of the three alternatives including capital costs and major maintenance cost associated with membrane replacement and UV (assumed to be required for Alternatives 1 and 2) power and lamp replacement concluded that Alternative 1 was the least costly. Alternative 2 was 10 percent more and Alternative 3 was 75 percent more comparing only project components specifically required for each alternative.

6.04 RECOMMENDED TREATMENT ALTERNATIVE

The recommended alternative is Alternative 2: Conventional Treatment with Separate Flocculation and Sedimentation. This alternative offers an excellent combination of operability, process stability, and cost effectiveness. It will be even more cost-effective if further testing indicates additional filtration capacity and UV equipment are not required. Additional improvements to existing facilities will be required, most notably an expansion of the clearwell and new chemical handling equipment and storage. These improvements will further be developed throughout preliminary and final design with the input of Central City staff.

6.05 RESIDUALS HANDLING

Currently, the WTP discharges sedimentation and filtration residuals to a ditch leading to a sludge lagoon commonly known as Devil's Lake. As flow enters the lagoon, solids settle out and decanted water overflows the bank to a secondary lagoon, which drains to a culvert leading to the Green River. These discharges are regulated by a Kentucky Pollution Discharge Elimination System (KPDES) general permit. The permit has requirements for pH and total suspended solids (TSS). Compliance samples are taken just upstream from the culvert.

Central City has an agreement with Peabody Energy to discharge to this location. However, no information was available to assess the size of the lagoon. The depth of water and solids are also unknown at this time. We recommend that appropriate measurements and samples be taken to assess the remaining capacity for treating residuals. Depending on the results of this investigation, a contractor could be hired to dredge the lagoon as part of this project.

6.06 RECOMMENDED TREATMENT STUDIES AND ANALYSES

KDOW allows filtration rates of up to 5 gpm/ft^2 if continuous turbidity monitoring is provided for each filter effluent. Strand evaluated using the existing filters to operate at the proposed design flow of 7 mgd to compare the proposed filter loading rate to the filter loading regulatory limit.

Table 6.06-1 lists the existing and proposed filter and backwashing loading rates, based on the existing design flow of 4 mgd, existing record drawings, and the proposed design flow of 7 mgd. Table 6.06-1 shows that the proposed filter loading rate is below 5 gpm/ft^2.

Parameter	Units	Existing at 4 mgd	Proposed at 7 mgd
Filter units	No.	4	4
Design flow, each (3 in service)	gpm	926	1,621
Filter loading rate (3 in service)	gpm/ft^2	2.57	4.50
Design flow, each (4 in service)	gpm	694	1,215
Filter loading rate (4 in service)	gpm/ft^2	1.93	3.38
Wash water pump flow rate[1, 2]	gpm	~6,000	~6,000
Total wash water loading rating[2]	gpm/ft^2	~16.67	~16.67

[1] Based on discussions with operators.
[2] Actual capacities may be greater.

Table 6.01-1 Existing and Proposed Filter Loading Rates

Recently, Southeastern Environmental Group performed a flocculation retention test on Filter No. 2. The preliminary filter testing results indicated that Filter No. 2 filter media had lost 4 inches of depth and the wash arms did not perform adequately. The testing did not include any other filters, and the evaluation was only conducted on the media and wash arms. At the time of writing this report, Strand had not received the completed filter testing report. Operations staff have expressed that challenges have occurred with operating filters at significantly higher rates than 4 mgd. Effluent valves have been set to limit flow through the filters. At this point, it is unknown whether loss of media or some other cause limits the allowable flow rate for effective treatment.

Strand recommends inspecting and repairing the existing filter media and equipment to optimize treatment and capacity. Strand also recommend additional filter load testing be performed before treatment plant expansion to determine loading rate limits. Results should indicate whether additional filters are required.

The proposed filter testing will be performed in two parts; Preliminary Filter Limit Testing and Real-Time Filter Testing.

Preliminary Filter Limit Testing will occur after normal treatment plant hours, when the treatment plant is shutdown. Three filters will be taken out of service, and the sedimentation basin effluent flow will be diverted to one filter. The filter effluent will be discharged to Devils Lake Lagoon. Filter testing begins when one small river water pump will be turned on and the operator will throttle a valve to slowly increase the river water flow to the treatment plant. The influent river water meter will be used to assess the flow to the filter. Prior to filter testing, the river water flow meter measurements will be verified. During filter testing, the river water flow will initially be set to 900 gpm for a period of about 20 minutes. Then, the river water flow will be increased in 100 gpm increments until the filter effluent turbidity is above one nepholometric turbidity unit (NTU). This process will be repeated for each filter, so the filter loading rate limits for each filter can be reviewed.

If it is determined that filters cannot be loaded at the proposed filter loading rate, additional filter area will be required to treat the design flow rate of 7 mgd.

If the Preliminary Filter Limit Testing indicates the maximum filter loading rate is above the proposed filter loading rate, then Real-Time Filter Testing can begin. This extended testing will occur during normal operating hours and involves testing the filtration capacity of individual filters by reducing flow to the remaining filters. The operator would then continue to monitor turbidity of the higher loaded filter, and backwash the filter based on filtered turbidity readings. This process will be repeated for each filter, so the filter backwash frequency, filter backwash volume, and filter backwash rates can be assessed. If results are conclusively positive, then additional filtration capacity-related improvements may be removed from the project.

Geotechnical services will be required to provide recommendations for the design of new structures at the WTP and river water pumping station sites. The services should include soil borings and analyses with an associated report of findings and recommendations. Strand can develop a letter indicating the scope of requested services so that a cost proposal can be developed by a geotechnical engineering firm. The geotechnical recommendations will be required before major structural design can take place.

SECTION 7
RECOMMENDED TREATMENT TRAIN ALTERNATIVE

7.01 GENERAL

The purpose of this section is to outline the recommended treatment train, design criteria, schematics, and total project costs. Section 6 described the basic treatment train recommended as the Conventional Treatment with Separate Flocculation and Sedimentation. Section 8 will discuss improvements to the river water pumping station.

7.02 RECOMMENDED TREATMENT TRAIN

In general, the WTP expansion will be designed in two phases. Phase I will expand the treatment plant capacity to 7 mgd by constructing two identical rapid mix, flocculation, and sedimentation trains with 3.5 mgd capacity each. Phase II will expand the treatment plant capacity from 7 mgd to 10.5 mgd, by constructing one more identical 3.5 mgd treatment train for a total of three rapid mix, flocculation, and sedimentation trains. The following narrative describes the selected processes.

Preliminary design criteria, a schematic diagram, and conceptual plans of the proposed river water pumping station and WTP improvements are presented in Appendix A.

7.03 EXISTING RAPID MIX AND CONTACT CLARIFIERS

The existing rapid mixer, river water piping, and contact clarifiers will remain in place. Additional river water piping will be installed to bypass these systems. Some modifications will be made so that these systems may be utilized for pretreatment purposes on an as-needed basis. However, it is not anticipated that these treatment processes will be necessary under routine operating conditions.

7.04 RAPID MIX

A new river water main and valves will be installed to divert flow to the new rapid mixers. A flow meter will be placed on the river water main to monitor river water flow to the rapid mixers. Each rapid mix train shall be designed to handle 3.5 mgd flow. Four rapid mixers will be installed initially (one operating and one redundant mixer per train), and two more rapid mixers will be installed in the future. Each rapid mix train will consist of two concrete tanks and vertical turbine-type mixers with variable speed drives mounted above each tank. Multiple chemical injection points will be provided to allow sodium hypochlorite, coagulant, PAC, and a polymer to be added to the rapid mixers. After chemical addition and mixing, the water will flow by gravity to the flocculation basins.

7.05 FLOCCULATION

The existing sedimentation basin will be divided into three equal volumes along the length of the tank to accommodate three new flocculation trains. Coagulated water from the new rapid mixers will be fed into each train. Each flocculation train will be designed to handle 3.5 mgd. Each flocculation train will consist of four vertical turbine-type flocculators with variable speed adjustment installed above the basins. Each mixer in series will be designed to slowly mix the coagulated water to promote larger, more settleable flocculated particles, which will be collected on the new sedimentation basin floors. Baffle walls will be used to divide the flocculation basins into stages to minimize short-circuiting of water. The new basins will be connected to the existing sedimentation basin drains to Devil's Lake Lagoon for maintenance of the flocculation tanks.

7.06 SEDIMENTATION

New sedimentation basins will be constructed as part of Phase I and II of the treatment plant improvements. Phase I includes the construction of two new sedimentation basins. Flocculated water from the new flocculation trains will be fed into each sedimentation train through a new baffle wall. The flocculated particles settle to the bottom of each sedimentation basin as flow passes through the basin. Each sedimentation train will consist of three circular sludge rake arms that collect sludge to a central hopper. The sludge will be transferred from the basins to Devil's Lake Lagoon through the operation of valves. Additionally, tank drains will allow each train to be separately taken out of service for maintenance.

7.07 FILTRATION

The preliminary plan is to construct two new filters as part of Phase I of the treatment plant improvements, which will bring the total operating filters to six (two new filters and four existing filters). Currently, the existing filters are loaded at less than the Kentucky regulatory filtration rate limit. Initial calculations have shown that the existing filters could be loaded at the Phase I design rate (7 mgd) and still be under the regulatory filtration limit. Therefore, it is recommended that prior to commencement of Phase I, the filters be tested to determine the filtration loading limit, which may eliminate the need for additional filters.

7.08 CHEMICAL FEED IMPROVEMENTS

Chemical feed improvements will include both new equipment and relocated existing equipment. A new PAC and sodium hypochlorite building will be built. The new PAC equipment will allow for a cleaner operation and ample storage for expected chemical use through the Phase II design flow rate. New sodium hypochlorite bulk tanks and room will provide capacity for Phase II design flows.

Relocating the coagulant storage to the existing sodium hypochlorite room improves containment and eases operation and maintenance of the feed system. Other minor modifications to chemical feed systems will also be provided.

7.09 CHLORINE CONTACT CLEARWELL AND HIGH SERVICE PUMPING STATION

Additional clearwell volume will be provided as required by regulatory agencies. A new high service pumping station will also be built to meet Phase I flow requirements with provisions for future expansion. These improvements have been planned by McGhee Engineering Inc.

7.10 PROCESS SLUDGES AND WASTE

As discussed in Section 6, Central City WTP discharges to a sludge lagoon commonly known as Devil's Lake. Central City collects samples at an effluent culvert from Devil's Lake to the Green River to meet their KPDES permit requirements. Depending on the results of the analysis of available storage, a contractor could be hired to dredge the lagoon.

Strand also recommends installing a new flow meter to monitor backwash flows discharged to the Devil's Lake Lagoon.

SECTION 8
INTAKE AND PUMPING FACILITIES

Green River is the river water source of the Central City WTP. The river water intake pumping station and facilities are located about two miles north of Central City approximately halfway between mile 85 and 86 of the Green River. Refer to Figure 2.04-1 for the location of the Central City WTP and river water pumping station.

8.01 RIVER WATER INTAKE PUMPS

The Central City WTP currently uses three river water intake pumps. Two of the pumps are 75 hp Johnston vertical turbine pumps each with a 10-inch pipe column and a capacity of 2 mgd at 175 feet total dynamic head (TDH). The remaining pump is a 125 hp Layne and Bowler vertical turbine pump with 10-inch pipe column and a capacity of 2.6 mgd at 195 feet TDH. The pumps discharge into a 16-inch-diameter water main within the pumping station property. The water main increases to 20 inches in diameter outside the river water intake property to the rapid mix discharge at the Central City WTP. A valve is partially closed on the river water main at the WTP to restrict the amount of flow from the intake pumps. The Central City WTP normally operates one 75 hp pump with one 125 hp pump. From 2005 to 2007, Central City WTP treated an average of 3.4 mgd of river water with a maximum of 4.3 mgd.

Results of a hydraulic evaluation indicates the 125 hp pump may operate close to its runout point under certain pressure head conditions. The 75 hp pumps are undersized. The river water intake structure can only hold three pumps unless significant changes are made to the structure. Therefore, to upgrade the river water pumping station capacity to 7 mgd requires that all three pumps be replaced.

Two options were considered to upgrade the river water pumping station capacity to 7 mgd. These options are listed below:

1. Install three 3.5 mgd pumps. Two pumps will operate to meet the design flow with one pump out of service.

2. Install two 7 mgd pumps. One pump will operate to meet the design flow with one out of service. The existing third pump would remain in place for emergency situations.

The improvements chosen to upgrade to 7 mgd could impact the feasibility of future capacity increases at the river water intake. Therefore, the above options were considered for a future capacity increase to 10.5 mgd based on the 7 mgd upgrade options. An upgrade to 10.5 mgd will require the installation or replacement of a parallel transmission main to the plant. Transmission main improvements were therefore included to further evaluate the following future supply increase options:

1A. Replace two of the 3.5 mgd pumps with 7 mgd pumps. One 7 mgd pump and one 3.5 mgd pump will meet the design flow. Utilizing VFDs installed on both 7 mgd pumps, the two 7 mgd pumps could be used to meet the design flow of 10.5 mgd as well.

1B. Replace all 3.5 mgd pumps with 5.25 mgd pumps. Two pumps will operate to meet the design flow with one pump out of service.

