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Kentucky American Water
Lexington, Kentucky

Kentucky River Pool 3 Water Treatment Plant

Basis of Design Report
Addendum No. 1
(Provision of additional 5 MGD Capacity for 25 MGD Water Treatment Plant)

Exhibit A – Specifications
Volume IV

March 2007

GANNETT FLEMING
Harrisburg, Pennsylvania

Kentucky American Water
Lexington, Kentucky

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Addendum No. 1
(Provision of additional 5 MGD Capacity for 25 MGD Water Treatment Plant)

March 2007

STATE OF KENTUCKY
GENE C. KOONTZ
REGISTERED
PROFESSIONAL ENGINEER

3/5/07

GF Project No. 45260

Gannett Fleming, Inc.
Harrisburg, Pennsylvania

KENTUCKY AMERICAN WATER
KENTUCKY RIVER POOL 3 WATER TREATMENT PLANT
BASIS OF DESIGN REPORT
ADDENDUM 1
(Provision of additional 5 MGD Capacity for 25 MGD Water Treatment Plant)

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Appendices

A. Background

The need for additional source of supply and/or water treatment capacity to meet future demands has long been recognized by Kentucky American Water (KAW). In 1998, KAW began final planning and design of an Ohio River supply project, which would include bulk purchase of treated water from the Louisville Water Company and transmission of the water to the KAW system through a large-diameter main; however, this project met with significant public opposition and work was eventually halted.

The Bluegrass Water Supply Consortium (BWSC) was formed in 1999 to identify and implement a regional solution to the area's water supply deficiencies. A report in February 2004 documented a conceptual network of treated water pipelines, construction of a new water treatment plant (WTP) to treat water from the Kentucky River Pool 3, and a supplemental raw water supply pipeline from the Ohio River as the solution to the regional water supply deficiencies. KAW supports a regional solution to the water supply problem, actively participating and providing resources to the BWSC. Under regulatory and customer pressure, KAW committed to present its plan to the PSC by Spring 2007, announcing it would build a treatment plant and transmission line for adequate water supply by 2010. KAW is continuing to work with the BWSC on a partnership for the new facilities.

During the design of the proposed water treatment plant, KAW decided to incorporate into the design an additional 5 MGD capacity module. The facility requirements for this capacity are described in this Addendum 1. Changes in the Basis of Design to incorporate this additional capacity are shown in Bold lettering. Only sections that include changes related to the increased capacity are included in this addendum. The decision as to whether to construct the additional capacity will be made at a later date.

B. Proposed KAW WTP

The proposed pumping and treatment facilities are designed with an initial treatment capacity of **25** mgd and a hydraulic capacity of 30 mgd. The facilities are to be configured so that future treatment expansion to 30 mgd is possible. Treatment expansion could be accomplished by high rating the proposed process units or constructing new parallel process units.

A process flow diagram schematically representing the pumping and treatment facilities schematically is shown on Exhibit 1.

The new WTP will be constructed on recently acquired property that is located in Owen County just north of the dividing line between Owen and Franklin counties. The raw water intake will be located at Pool 3, with water flowing by gravity approximately 150 feet to the Raw Water Pumping Station, with an operating floor elevation located above the 500 year flood elevation. Water will be pumped approximately 1,300 feet to the water treatment plant. A clarification and filtration process will be provided to remove suspended and colloidal particles, including iron and manganese, natural organic matter (NOM), and pathogenic microorganisms in the raw water. Chemical treatment will be provided for oxidation of soluble iron and manganese, taste and odor control, pH adjustment, coagulation, corrosion control, disinfection, and emergency mitigation of chemical spills in the river. The proposed clarification and filtration processes are highly effective in removing pathogenic cysts such as *Giardia* and *Cryptosporidium* when chemical pretreatment is optimized. There will also be provisions to add granular activated carbon (GAC) as a filter media in place of anthracite in the filters, to further provide taste and odor control, if necessary.

Post-filtration disinfection with chlorine will be provided as an additional primary barrier to *Giardia* and viruses. The cast in place concrete finished water storage clearwell will be designed to provide disinfection contact time (CT) for no less than 4 log virus and 1 log *Giardia* inactivation and backwash and equalization storage. Provisions are included for future installation of ultraviolet light disinfection, should it become necessary to enhance disinfection and provide an added barrier against *Giardia* and *Cryptosporidium*. Finished water will be pumped to the transmission system via a new high service pump station.

Process wastewater facilities will include wastewater clarification, sludge thickening, and dewatering with belt filter presses. Clarified wastewater will be discharged to the Kentucky River in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. Dewatered sludge will be utilized for beneficial use, either onsite or at a nearby site recently acquired by KAW and located just above the floodplain near Pool 3 of the Kentucky River.

A.	**Anticipated WTP Production, mgd**		
	1.	**Minimum**	**4.0**
	2.	**Winter Average**	**6.0**
	3.	**Summer Average**	**18.33**
	4.	**Maximum**	**25.0**
	5.	**Ultimate**	**30.0**
B.	Hydraulic capacity of underground piping and other facilities not easily expandable, mgd		40.0

A. Design Concept

Source water is to be withdrawn from the Kentucky River at Pool 3. Intake screens will be wedge wire basket screens in a tee configuration. Screens will be manifolded together and located within the river, approximately 25 feet offshore. The facility will be designed for addition of future screens to support the ultimate design capacity.

Two intake mains will be hard-piped from the screen manifold to the pumping station, where flow will split to **five** raw water pumps. Access shall be provided to allow intake main maintenance.

An air burst backwash system will be provided for automated screen cleaning based on time or differential pressure.

B. Intake Facilities

1. **Flow, mgd**

a.	**Minimum**	**4.0**
b.	**Winter average**	**6.0**
c.	**Summer average**	**18.33**
d.	**Maximum**	**25.0**
e.	**Ultimate**	**30.0**

2. River levels

a.	Lock and Dam 3 weir level	457.13
b.	Upstream sill elevation	448.52
c.	Downstream sill elevation	437.47
d.	Minimum water level	455.13
e.	100 year flood level	493.21
f.	500 year flood level (1937 Lock 3 High Flood Mark)	499.40
g.	Maximum barge draft (based on upper sill)	8.61

3. Intake Screens

a.	Type	Wedgewire tee screens
b.	Material	Stainless steel
c.	**Number of screens**	**3**
d.	Capacity per screen, mgd	15
e.	Diameter, feet	3.5
f.	Maximum through slot velocity, fps	0.5
g.	Screen slot opening, inches	1/8
h.	Number of intake levels	1
i.	Minimum screen submergence	one screen diameter
j.	Centerline screen elevation (Upper sill minus screen diameter / 2) (Set top of screen at sill level to ensure intake will be below barge draft)	446.50

C. Airburst Backwash System

1. Design air burst compressor, receiver and piping system to deliver 3 screen volumes of air to each individual screen over a period of 1 to 2 seconds.
2. The air compressor system shall be designed to recharge the receiver system in no greater than 30 minutes.
3. Provide individual pneumatically operated valve and air supply line for each screen. Provide connections for future screen air supply.
4. Air supply piping to be type 304 stainless steel.
5. Location

a.	Compressor	Raw water pumping station
b.	Receivers	Raw water pumping station
c.	Air burst valves	Raw water pumping station
d.	Control station	Raw water pumping station

6. Compressor

a.	Type	Skid mounted rotary screw or reciprocating
b.	Number	2
c.	Controls	Backboard mounted control panel, HOA switch for each compressor, auto alternation, low pressure alarm, normal pressure/receiver ready lights

d. Pressure, psi 140
e. Horsepower 10

7. Receiver
   a. Number 1, with an auxiliary receiver for valve control
   b. Capacity, gallons 660
   c. Auxiliary receiver capacity, gallons 12
   d. Configuration Vertical

8. Valves
   a. Type Pneumatic operated bubble tight butterfly
   b. Size, inches 6
   c. Controls
      1) Auto timer with adjustable duration between bursts
      2) Automatic head loss control based on setpoint differential water level
      3) Remote manual control
      4) Local manual control
      5) Solenoid valves for air burst valves to allow manual operation

D. Chemical feed Points
   1. Future Zebra Mussel polymer, at each screen
   2. Potassium permanganate, at each screen
   3. Include provisions for extending chemical feed to future screen

E. Intake Main
   1. Velocity, fps 3-5
   2. Material Ductile iron, cement lined
   3. Number 2
   4. Diameter, inches 30
   5. Flow within velocity criteria, mgd 10-16, single main
      19 - 30 dual main
   6. Velocity at minimum flow, fps 1.3

F. Intake Main Flushing
   1. Provide capability to back flush main from raw water pumping station to intake.
   2. Provide reduced pressure flushing water from raw water main.
   3. Provide discharge capability at intake without backflow through screens.

G. Raw Water Monitoring

1. Provide raw water sample upstream of chemical addition. Pump to raw water pumping station for turbidity and pH monitoring.
2. Provide stilling well for river level transmitter.

A. Design Concept

1. Vertical turbine pumps drawing water from a wet well formed by the foundation caisson.
2. Ultimate capacity to be provided with additional pump in spare location.
3. Fully flood proofed facility with electrical and mechanical equipment no less than 2 feet above worst flood of record.
4. Maximum discharge pressure, psi — 120±

B. Facilities - Raw Water Pumping Station

1. Elevations, ft.
   a. 500-year flood level (GF HEC Study) — 499.40
   b. Pump room floor elevation, feet — 502
   c. Pump suction hydraulic grade, ft. Elev.
      1) Normal water level — 457.13
      2) Low water level — 455.13
   d. Water treatment plant influent hydraulic grade, ft. Elev. — 762.67±
2. Raw water pumps
   a. Type — Vertical turbine with open line shaft and clean water pre-lube
   b. Number — 4 plus 1 future
   c. Overall pumping requirements, mgd
      1) Minimum Flow — 4
      2) Winter Average Flow — 6
      3) **Summer Average Flow — 18.33**
      4) **Maximum Flow — 25**
      5) Ultimate Flow — 30
      6) **Firm Capacity, largest unit out of service — 30**

d. Pump design criteria

	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Pump No. 5
Type	Vertical Turb.	Vertical Turb.	Vertical Turb.	Vertical Turb.	Vertical Turb
Rated Capacity (MGD)	10	10	7	7	6
Rated Head (feet)	325	325	325	325	**325**
Horsepower	700	700	500	500	**500**
Nominal Motor Speed	1,200	1,200	1,200	1,200	**1,200**
Motor Voltage	4160	4160	4160	4160	**4160**
Constant Speed or VFD	VFD	VFD	Constant	Constant	**Constant**
Discharge Diameter (inches)	20	20	16[2]	16[1]	**16[1]**
Discharge Centerline Elevation (feet)	505 +/_	505 +/_	505 +/_	505 +/_	**505 +/_**

[1]Increase to 20-inch connection at discharge isolation valve for future pump change-out to larger capacity

1) Pump design to provide a flow continuum from 4 mgd to 30 mgd based on pump selected and speed control

2) Motors - 4160 V, 3 phase, 60 hz motors

3. Pump discharge

a. Discharge maximum velocity, fps — 8

b. Manifold maximum velocity, fps — 5

c. Material — flanged ductile iron

d. Appurtenances

1) Vacuum/air release valve

2) Pressure gauge, psi range — 0-200

3) Discharge check valve — Tilting disk

4) Isolation valve — Butterfly

5) Surge facilities — Surge anticipator valve

6) Pressure switch, high, normal, low, each discharge header

7) Pump pre-lube water, potable, with flow switch.