2A. Replace the remaining pump used only for emergencies with a 3.5-mgd pump. One 7 mgd pump and one 3.5 mgd pump will meet the design flow. Utilizing VFDs installed on both 7 mgd pumps, the two 7 mgd pumps could be used to meet the design flow of 10.5 mgd as well.

Option 1 provides greater flexibility in flow and will be more energy efficient at low flow rates than Option 2. VFDs could control flow rates for Option 2, but would result in the pumps operating off their best efficiency point (BEP) and less energy savings because the hydraulic conditions are predominantly static head. For these reasons, Option 1 is recommended to upgrade the design flow to 7 mgd.

To upgrade to 10.5 mgd, all options provide flexibility in flow rates and would not require significant alterations to the river water intake structure. Options 1A and 2A assume existing pumps will operate efficiently under the new hydraulic conditions, which may not be the case. Therefore, Option 1B is the preliminary recommendation to upgrade the design flow to 10.5 mgd. A final recommendation should be based on a hydraulic analysis at the time of the upgrade.

8.02 TRAVELING WATER SCREEN

Central City currently uses one traveling water screen at the river water intake structure. The screen is a Rex Chainbelt Traveling Water Screen. The screen uses 3-foot-wide baskets, is approximately 54 feet tall, and is rated for 5,500 gpm (7.9 mgd) at low water level with a clean mesh velocity of 1.5/ft^2. As part of a rehabilitation in 2007, the lower 20 feet of structural supports and gear were replaced as well as the entire screen and chain. The screen is reported by operations staff to be operating well since the improvements were made. The rated capacity of the river water traveling water screen is greater than the capacity of the proposed upgrade; therefore, the screen should not need to be replaced or upgraded. Future design flows may require screen improvements.

8.03 POTASSIUM PERMANGANATE FEED

Potassium permanganate is a strong oxidizing agent, used at the river water pumping station to remove problematic odors and tastes from the influent river water. Central City uses an Acrison W-105Z DD/2 volumetric feeder with a 3 cubic feet (ft^3) hopper that feeds powdered potassium permanganate into a pipe that flows directly into the river water pumping station. The W-105Z can feed chemicals at a maximum rate of 2 ft^3 per hour. Potassium permanganate is currently fed at 15 grams per minute or approximately 0.02 ft^3 per hour, which would be increased to 26 grams per minute or approximately 0.04 ft^3 per hour after the WTP has been upgraded to 7 mgd. The W-105Z therefore has enough capacity to accommodate the increase in treatment capacity and does not need to be upgraded.

8.04 RIVER WATER TRANSMISSION MAIN

Central City staff indicated the original river water transmission main was replaced several years ago with a 20-inch main. However, no plans were available for connecting the river water pumping station to the WTP. Pump hydraulic design will be based on 20-inch piping. Based on USGS topographical maps, the highest working pressure that might be expected is 55 pounds per square inch (psi), which is expected to be found at the pumping station. This pressure also assumes an alignment following the existing utility easement to the WTP.

SECTION 9
STRUCTURAL, ARCHITECTURAL, AND HEATING, VENTILATION, AND AIR-CONDITIONING IMPROVEMENTS

9.01 GENERAL ARCHITECTURAL DESIGN PARAMETERS

This section discusses recommended improvements to the existing facilities and the general guidelines and design criteria to be used in the architectural, structural, and mechanical design of new and expanded facilities.

A. Architectural

1. Exterior (General)

Loose or missing concrete stair tread nosings will be replaced. An existing concrete ramp/walkway between the treatment building and sedimentation basin will be replaced with a concrete sidewalk. Existing sidewalks with extreme cracking, spalling, and differential settlement will be replaced and additional concrete sidewalks and stairs will be incorporated into the site as appropriate for easy access.

Colors for exterior trim materials will be coordinated to match the existing facilities to present a pleasant appearance.

2. Flat Roof

New roof assemblies will be constructed of a two-ply modified bitumen roofing system on ventilated base sheet on tapered polystyrene roofing insulation (3-inch minimum thickness, ¼-inch per foot minimum pitch) mechanically fastened to 8-inch thick hollow-core precast concrete roof planks spanning load-bearing masonry walls. Flat roof drainage is directed to the interior of the roof and is collected by roof drains and directed to discharge.

The treatment building roof is showing signs of leakage due to screws protruding through the bottom of the precast double tee roof members. It is recommended the existing roofing materials be replaced with a new two-ply modified bitumen roofing system on ventilated base sheet on tapered polystyrene roofing insulation (3-inch minimum thickness, ¼-inch per foot minimum pitch) mechanically fastened to the existing roof members. The protruding screws will be removed and the holes will be patched. The mechanical fasteners will be sized to prevent complete penetration of the double tee flanges. Roof drainage will be directed to the existing scuppers around the perimeter of the building. The existing scuppers will be repaired or replaced as needed.

3. Floors

Building floors will be elevated and on-grade reinforced concrete slabs. On-grade floor slabs will be fiber reinforced concrete slabs (6-inch minimal thickness) on 6 mil vapor barrier, on crushed stone (6-inch minimum). Elevated floor slabs will be reinforced concrete slabs designed for the appropriate span and load. Interior floors will receive a hardener and a sealer. Existing floors may be painted in rooms where existing equipment is removed.

4. Walls

a. Exterior Walls

The exterior walls will be constructed of nominal 8-inch concrete block load-bearing concrete masonry unit (CMU) wall with a nominal 4-inch brick veneer with 1 ½-inch thick rigid polystyrene wall insulation and horizontal reinforcing at 16 inches on center. The exterior surface of the wall will have concave mortar joints and receive a water-repellent coating. The interior surface of the wall will have tooled concave mortar joints and receive a three-coat, two-part epoxy paint.

b. Interior Walls

Interior walls will be concrete block CMU units of varying sizes. The exposed interior surface of the wall will have tooled concave mortar joints and receive a three-coat, two-part epoxy paint.

5. Ceilings

Ceilings will be exposed precast concrete roofing planks. The exposed interior surface of the planks will receive masonry filler and a three-coat, two-part epoxy paint finish system.

6. Doors

New and replacement personnel doors will be prefinished, anodized aluminum doors and frames, with headseals, thresholds, weather-stripping, and appropriate operating hardware. Doors and frames in chemical rooms will be fiberglass. Floor mounted access hatches will be aluminum construction double-leaf design.

7. Windows

New and replacement exterior window units will be of thermal-break, prefinished, anodized aluminum, fixed and awning style construction, with double-pane thermal-break, 1-inch thick glazing, insect screens, and operating hardware.

8. Railing

New and replacement handrailing will be a three-rail mill-finish aluminum pipe post and rail system, with toe plates as necessary, in accordance with the Kentucky Building Code in most areas. Existing structures receiving new or replacement railing include portions of the contact clarifiers, sedimentation basin, treatment building, and filters. Handrail in chemical rooms will be fiberglass.

9. Grating

Floor grating will be aluminum flat bar with serrated surface. Grating in chemical rooms will be fiberglass.

9.02 GENERAL STRUCTURAL DESIGN PARAMETERS

A. General

ACI 318-05 will be used for the design of concrete structures. In addition, the recommendations of ACI 350 will be used in the design of tanks, channels, and other water-holding structures. The ultimate strength method will be used for design.

ACI 530-05 will be used in the design of masonry walls. Precast planks will be designed by the plank manufacturer in accordance with the PCI Manual for the Design of Hollow Core Slabs and the PCI Design Handbook.

Structural steel will be designed in accordance with the AISC Specification for Structural Steel Buildings-Allowable Stress Design Method, 13th Edition.

Structural aluminum will be designed in accordance with the Aluminum Association Specifications for Aluminum Structures.

B. Loads

Water-containing structures will generally be designed for a triangular pressure attributable to a fluid density of 62.4 pounds per ft^3, and passive soil pressure will be ignored. A load factor of 2.2 will be applied to the load with the water level at a maximum hydraulic design level for flexural design. In addition, a load factor of 1.7 will be applied to the load with the water level at the top of the tank. The latter case is to cover unintentional blockage of the tank outlet. Both flexure and shear will be checked for this load. For circular tanks and other direct tension members, a load factor of 2.81 will be applied.

Where tanks are constructed with common walls, a combination of full and empty tanks will be evaluated in the design.

Exterior loads from lateral soil pressure will be treated as equivalent fluid pressures. Granular backfill will be used around the structures, so equivalent fluid pressures appropriate for granular backfill will be used in the design. Actual values will be provided by the geotechnical engineer. A load factor of 1.7 will be applied to the soil pressure due to high ground water or 100-year flood for flexure and shear. Load factors of 2.2 and 1.7 will be applied to soil pressure due to normal ground water for flexure and shear, respectively.

The design groundwater level for tanks, which are normally full, will be as provided by geotechnical investigation. Base slabs will be designed for hydrostatic pressure caused by groundwater. Tanks will be assumed to be empty. Base slabs will also be checked for the factored gravity load due to the weight of the tank walls and building structure supported by the slab.

Soil bearing capacity will be checked assuming tanks are full. The allowable soil bearing pressure for each structure will be confirmed through geotechnical investigation.

C. Frost Depth

Depth to be used shall be according to applicable building codes and the geotechnical investigation.

D. Uplift Stability

The structures, in combination with the surrounding soil, must generally have sufficient mass to counteract the buoyant force caused by the groundwater. With the tank empty and groundwater at the 100-year flood level (or measured groundwater level, if higher), a safety factor of 1.25 or greater will typically be provided against uplift. In addition to the weight of concrete, the soil above any footing ledge and soil at a slope as recommended by the geotechnical engineer above the ledge (for structures built with open cut excavations and backfilled with granular material) will be counted as providing resistance to uplift.

E. Concrete and Reinforcing Materials

Except for fill concrete, all cast-in-place concrete will be a minimum six-bag mix with a minimum 4,000 psi compressive strength at 28 days. Air entraining and water reducing admixtures will be used in the mix. Fly ash and superplasticizer may also be used. Reinforcing steel will be grade 60. The reinforcing steel ratio will generally be limited to half that corresponding to the balanced strain condition.

F. Concrete Detailing

Construction joints in concrete walls and slabs will be located with consideration for constructability and will generally be provided at the following spacings:

Walls - horizontal at 12 to 15 feet lifts
- vertical at 40 feet, 15 feet from corners, and 20 feet between two corners.

Slabs - limit volume to 200 cubic yards
- limit area to a finishable size

Expansion joints will be considered for tanks and structures over 100 feet in length. The effect of such joints will be considered in the analysis.

Reinforcing clearances will generally follow ACI standards except that two inches clear will be used for all bar sizes where exposed to liquid. For opening corners, U-bars as detailed in ACI 315 will generally be used.

PVC waterstops will be used in expansion joints and at construction joints in walls and slabs that separate "dry" structures from liquid-containing structures and/or groundwater. Other tank construction joints will typically be water-stopped with a bentonite butyl waterstop.

G. Elevated Concrete Floor Systems

In general, a minimum live load of 100 per ft^2 will be used for design. Equipment such as generators, switchgear, and large pumps may result in loads in excess of 100 ft^2. Each room will be evaluated and designed for actual loads. Equipment pads will also be included. Vibration isolators will typically be provided on reciprocating equipment as necessary.

H. Building Walls

Wall types will be as described in the preceding architectural section. Walls will be designed in accordance with the Kentucky Building Code.

I. Roofs

Roofs will be designed in accordance with the Kentucky Building Code. Precast concrete hollow core plank or steel bar joists with metal deck will be used depending on the building occupancy and environment.

J. Structural Repairs

Large concrete spalls have been noted in the contact clarifiers, clearwell, and sedimentation basin walls. These spalls will be repaired with concrete patches. Epoxy crack injection will be used to seal cracks that show evidence of active leaks in the sedimentation basin and clarifiers. The sedimentation basin expansion joint is actively leaking so the joint will be replaced with a new expansion joint system and sealed. Several pipe penetrations in the treatment building are showing signs of leaking. The existing grout and waterstop around the pipe penetrations will be removed and replaced to reduce/prevent further leaks.

The clearwell has experienced some minor cracking in the top slab. Additional investigation from inside the clearwell is required to determine if these cracks are actively leaking. If active leaking is found, the top slab should be sealed to prevent rainwater intrusion into the clearwell. A diver could be hired prior to construction to assess the condition further. Alternatively, the tank interior could be assessed during construction after the new clearwells are placed into service. Construction contingency funds and an allowance could be provided to address the required repairs. Some minor cracking with efflorescence has also been noted in the clearwell walls. These cracks will be sealed with epoxy crack injection to prevent further leakage.

K. Containment Lining

The containment area for the chlorine tanks in the chemical building are reported to leak. The containment area walls and slab will be sealed with a spray applied elastomeric lining system compatible with the chlorine solution.

9.03 GENERAL HEATING, VENTILATION, AND AIR-CONDITIONING DESIGN PARAMETERS

The heating, ventilating, and air-conditioning (HVAC) systems will be designed in accordance with the 2006 International Mechanical Code.