4. Pump discharge manifold appurtenances

a. Appurtenances

1) Pressure transmitter

5. Appurtenances for pump station

a. Raw water sample to analyzers from submersible pump

b. Raw water turbidimeter

c. Raw water pH meter

d. Raw water temperature transmitter

e. Traveling bridge crane

f. Ultrasonic level transmitter for wet well

g. Temperature controlled environment as required for variable frequency drives

h. Plant service water setting with pressure reducing valve (80 psi) for pump lube water, chemical feed facilities, washdown/flushing and eyewash/shower.

i. Eyewash and shower

j. Electrical room

k. Space for air burst equipment

l. Potassium permanganate day tank and feed area with spill containment.

6. Chemical Application

a. Potassium permanganate – points of application within raw water intake screens and into raw water wet well. Volumetric feeder and chemical storage facilities are to be located at the WTP, while a day tank and chemical feed pumps are to be located at the RWPS.

A. General Design Criteria for Chemical Storage and Feed Facilities

1. Bulk Storage: 30-day storage at ultimate average flow and average feed rate which is equivalent to 20 mgd flow and average feed rate.
2. Day Tanks/ Hoppers: 24-hour storage at ultimate flow (30 mgd) and maximum dose.
3. Transfer - transfer to day tanks
    a. Size for transfer in 2 minutes for smaller day tanks with manual pushbutton control
    b. Size for transfer in 20 minutes for larger day tanks with fully automated, manually initiated transfer
4. Provide spill protection and containment for chemical storage and transfer.
5. Provide flexible connectors at all piping connections to bulk storage tanks
6. Chemical Feeders
    a. Size for maximum flow and feed rate, initial capacity
    b. Sized to handle minimum flow/minimum feed rate within the manufacturer's recommended turn-down limits
    c. Control – Automatic flow pacing or compound loop pacing
    d. Chemical feed pumps to be single head
7. Redundancy
    a. Provide single feeder for each primary application point and one standby feeder. When possible a common spare feeder can be used.
    b. Provide secondary application points, where appropriate, to provide treatment flexibility.
    c. Provide redundant feed lines for critical chemicals when lines are difficult to access.
8. Future Chemical:
    a. Provide space in plant layout for future chemical feed room, with provisions for containment.

B. General – Pretreatment Chemicals

A series of pre-treatment chemicals will be fed to the process stream between the raw water intake and the filters. These chemicals and feed rates were determined based on the

Kentucky River water quality, the treatment goals established for the WTP, and past chemical usage at the Kentucky River Station, which treats water from Pool 9 of the Kentucky River.

Chemical feed points are shown on the Process Flow Diagram in Exhibit 1. As shown in Exhibit 1, alternative feed points for some of the chemicals are provided for flexibility. The purpose and application points of selected treatment chemicals and the chemical facilities are tabulated in the following articles. The detailed chemical dosages, daily usage rates, chemical feed system and bulk and daily storage requirements are included in Appendix A.

C. Purposes and Application Points of Pre-treatment Chemicals

Chemical	Purpose	Feed Points	Control
Potassium Permanganate $KMnO_4$	Primary • Oxidation of iron and manganese • Zebra mussel control Secondary • Oxidation of some tastes and odors	Primary: Raw water pumping station wet well, just after intake pipe entrance Secondary: Raw water intake screens	Flow paced based on raw water flow
Powdered Activated Carbon (PAC) C	Primary • Taste and odor control Secondary • Adsorption of color • Adsorption of NOM • Spill control	Primary: Raw water pipe, as far upstream from WTP as practical (Provide multiple access points along feed line route for maintenance of feed hose - leave secondary containment ends open into access chamber for leak detection)	Flow paced based on raw water flow
Chlorine Cl	Primary • Disinfection • Inhibit microorganism growth in filter media and enhance particle removal Secondary • Oxidation of iron and manganese	Primary: Common filter influent (provide redundant feed lines) Secondary: Raw water main, upstream of rapid mixers.	Flow paced based on filter effluent flow and trimmed based on filter influent sample Flow paced based on raw water flow
Caustic Soda NaOH	Primary • See post-treatment chemicals, below Secondary • pH adjustment and alkalinity • Addition for coagulation • Oxidation catalyst	Secondary: Raw water main, upstream of rapid mixers Secondary: Common filter influent	Raw water flow paced and trimmed based on mixed water pH analyzer Flow paced based on filter effluent flow
Polyaluminum chloride[1] (PACl)	• Coagulation	Primary: Rapid mixer No. 1 Secondary: Rapid mixer No. 2	Flow paced based on raw water flow and trimmed based on streaming current
Ferric Chloride[1] FeCl	• Coagulation	Primary: Rapid mixer No. 1 Secondary: Rapid mixer No. 2	Flow paced based on raw water flow and trimmed based on streaming current
Coagulant Aid Polymer	• Enhance coagulation process	Primary: Rapid mixer No 2 Secondary: Rapid mixer No.1 Secondary: Downstream of pre-treatment rapid mixer	Flow paced based on raw water flow
Filter Aid Polymer	• Enhance filter performance	Primary: Common filter influent	Flow paced based on filter effluent flow

[1]The WTP will not be feeding PACl and FeCl simultaneously, but will have multiple tanks to allow switching between the two coagulants as water quality necessitates.

D. General – Post Treatment Chemicals

The post-treatment chemicals that are added to the filtered water or clearwell effluent include chlorine, ammonia, caustic soda, fluoride and corrosion inhibitor. Provisions are also included for adding polyaluminum chloride to the washwater and sodium thiosulfate to dechlorinate process wastewater. The purposes and the feed points for each are summarized in the following articles. The points of application are also depicted in Exhibit 1 (Process Flow Diagram). The detailed chemical dosages, daily usage rates, chemical feed systems, and storage requirements are described in Appendix A.

E. Purposes and Locations of Post Treatment Chemicals

Chemical	Purpose	Feed Points	Controls
Chlorine Cl	Primary • Disinfection	Primary: Clearwell Influent, normally fed (provide redundant feed line) Primary: Clearwell effluent, boost residual Secondary: Influent to second cell of the clearwell.	Clearwell influent flow paced based on filter effluent flow and trimmed based on clearwell influent chlorine analyzer Flow paced based on finished water flow and total chlorine residual Flow paced based on filter effluent flow
Caustic Soda NaOH	Primary • pH adjustment • Corrosion control	Primary: Clearwell Effluent (provide redundant feed lines) Secondary: Clearwell Influent	Flow paced based on finished water flow and trimmed based on finished water pH analyzer Flow paced based on filter effluent flow and trimmed based on finished water pH analyzer
Aqua Ammonia NH_3	• Formation of chloramines to minimize DBP formation and provide total chlorine residual	Primary: Clearwell effluent (provide redundant feed lines) Secondary: Clearwell influent Secondary: Influent to second cell of the clearwell	Flow paced based on finished water flow and trimmed based on ammonia and total chlorine residual Flow paced based on filter effluent flow and trimmed based on total chlorine residual
Fluoride (Hydrofluosilicic Acid)	• Fluoridation of the water to prevent dental cavities	Primary: Clearwell effluent, downstream of the washwater withdrawal, but upstream of the high service pumps (provide redundant feed lines) Secondary: Clearwell influent	Flow paced based on finished water flow Flow paced based on filter effluent flow
Corrosion Inhibitor (CI)	• General corrosion control • Lead and copper solubility reduction	Primary: Clearwell effluent, downstream of the washwater suction, but upstream of the high service pumps (provide redundant feed lines)	Flow paced based on finished water flow
Sodium Thiosulfate	• Dechlorinating process wastewater	Primary: Clarified wastewater discharge pipe, at point where pipe enters WTP	Flow paced based on wastewater discharge flow and trimmed based on wastewater discharge chlorine residual
Polyaluminum chloride (PACl)	• Assist in ripening filters	Primary: Filter washwater	Washwater coagulant based on concentration target, filter basin volume, and low wash rate
Wastewater Polymer	• Enhance settling of residuals	Primary: Wastewater drain Primary – Common sed basin blowdown	Flow paced based on backwash flow Flow paced based on sedimentation basin blow down
Dewatering Polymer	• Improve dewatering	Primary: Belt filter press feed	Manually adjusted at the Dewatering Building

D. Chemical Facilities

The primary components of the chemical systems are listed in the table below. Tank and pump capacities are listed in Appendix A.

Chemical System	Feed Equipment	No.	Location
Potassium Permanganate One drum-fed volumetric feeder, dissolver tank and mixer with a drum inverter at WTP with solution transfer to RWPS	a. Storage – Drums (330 lb net weight) b. Volumetric feeder, tank, mixer (WTP) c. Transfer Pump to WTP batch tank d. Batch tank 550 gallons (WTP) e. Transfer pumps to RWPS (WTP) f. Day tank 1400 gal (RWPS) f. Scale (WTP) g. Metering pumps (RWPS)	20 1 1 1 2 1 1 2	Potassium Permanganate area at WTP and Raw Water Pumping Station
Chlorine Gas phase vacuum chlorinator system with cylinder mounted vacuum regulators, Auto switchover and remote eductors at feed points	a. Ton cylinder storage b. Two-ton scales c. Chlorinators (Filt Inf, CW Inf, and CW Eff Feeders with Pre-Common Spare) d. Chlorine scrubber e. Space for future evaporator	8 2 4 1 1	Chlorine Storage Room Chlorine Storage Room Chlorine Feed Room Exterior Installed dry scrubber Chlorine Storage Room
Powdered Activated Carbon Frame mounted Super Sacks with volumetric feeders and eductor pumps	a. Super sack storage; 15,000 lbs. b. Super sack unloading system c. Hopper with vibration system d. Dry volumetric feeder e. Future dry volumetric feeder f. Educting system g. Slurry tank h. Load cells	1 1 1 1 1 1 1 4	Carbon Storage Room, 2nd Floor WTP Carbon Feed Room, 1st Floor WTP
Caustic Soda Bulk storage of 50% caustic soda with auto transfer system to day tank and one post, one pre, and one spare chemical feed pump	a. Bulk tanks; 5,000-gal. (50% caustic soda) b. Transfer pumps, 50 gpm c. Day tanks; 1000 gal. d Diaphragm metering pumps (size for 25% caustic soda) e. Hot water for flushing feed lines	2 2 1 3	Caustic Soda Room (1 pre, 1 post, 1 spare)
Polyaluminum chloride Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 12,000-gal. [2] b. Transfer pumps, 125 gpm c. Day tanks; 2,100-gal. d. Diaphragm metering pumps[1] e. Washwater diagphragm metering pumps	2 2 2 3 2	Coagulant Room
Ferric Chloride **Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps**	**a. Bulk tanks; 12,000-gal.** [2] **b. Transfer pumps, 75 gpm** **c. Day tanks; 1,500-gal.** **d. Diaphragm metering pumps**[1]	**2** **2** **1** **3**	**Alternate Coagulant Room**
Coagulant Aid Polymer Direct drum fed liquid polymer blending units with common spare feeder with Filter Aid System	a. Drum storage b. Polymer blending units c. Drum scale d. Drum mixer	4 2 1 1	Polymer Room
Filter Aid Polymer Direct drum fed liquid polymer blending units with common spare feeder with Coagulant Aid System	a. Drum storage b. Polymer blending units c. Drum scale d. Drum mixer	1 1 1 1	Polymer Room
Ammonia Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 8,000-gal. pressure CS b. Transfer pumps, 125 gpm c. Day tanks; 150-gal. pressure CS d. Diaphragm metering pumps e. Water softener for chase water	1 2 1 2 1	Ammonia Room