Outside design conditions are 7°F for winter and 91°/75°F (dry bulb/wet bulb) for summer. Winter design inside temperatures will generally be 55°F for process and storage areas. Summer inside design temperatures will generally be 104°F for process, storage, and maintenance areas, and 75°F/63°F (dry bulb/wet bulb) for air-conditioned spaces.

Design heat loss and heat gain calculations will generally be based on American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Fundamentals including thermo-conductivity estimates for building materials. Commercially available computer software for calculating heat losses and heat gains from buildings will be used.

Air handling and distribution equipment will be sized based on the calculated loads, required ventilation, and ASHRAE and Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) information on static pressure losses in ducted air systems.

Sizing for heating equipment for intermittently ventilated spaces will include nominal excess capacity (generally equivalent to a minimum of one air change per hour of continuous ventilation air) to compensate for room temperature drops following periods when the ventilation system operates. Heating equipment for continuously ventilated areas will be sized for building heat loss in addition to ventilation heat load.

Ventilation systems for hazardous locations and chemical facilities will be designed and balanced to achieve a negative static pressure relative to adjacent spaces. In general, a supply air quantity that is 10 percent lower than the exhaust air quantity will be used to achieve this pressure relationship.

To minimize premature corrosion of electrical equipment, the electrical equipment and electrical control rooms will be provided with a ventilation system that, when operating, is expected to achieve a positive static pressure relative to adjacent spaces. In general, supplying air into the room with gravity exhaust will be used to achieve this pressure relationship.

Dehumidification will be provided in areas where condensation is likely, such as piping galleries. Rooms with open water surfaces will not be dehumidified.

Ventilation will be provided to the following spaces as noted below.

A. <u>River Water Intake and Pumping Station Site</u>

1. Existing Pumping Building

Ventilation will be provided by exhaust fans and louvers for the heat dissipated from the pumps and motors. Heat will be provided by electric unit heaters and sized for the building envelope loss.

2. Chemical Feed and Electrical Building

a. Liquid Polymer Room

Ventilation will be provided by exhaust fans and louvers sized for six air changes per hour (ACH) and operated when the space is occupied and on a repeat cycle timer. Heat will be provided by electric unit heaters and sized for the room's heat loss.

b. Potassium Permanganate Room

Ventilation will be provided by exhaust fans and louvers sized for 30 ACH to operate intermittently. Intermittent ventilation shall operate 5 minutes per hour and on a door switch with a timer. Heat will be provided by electric unit heaters and sized for the room's heat loss.

c. MCC Room

Ventilation will be provided by an air conditioning system with a backup system of a supply fan and louvers for the heat dissipated from the MCCs and VFDs. Heat will be provided by electric unit heaters and sized for the rooms' heat loss.

B. <u>Water Treatment Plant Site</u>

1. Existing Chemical Feed Building (Bulk Coagulant Room)

Ventilation will be provided by exhaust fans and louvers sized for 30 ACH to operate intermittently. Heat will be provided by electric unit heaters and sized for the room's heat loss.

2. New Chemical Feed Building

a. Sodium Hypochlorite Room

Ventilation will be provided by a fan coil unit and louvers sized for 1 cubic feet per minute (cfm)/ft^2 to operate continuously. Heating and cooling will be provided by the same fan coil unit with electric heat and compressed refrigerant cooling. Cooling is provided for the space to maintain the integrity of the chemical.

b. PAC Room

Ventilation will be provided by exhaust fans and louvers sized for 30 ACH to operate intermittently. Heat will be provided by electric unit heaters and sized for the room's heat loss. Equipment in this room shall be suitable for Class II, Division 2 environments.

3. Existing Administration and Filter Building

a. Filter Room

Ventilation will be provided by a make-up air unit, exhaust fans, and louvers sized for 6 ACH to operate continuously. Heat will be provided by the make-up air unit and sized to maintain a 60°F discharge temperature on the unit. Portable dehumidification equipment will be used to control space humidity.

b. Pipe Gallery

Ventilation will be provided by a make-up air unit, exhaust fans, and louvers sized for 6 ACH to operate continuously. Heat will be provided by the make-up air unit and sized to maintain a 60°F discharge temperature on the unit. Portable dehumidification equipment will be used to control space humidity.

SECTION 10
PLANT UTILITIES

10.01 WATER SUPPLY

The source for potable water for restrooms, fountains, washdown, and other general uses will be from a finished water main tapped off the discharge header of the new high service pumps. A pressure reducing valve will be provided to maintain a maximum 80 psi operating pressure and reduced pressure zone backflow preventers will be installed on all branch lines used for chemical mixing, washdown, and other nonpotable purposes.

10.02 WASTEWATER DISPOSAL

The treatment plant currently has an on-site treatment system via a septic tank at the front of the facility. This septic system will be maintained throughout the plant expansion. If the City wishes, in the future, it could potentially connect into the force main serving the prison across the street.

10.03 ELECTRIC SERVICE

A. River Water Intake/Pumping Station

1. Power

The existing motor control center (MCC) is too small for the new motors and is in poor condition. The existing service is large enough for the new equipment, but is not sized for future expansion. The existing equipment will be replaced with modern equipment properly sized for all electric equipment served in the structure and future expansion. The three new river water pumps will each be controlled with a VFD located within the new MCC. These VFDs will vary the speed of the associated pump to maintain an operator adjustable flow rate. To minimize corrosion of the new equipment, the new MCC will be placed in a new structure separate from the pumping station. Additional space will be reserved in the event that the motors are upsized again in the future. The service should also be upsized to maintain enough electrical capacity of the future pumps as well.

2. Standby Power

Standby power will be provided at the pumping station to keep the station in operation during power outages. Standby power will be provided by an engine generator, which will be automatically activated when normal power to the facility is interrupted.

Engine driven power sources has been the option of choice in providing standby power for pumping facilities. There are basically two types of power sources. The first is a fuel-driven engine that couples directly to the line shaft of the pump. This necessitates a differential coupling between the pump and motor to lock out the motor when the pump is driven by the engine and vice-versa. Since this type of drive system requires direct linkage between the power source and the pump, each engine can only operate one pump. In addition, direct drive-engine units are typically controlled manually, which necessitates full-time staffing when in use. This can be difficult during extended power failure situations.

The second type of power source consists of a fuel-driven engine generator. The quantity of pumps determines the size of the generator. This pumping station will require multiple pumps to meet the design flow and the station will be the only source of river water supply; therefore, operating more than one pump is prudent. A generator permits operation of local controls, heating and ventilation, equipment, and chemical feed. For these reasons, the engine generator option is selected.

During a power outage, the automatic transfer switch will transfer power from the normal utility power to emergency power. The generator will then be brought on-line and provide power to the MCC and VFDs for the equipment at the station. The nonessential equipment in the station will be disabled by the Programmable Logic Controller (PLC) and will remain off until normal power has been reestablished and the transfer switch has returned to the normal position.

B. Water Treatment Plant

1. Power

The MCC for the plant is located on the lower level of the filter building. This MCC houses the motor starters, feeder circuit breakers, step-down transformers, and lighting panels needed for plant operation.

There is an unusually high number of feeder circuit breakers in this MCC. It is recommended that these breakers be fed from a distribution panel that is better suited for this function. The MCC should also be relocated to a more climate controlled location. This will likely be in a new high service pump building so that it is closest to the largest power load on-site.

2. Standby Power

Standby power is needed to keep the plant in operation during power outages. Standby power can be provided by one of two methods. The first utilizes an engine generator to provide electric power and the second consists of two separate feeds from two different substations within the electric utility's power grid system. Electric utility grids in this area do not lend themselves to feeding a single location from two separate grids. Adding an additional feed from an alternate substation requires significant infrastructure improvements that would be paid for by the Water Utility.

Therefore, a standby engine generator will be provided for backup power to critical process equipment at the plant. During a power outage, the automatic transfer switch will transfer power from the normal utility power to emergency power. The generator will then be brought on-line and provide power to the MCC and VFDs for the equipment at the station. The nonessential equipment in the station will be disabled by the PLC and will remain off until normal power has been reestablished and the transfer switch has returned to the normal position.

SECTION 11
INSTRUMENTATION, CONTROLS, AND SUPERVISORY CONTROL AND DATA ACQUISITION

11.01 GENERAL DESCRIPTION AND PRELIMINARY LAYOUT

A. River Water Intake/Pumping Station

A Supervisory Control Center (SCC) will be installed at the MCC to collect data from equipment and field devices and to perform any control logic or calculations required to control the associated processes. This SCC will function as the SCADA system for the station.

Instrumentation will include electronic analog instruments for measurement of process parameters. Switch sensors will be used in some cases to actuate interlocks or alarms for levels, pressures, and such. Process equipment motors will be monitored for "running", "failed", and "in auto" status.

The SCC at this site will communicate with the main SCC at the WTP via digital data radio. This radio link will give the operators at the WTP site all process control and information from the pumping station. For example, an operator at the WTP will be able to monitor pumping station equipment status such as monitoring which pump is on-line and taking manual control of the pump, if needed. This pumping station data will be available to all computers on the Local Area Network (LAN) at the WTP. The SCADA software will collect data from the PLC and store it in a database for station reporting.

B. Water Treatment Plant

A distributed control system will be utilized for the SCADA system. The existing filter controller will be removed and replaced by a modern PLC-based control panel. The existing valve actuators are problematic and will be replaced by air-actuated valves. A separate compressed air system may be required to service the filter valve actuators. PLCs will be installed at the MCC location and at the filters. Each PLC will be used to collect data from equipment and field devices within its vicinity and to perform any control logic or calculations required to control the associated processes. Data in the PLCs will be shared between each other over the plant ethernet network as required by the plant control system. PLCs in the distribution system should be updated to wireless communications and communicate with the WTP SCADA system via digital radio.

Instrumentation will include electronic instruments for measurement of temperature, pressure, flow, level, pH, turbidity, residual chlorine, and other process parameters. Switch sensors will be used in some cases to actuate interlocks or alarms for levels, pressures, and such. Process equipment motors will be monitored for "running", "failed", and "in auto" status.

There will be a total of two SCADA system computers located in the Filter Control Room. These machines will be running a human-machine interface (HMI) software package. They will provide control of the system and trending of the process parameters to optimize plant operation. They will be redundant systems so loss of either machine will not compromise system availability.

The PLCs will communicate with each other and the two SCADA computers via the plant ethernet network. LAN will connect the two workstations and two printers together with Category 5e network cabling and a network switch. This will allow an operator at any workstation to access all plant information. The SCADA software will collect data from the PLCs for historical trending and plant reporting.

C. Remote Sites

The new system will be designed to monitor and/or control existing points throughout the distribution system via the SCADA system. Remote Telemetry Units (RTUs) should be installed at the remote sites to collect data from equipment and field devices. A radio path survey should be performed prior to designing the system to provide proper communication routes for all signals.

Instrumentation will include electronic instruments for measurement of water level, flow, and pressure. Switch sensors may be used in some cases to actuate backup alarms.

RTUs at these sites will communicate with the main PLC at the WTP via digital data radio. The telemetry data will be available to all computers on the LAN at the WTP.

11.02 CONTROL THEORY

A. Raw Water Intake/Pumping Station

Process control logic, calculations, and totalizations will be performed by the RTU. All alarm logic will also be processed within the RTU and then transmitted to the SCADA computers at the WTP. The PLC will be located next to the MCC to minimize the interface wiring between the process equipment starters and the RTU.

B. Water Treatment Plant

The SCADA workstation computers will be used for plant process monitoring, alarm handling, adjustment of plant operational parameters, and report generation. Process control logic, calculations, and totalizations will be performed by the PLC. The SCADA computers will not perform any of these functions. This will allow station processes to operate independently of the computers and the LAN. All alarm logic will also be processed within the PLC and then transmitted to the SCADA computers. The PLCs will be located next to each MCC to minimize the interface wiring between the process equipment starters and the PLC. PLCs will be part of the plant ethernet network to allow the SCADA computers to make control and setpoint modifications.

11.03 HARDWARE

A. Raw Water Intake/Pumping Station

The SCADA system at the pumping station will consist of an RTU that will transmit data to the main PLC at the WTP. The RTU will be capable of accessing/utilizing all features required to run the pumping station from the SCADA system.

B. Water Treatment Plant

The SCADA workstations will be PC-based with a Microsoft Windows operating system. The computers will be capable of accessing/utilizing all features of the SCADA system, as well as the reporting database and other PC-based applications.

All SCADA computers will be equipped with a battery backup Uninterruptible Power Supply (UPS) and Transient Voltage Surge Suppressor (TVSS) to maintain power quality in the event of power disturbances and to protect the computers from lightning strikes.

11.04 SOFTWARE

A. Water Treatment Plant

As indicated above, the computer operating systems will be Microsoft Windows. In addition, the computers will be installed with the Microsoft Office Professional software package.

The SCADA software to be utilized for this project will be a commercially available HMI software package such as Wonderware's *InTouch*.

The station reports will be developed utilizing the OPS SQL system, which is owned by the Hach Company.

11.05 COMMUNICATIONS

A. Raw Water Intake/Pumping station

As noted above, the RTU at this site will communicate with the WTP via radio. This will be confirmed during the radio path survey. This station will be polled on a cycling basis with the rest of the distribution system by the SCADA system at the plant.

B. Water Treatment Plant

The SCADA computers will communicate using a Microsoft Windows peer-to-peer network utilizing Category 5e cabling. High speed internet connected to network will allow the systems integrator to perform PLC programming modifications or troubleshoot on any PLC in the system from a remote site.

RTUs at remote sites will communicate with the WTP via digital radio and will interface with the plant PLCs to monitor remote station status.

SECTION 12
PERMIT REQUIREMENTS

12.01 GENERAL

This section describes the permits required for the river water pumping station and the water treatment plant site.

12.02 RIVER WATER PUMPING STATION

The River Water Pumping Station new electrical and chemical feed building will likely require approval from the Department of Housing, Buildings, and Construction as part of the water treatment plant building improvements.

KDOW, through the Watershed Management Branch, will require a revised river water withdrawal permit through the Watershed Management Branch of the agency. The current permit allows water withdrawal up to 4 mgd. The KDOW contact for additional information about the permit is Mr. Chris Yeary at (502) 564-3410.

12.03 WATER TREATMENT FACILITY

A. Drinking Water Branch

KDOW Drinking Water Branch will be responsible for the review and issuance of the construction permits associated with the WTP construction and operation. Four sets of complete drawings and specifications must be submitted for review. In addition to the drawings and specifications, a letter must be submitted from Central City indicating that it has reviewed the design and accepts it.

The final design components will rely on this preliminary design report and comments provided by KDOW following their review. Mike Riley (502-564-3410) has been assigned to review the drawings and specifications.

B. Kentucky Pollutant Discharge Elimination System Permitting Branch

A Kentucky Pollutant Discharge Elimination System (KPDES) permit allows for sludge handling and discharge of the respective byproducts of the water treatment process. The KPDES permit has already been obtained for the operation of the water treatment facility. Anne Fredenburg with KDOW indicated there are no plans to incorporate a total maximum daily load (TMDL) for suspended solids on the Green River. Therefore, only a letter explaining the increase in flow for informational purposes was requested by Mr. Ronnie Thompson (502-564-3410) of the KPDES Branch.

C. Building Requirements

The Department of Housing, Buildings, and Construction under the Kentucky Public Protection and Regulation Cabinet may require the drawings and applications described in Table 12.03-1.

Type of Building Permit	Responsible Division	No. of Drawings	Time Frame for Review (days)
Site Survey	Building Code Enforcement	1	7 to 30
Site Plan/Diagram	Building Code Enforcement	1	7 to 30
Construction Plans and Details	Building Code Enforcement	1	7 to 30
Energy Conservation Calculations	Building Code Enforcement	1	7 to 30
Seismic Design Data and Letter of Special Inspections	Building Code Enforcement	1	7 to 30
Plumbing	Plumbing	3	7 to 30
Fire Suppression Design Criteria	Fire Prevention	1	7 to 30
Fire Alarm and Monitoring	Fire Prevention	1	7 to 30
Fuel Tanks	Fire Prevention Hazardous Materials Section	1	7

Table 12.03-1 Kentucky Building and Construction Permits

The fees associated with each permit vary by type and amount of construction. State and local inspectors will be required to issue permits during construction and prior to occupancy of the facility by the utility staff.

SECTION 13
STAFFING

13.01 OPERATOR CERTIFICATION REQUIREMENTS

The Kentucky Administrative Record requires that each public water system with treatment and distribution facilities be operated under the supervision of a certified operator in responsible charge of the system. With a rated output greater than 3 mgd and the use of gravity filtration, the Central City WTP will operate as a Class IVA facility. The Class IVA treatment plant requires that at least one operator holds a Class IVA certification for the first shift of operation. Plants operating multiple shifts may operate with the assistance of Class IIIA operators if a Class IVA operator is in charge and can respond to calls within 30 minutes.

Class IVA operators must hold a baccalaureate degree from an accredited college or university, in addition to one-year experience of operating a Class IIIA or Class IVA treatment facility. Class IIIA operators must have completed high school or a General Education Diploma equivalency test, in addition to three years' experience of operating a public water treatment facility with one year at a Class IIA, Class IIIA, or Class IVA facility.

Laboratory and distribution personnel may be certified if they demonstrate to the satisfaction of the cabinet that they meet the education and experience requirements and possess the technical and practical knowledge to perform the procedures involved in the operation of a WTP or water distribution system.

13.02 STAFFING REQUIREMENTS

Central City is reported to have five full-time operators on staff and one part-time operator. Three operators work on day shift, one on second shift, and one on third shift. All operators are reported to be Class IVA certified. Additional equipment requiring operation and maintenance will be incorporated as part of the treatment plant expansion. However, the plant is expected to operate for two shifts under current production rates, and therefore, should not require additional operational staff.

SECTION 14
SCHEDULE AND CONSTRUCTION COST

14.01 GENERAL

The existing Central City WTP has a design capacity of 4 mgd and is approximately 40 years old. The current water demand is near capacity. The following implementation schedule has been developed to promote timely completion of the project.

14.02 PRELIMINARY DESIGN REPORT

The preliminary design report will be submitted to Central City by June 8, 2009 for comments. The comments will be addressed as necessary.

The preliminary design report is scheduled for submission to KDOW by July 1, 2009.

14.03 ADDITIONAL TESTING

Strand recommends investigating and testing sludge lagoon capacity and filtration rate testing prior to final design.

An investigation of the sludge lagoon (Devil's Lake) should be performed to assess the amount of sludge in the lake and the remaining sludge capacity. This investigation may lead to dredging of the lagoon and/or additional design modifications to the sludge lagoon to better serve Central City's needs. It is anticipated that the investigation should begin in August 2009 and the findings be presented in September 2009. This schedule assumes water depths of less than five feet are encountered. If greater depths are encountered, additional equipment and time will be required. This testing should not impede the progress of other project tasks.

Filtration rate limit testing should be performed to assess whether the existing filtration rates can be increased to accommodate the new design capacities. Filter testing cannot begin until the existing filters are functioning optimally. It is assumed that it will take one month to identify the filter deficiencies in the remaining filters and one month to implement improvements. It is anticipated that filtration rate testing can begin by September 1, 2009, and take two to three months to complete.

Geotechnical services are assumed to start August 1, 2009, report findings provided by September 1, 2009, and a final report developed by October 31, 2009.

14.04 FINAL DESIGN

It is anticipated that final design can begin August 1, 2009.

14.05 BIDDING

Bidding can take place once KDOW and the Department of Housing, Buildings, and Construction (HBC) approve the final design. Final project funding must also be in place. For the purposes of this schedule, a March 15, 2010 advertisement date is assumed. This date is subject to change based on actual approval and funding dates.

A four-week period will be provided between advertising and receiving bids to allow contractors to complete their bids. Once bidding is complete, two to three months are usually required before a Notice to Proceed can be given.

14.06 CONSTRUCTION

Table 14.06-1 includes the major components of the project that can be constructed under two separate construction contracts.

Contract 1	WTP and River Water Pumping Station.
Contract 2	Lagoon Sludge Removal (if required).

Table 14.06-1 Construction Project Major Components

Construction of treatment process must be staged to maintain the treatment capacity of the existing water treatment. New processes will be placed into service to replace the existing treatment process, which will be taken out of service. Construction for these contracts can be completed concurrently. A 14-month to 17-month construction period is anticipated depending on a need for filtration expansion.

Once construction is complete, the facilities will be placed on-line and the project closed out.

Table 14.06-2 lists the major milestones established to define the project implementation timeline.

14.07 OPINION OF PROBABLE CONSTRUCTION COSTS

The opinion of probable construction costs for the river water pumping station and WTP is shown in Table 14.07-1. The opinion of probable costs assumes the project is bid in spring 2010. The table includes equipment cost and structure cost, as appropriate, plus a percentage for site work, piping and valves, electrical, HVAC, bonds, insurance and contractor profit, contingencies, and inflation adjustment.

The cost was developed based on constructing the improvements as described in previous sections of this report. The facilities depend on common components such as shared walls, piping, and roofs. In some instances, the assignment of part of the costs of the facilities that share components is discretionary.

TABLE 14.06-2

MAJOR MILESTONE TIMELINE

Date	Activity
July 1, 2009	Submit Preliminary Design Report to KDOW.
July 2009	Initiate improvements to existing filters.
August 2009	Start final design.
August 1, 2009	Begin geotechnical services.
August 2009	Perform sludge survey of Devil's Lake Lagoon.
August 2009	Complete existing filter improvements.
September 1, 2009	Provide geotechnical findings.
September 1, 2009	Begin filter limit testing.
October 31, 2009	Complete geotechnical report.
October 31, 2009	Complete filter limit testing report.
February 1, 2010	Submit final plans for approval.
March 15, 2010	Advertise for bids.
April 15, 2010	Receive bids.
May 15, 2010	Award construction contract.
June 15, 2010	Issue Notice to Proceed.
August 15, 2011 to November 15, 2011	Complete construction.

TABLE 14.07-1

OPINION OF PROBABLE CONSTRUCTION COST

Item	Cost
River Water Pumps	$110,000
River Water Electrical and Chemical Building	$160,000
Rapid Mix	$150,000
Flocculation	$275,000
Sedimentation Basin	$1,490,000
WTP Chemical Building	$450,000
Other Chemical Feed Equipment	$40,000
Replace Filter Valves on Existing Filters	$200,000
Drainage Pump Station	$120,000
Site Work	$145,000
Electrical and Controls	$580,000
Process and Yard Piping	$145,000
HVAC and Mechanical Improvements to Existing Structures	$275,000
Miscellaneous Metals	$30,000
Painting	$30,000
Miscellaneous Structural Improvements and Demo	$350,000
Filter Building Expansion	$1,300,000
High Service Pump Station	$800,000
Clearwell Modifications and Addition	$750,000
Generators at River Water Pumping Station and WTP	$700,000
Sludge Removal/Dredging of Devil's Lake Lagoon	$300,000
Subtotal	**$8,400,000**
Sales Tax on Half the Cost of Improvements	$270,000
Planning Level Cost Opinion Contingency	$2,000,000
Subtotal	**$10,670,000**
Contractor General Conditions and Profit	$1,100,000
Subtotal	**$11,770,000**
Inflation to 2010	**$12,200,000**