Chemical System	Feed Equipment	No.	Location
Fluoride Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 6,000-gal. b. Transfer pumps, 30 gpm c. Day tanks; 150-gal. d. Diaphragm metering pumps	1 2	Fluoride Room
Corrosion Inhibitor Bulk storage with semi-auto transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 5,000-gal. b. Transfer pumps, 30 gpm c. Day tanks; 150-gal. d. Diaphragm metering pumps	1 2	Corrosion Inhibitor Room
Sodium Thiosulfate Bulk storage with manual transfer system to day tank and two chemical feed pumps	a. Bulk tanks; 5,000-gal. b. Transfer pumps, 25 gpm c. Day tanks; 50-gal. d. Diaphragm metering pumps	1 1 1 2	Sodium Thiosulfate Room
Wastewater Polymer	a. Drum storage b. Polymer blending units c. Drum scale d. Drum mixer	2 2 1 1	Polymer Room
Dewatering Polymer	a. Bulk tank; 6,300-gal. b. Recirculation pump c. Transfer pump d. Day tank, 100-gal. e. Spare pump	1 1[3] 1[3] 1 1	Residuals Dewatering Building Residuals Dewatering Building, not installed

[1]Pumps to be sized so that two pumping together will provide the maximum feed rate
[2]Tank to be designed for storing either coagulant or alternate coagulant.
[3]Recirculation pump and transfer pump to be piped to allow both pumps to be used for either purpose.

9.0 Pretreatment

A. Design Concept

Provide a two stage vertical turbine type flash mixer to disperse pre-treatment chemicals into the process stream, three-stage tapered flocculation, and plate settler clarification to provide settling of the flocculated materials.

B. Regulatory Design Criteria (Kentucky DOW and Ten State Standards, 2003 Edition)

1. Flash mixing
   - a. Number — 2
   - b. Detention time, seconds — <30
2. Flocculation
   - a. Number — N+1
   - b. Detention time, minutes — >30
   - c. Horizontal velocity, fps — >0.5, <1.5
   - d. Mixer peripheral paddle speed, fps — >0.5, <3.0
3. Plate Settler Sedimentation
   - a. Surface loading rate, gpm/sf of projected plate surface area — <0.5 at 80% efficiency

C. Flash Mixing

1. Description

   Two stage rapid mixing basins, with vertical turbine mixers
2. Type mixer — Vertical turbine
3. Number — 2
4. Number of impellers, each shaft — 2
5. G value, sec^{-1} at 0.5 degrees centigrade — 1,000
6. Detention time, seconds
   - a. Minimum flow, 4.0 mgd — 38 (with one mixer out of service)
   - b. Winter average flow, 6.0 mgd — 26 (with one mixer out of service)
   - **c. Summer average flow, 18.33 mgd, two basins in service — 16.4**
   - **d. Maximum flow, 25.0 mgd, two basins in service — 12**

e. Ultimate flow, 30.0 mgd, two basins in service — 10

7. Basin dimensions

a.	Width, feet	5.0
b.	Length, feet	5.0
c.	Depth, mixing zone, feet	9.5
d.	Effective mixing volume, cubic feet	238
e.	Influent pipe diameter, feet	3.5
f.	Lower level influent/effluent zone depth, feet	4.5
g.	Upper level influent/effluent zone depth, feet	4.0
h.	Total depth, feet	28.5

8. Chemical feed points
    a. Chlorine, upstream of the rapid mixers
    b. Caustic soda, upstream of the rapid mixers
    c. Coagulant and alternate coagulant
    d. Coagulant aid polymer

9. Motor

a.	Horsepower, HP	20
b.	Speed control	variable frequency drive

10. Controls
    a. Local manual speed control from variable frequency drives located in adjacent electrical room
    b. Start / stop control at VFD, mixer, and Distributed Process Control System (DPCS)
    c. Speed control at VFD and DPCS
    d. Drive status and run time monitored via DPCS
    e. Automatic speed control based on raw water temperature

11. Design concepts
    a. Mixers to be outside with no superstructure
    b. Chemical feed lines to penetrate basin walls from inside plant, above normal water surface
    c. Top of mixer to be open with UV resistant FRP grating with steel support structure.

d. Provide slot openings in outside wall for overflow.

e. Rapid Mixer No. 1 to flow from low to high; Rapid Mixer No. 2 to flow from high to low. Normal flow in series.

D. Flocculation

1. Influent Flume

a. Lower level influent channel with influent flume on top

b. Dimensions, ft

1) Width 4.0

2) Depth

a) Lower level channel 7.8

b) Sidewater depth, upper flume 6.8±

c. Mud valves between lower channel and upper flume

1) Design for head loss to accommodate flow split to each of four basins. Design for initial capacity, with consideration of potential future high rating.

2) Number per flocculator 2

3) Diameter, inches 18

d. Provide UV resistant FRP grating on top of flume for access.

e. Include provisions for cleaning and draining lower channel and upper flume

2. Process Units

a. Number **5**

b. Flow per basin, mgd

	All Units in Service	**One Unit Off-Line**
Minimum	**0.8**	**1.0**
Winter Average	**1.2**	**1.5**
Summer Average	**3.67**	**4.58**
Maximum	**5.0**	**6.25**

c. Description

1) Three stage basins with ported baffle walls separating each stage, and two parallel compartments per stage. Each

compartment to have one horizontal paddle wheel assembly oriented parallel to flow.

d. Flocculation stages per basin — 3

e. Overall Dimensions, ft.

1) Width

a) Total — 30.0

b) Each parallel flocculation compartment — 14.7

2) Total length, excluding baffle walls — 47.5

3) Sidewater depth — 14.7

4) Flocculation stage length, each — 15.8

f. Volume per basin, gal.

1) Each flocculation compartment — 25,500

2) Each stage — 51,000

3) Total — 153,000

g. **Detention time, min.**

	All basins in service	**One basin out of service**
Minimum Flow	**275**	**220**
Winter Average Flow	**184**	**147**
Summer Average Flow	**60**	**48**
Maximum Flow	**44**	**35**

3. Mixing

a. G-Values, $seconds^{-1}$

1) Stage 1 — 75

2) Stage 2 — 50

3) Stage 3 — 35

b. Mixers

1) Type — horizontal reel

2) Shaft and paddle orientation to flow — parallel

3) Drives

a) Variable frequency drive speed control

b) One drive for both Stage 1 mixers

c) One drive common to all Stage 2 and Stage 3 mixers per basin

c. Controls

1) Local manual speed control from variable frequency drives

2) Start / stop control at VFD, flocculator drive, and DPCS

3) Drive status and run time monitored via DPCS

4) Automatic speed control based on setpoint G-value and water temperature via DPCS

4. Baffle Walls

a. Type — Ported

b. Material — Concrete

c. Velocity gradient through ports, $seconds^{-1}$

1) Influent — 75

2) Stage 1 effluent — 60

3) Stage 2 effluent — 45

4) Stage 3 effluent — 15

d. Install flow diffusers on Stage 3 effluent openings

5. Appurtenances

a. Drain via slide gate connection to sedimentation basins

E. Plate Settler Sedimentation

1. Number of settling basins — **5**

2. Flow per basin, mgd

	All Units in Service	One Unit Off-Line
a. Minimum	0.8	1.0
b. Winter Average	1.2	1.5
c. Summer Average	3.67	4.58
d. Maximum	5.0	6.25

3. Basin dimensions - each, ft

a. Width — 30.50

b. Length — 36.08

c. Sidewater depth 19.00

4. Volume - each basin

a. Cubic feet 20,900

b. Gallons 156,000

5. Detention time, min.

	Flow Rate (mgd)	All Units in Service (minutes)	One Unit Off-line (minutes)
a. Minimum	**4.0**	**280**	**224**
b. Winter Average	**6.0**	**187**	**150**
c. Summer Average	**18.33**	**61**	**49**
d. Maximum	**25.0**	**45**	**36**

6. Plates (based on MRI plates with effluent troughs on side)

a. Number

1) Rows per basin 5

2) Packs per row 2

3) Plates per pack 50

4) Total plates per basin 500

5) Total plates 2,000

b. Dimensions

1) Plate width, ft 4.5

2) Plate length, ft 10.0

c. Angle of incline, deg. 55

d. Effective surface area, % 80

7. Surface area, sf

a. Projected surface area per plate 25.81

b. Effective surface area per plate (at 80% efficiency) 20.65

c. Effective surface area per basin 10,324

d. Total 51,620

8. Plate surface overflow rate, gpm/sf

	Flow Rate (mgd)	All Units in Service (gpm/sf)	One Unit Off-line (gpm/sf)
a. Minimum	**4.0**	**0.05**	**0.07**
b. Winter Average	**6.0**	**0.08**	**0.10**
c. Summer Average	**18.33**	**0.25**	**0.31**
d. Maximum	**25.0**	**0.34**	**0.42**

9. Sludge Collection

a.	Type	Hoseless vacuum sludge collection and motor operated plug valves
b.	Number of units per basin	2
c.	Discharge flow per basin, gpm	250
d.	**Total discharge flow, all basins, gpm**	
	a. 25 mgd	**1,250**
	b. 30 mgd	**1,500**

10. Appurtenances

a.	Inclined plates, system supports, and hardware	Stainless steel

11. Influent velocity between plate rows

a.	Maximum, fps	0.5

12. Effluent trough velocity

a.	Maximum, fps	2.0

13. Operation controls

    a. Sludge blowdown control

    Provide local manual control on valves in pipe gallery. Provide remote manual control via SCADA. Provide automatic control via SCADA. In automatic mode, operation of blowdown valves will be time based for interval and duration.