APPENDIX A
PRELIMINARY DRAWINGS

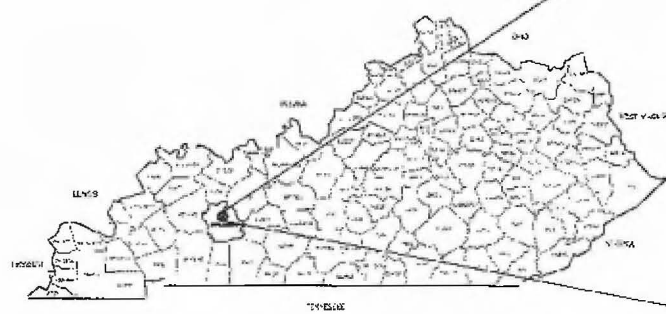
RIVER WATER PUMPING STATION & WATER TREATMENT PLANT EXPANSION

FOR

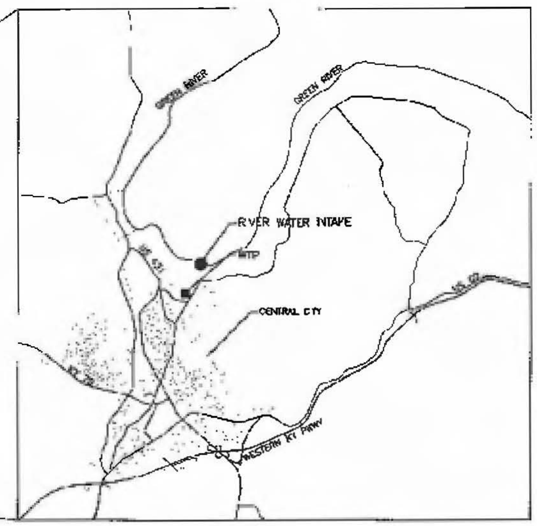
CENTRAL CITY, KENTUCKY

AUGUST 2009

NOT FOR CONSTRUCTION



KENTUCKY STATE MAP



VICINITY MAP
NOT TO SCALE

325 West Main Street, Suite 710
Louisville, KY 40202
502 583-7020
502 583-7026 FAX

www.strand.com

CONTRACT X-XXXX

STRAND ASSOCIATES, INC.® ENGINEERS

SHEET 1
00-G.1
JOB NO. 5-109-001

SHEET NUMBER	DRAWING NUMBER	DRAWING TITLE
00-GENERAL DRAWINGS		
1	00 - G - 01	TITLE SHEET AND PROJECT LOCATION MAP
2	00 - G - 02	LIST OF DRAWINGS AND GENERAL NOTES
3	00 - G - 03	STANDARD SYMBOLS 1
4	00 - G - 04	ABBREVIATIONS
5	00 - G - 05	DESIGN CRITERIA
6	00 - G - 06	PROCESS FLOW SCHEMATIC & ABBREVIATIONS
7	00 - G - 07	HYDRAULIC PROFILE
05-WATER TREATMENT PLANT SITE		
8	05 - C - 01	RIVER WATER INTAKE SITE & ELECTRICAL PLAN
9	05 - C - 02	WTP SITE LOCATION PLAN
10	05 - C - 03	WTP SITE GRADING AND EROSION AND SEDIMENT CONTROL PLAN
11	05 - C - 04	YARD PIPING PLAN
12	05 - E - 01	WTP ELECTRICAL SITE PLAN
10-EXISTING RIVER WATER PUMP STATION		
13	10 - C - 01	RIVER WATER PUMP STATION SITE GRADING AND EROSION AND SEDIMENT CONTROL PLAN
14	10 - ASME - 01	EXISTING RIVER WATER PUMP STATION PLANS
15	10 - ASME - 02	EXISTING RIVER WATER PUMP STATION SECTIONS - 1
15-RIVER WATER PUMP ELECTRICAL AND CHEMICAL FEED BUILDING		
16	15 - ASM - 01	ELEVATIONS & LIFE SAFETY PLAN
17	15 - ASM - 02	PRECAST PLANK, ROOF, & FOUNDATION PLANS
18	15 - ASM - 03	PLAN, SECTION, & DETAILS
19	15 - HE - 01	HVAC & ELECTRICAL PLANS
20-EXISTING RAPID MIX		
20	20 - ASME - 01	EXISTING RAPID MIX MODIFICATIONS
30-CONTACT CLARIFIER		
21	30 - ASME - 01	EXISTING CONTACT CLARIFIER MODIFICATIONS
40-EXISTING SEDIMENTATION AND NEW RAPID MIX/FLOCCULATION BASINS		
22	40 - ASM - 01	EXISTING SEDIMENTATION DEMOLITION PLAN & SECTIONS
23	40 - ASM - 02	NEW RAPID MIX AND FLOCCULATION PLAN
24	40 - ASM - 03	NEW RAPID MIX AND FLOCCULATION PLAN SECTIONS - 1
25	40 - ASM - 04	NEW RAPID MIX AND FLOCCULATION PLAN SECTIONS - 2
26	40 - E - 01	NEW RAPID MIX AND FLOCCULATION ELECTRICAL PLAN
50-NEW SEDIMENTATION BASIN		
27	50 - ASM - 01	NEW SEDIMENTATION BASIN PLANS - 1
28	50 - ASM - 02	NEW SEDIMENTATION BASIN PLANS - 2
29	50 - ASM - 03	NEW SEDIMENTATION BASIN SECTIONS - 1
30	50 - ASM - 04	NEW SEDIMENTATION BASIN SECTIONS - 2
31	50 - ASM - 05	NEW SEDIMENTATION BASIN DETAILS
32	50 - E - 01	NEW SEDIMENTATION BASIN ELECTRICAL PLAN
60-TREATMENT BUILDING		
33	60 - ASM - 01	TREATMENT BUILDING LIFE SAFETY PLAN
34	60 - ASM - 02	TREATMENT BUILDING ELEVATIONS
35	60 - ASM - 03	FILTER ROOM DEMOLITION PLAN
36	60 - ASM - 04	HIGH SERVICE PUMP ROOM DEMOLITION PLAN
37	60 - ASM - 05	FOUNDATION PLAN
38	60 - ASM - 06	PRECAST PLANK & ROOF FRAMING PLAN
39	60 - ASM - 07	FILTER ROOM & PIPE GALLERY PLANS
40	60 - ASM - 08	FILTER ROOM & PIPE GALLERY SECTIONS - 1
41	60 - ASM - 09	FILTER ROOM & PIPE GALLERY SECTIONS - 2
42	60 - ASM - 10	FILTER ROOM & PIPE GALLERY DETAILS
43	60 - ASM - 11	HIGH SERVICE PUMP ROOM DEMOLITION AND MODIFICATIONS
44	60 - P - 01	FILTER ROOM & PIPE GALLERY PLUMBING PLAN, SCHEMATICS, & DETAILS
45	60 - H - 01	FILTER ROOM & PIPE GALLERY ELECTRICAL PLAN
46	60 - E - 01	FILTER ROOM & PIPE GALLERY ELECTRICAL PLAN

SHEET NUMBER	DRAWING NUMBER	DRAWING TITLE
70-CHEMICAL STORAGE AND FEED BUILDING		
47	70 - ASM - 01	CHEMICAL FEED BUILDING LIFE SAFETY PLAN
48	70 - ASM - 02	CHEMICAL FEED BUILDING ELEVATIONS
49	70 - ASM - 03	CHEMICAL FEED BUILDING FOUNDATION PLAN
50	70 - ASM - 04	CHEMICAL FEED BUILDING PRECAST PLANK & ROOF FRAMING PLAN
51	70 - ASM - 05	CHEMICAL FEED BUILDING FLOOR PLAN
52	70 - ASM - 06	CHEMICAL FEED BUILDING SECTIONS AND DETAILS
53	70 - ASM - 07	SODIUM HYPOCHLORITE FEED SYSTEM SCHEMATIC
54	70 - ASM - 08	POWDERED ACTIVATED CARBON FEED SYSTEM SCHEMATIC
55	70 - HE - 01	CHEMICAL FEED BUILDING HVAC AND ELECTRICAL PLAN
75-EXISTING CHEMICAL STORAGE AND FEED BUILDING		
56	75 - ASME - 01	EXISTING CHEMICAL FEED BUILDING MODIFICATIONS
57	75 - ASME - 02	COAGULANT FEED SYSTEM SCHEMATIC
80- HIGH SERVICE PUMP STATION		
58	80 - ASM - 01	NEW HIGH SERVICE PUMP BUILDING LIFE SAFETY PLAN
59	80 - ASM - 02	NEW HIGH SERVICE PUMP BUILDING ELEVATIONS AND LIFE SAFETY PLAN
60	80 - ASM - 03	NEW HIGH SERVICE PUMP BUILDING FOUNDATION PLAN
61	80 - ASM - 04	NEW HIGH SERVICE PUMP BUILDING PRECAST PLANK & ROOF FRAMING PLAN
62	80 - ASM - 05	NEW HIGH SERVICE PUMP BUILDING FLOOR PLAN
63	80 - ASM - 06	NEW HIGH SERVICE PUMP BUILDING SECTIONS AND DETAILS
64	80 - HP - 01	NEW HIGH SERVICE PUMP BUILDING HVAC AND PLUMBING PLAN
65	80 - E - 01	NEW HIGH SERVICE PUMP BUILDING ELECTRICAL PLAN & DETAILS
85- CLEARWELL		
66	85 - ASM - 01	NEW CLEAR WELL / CHLORINE CONTACT TANK FOUNDATION PLAN
67	85 - ASM - 02	NEW CLEAR WELL / CHLORINE CONTACT TANK PLAN
68	85 - ASM - 03	NEW CLEAR WELL / CHLORINE CONTACT TANK SECTION
69	85 - ASM - 04	NEW CLEAR WELL / CHLORINE CONTACT TANK DETAILS - 1
90- SLUDGE LAGOON		
70	80 - C - 01	LAGOON SITE PLAN
100 DETAILS AND SCHEDULES		
71	100 - S - 01	TYPICAL STRUCTURAL DETAILS 1
72	100 - S - 02	TYPICAL STRUCTURAL DETAILS 2
73	100 - S - 03	TYPICAL STRUCTURAL DETAILS 3
74	100 - S - 04	TYPICAL STRUCTURAL DETAILS 4
75	100 - S - 05	SCHEDULES
76	100 - ASM - 01	TYPICAL CIVIL DETAILS 1
77	100 - ASM - 02	TYPICAL CIVIL DETAILS 2
78	100 - ASM - 03	TYPICAL CIVIL DETAILS 3
79	100 - H - 01	HVAC DETAILS
80	100 - H - 02	HVAC SCHEDULES 1
81	100 - H - 02	HVAC SCHEDULES 2
82	100 - E - 01	SCADA SYSTEM RISER
83	100 - E - 01	ELECTRICAL DETAILS
84	100 - E - 02	MCC SCHEDULE
85	100 - E - 03	MCC SCHEDULE
86	100 - E - 04	ONE LINE DIAGRAMS & MCC ELEVATIONS

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RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
PRELIMINARY DESIGN REPORT
CENTRAL CITY
MUHLENBURG COUNTY, KENTUCKY

STRAND ASSOCIATES, INC.®
ENGINEERS

SHEET
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JOB NO. 5109.001

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DESIGN CRITERIA

Item			Units	Design	Ultimate	Comments
Plant Capacity						
	Date		year	2011	2031	
	Minimum Flow		MGD			
	Average Daily Flow		MGD	7	10.5	
	Firm Capacity		MGD	7	10.5	based on 24 hour operation
River Water Pumping						
New Pump(s)						
Type:	Vertical Turbine, variable speed drive					
	Quantity			3	[illegible]	
	Capacity: Each		MGD	[illegible]	[illegible]	
	Capacity, Firm			7	[illegible]	
	TDH		FT	110	TBD	
	Motor Horsepower		HP	150	TBD	
Water Treatment Facility						
Rapid Mix						
Type:	Vertical impeller, variable speed drive					
	Flow		MGD	7.2	10.8	
	Quantity of Trains		No.	2	[illegible]	
	Quantity of Stages/Train		No.	2	2	
	Size, Each Stage		ft3	94.5	94.5	
	Mixing Energy, G		1/sec	1,000	1,000	
	Mixing time					
		1st Stage	sec	17	17	
		2nd Stage	sec	17	17	
	Quantity of Mixers per train		No.	2	[illegible]	
	Total Mixers		No.	4	[illegible]	
	Motor Horsepower					
		1st Stage	hp	TBD	TBD	
		2nd Stage	hp	TBD	TBD	
Flocculation Basins						
Type:	Open Top, Cast in place Concrete Tanks					
	Flow		MGD	7.8	10.3	
	Quantity of Trains		No.	2	3	
	Quantity of Stages Per Train		No.	4	4	
	Size Each Stage		ft x ft	20x19.5	20x19.5	
	Water Depth (avg)		ft	10.7	10.7	avg depth based on sloped bottom
	Volume Per Train		cuft	16,692	16,696	
	Volume Total		cuft	33,384	50,076	
	Horizontal Flow Velocity		fpm	1.6	1.6	
	Detention Time (nominal)		min	50	50	
Flocculation						
Type:	Variable speed, Vertical Impeller					
	Quantity Each Stage		No.	1	1	
	Paddle Peripheral Speed		fps	0.5 - 2.0	0.5 - 2.0	
	Mixing Energy, G					
		1st Stage	1/sec	20-60	20-60	
		2nd Stage	1/sec	20-60	20-60	
		3rd Stage	1/sec	20-40	20-40	
		4th Stage	1/sec	10-20	10-20	
	Motor Horsepower					
		1st Stage	hp	TBD	TBD	
		2nd Stage	hp	TBD	TBD	
		3rd Stage	hp	TBD	TBD	
		4th Stage	hp	TBD	TBD	
Sedimentation Basins						
Type:	Rectangular, plug flow					
	Flow Rate		MGD	7.2	10.8	
	Quantity		No.	2	3	
	Size		ft x ft	122 x 78	122 x 117	
	Size per train		ft x ft	122 x 39	122 x 39	
	L/W Ratio each basin			3.1	3	
	Surface Area, per Train		ft2	4,758	4,758	
	Surface Area, Total		ft2	9,516	14,274	
	Surface Loading Rate		gpm/ft2	0.53	0.53	
	Side Water Depth		ft	17.65	17.65	
	Volume per train		ft3	83,979	83,979	
	Volume Total		ft3	167,957	251,936	
	Detention time		hr	4.19	4.19	
	Horizontal Flow Velocity		ft/min	0.49	0.48	
Outlet Control						
Type	V notch weir					
	Weir length per train		ft	800	800	
	Weir length total		ft	400	600	
	Weir Overflow Rate per train		gpd/ft	18,000	18,000	
	Weir Overflow Rate Total		gpd/ft	18,000	18,000	
Sludge Collection						
Type:	chain					
	Quantity, Each Train		No.	[illegible]	[illegible]	
	Quantity, Total		No.	[illegible]	4	
Filters						
Type	Gravity, constant rate, backwash with surface wash					
	Flow Rate		MGD	7.2	10.8	
	Quantity, Existing		No.	4	4	
	Quantity, New		No.	2	4	Assume adding 2 new filters in addition to existing 4
	Quantity, Total		No.	6	8	filters pending results of filter capacity testing.
	Size Existing and New		ft x ft	19.5 x 18.5	19.5 x 18.5	
	Surface Area, each		ft2	361	361	
	Surface Area, total		ft2	2,165	2,886	
Media Type:	Sand/Anthracite					
	Media Depth		in	30	30	
Filtration Rate						
	All filters		gpm/ft2	2.31	2.60	
	One filter out of service		gpm/ft2	2.77	2.97	
	Two filters out of service		gpm/ft2	3.47	3.47	
Backwash						
	Type:	Vertical turbine				
	Flow Rate		gpm	7,200	7,200	
	Wash Water Loading Rate		gpm/ft2	20	20	
Surface Wash						
	Type	Rotating arm				
	Flow rate		gpm	100	100	
	Wash Rate		gpm/ft2	100	100	
	Pressure		psi	150	150	

Item		Units	Design	Ultimate	Comments
Clearwell / Chlorine Contact Chamber					
	Flow Rate	MGD	7	10.5	
Existing Clearwell(s)					
Type	Rectangular, baffled tank				
	Quantity		1	1	
	Size	ft x ft	70 x 52.5	70 x 52.5	
	Side water depth (maximum from record drawings)	ft	11.45	11.45	
	Volume (maximum)	gal	314,749	314,749	
New Clearwell(s)					
Type	Circular, baffled, glass lined				
	Quantity	No.	2	3	
	Diameter (ea)	ft	58	58	
	Side water depth (maximum)	ft	28	28	
	Volume, Total Maximum, Ea.	gal	541,654	541,654	
	Volume, Total Maximum	gal	1,083,307	1,624,961	
	Required Giardia Log Inactivation Credit	log	0.5	0.5	
	Required Ct at 5 C & 2 mg/L free chlorine	mg-min/L	41	41	
	Baffling factor	ratio	0.5	0.5	
	Contact Time @ minimum volume	min	41	41	
	Volume, Total Minimum	gal	189,305	280,958	
	Side Water Depth Both Clearwells, Minimum	ft	4.4	4.4	Based on new clearwell capacity
High Service Pumping					
New Pump(s)					
Type	Vertical Turbine, variable speed drive				
	Quantity	No.	TBD	TBD	
	Capacity: Each	MGD	TBD	TBD	
	Capacity, Firm	MGD	7	10.5	
	TDH	FT	TBD	TBD	
	Motor Horsepower	HP	TBD	TBD	

Water Treatment Chemical Feed Equipment and Sizing

Chemical Dosages at Point of Application — Based on historical 2006-2007 operational data		Min (ppm)	Avg (ppm)	Max (ppm)	Comments
Polymer (at River Water Pump Station)		0.1	0.4	1	Max design is 2x reported max daily dose
Powdered Activated Carbon		2.6	7.9	40	Reported max daily dose is TBD
Coagulant		1.8	8.9	51	Max design is 1.4x reported max daily dose
Sodium Hypochlorite as dry NaOCl	Rapid Mix	0.5		12	Not currently added
	Pre-Filter	1.2	2.6	12	Max. design is 2x reported max daily dose
	Post Filter	0.7	1.5	11	Max. design is 2x reported max daily dose
	Pre-Distribution	0.2		12	Not currently added

Chemical Feed Capacities		Units	Min	Max	Comments
Polymer 525 (at River Water Pump Station)					
Solution Strength	0.6 (lbs polymer/gal soln)				
Injection Location(s)	River Water Pump Station				
Type of metering pump					
Number of Metering Pumps		No.	2	2	
Capacity, Each		gph	0.06	0.4	Min = min dose at 7 mgd Max = max dose at 10.5 mgd
Powdered Activated Carbon					
Density		lbs/ft3	32	32	Based on product from Calgon
Injection Location(s)	Pretreatment, Rapid Mix				
Type of Feeder	Volumetric				
Number of Dry Feeders		No.	1	1	
Capacity Range (min-max)		lbs/day	107	8,000	
Volumetric Capacity (min/max)		ft3/hour	[illegible]	4.0	
Coagulant					
Solution Strength 50% solution	5.6 (lbs coagulant/gal solution)				
Injection Location(s)	Pretreatment, Rapid Mix				
Type of metering pump					
Number of Metering Pumps		No.	[illegible]	[illegible]	
Capacity, Each		gph	[illegible]	[illegible]	Min = min dose at 7 mgd Max = max dose at 10.5 mgd
Sodium Hypochlorite					
Solution Strength 12.5% solution	1.29 (lbs NaOCl/gal solution)				
Injection Location(s)	Rapid mix, Pre-Filter, Post-Filter, Predistribution				
Type of metering pump					
Number of Metering Pumps		No.	[illegible]	4	
Capacity Range (min/max), Each		gph	0.1	84	Min = min dose at 7 mgd Max = max dose at 10.5 mgd

Chemical Storage Requirements

	Storage Criteria	Required Value	Container Type	Storage Capacity
Potassium Permanganate	Historical maximum 30-day chemical use at 625 lbs/mgd and an average ultimate flow of 8.66 mgd	5,400 lbs	330 lb drums	17 drums
Polymer 525	Historical maximum 30-day chemical dose of 2.25 gal/mgd and an average ultimate flow of 8.66 mgd	590 gal	55-gal drum	11 drums
Powdered Activated Carbon	Historical maximum daily chemical dose of [illegible] lbs/mgd for 14 days (10 days is historically most used in a row) and an average ultimate flow of 8.66 mgd	10,370 lbs	900 lb bags	12 bags
Coagulant	Historical maximum 30-day chemical dose of 24.5 gal/mgd and an average ultimate flow of 8.66 mgd	6,370 gal		TBD
Sodium Hypochlorite	Historical maximum 30-day chemical dose of 44 gal/mgd and an average ultimate flow of 8.66 mgd	11,450 gal	HDPE Tank	2 - 6,000 gal bulk tanks + 1 - 800 gal day tank

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DESIGN CRITERIA

RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
PRELIMINARY DESIGN REPORT
CENTRAL CITY
MUHLENBURG COUNTY, KENTUCKY

DATED 08/09
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BY:
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STRAND ASSOCIATES, INC.® ENGINEERS

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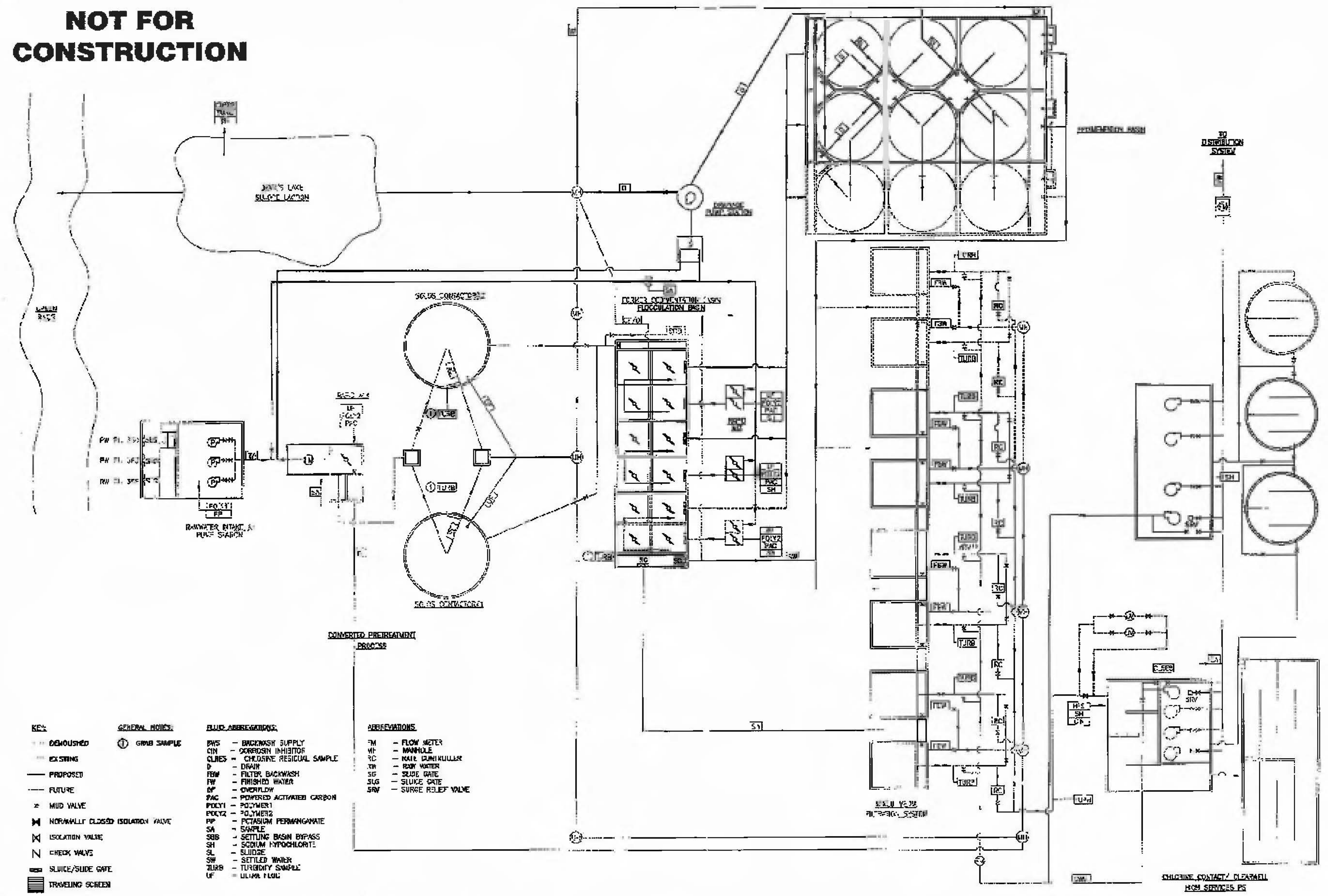

KEY:

- DEMOLISHED
- EXISTING
- PROPOSED
- FUTURE
- MUD VALVE
- NORMALLY CLOSED ISOLATION VALVE
- ISOLATION VALVE
- CHECK VALVE
- SLUICE/SLIDE GATE
- TRAVELING SCREEN

GENERAL NOTES:

① GRAB SAMPLE

FLUID ABBREVIATIONS:

BWS – BACKWASH SUPPLY
CIN – CORROSIN INHIBITOR
CLRES – CHLORINE RESIDUAL SAMPLE
D – DRAIN
FBW – FILTER BACKWASH
FW – FINISHED WATER
OF – OVERFLOW
PAC – POWERED ACTIVATED CARBON
POLY1 – POLYMER1
POLY2 – POLYMER2
PP – POTASIUM PERMANGANATE
SA – SAMPLE
SBB – SETTLING BASIN BYPASS
SH – SODIUM HYPOCHLORITE
SL – SLUDGE
SW – SETTLED WATER
TURB – TURBIDITY SAMPLE
UF – ULTRA FLOC

ABBREVIATIONS:

FM – FLOW METER
MH – MANHOLE
RC – RATE CONTROLLER
RW – RAW WATER
SG – SLIDE GATE
SLG – SLUICE GATE
SRV – SURGE RELIEF VALVE

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PROCESS FLOW SCHEMATIC & ABBREVIATIONS

RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
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CENTRAL CITY
MUHLENBURG COUNTY, KENTUCKY

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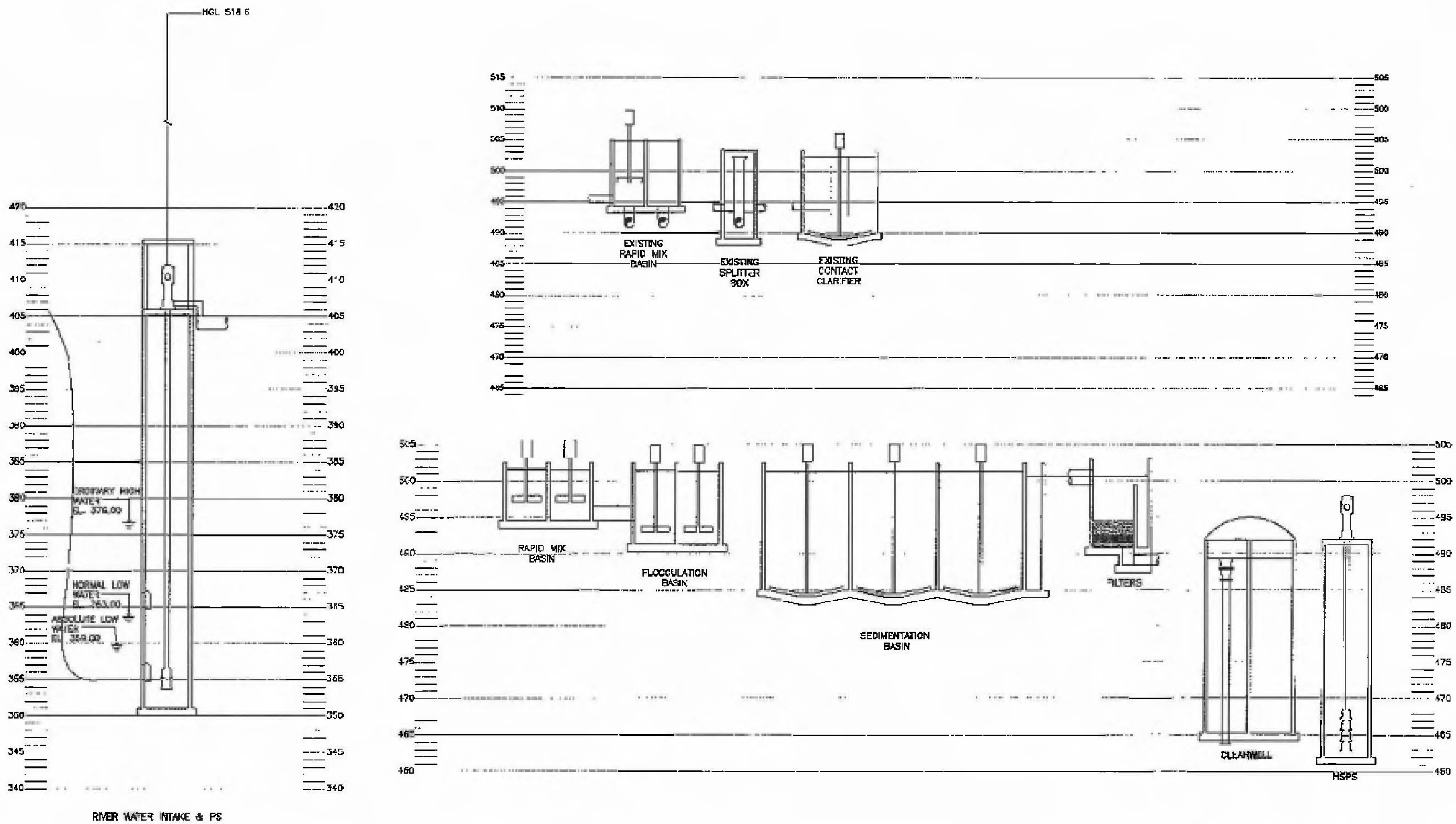