F. Monitoring and Control

1. Streaming current detector (downstream of mixer)
2. pH analyzer (downstream of mixer)
3. Mixed sample pumped to lab; include manual tap at sample location.
4. Settled water turbidimeter - each basin

10.0 Filtration

A. Design Concept

Dual media filters with silica sand and anthracite are to be constructed. The filters shall be designed with adequate depth to install granular activated carbon in lieu of anthracite in the future, if necessary, for taste and odor control. Each filter is designed with adequate area so as not to exceed the maximum surface loading rate assuming one filter is out of service. Future expansion from the WTP design capacity of **25 mgd** to 30 mgd may, however, be accomplished by high rating the filters. Therefore, piping shall be designed for possible high rating. Structural provisions shall also be included for future filters.

Water will flow from the sedimentation basins to the filters through a flume. The flume will be configured with a center wall to form a serpentine flow path and a single location for application of filter influent chemicals. An overflow will be provided in the flume. Provisions will be included to manually clean the flume.

The filters shall be designed in accordance with the Ten States Standards 2003 Edition

B. Regulatory Design Criteria (Kentucky DOW and Ten State Standards (2003 Edition))

1. Maximum surface loading rate, gpm/sf	5
2. Number of units	>2
3. Minimum depth, feet	>8.5
4. No structural cross connections	
5. Maximum horizontal wastewater travel to trough, feet	3
6. Media depth, inches	>24
7. Media size	
a. Silica sand, mm	0.45 to 0.55 D_{10} and D_{60}/D_{10} <1.65
b. Anthracite, mm	0.80 to 1.20 D_{10} and D_{60}/D_{10} <1.85

C. Filter Sizing

1. Type of filter	Dual cell rapid gravity filter with dual media
2. Number of filters	
a. Structures	7
b. Equipped	**6**
3. Maximum surface loading rate with one filter out of service, gpm/sf	5.0

4.	Filter box material				Cast in place concrete
5.	Filter dimensions				
	a.	Surface area, sf			
		1)	Each filter unit (total of 2 cells)		702
		2)	**Total equipped**		**4,212**
	b.	Filter dimensions, filter area only			
		1)	Length, ft		27
		2)	Width per cell, ft		13
		3)	Depth, inches (Bottom of filter El. 745)		
			a)	Underdrain	6±
				(Alternate 12 inches, ±)	
			b)	Media	
				(1) Support Gravel (Alternate media support cap with 3" torpedo sand)	12
				(2) Silica sand	12
				(3) Anthracite	18
				(4) Additional depth for GAC (Total future GAC media depth of 54", >10 minute empty bed contact time, with all filters in service at average flow; with 6" of sand)	30
			c)	Depth - media to bottom of trough	
				(1) 30" sand and anthracite (initial)	71
				(2) 60" deep bed configuration (50% Expansion)	41
			d)	Trough depth	21
			e)	Water depth above trough (>8 feet to sand anthracite interface)	18
			f)	Free board	34
		4)	Filter depth, ft.		16.0

6. Filter media characteristics

a. Filter media

Type of Media	Depth (inch)	Effective Size (mm)	Uniformity Coefficient
1) Anthracite	18	0.95 to 1.05	≤1.4
2) Silica sand	12	0.45 to 0.55	≤1.4

7. **Filtration rate**

	Plant Flow (mgd)	Surface Loading Rate (gpm/sf)	
		All Filters In Service	One Filter Off-line
1) Minimum	**4.0**	**0.66**	**0.79**
2) Winter Average	**6.0**	**0.99**	**1.19**
3) Summer Average	**18.33**	**3.02**	**3.63**
4) Maximum	**25.0**	**4.12**	**4.94**

8. Filter Underdrain System

a. Low profile water only underdrain

b. Air System — Fixed air grid

9. Filter Washwater Troughs

a. Design flow (25 gpm/sf x 1 cell at 351 sf), gpm — 8,780

b. U-shape fiberglass trough

c. Approximate dimensions, inches

1) Width — 18

2) Depth — 21

d. Number per filter cell — 4

10. Overflow protection

Provide filter box overflow openings between filter and influent flume

11. Filter Control and Monitoring

a. Filter flow equally split among online filters while maintaining constant influent level

b. Total loss of head transmitter with high alarm for each filter

c. Flow meter/transmitter for each filter – venturi

d. Effluent turbidimeters with high alarm for each filter

e. Effluent particle monitor, each filter

f. Turbidimeter for combined filter effluent

g. Common filter effluent sample piped to lab; with manual sample tap

h. Common filter influent sample piped to lab; with manual sample tap

i. Common filter influent turbidimeter

j. Combined filter influent level transmitter

k. Filter backwash program

    1) Auto or manually initiated on:

        a) Loss of head

        b) Filter effluent turbidity

        c) Time

k. Filter control stations

    1) Single local control station with touch screen interface

    2) Main control station in main control room

    3) Manual via individual valves

l. Motor operated control valves

1)	Influent (maximum velocity 2.0 fps)	30-inch BFV
2)	Wash (25 gpm/sf and < 6.5 fps)	24-inch BFV
3)	Waste (25 gpm/sf)	30-inch BFV
4)	Air (3 scfm/sf and < 3000 fpm)	8-inch BFV
5)	Effluent (< 6.5 fps)	16-inch BFV
6)	Filter to waste (< 6.5 fps)	16-inch BFV

m. Discharge filter to waste into common header and discharge to drain with air gap located outside

n. Filter level transmitter for backwash sequencing

o. Filter backwash turbidimeter, each filter

12. Filter backwash system

    a. Method - Air scour and upflow water wash, sequential or combined

b. Backwash design (Wash one half filter in sequence)

1) Design for collapse pulse concurrent air water wash

2) Design for 30% expansion during high wash using D_{90} particle size and 30 degree centigrade backwash water temperature.

3) Design for concurrent air water wash flow at 50% minimum fluidization velocity

4) Design for future 25 gpm/sf wash flow for GAC media (8,775 gpm).

5) Source of backwash water -finished water from clearwell directly via backwash pumps, one duty, one standby

6) Backwash water supply line provided with coagulant feed point for feed of coagulant during second low wash cycle.

7) Typical backwash rates under warm water conditions

		30 degrees centigrade	
	Time (Minutes)	**Wash Rate (gpm/sf)**	**Flow Rate (gpm)**
a) Air scour (overlap low wash rate)	5	3 scfm/sf	1,053 scfm
b) Concurrent air water low rate wash	4	5	1,755
c) High rate wash	6	20	7,020
d) Low wash rate	4	5	1,755

c. Air Scour Blower

1) Air flow rate, scfm/sf — 3

2) Blower capacity, scfm — 1,053

3) Discharge pressure, psig — 6.0

4) Discharge pipe, inches (less than 3,000 fpm) — 8

5) Horsepower — 60

6) Number — 1, plus space for 1 future

7) Locate in High Service Pump Station

8) Controls

   a) Air flow meter

   b) Pressure switches; high, low, normal

C. Filter Influent Flume

1. Maximum velocity, fps (at ultimate flow) <2.0

D. Other Features

1. Full superstructure covering filters and control room.
2. Filter cells enclosed in room separate from control floor.
3. Filter influent flume overflow weir with discharge to wastewater facilities.
4. Provide lighting and ventilation in the filter area and filter operating floor.
5. Provide dehumidification in the filter pipe gallery.
6. Provisions to clean influent flume.

E. Chemical Feed

1. Filter influent - feed between sedimentation basin effluent flume and filter influent flume
   a. Chlorine
   b. Filter aid polymer
   c. Caustic soda
2. Filter effluent - feed in combined filter effluent pipe, after future UV connections
   a. Chlorine
   b. Caustic soda
   c. Ammonia
   d. Fluoride
3. Provide access hatch above filter influent chemical feed points
4. Provide base and mid level diffusers to mix filter influent chemicals

11.0 Disinfection CT and Additional Removal/ Inactivation of Pathogens

A. Description

Current regulations will require that treatment techniques be provided and operated for surface water sources to achieve the following levels of disinfection as a minimum:

- 3-log *Giardia* removal/ inactivation
- 4-log virus inactivation
- 3-log *Cryptosporidium* removal/inactivation

The clarification-filtration process is designed with the capability to meet the following filter effluent turbidity requirements:

- Less than 0.3 NTU combined filter effluent turbidity in 95% of the samples recorded every 4 hours on a monthly basis

The clarification-filtration process is also designed with the capability to exceed the filter effluent turbidity requirements in order to attain 1 additional log removal credit in accordance with the LT2ESWTR:

- Less than 0.15 NTU combined filter effluent turbidity in 95% of the samples recorded every 4 hours on a monthly basis
- Less than 0.15 NTU individual filter effluent turbidity in 95% of the samples recorded on a monthly basis

In doing so, the following disinfection credit is acknowledged by regulation:

- 3.5-log *Giardia* removal
- 4.0-log *Cryptosporidium* removal (3 log by filtration and 1 log via clarification)

The chemical disinfection system is designed with the following capability to meet the remaining disinfection requirement under normal operations when filtration performance achieves the turbidity requirements.

- 1.0-log *Giardia* inactivation with free chlorine, with contact time in the clearwell
- 4.0-log virus inactivation with free chlorine, with contact time in the clearwell

The LT2ESWTR may increase the disinfection requirements for *Cryptosporidium* if source water monitoring results in classification greater than Bin 2, so it is necessary to design options for increasing the removal and inactivation of this pathogen. The actual level of disinfection required will be determined based upon the bin classification of the source water following 24 months of source water sampling for *Giardia*, *Cryptosporidium*, and E. Coli. If needed, additional *Cryptosporidium* and *Giardia* disinfection capability may be provided by future UV disinfection.

To assure compliance with future regulations, the facility will be designed with provisions to provide future additional log inactivation as follows:

- 3.0-log *Giardia* inactivation by UV
- 3.0-log *Cryptosporidium* inactivation by UV

The design will assure the capability of achieving a total of 3.0-log *Giardia* inactivation in the event of filter failure by disinfection with free chlorine through the entire process train and clearwell. A pre-chlorine chlorinator will be supplied to allow chlorine feed rates in excess of normal operating levels. Ammonia will typically be fed at the end of Clearwell No. 2, to form chloramines for carrying residual through the distribution system, with free chlorine residual carried through the clearwells. There are provisions to allow ammonia to be fed at the beginning of Clearwell No. 1 or the beginning of Clearwell No. 2, to minimize DBP formation when water quality and flows will allow the required *Giardia* and virus disinfection to be met with chloramine in one or both of the clearwells.

Disinfection contact time calculations are included in Appendix B.

B. Disinfection Contact Time (CT)

1. Normal operations, post-filtration CT

a.	Minimum *Giardia* inactivation required	1.0-log
b.	Worst-Case Disinfection CT conditions	
	1) pH	8.0
	2) Temperature, °C	0.5
	3) Minimum free chlorine residual, mg/L	2.0
c.	Clearwell baffle factor	0.7

d. Disinfection CT required, mg-min/L

1)	Worst case condition	116

e. Effective clearwell volume required for disinfection, gal.

1)	**25 mgd capacity**	**1,007,000**
2)	**30 mgd capacity**	**1,208,000**

f. Gross clearwell volume required for disinfection based on 0.7 baffle factor

1)	**20 mgd capacity, gal.**	**1,439,000**
2)	**30 mgd capacity, gal**	**1,726,000**

2. Operations with CT capability through entire process

a. Minimum temperature, °C — 0.5

b. Maximum pH

1)	Pre-treatment and filters	8.0
2)	Clearwell	8.0

c. Chlorine Residual, mg/L

1)	Pre-treatment processes	2.5
2)	Filters	3.5
3)	Clearwell	3.7

d. Baffle Factor

1)	Flocculation Basins	0.5
2)	Clarification Basins	0.5
3)	Filters	0.7
4)	Clearwell	0.7

e. **Volume - total, gal.**

1) **Flocculation Basins** **765,000**

2) **Clarification Basins** **337,000**[1]

3) **Filters** **283,000**[2]

4) **Clearwell** **1,971,000**[3]

f. **Effective Detention Time, min.**

	Flocculation Basins	Clarification Basins	Filters	Clearwell	Total
Minimum Flow	138	60	71	496	765
Winter Average Flow	92	40	47	331	510
Summer Average Flow	30	13	15	154	212
Maximum Flow	22	10	11	79	122

g. **Disinfection CT, mg-min/L**

	Flocculation Basins	Clarification Basins	Filters	Clearwell	Total
Minimum Flow	345	150	248	1,835	2,578
Winter Average Flow	230	100	164	1,224	1,718
Summer Average Flow	75	32	52	569	728
Maximum Flow	55	25	38	292	410

h. *Giardia* Inactivation, log inactivation

	Flocculation Basins	Clarification Basins	Filters	Clearwell	Total
Minimum Flow	2.83	1.25	2.08	14.44	20.60
Winter Average Flow	1.89	0.83	1.38	9.63	13.73
Summer Average Flow	0.62	0.27	0.45	3.15	4.49
Maximum Flow	0.45	0.20	0.33	2.31	3.29

[1] Clarifier CT is based on the volume from the water surface to the bottom of the plates, where clarification primarily occurs. The area below the plates is predominantly a sludge settling zone.
[2] Does not include media and underdrain volume.
[3] **Using a water depth of 18.00 feet to allow for volume reduction for filter backwash water.**

12.0 UV Disinfection(Future)

A. Description

Space is provided for future installation of a ultraviolet (UV) disinfection facility within the WTP. The ultraviolet (UV) disinfection facility is provided to assure a disinfection system capable of meeting or exceeding LT2 ESWTTR requirements for pathogen inactivation and removal. The UV system will be designed to generate the design dose under maximum flow conditions, with minimum UV transmittance and one unit out of service. It will be capable of being expanded or replaced to treat the ultimate flow of 30.0 mgd.

Current design should consider hydraulic, electrical, and space requirements for locating the future units in a separate UV area treating the combined filter effluent.

B. UV Disinfection Criteria

1. *Cryptosporidium*	3.0-log inactivation

C. Facility Design Criteria

1. Capacity of system, mgd	
a. Initial	**25**
b. Ultimate	30
2. Number of reactors	N+1
3. UV transmittance, %	90
4. UV dose, mJ/cm^2	42
5. Maximum head loss through each unit, feet	2.0
6. Lamp cleaning rate	adjustable

D. Appurtenances

1. Valves
    a. Isolation valves
2. Flow monitoring – Sum of filter effluent meters
3. Ballasts
4. PLC controls with connectivity to the Process Control and Monitoring System (PCMS)

5. Provisions for equipment removal

13.0 Finished Water Storage

A. Concept

A clearwell located on the plant site partially below the filters will provide finished water storage for disinfectant contact time (CT), filter backwash water and pump flow equalization. Distribution system operating storage will be provided in additional storage along the proposed transmission route. The clearwell will have two cells in series with interior baffles to minimize short-circuiting and maximize the effective CT. The CT criteria for clearwell sizing includes volume for 1.0-log inactivation of *Giardia* cysts.

B. Disinfection CT

1. Disinfection Conditions (worst-case)	
a. pH	8.0
b. Water temperature, °C	0.5
c. Minimum free chlorine residual, mg/L	2.0
d. Flow rate, mgd	**25.0**
2. Baffling	
a. Length-to-width ratio	**80:1**
b. Baffling factor	0.7[1]
3. Requirements for1.0-log *Giardia* inactivation under worst-case conditions	
a. Minimum CT, min-mg/L	116
b. Effective volume, gal	**1,007,000**
c. Total volume, gal	**1,439,000**

C. Filter backwash water

1. Volume per filter (25 gpm/sf for 10 minutes and 6 gpm/sf for 10 minutes), gal.	217,600

[1] Based on research presented in AWWARF's "Improving Clearwell Design for CT Compliance", 1999.

D. Pump Equalization Storage (>2.0 feet of clearwell depth) 175,200

E. Clearwell Design

1. **Volume, gal.**

a.	**Disinfection CT**	**1,439,000**
b.	**Filter backwash**	**217,600**
c.	**Equalization**	**533,400**
d.	**Total design capacity**	**2,190,000**

2. **Interior Dimensions**

a.	**Cells**	**2**
b.	**Length, feet**	**134.5**
c.	**Width – each cell, feet**	**54.42**[1]
d.	**Side water depth, feet**	**20**

3. Construction Materials

a.	Walls and floor	concrete, cast-in-place
b.	Roof	concrete, pre-cast or cast-in place
c.	Baffle walls	Concrete
d.	Roof liner	waterproof membrane

4. Controls
   a. Ultrasonic level transmitter, each cell
   b. High level alarm based on level switch, each cell

5. Appurtenances
   a. Overflow
   b. Access hatches and ladders
   c. Vents

6. Chemical Feed Points - Between Clearwell No. 1 and Clearwell No. 2
   1) Chlorine
   2) Ammonia

7. Sample Point - Between Clearwell No. 1 and Clearwell No. 2
   1) Provide one pump to draw sample either from this point or the clearwell effluent, depending on manual valve settings

[1] Does not include baffle wall width.

14.0 Finished Water Pumping

A. Description

Four finished water and two washwater pumps will be housed in the High Service Pump Station. The filter backwash air blower will also be located in the High Service Pump Station. All pumps will be vertical turbine configuration. Each pumping system will be sized to provide required pumpage with the largest unit out of service.

2. Finished Water Pumps

a. Type — Vertical turbine with hard piped suction

b. Number — 5

c. Total dynamic head (TDH) — 324

d. Overall pumping requirements, mgd

1) Minimum Flow — 4

2) Winter Average Flow — 6

3) Summer Average Flow — 15

4) Maximum Flow — 20

5) Ultimate Flow — 30

6) Firm Capacity, largest unit out of service

i) Initial design — 24

ii) Ultimate design — 30

e. Pump design criteria

	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Pump No. 5
Type	Vertical Turb.	Vertical Turb.	Vertical Turb.	Vertical Turb.	**Vertical Turb.**
Rated Capacity (MGD)	10	10	7	7	**6**
Rated Head (feet)[1]	324	324	324	324	**324**
Motor Horsepower (HP)	700	700	500	500	**500**
Nominal Motor Speed	1200	1200	1200	1200	**1200**
Motor Voltage	4160	4160	4160	4160	**4160**
Constant Speed or VFD	VFD	VFD	Constant	Constant	**Constant**
Discharge Diameter (inches)	20	20	12[1]	12[1]	**12[1]**
Discharge Centerline Elevation (feet)	745.50	745.50	745.50	745.50	**745.50**

[1]Increase to 20-inch upstream of isolation valve for future pump change-out to larger capacity

1) **Pump design to provide a flow continuum from 4 mgd to 30 mgd based on pump selected and speed control**

2) Motors - 4160 V, 3 phase, 60 hz motors

3. Pump discharge

a.	Discharge maximum velocity, fps	8
b.	Manifold maximum velocity, fps	5
c.	Material	flanged ductile iron
d.	Appurtenances	
1)	Vacuum/air release valve	
2)	Pressure gauge, psi range	0-200[1]
3)	Check valves	
a)	High Service Pump Nos. 1 and 2	tilting disk
b)	High Service Pump Nos. 3 and 4	Hydraulic ball type
4)	Isolation valve	Butterfly
5)	Surge facilities	Surge anticipator valve
6)	Pressure switches, each discharge header	
a)	Normal	
b)	High	

4. Pump discharge manifold appurtenances
   a. Appurtenances
      1) Pressure transmitter
      2) Finished water meter and flow transmitter

5. Appurtenances for pump station
   a. Finished water sample to laboratory and analyzers
   b. Finished water analyzers
      1) pH meter
      2) Temperature transmitter
      3) Ammonia analyzer
      4) Free chlorine analyzer

[1] Confirm maximum pressure exceeds shut off pressure rating of the hydraulic ball type check valve

    5) Monochloramine/ total chlorine analyzer
    6) Fluoride analyzer
    7) Turbidimeter
    8) Phosphate analyzer

c. Monorail and hoist or traveling bridge crane

d. Temperature controlled environment as required for variable frequency drives

e. Rollup or other suitable removable door or window openings large enough to pass pump and motor components

f. Finished water chemical feed points - after point of washwater withdrawal

    1) Chlorine
    2) Caustic soda
    3) Fluoride
    4) Ammonia
    5) Corrosion Inhibitor

16.0 Flow Metering

A. Design Concept

All flows into and out of the plant are to be metered for accounting. Filter, washwater, and air wash flows are to be metered for process control.

B. A listing of expected flows to be monitored follows:

Description	**Quantity and Max. Flow**	**Type**	**Function**	**Location**
Raw Water	1 — 24 mgd **1 – 6 mgd parallel meter**	Magmeter	Measure raw water	Raw Water Meter Chamber
Filter Effluent	5 - 7.5 mgd	Venturi	Measure filter effluent and rinse flow	WTP - Filter Pipe Gallery
Filter Washwater	1 – 9,000 gpm	Venturi	Measure filter washwater flow	WTP – High Service Pump Station
Filter Air Wash	1 - 1,100 scfm	Pitometer	Measure filter wash air flow	WTP - High Service Pump Station
Plant Effluent	1 - 24 mgd **1 – 6 mgd parallel meter**	Venturi	Measure finished water flow to system	WTP – High Service Pump Station
Clarified Wastewater	1 - 6,000 gpm	Magmeter	Measure wastewater discharge	Wastewater Pumping Station
Sludge Blowdown	**1 – 2,000** **1 -1,000**	**Magmeter**	**Measure sludge blowdown for flowsplit**	**Wastewater Pumping Station**
Plant Service	1 – 900 gpm	Turbine	Measure plant service	WTP - High Service Pump Station

18.0 Process Wastewater and Residuals

A. Description

The wastewater treatment system will include two circular batch wastewater clarifiers for filter backwash and rinse water, **two** residuals thickeners for clarifier blowdown sludge, and a residuals dewatering facility. The filter backwash and rinse water will be directed to the active wastewater clarifier. The supernatant decanted from the wastewater clarifiers will be pumped to the Kentucky River, while the wastewater clarifier settled sludge will be directed to the sludge **thickeners.** Sludge from the **thickeners** will be pumped to the dewatering facility. Thickener supernatant will be pumped to the Kentucky River. Thickened residuals will be dewatered and land applied onsite. Filtrate from the dewatering process will flow by gravity the thickener.