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HYDRAULIC PROFILE

RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION

PRELIMINARY DESIGN REPORT

CENTRAL CITY

MUHLENBURG COUNTY, KENTUCKY

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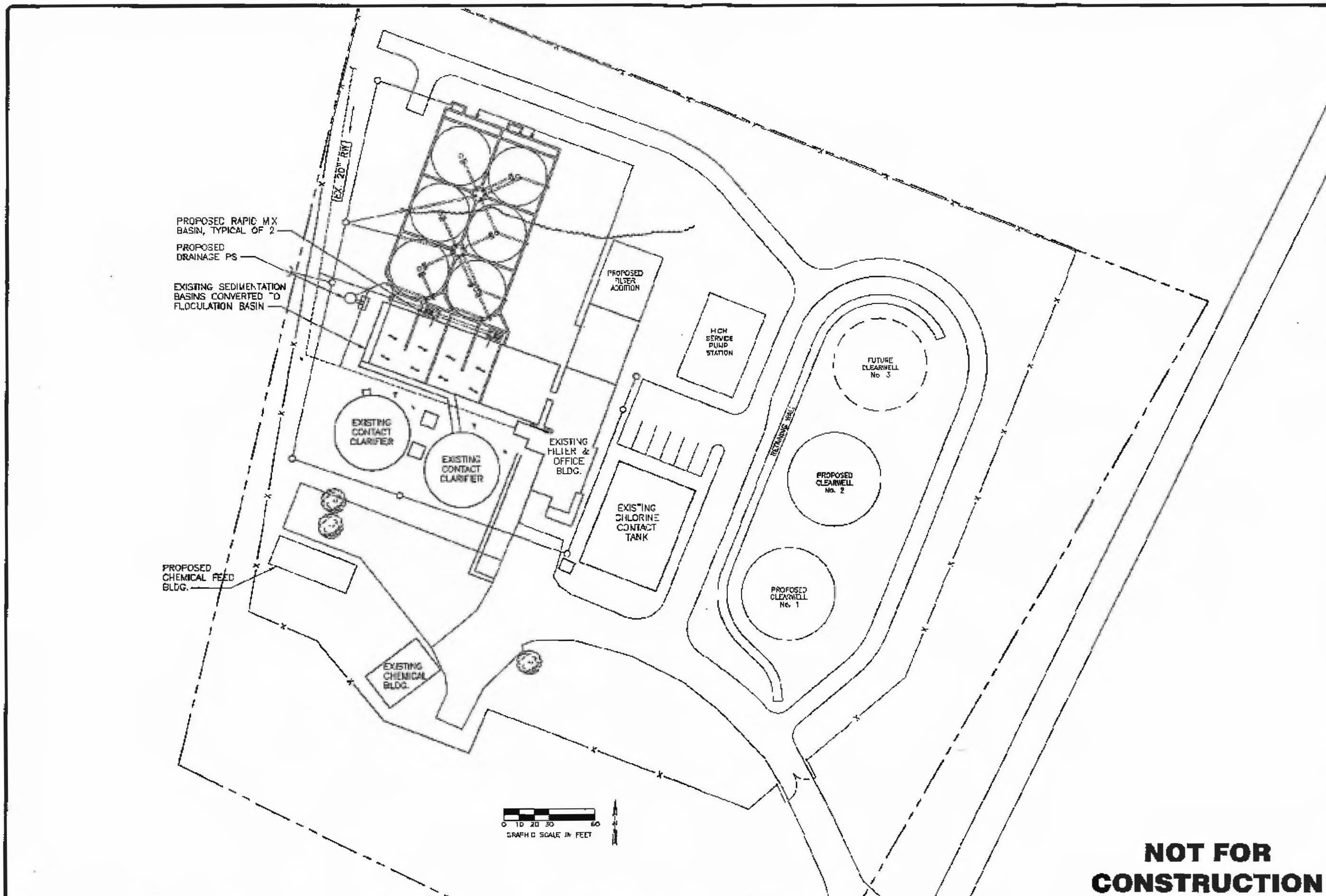

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WTP YARD PIPING PLAN

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STRAND ASSOCIATES, INC. ENGINEERS

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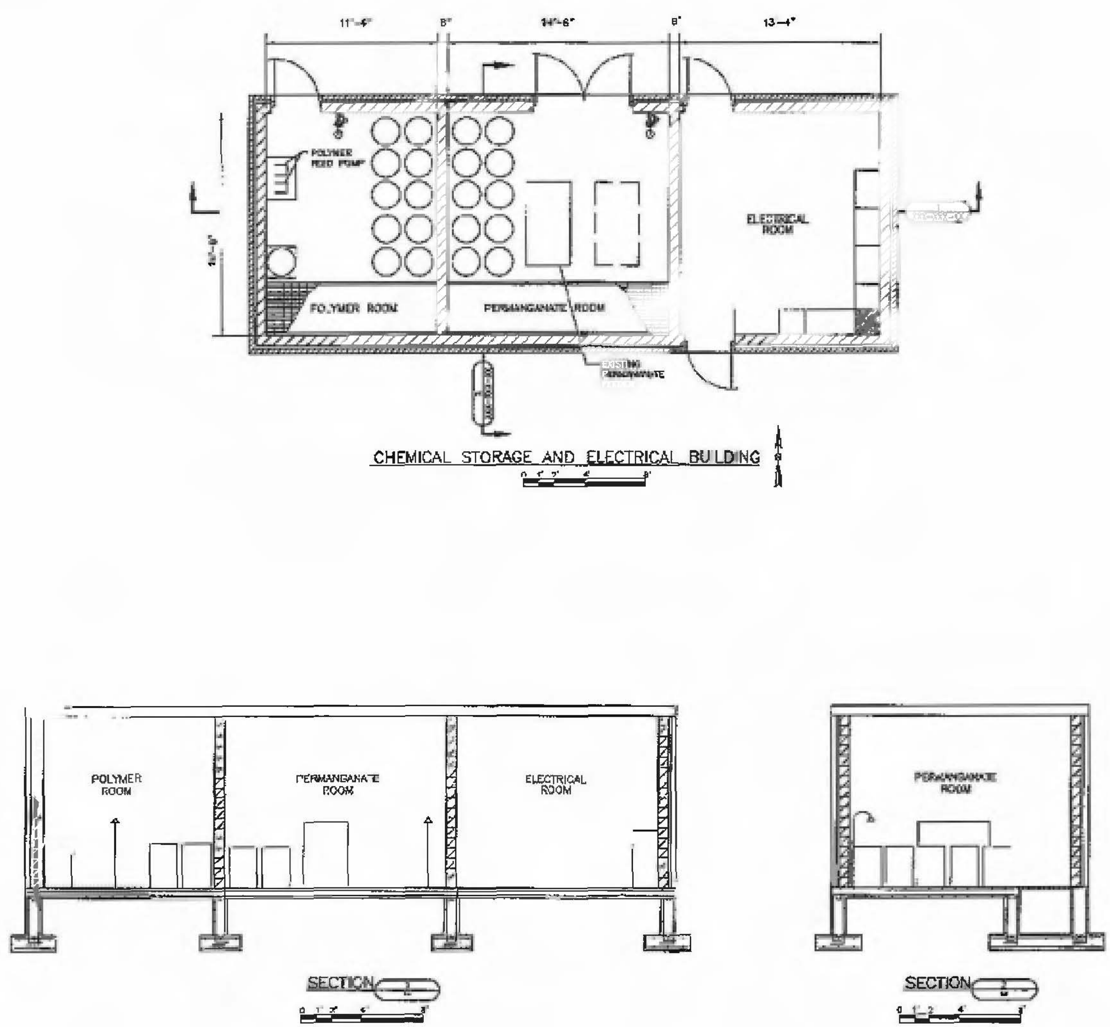

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CHEMICAL STORAGE AND ELECTRICAL BUILDING

RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
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CENTRAL CITY
MUHLENBURG COUNTY, KENTUCKY

STRAND ASSOCIATES, INC.® ENGINEERS

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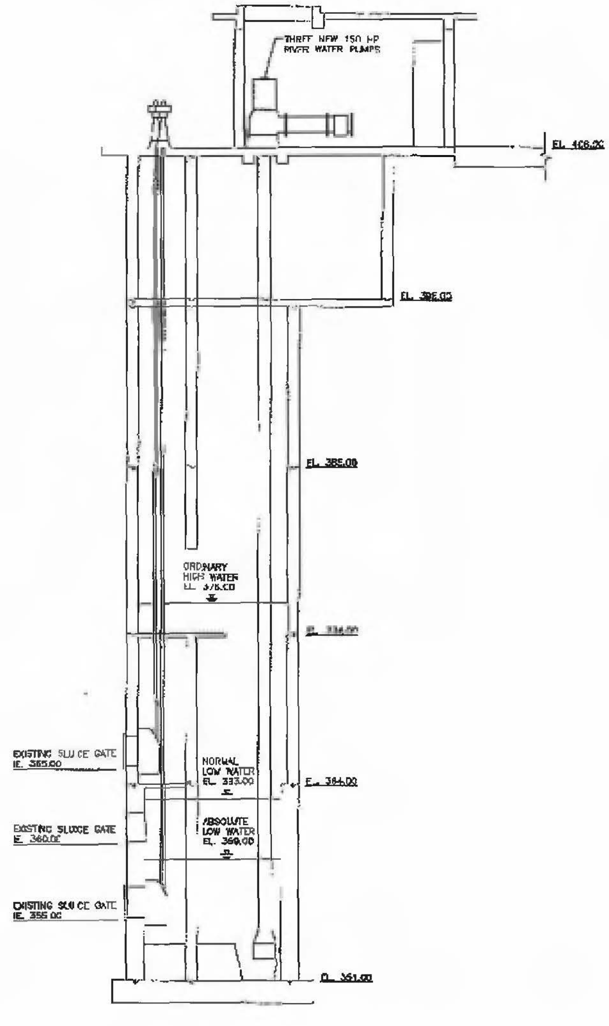
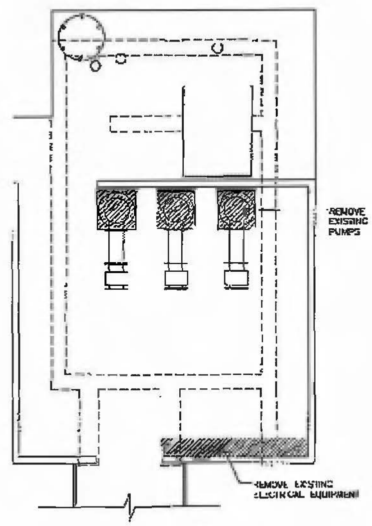
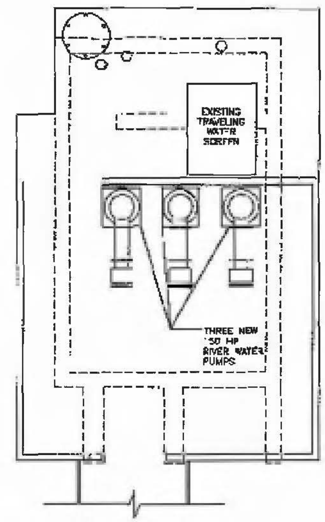


ELEVATION



DEMOLITION PLAN AT EL. 406.00



PLAN AT EL. 406.00

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EXISTING RIVER WATER PUMP STATION
PLANS & SECTIONS
RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
PRELIMINARY DESIGN REPORT
CENTRAL CITY
MUHLENBURG COUNTY, KENTUCKY