The primary components proposed for residuals waste handling are depicted on Exhibit 2- Wastewater Process Flow Diagram. Detailed design data and computations related to residuals production and process unit sizing are included in Appendix C.

B. Residual Sources

1. Residual solids
   a. Suspended solids in the raw water
   b. Oxidation and precipitation of iron and manganese in the raw water
   c. Treatment chemicals
      1) Powdered Activated Carbon
      2) Coagulant
      3) Polymers
2. Process Wastewater
   a. Overflow of process basins
   b. Drainage from process basins
   c. Filter backwash wastewater
   d. Filter to waste (rinse)
   e. Sedimentation basin blowdown sludge
      1) Expected sludge solids concentration
         a) At average solids production 1.0%
         b) At maximum solids production 2.0%

f. Sample line discharges

g. Laboratory sample streams

C. Design Concept

1. Sanitary waste is to be collected separately from process wastes and sent to the sanitary system. A separate system will be provided for disposal of laboratory chemically contaminated wastes.

2. Filter backwash water and filter rinse water are to be directed to the wastewater clarifiers. These discharges will be piped separately to a common point outside the building where an air gap will be provided to protect the rinse system from backflow from the wastewater drain system. Each of the two basins will be sized to hold the wastewater from one filter backwash and rinse, with an additional 2-foot deep solids settling zone at the bottom. The solids will be settled and removed with a circular sludge collection system and pumped to the thickeners. Following settling, the supernatant is to be pumped to the Kentucky River.

3. Clarifier blowdown sludge will be discharged by gravity to the residuals thickener for equalization and settling. **A control valve and meter will be provided to split flow to the two thickeners.** Thickened sludge will be pumped to the dewatering system. Supernatant from the residuals thickener will be pumped to the Kentucky River. Clarified wastewater from the thickener and wastewater clarifiers will be de-chlorinated in the discharge main, which will be routed beside the WTP on the way to the river.

4. Drain water from the flocculators and clarifiers will be discharged to the wastewater clarifiers.

5. Filtrate and wash water from the dewatering building will flow by gravity into the residuals thickener.

6. When draining water from the clearwell for maintenance, this water will be pumped and discharged to a wastewater clarifier and pumped to the Kentucky River using the decant pumps.

7. Sample line discharges without analyzer chemical addition are to be directed to the wastewater clarifiers. Others will be sent to the sanitary system.

8. Plant floor drains will be sent to the sanitary system.

9. Valves and pumps for distribution of wastewater and residual flows will be located in a wastewater pumping station building common to the clarifiers and thickener.

D. Residuals Waste Handling Facilities

1. Wastewater Clarifiers

a. Type — Circular concrete tank with sludge scraper

b. Number — 2

c. Basin dimensions, each

1) Diameter, feet — 60

2) Side water depth, feet

a) Clarification zone — 12

b) Sludge settling zone — 2

c) Total — 14

3) Volume, gal.

a) Clarification — 253,800

b) Sludge settling zone — 42,300

c) Hopper (Slope 0.083 ft/ft) — 17,600

d) Total — 313,700

d. Supernatant collection and discharge

1) Provide decant lines at three elevations

2) Decanted water pumped to the Kentucky River

3) Clarified wastewater pumps

a) Number — 2

b) Type — horizontal centrifugal end suction

c) Capacity, gpm (253,800 gallons in 1.5 hours) — 2,820

d) Total dynamic head, ft — 48 (confirm upon final design)

e) Motor horsepower, HP — 50

f) Isolation valves — Rubber lined plug

g) Check valves — Rubber flapper, swing type

h) Pressure switches and gauges with diaphragm seals

i. Low

ii. Normal

iii. High

e. Other features

1) Decant instrumentation

a) Chlorine residual analyzer

b) Turbidimeter

c) pH analyzer

d) Flowmeter and flow transmitter

e) Pump and valve control based on basin level transmitter

f. Wastewater clarifier sludge transfer

1) Pumped to thickener

2) Isolation valves — Plug

3) Pipe size, inches — 8

2. Wastewater clarifier sludge transfer pumps

a. Number (one duty, one standby) — 2

b. Type — Centrifugal non-clog sewage type pump

c. Pump capacity, gpm (42,300 gallons in 1 hour) — 705

d. Total dynamic head, ft. — 13

e. Pump horsepower, HP — 5

f. Discharge pipe size, inches — 8

g. Isolation valves — Rubber lined plug

h. Check valves — Rubber flapper, swing type

i. Pressure switches and gauges with diaphragm seals — Low, normal, high

j. Pump and valve control based on basin level transmitter

3. Residuals Thickeners

a. Design Criteria

1) Solids loading, lb/sf/day — < 5.0

2) Hydraulic loading, gpm/sf — < 0.50

3) Provide storage for solids exceeding dewatering processing capacity during maximum 10-day event

b. Solids Production

1) Average day, lb/MG — 888

2) Average day at winter average flow (6 mgd), lb/day — 5,350

3) Average day at summer average flow **(18.33 mgd), lb/day** — **16,277**

4) Maximum day, lb/MG — 13,300

5) Maximum day at maximum flow **(30 mgd),** lb/day — **399,000**

c.	Required storage, gal.		**2,043,000**
d.	Dimensions		
	1)	Diameter, ft.	
		i. Thickener 1	**113**
		ii. Thickener 2	**80**
	2)	Sidewater Depth, ft.	22.50
	3)	Hopper slope, ft/ft	0.25
e.	Volume, gal.		
	1)	Straight-walled portion	
		i. Thickener 1	**1,688,000**
		ii. Thickener 2	**846,000**
	2)	Hopper	
		i. Thickener 1	**353,200**
		ii. Thickener 2	**125,300**
	3)	Total	
		i. Thickener 1	**2,041,000**
		ii. Thickener 2	**971,300**
	4)	Available for sludge storage[1]	
		i. Thickener 1	**1,338,000**
		ii. Thickener 2	**821,000**
f.	Surface area, sf		
		i. Thickener 1	**10,029**
		ii. Thickener 2	**5,027**
g.	Solids loading, lb/sf/day		5.0
h.	Flow (maximum day solids at maximum flow plus wastewater clarifier sludge transfer at 705 gpm), gpm		
		i. Thickener 1	**1,523**
		ii. Thickener 2	**761**
i.	Surface overflow, gpm/sf		0.15
j.	Thickener supernatant trough		

[1] Assumes 4' sludge settling zone at top of thickener.

1) Located along inside of thickener wall
2) Width, ft — 1.5
3) Maximum sidewater depth, ft — 4.0
4) Bottom elevation, ft — 731.75
5) Weir elevation, ft — 735.97
6) Volume, gal. — 15,720
   i. Thickener 1 — **15,720**
   ii. Thickener 2 — **11,200**
7) Trough provides equalization between thickener supernatant flow and thickener supernatant transfer pump flow

k. Thickened Sludge Transfer Pumps

1) **Number** — **4 (3 active, 1 spare)**
2) Type — Progressing cavity
3) Pump capacity, gpm — 200
4) Total dynamic head, ft. — 120
5) Motor horsepower, HP — 20
6) Motor drive — VFD
7) Discharge pipe size, inches — 3
8) Isolation valves — Rubber lined plug
9) Check valves — Rubber flapper, swing type
10) Pressure switches and gauges with diaphragm seals
   a) Low
   b) Normal
   c) High

l. Thickener Supernatant Pumps

1) **Number** — **4 (3 active, 1 spare)**
2) Type — horizontal centrifugal end suction
3) Capacity, gpm — 955
4) Total dynamic head, ft — 41 (confirm upon final design)
5) Motor horsepower, HP — 10
6) Motor drive — VFD

7) Isolation valves — Rubber lined plug

8) Check valves — Rubber flapper, swing type

9) Pressure switches and gauges with diaphragm seals

   a) Low

   b) Normal

   c) High

10) Pump speed and start/stop control based on effluent trough level

5. Residuals Dewatering Building

   a. See Section 22.0 for architectural treatment

   b. One story building

   c. Floor elevation, ft — 739.0

   d. Dewatered sludge conveyed from belt filter presses to truck located outside the building

   e. Equipment

      1) Belt filter presses

         a) **Number of units** — 3

         b) Minimum capacity per unit

            i) Lb/hr — 1,045

            ii) Gal/min — 100

         c) Solids concentration, %

            i) Influent — 1.2 - 5.5

            ii) Dewatered residuals, minimum — 20.0

         d) Include space and provisions for future addition of one additional belt filter press

         e) Provide additional 3 ft section at front of each press for gravity dewatering.

      2) Polymer feed system

         a) Feed polymer to the belt filter press influent

         b) Dose, active lb/ton dry solids — 8-14

         c) Provide hot water for polymer blending

      3) Provide conveyor transfer system to evenly distribute solids into bed of truck

a) Bed length, ft. 10

b) Truck type Ford F700 or International 4700

4) Provide water heater for polymer blending water and for cleaning presses.

a) Maximum temperature, °F 140

b) Consider on-demand heater

f. Provide connection for future transfer of thickened sludge from temporary sludge storage.

1) Diameter, inches 6

27.0 Conceptual Planning for Potential Future Facilities

1. The new WTP is being designed with a process capacity of **25 mgd** and hydraulic capacity of 30 mgd. Provisions are to be included to expand to 30 mgd. The following process expansion provisions shall be included.

   A. Extending flocculator influent flume to **one** more basin

   B. Constructing **one** new flocculation basin

   C. Constructing **one** more sedimentation basin with plate settlers.

   D. Installing additional plates in initial sedimentation basins to allow expansion or improve performance.

   E. **Equipping one new filter**

   F. Adding UV reactors, if required based on source water classification in accordance with LT2 ESWTR

   G. Replacement of anthracite filter media with GAC

Appendices

KENTUCKY AMERICAN WATER COMPANY

25 MGD WATER TREATMENT PLANT
AND RELATED FACILITIES

ADDENDUM 1

DESIGN MEMORANDUM

APPENDIX B

DISINFECTION CT CALCULATIONS

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description:
Select Contactor Type: Flocculation Basin

Select Disinfectant: Free Chlorine

Click box if basin is compartmented. ☑
Check box if basin is circular. ☐

Vessel Width (ft): 147
Vessel Depth (ft): 17
Vessel Length (ft): 47.5
Applied Baffling Factor: 0.5

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes Total (gal)	Volumes Effective (gal)	Volumes Allowed (gal)	Contact Time Calculated (min)	Contact Time Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT Provided (mg*min/L)	CT 3 log (mg*min/L)	Inactivation Provided CT Ratio	Inactivation Provided Logs
1			887895	0	0	0.0					0.00	0.00	0.00	0.00
2			887895	0	0	0.0					0.00	0.00	0.00	0.00
3			887895	0	0	0.0					0.00	0.00	0.00	0.00
4			887895	0	0	0.0					0.00	0.00	0.00	0.00
5			887895	0	0	0.0					0.00	0.00	0.00	0.00
6			887895	0	0	0.0					0.00	0.00	0.00	0.00
7			887895	0	0	0.0					0.00	0.00	0.00	0.00
8			887895	0	0	0.0					0.00	0.00	0.00	0.00
9			887895	0	0	0.0					0.00	0.00	0.00	0.00
10	17360	14.7	887895	766027	383013	22.1		2.50	8.0	0.5	55.16	364.79	0.15	0.45
11	12728	14.7	887895	766027	383013	30.1		2.50	8.0	0.5	75.23	364.79	0.21	0.62
12	4167	14.7	887895	766027	383013	91.9		2.50	8.0	0.5	229.79	364.79	0.63	1.89
13	2778	14.7	887895	766027	383013	137.9		2.50	8.0	0.5	344.68	364.79	0.94	2.83
14			887895	0	0	0.0					0.00	0.00	0.00	0.00
15			887895	0	0	0.0					0.00	0.00	0.00	0.00
16			887895	0	0	0.0					0.00	0.00	0.00	0.00
17			887895	0	0	0.0					0.00	0.00	0.00	0.00
18			887895	0	0	0.0					0.00	0.00	0.00	0.00
19			887895	0	0	0.0					0.00	0.00	0.00	0.00
20			887895	0	0	0.0					0.00	0.00	0.00	0.00
21			887895	0	0	0.0					0.00	0.00	0.00	0.00
22			887895	0	0	0.0					0.00	0.00	0.00	0.00
23			887895	0	0	0.0					0.00	0.00	0.00	0.00
24			887895	0	0	0.0					0.00	0.00	0.00	0.00
25			887895	0	0	0.0					0.00	0.00	0.00	0.00
26			887895	0	0	0.0					0.00	0.00	0.00	0.00
27			887895	0	0	0.0					0.00	0.00	0.00	0.00
28			887895	0	0	0.0					0.00	0.00	0.00	0.00
29			887895	0	0	0.0					0.00	0.00	0.00	0.00
30			887895	0	0	0.0					0.00	0.00	0.00	0.00
31			887895	0	0	0.0						Averages	0.48	1.45

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description:
Select Contactor Type: Sedimentation Basin

Select Disinfectant: Free Chlorine

Check box if basin includes intra-basin & outlet baffling. ☑
Check box if basin is circular. ☐

Vessel Width (ft): 152.5
Vessel Depth (ft): 18
Vessel Length (ft): 36.0833333
Applied Baffling Factor: 0.5

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes			Contact Time		Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT		Inactivation Provided	
			Total (gal)	Effective (gal)	Allowed (gal)	Calculated (min)	Tracer (min)				Provided (mg*min/L)	3 log (mg*min/L)	CT Ratio	Logs
1			740885	0	0	0.0					0.00	0.00	0.00	0.00
2			740885	0	0	0.0					0.00	0.00	0.00	0.00
3			740885	0	0	0.0					0.00	0.00	0.00	0.00
4			740885	0	0	0.0					0.00	0.00	0.00	0.00
5			740885	0	0	0.0					0.00	0.00	0.00	0.00
6			740885	0	0	0.0					0.00	0.00	0.00	0.00
7			740885	0	0	0.0					0.00	0.00	0.00	0.00
8			740885	0	0	0.0					0.00	0.00	0.00	0.00
9			740885	0	0	0.0					0.00	0.00	0.00	0.00
10	17360	8.2	740885	337103	168551	9.7		2.50	8.0	0.5	24.27	364.79	0.07	0.20
11	12728	8.2	740885	337103	168551	13.2		2.50	8.0	0.5	33.11	364.79	0.09	0.27
12	4167	8.2	740885	337103	168551	40.4		2.50	8.0	0.5	101.12	364.79	0.28	0.83
13	2778	8.2	740885	337103	168551	60.7		2.50	8.0	0.5	151.68	364.79	0.42	1.25
14			740885	0	0	0.0					0.00	0.00	0.00	0.00
15			740885	0	0	0.0					0.00	0.00	0.00	0.00
16			740885	0	0	0.0					0.00	0.00	0.00	0.00
17			740885	0	0	0.0					0.00	0.00	0.00	0.00
18			740885	0	0	0.0					0.00	0.00	0.00	0.00
19			740885	0	0	0.0					0.00	0.00	0.00	0.00
20			740885	0	0	0.0					0.00	0.00	0.00	0.00
21			740885	0	0	0.0					0.00	0.00	0.00	0.00
22			740885	0	0	0.0					0.00	0.00	0.00	0.00
23			740885	0	0	0.0					0.00	0.00	0.00	0.00
24			740885	0	0	0.0					0.00	0.00	0.00	0.00
25			740885	0	0	0.0					0.00	0.00	0.00	0.00
26			740885	0	0	0.0					0.00	0.00	0.00	0.00
27			740885	0	0	0.0					0.00	0.00	0.00	0.00
28			740885	0	0	0.0					0.00	0.00	0.00	0.00
29			740885	0	0	0.0					0.00	0.00	0.00	0.00
30			740885	0	0	0.0					0.00	0.00	0.00	0.00
31			740885	0	0	0.0					0.00	0.00	0.00	0.00
												Averages	0.21	0.64

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description:
Select Contactor Type: Filter

Select Disinfectant: Free Chlorine

Check box if basin is circular.
Media Volume (Gallons): 65637
Support Gravel Volume (Gallons): 26254.8
Underdrain Volume (Gallons): 13127.4
Vessel Width (ft): 156
Vessel Depth (ft): 15
Vessel Length (ft): 27
Applied Baffling Factor: 0.7

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes Total (gal)	Volumes Effective (gal)	Volumes Allowed (gal)	Contact Time Calculated (min)	Contact Time Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT Provided (mg*min/L)	CT 3 log (mg*min/L)	Inactivation Provided CT Ratio	Inactivation Provided Logs
1			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
2			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
3			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
4			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
5			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
6			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
7			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
8			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
9			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
10	17360	12.8	472586	299305	209513	12.1		3.50	8.0	0.5	42.24	381.52	0.11	0.33
11	12728	12.8	472586	299305	209513	16.5		3.50	8.0	0.5	57.61	381.52	0.15	0.45
12	4167	12.8	472586	299305	209513	50.3		3.50	8.0	0.5	175.98	381.52	0.46	1.38
13	2778	12.8	472586	299305	209513	75.4		3.50	8.0	0.5	263.97	381.52	0.69	2.08
14			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
15			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
16			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
17			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
18			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
19			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
20			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
21			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
22			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
23			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
24			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
25			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
26			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
27			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
28			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
29			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
30			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
31			472586	-105019	-73513	0.0					0.00	0.00	0.00	0.00
												Averages	0.35	1.06

System Name 0
System Number 0
Treatment Plant Name 0
Sequence Description: Clearwell
Select Contactor Type: Clear Well

Select Disinfectant: Free Chlorine

Check box if basin is circular. ☐

Vessel Width (ft): 13.5
Vessel Depth (ft): 20
Vessel Length (ft): 1084
Applied Baffling Factor: 0.7
State Assigned Baffling Factor: 0.7

Profile for: June-03

Date	Flow Rate (gpm)	Water Depth (ft)	Volumes Total (gal)	Volumes Effective (gal)	Volumes Allowed (gal)	Contact Time Calculated (min)	Contact Time Tracer (min)	Disinfectant Residual (mg/L)	pH	Temperature (°C)	CT Provided (mg*min/L)	CT 3 log (mg*min/L)	Inactivation Provided CT Ratio	Inactivation Provided Logs
1			2189246	0	0	0.0					0.00	0.00	0.00	0.00
2	17360	15.0	2189246	1641935	1149354	66.2		2.00	8.0	0.5	132.41	345.81	0.38	1.15
3	17360	15.0	2189246	1641935	1149354	66.2		2.35	8.0	0.5	155.59	359.30	0.43	1.30
4			2189246	0	0	0.0					0.00	0.00	0.00	0.00
5			2189246	0	0	0.0					0.00	0.00	0.00	0.00
6			2189246	0	0	0.0					0.00	0.00	0.00	0.00
7			2189246	0	0	0.0					0.00	0.00	0.00	0.00
8			2189246	0	0	0.0					0.00	0.00	0.00	0.00
9			2189246	0	0	0.0					0.00	0.00	0.00	0.00
10	17360	18.0	2189246	1970322	1379225	79.4		3.70	8.0	0.5	293.96	381.52	0.77	2.31
11	12728	18.0	2189246	1970322	1379225	108.4		3.70	8.0	0.5	400.94	381.52	1.05	3.15
12	4167	18.0	2189246	1970322	1379225	331.0		3.70	8.0	0.5	1224.65	381.52	3.21	9.63
13	2778	18.0	2189246	1970322	1379225	496.5		3.70	8.0	0.5	1836.98	381.52	4.81	14.44
14			2189246	0	0	0.0					0.00	0.00	0.00	0.00
15	4167	18.0	2189246	1970322	1379225	331.0		3.00	7.8	10	992.96	186.25	5.33	15.99
16			2189246	0	0	0.0					0.00	0.00	0.00	0.00
17			2189246	0	0	0.0					0.00	0.00	0.00	0.00
18			2189246	0	0	0.0					0.00	0.00	0.00	0.00
19			2189246	0	0	0.0					0.00	0.00	0.00	0.00
20			2189246	0	0	0.0					0.00	0.00	0.00	0.00
21			2189246	0	0	0.0					0.00	0.00	0.00	0.00
22			2189246	0	0	0.0					0.00	0.00	0.00	0.00
23			2189246	0	0	0.0					0.00	0.00	0.00	0.00
24			2189246	0	0	0.0					0.00	0.00	0.00	0.00
25			2189246	0	0	0.0					0.00	0.00	0.00	0.00
26			2189246	0	0	0.0					0.00	0.00	0.00	0.00
27			2189246	0	0	0.0					0.00	0.00	0.00	0.00
28			2189246	0	0	0.0					0.00	0.00	0.00	0.00
29			2189246	0	0	0.0					0.00	0.00	0.00	0.00
30			2189246	0	0	0.0					0.00	0.00	0.00	0.00
31			2189246	0	0	0.0								
												Averages	2.28	6.85

KENTUCKY AMERICAN WATER COMPANY

25 MGD WATER TREATMENT PLANT AND RELATED FACILITIES

DESIGN MEMORANDUM

ADDENDUM 1

APPENDIX C

RESIDUALS WASTE TREATMENT

I. Concept

A. General

Several process wastewater sidestreams will be generated at the proposed Kentucky River Pool 3 Water Treatment Plant (WTP) from various treatment processes and operations. The primary wastewater sources generated by the water treatment processes are the sedimentation basin sludge and filter backwash wastewater. Additional process wastewater sidestreams include sample sink and water quality analyzer drains, drainage and overflow from process basins, and certain plant floor drains.