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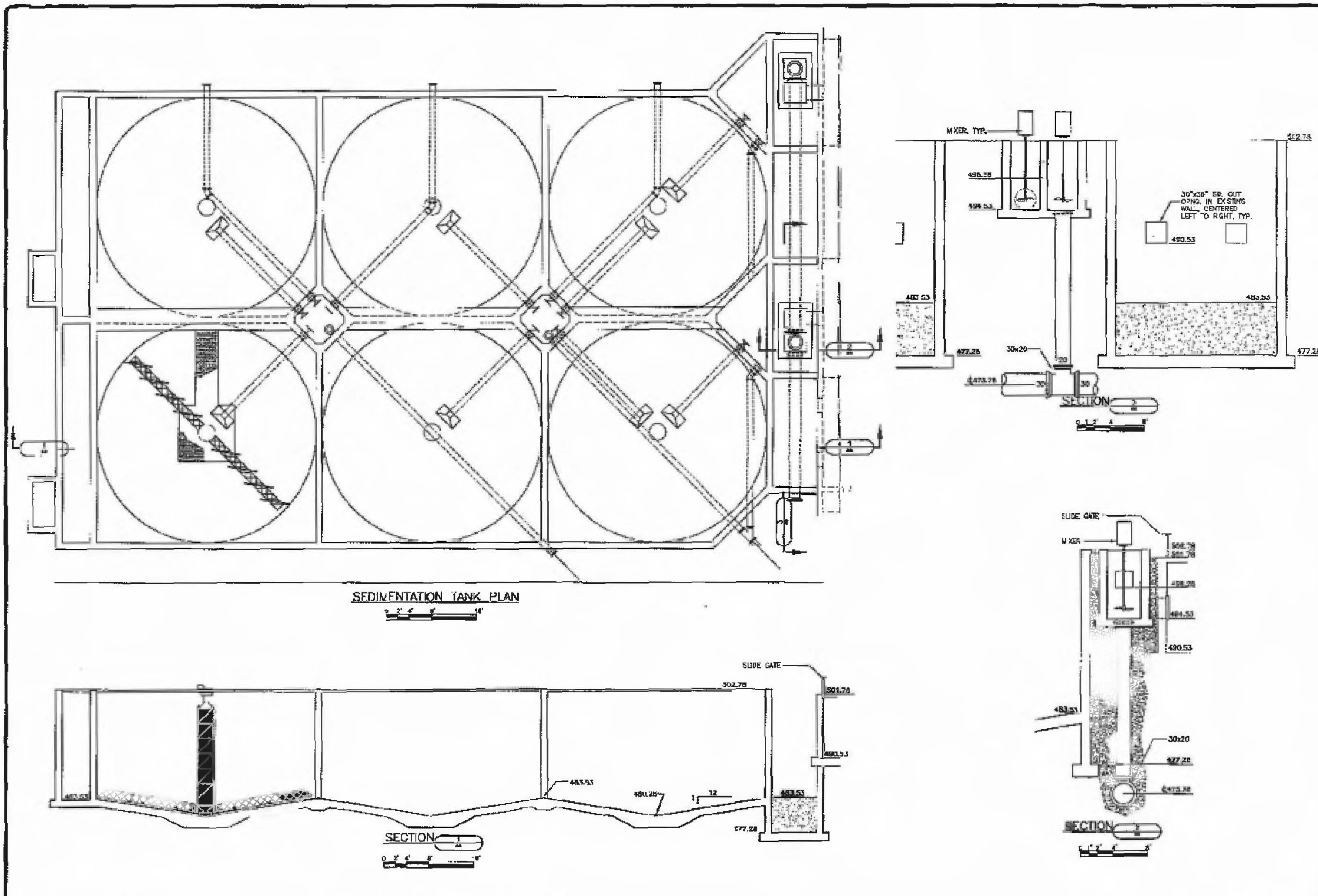

SEDIMENTATION BASIN
RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
PRELIMINARY DESIGN REPORT
CENTRAL CITY
MUHLENBURG COUNTY, KENTUCKY

NO.	REVISIONS	DATE

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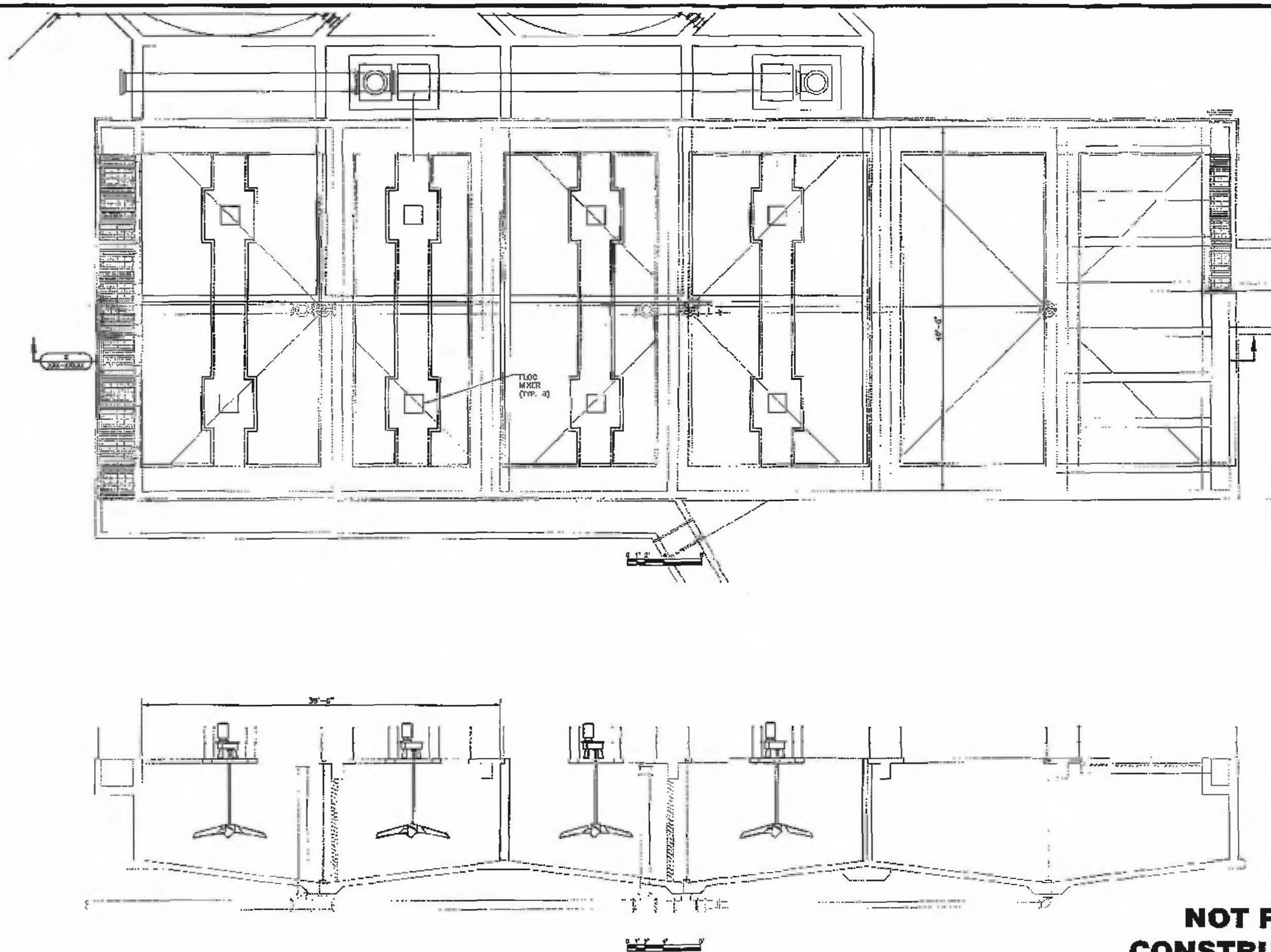

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NEW FLOCCULATION BASIN PLAN & SECTION

RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
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MUHLENBURG COUNTY, KENTUCKY

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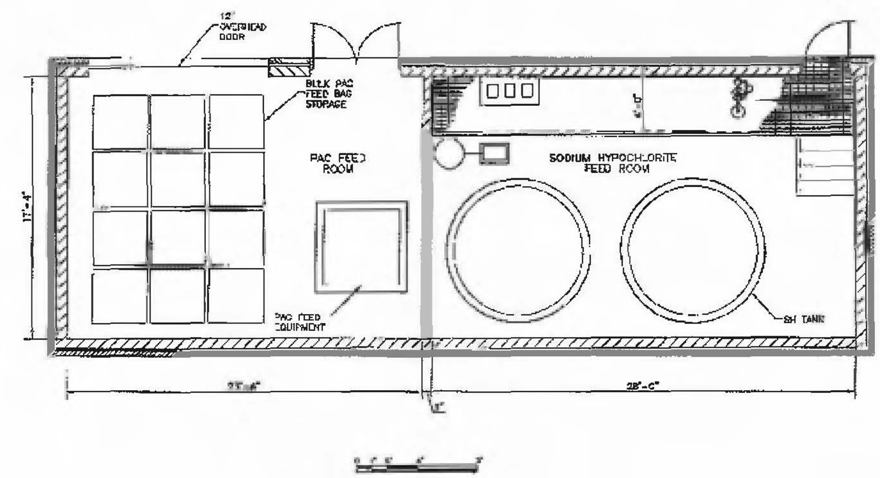

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NEW CHEMICAL FEED BUILDING

RIVER WATER PUMPING STATION & TREATMENT PLANT EXPANSION
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DES BY: CJK CHK BY: CJK
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BY:
DATE:
CONTRACTOR:

SHEET XXX
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JOB NO. 5109.001

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APPENDIX B
CALCULATIONS FOR EXISTING PLANT CAPACITY AND DESIGN CAPACITY

Central City Water Treatment Plant

Spreadsheet for the calculation of Chlorine Residual and Clearwell Requirements

project: WTP
job number: 5109.001
by: CJK

CT Values and Baffling Factors taken from:

Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, 1991

Assumed Conditions

Temperature 5 °C

Log Inactivatn 0.5 log

Percent Inactivation 68.38%

ph 8

Chlorine dose 1.92 mg/L

CT from table 41 mg-min/L

Calculate Contact Time at several baffling factors ranging from 1 to 0.1.

Contact Time = CT Value / (Chlorine Conc * Baffling Factor)

Baffling Factor (T_{10}/T)		*1*	*0.7*	*0.5*	*0.3*	*0.1*
Chlorine Conc (mg/L)	CT Value	Contact Time minutes	Contact Time minutes	Contact Time minutes	Contact Time minutes	Contact Time minutes
1.92	41	21.4	30.5	**42.7**	71.2	213.5

Calculate Volume required based on flow and a baffling factor.

Required volume average baffling; BF = 0.5

Table of Flow rates through plant assuming 24 hr operation per day

Flow Rate (mgd)	4.0
Flow Rate (gpm)	2,778

Volume = (flow *contact time)

Chlorine Conc. (mg/L)	Contact Time (minutes)	Required Vol. (gallons)
2,778	42.7	118,634

The volume of the clearwell is based on the CT requirements or 15% of the total flow, which ever is greater.

CT Volume required	118,634	gal	is < than	600,000	gal	(req'd volume at 15% of plant capacity)
CT Volume required	15,860	ft^3	is < than	80,214	ft^3	(req'd volume at 15% of plant capacity)

	WSEL (msl)	Bottom El @ Wall (msl)	Surface Area (sf)	Total Volume (cf)	Total Volume (gal)
Actual Clearwell Volume	489.25	477.8	4775	54,674	408,960

Calculate Depth Required for 0.5 log removal in existing Clearwell 35,717 gal/ft of existing clearwell

3.3 minimum depth of clearwell in feet

Central City Water Treatment Plant

Spreadsheet for the calculation of Chlorine Residual and Clearwell Requirements

project: WTP
job number: 5109.001
by: CJK

CT Values and Baffling Factors taken from:

Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, 1981

Assumed Conditions

Temperature 5 °C | Log Inactivatn 0.5 log | ph 8
Percent Inactivation 68.38%

Chlorine dose 2 mg/L | CT from table 41 mg-min/L

Calculate Contact Time at several baffling factors ranging from 1 to 0.1.

Contact Time = CT Value / (Chlorine Conc * Baffling Factor)

Baffling Factor (T_{10}/T)		*1*	*0.7*	*0.5*	*0.3*	*0.1*
Chlorine Conc (mg/L)	CT Value	Contact Time minutes	Contact Time minutes	Contact Time minutes	Contact Time minutes	Contact Time minutes
2	41	20.5	29.3	41.0	68.3	205.0

Calculate Volume required based on flow and a baffling factor.

Required volume average baffling; BF = 0.5

Table of Design Flow rate through plant assuming 24 hr operation per day

Flow Rate (mgd)	7.0
Flow Rate (gpm)	4,861

Volume = (flow *contact time)

Parameter	Value	
Flow	4,861	gpm
Contact Time	41	min
Volume	**199,306**	**gallons**

The volume of the clearwell is based on the CT requirements or 15% of the total flow, which ever is greater.

CT Volume required	199,306	gal	is < than	1,050,000	gal	(req'd volume at 15% of plant capacity)
CT Volume required	26,645	ft^3	is < than	140,374	ft^3	(req'd volume at 15% of plant capacity)

Clearwell Design	WSEL	Bottom El	Surface Area	Total Volume	
Clearwell Volume - (2) New 62' dia x	489.25	465.25	3,019	72,458	cubic feet ea - 2 total
24' tall tanks				541,984	gallons ea - 2 total

Therefore capacity provided is acceptable 1,083,967 > 1,050,000

Calculate Depth Required for 0.5 log removal

22,583 gal/ft ea - 2 total
4.4 minimum depth of clearwell in feet