Sludge collected from the sedimentation basins will flow by gravity to a sludge thickener. Provisions will be included in the piping to divert the sludge to a wastewater clarifier in case of maintenance required on the thickener. Two wastewater clarifiers will be provided at the plant site for filter backwash wastewater collection, settling and removal of the solids in the wastewater, and storage and discharge of the clarified wastewater to the Kentucky River. A residuals dewatering facility will dewater thickened residuals for beneficial use on the plant site or at a nearby site. A septic system will be provided for sanitary wastes, certain plant floor drains, and chemical contaminated wastes. A separate system will be provided for handling storm water.

B. Wastewater Treatment Process

The facilities proposed at the WTP to process wastewater include two wastewater clarification basins for the filter backwash and rinse water, a residuals thickener for sedimentation basin blowdown sludge and wastewater clarifier sludge, a wastewater pumping station, and a residuals dewatering facility. The operation of these facilities would be as follows:

1. Solids removed from the sedimentation basins will flow by gravity to the residuals **thickeners. A meter and flow control valve will be provided on each influent line to proportion flow.** 2. The filter backwash wastewater, filter to waste (rinse water), basin drains, sample sink drains and plant overflow will be directed to one of two wastewater clarifiers.

3. Intermittent draining of basins for maintenance will be scheduled on off-peak days and directed to the wastewater clarifiers.

4. The wastewater clarification basins will be operated in batch sequence. Each operating cycle includes filling, settling, sludge removal by pumping, and pumping clarified decant water to the river. The sludge removal step can be deferred until adequate solids have collected at the bottom of the basin.

5. The supernatant from the wastewater clarifiers will be metered and pumped to the top of the bluff and then will flow by gravity to the Kentucky River in a channel.

The settled sludge from the wastewater clarifiers will be pumped to the residuals thickener.

6. Supernatant from the residuals **thickeners** will be pumped to the top of the bluff along with the wastewater clarifier supernatant, flowing by gravity from the top of the bluff to the Kentucky River.

7. Residuals from the residuals **thickeners** will flow by gravity to the dewatering building, and will be treated by **three** belt filter presses. Dewatered residuals will be conveyed to a truck and then temporarily stored onsite or hauled to a beneficial reuse disposal site nearby. Filtrate will be returned to the thickeners.

8. The wastewater system will be controlled by a programmable logic controller (PLC) interfaced with the Supervisory Control and Data Acquisition (SCADA) system at the water treatment plant.

II. Solids Production

The solids generation rate is computed based on the expected raw water quality characteristics and pre-treatment chemical addition.

A. Average Solids removed from treated stream, mg/L

1.	Suspended solids (1.9 x avg. turbidity of 44 NTU)	83.6
2.	Iron oxides (iron oxidized by potassium permanganate) (2.64 x average Fe of 0.77 mg/L)	2.03
3.	Manganese oxides (manganese oxidized by potassium permanganate) (2.43 x average Mn of 0.24 mg/L)	0.58
4.	Polyaluminum chloride (0.274 x avg. dosage of 42 mg/L)	11.51
5.	Ferric chloride (1.0 x avg. dosage of 32 mg/L)	32.0
6.	Powdered activated carbon	0.50
7.	Filter aid polymer	0.05
8.	Coagulant aid polymer	0.38
9.	Theoretical average concentration based on historical water quality and assumed chemical feed rates, and application of PACL only	98.7
10.	Average concentration based on historical operating data from Kentucky River Station	106.5

B. Maximum Solids removed from treated stream mg/L

1.	Suspended solids (1.9 x max turbidity of 819 NTU)	1,560
2.	Iron oxides (iron oxidized by potassium permanganate) (2.64 x maximum Fe of 1.67 mg/L)	4.41
3.	Manganese oxides (manganese oxidized by potassium permanganate) (2.43 x maximum Mn of 1.10 mg/L)	2.67
4.	Polyaluminum chloride (0.274 x maximum dosage of 112 mg/L)	30.7
5.	Ferric chloride (1.0 x maximum dosage of 100 mg/L)	100
6.	Powdered activated carbon	25.0
7.	Filter aid polymer	0.10
8.	Coagulant aid polymer	0.50
9.	Theoretical maximum concentration based on historical water quality and assumed chemical feed rates, and application of PACL only.	1623.4

10. Maximum concentration based on historical operating data from Kentucky River Station 1596.3

C. Solids Production

Treated Flow (mgd)		Solids Production – pounds per day (ppd)	
		Average Solids (107 mg/L)	Maximum Solids (1,596 mg/L)
Minimum	4.0	3,570	53,240
Winter Average	6.0	5,350	79,860
Summer Average	**18.33**	**16,375**	**244,033**
Maximum	**25.0**	**22,250**	**332,750**
Ultimate	30.0	26,800	399,300

A. Type of Waste Streams

1. Process clarifier sludge
2. Filter backwash and filter to waste (filter rinse water)
3. Sample sink and analyzer drains
4. Process unit overflows
5. Basin cleaning and drainage
6. Chemical unloading area drains
7. Plant floor drains
8. Sanitary waste
9. Stormwater

B. Sedimentation Basin and Wastewater Clarifier Sludge (Total solids)

1. Estimated solids concentration — 1.0% - 2.0%
2. Estimated sludge specific gravity — 1.0
3. Total sludge volume, gallons per day

	Sludge Production (gpd)	
Solids Concentration	**1.0% (1)**	**2.0% (2)**
a. Minimum Flow	42,800	319,200
b. Winter Average flow	64,100	478,800
c. Summer Average Flow	**196,742**	**1,462,734**
d. Maximum flow	**266,000**	**1, 995,000**
e. Ultimate flow	321,000	2,394,000

(1) Sludge production based on average solids
(2) Sludge production based on maximum solids production

4. Estimated solids removal in sedimentation basins — 90%
5. Sludge from sedimentation basin blow down to thickener

	Sludge Production (gpd)	
Solids Concentration	**1.0% (1)**	**2.0% (2)**
a Minimum	38,500	287,300
b. Winter Average	57,700	430,900
c. Summer Average	**177,000**	**1,316,000**
d. Maximum	**240,000**	**1,795,000**
e. Ultimate	289,000	2,155,000

(1) Sludge production based on average solids
(2) Sludge production based on maximum solids production

6. Estimated solids removal in filters 10%

7. Sludge from wastewater clarifiers to thickener

	Sludge Production (gpd)	
Solids Concentration	**1.0% [1]**	**2.0% [2]**
a. Minimum	4,280	31,920
b. Winter Average	6,410	47,880
c. Summer Average	**19,700**	**146,300**
d. Maximum	**26,625**	**199,500**
e. Ultimate	32,100	239,400

[1] Sludge production based on average solids
[2] Sludge production based on maximum solids production

8. Thickened sludge from residuals thickener

	Sludge Production (gpd)		Sludge Transferred to Belt Presses (gpd)[3]	Sludge Stored in Thickener (gpd)
Solids Concentration	**3.0% [1]**	**5.0% [2]**	**5.0%**	**5.0%**
a. Minimum	14,300	127,700	119,900	7,800
b. Winter Average	21,400	191,500	119,900	71,600
c. Summer Average	**65,600**	**585,200**	**179,900**	**405,300**
d. Maximum	**88,750**	**798,400**	**179,900**	**618,500**
e. Ultimate	107,000	957,600	179,900	777,700

[1] Sludge production based on average solids
[2] Sludge production based on maximum solids
[3] **Sludge transfer based on maximum solids processing capacity of 75,000 ppd for the design flow and ultimate flow. Excess sludge on maximum solids days will be stored temporarily in the residuals thickener.**

9. Maximum sludge stored in thickener

a. Based on Kentucky River Station maximum 10-day solids production

b. Maximum 10-day average flow (95% of design flow), mgd 29.0

Day	Solids Production (lb/MG)	Solids Production (lb/day)	Solids Transferred to Belt Presses (lb/day)	Solids Stored in Thickener (lb/day)	Total Solids Stored in Thickener (lbs)	Total Sludge Stored in Thickener (gal at 5.0% solids)
1	4,417	125874	75,000	50874	33,920	122,001
2	4,599	131073	75,000	56073	71,300	256,469
3	4,643	132324	75,000	57324	109,500	393,936
4	6,326	180299	75,000	105299	179,700	646,451
5	7,472	212940	75,000	137940	271,700	977,242
6	13,310	379417	75,000	304417	474,600	1,707,259
7	6,627	188868	75,000	113868	550,500	1,980,323
8	3,543	100988	75,000	25988	567,800	2,042,644
9	2,538	72340	75,000	-2660	566,100	2,036,265
10	2,360	67263	75,000	-7737	560,900	2,017,711

c. **Maximum sludge stored in thickener, gal.** **2,042,644**

C. Filter Backwash and Filter Rinse Water - Discharged to Wastewater Clarifiers

1. Number of filters 4
2. Filter area - each, sf 468
3. Minimum filter run length, hours 24
4. Average filter run length, hours 48
5. Maximum filter run length, hours 72
6. Maximum washwater flow per filter wash and filter to waste

	Flow (gpm/sf)	Time (min)	Volume (gal)
a. Low wash	6	5	21,060
b. High wash	25(1)	8	140,400
c. Low wash	6	5	21,060
d. Filter to waste (2)	4	19	53,350
Total		37	235,870

(1) Ultimate maximum flow, if filters are converted to GAC in the future. Maximum flow is 20 gpm/sf for dual media filters.
(2) Approximately one filter volume

7. Number of washes per day at 25 mgd with 6 filters

- a. **Minimum** **2.0**
- b. **Average** **3.0**
- c. **Maximum** **6.0**

8. Washwater and rinse water volume, gpd

- a. **Minimum** **471,740**
- b. **Average** **707,610**
- c. **Maximum** **1,415,220**

9. Solids concentration in backwash, mg/L

- a. Winter average flow/ Average solids 160
- b. **Summer average flow/ Average solids** **377**
- c. Winter average flow/ Max solids 2,388
- d. **Summer average flow/ Max solids** **5,638**
- e. **Maximum flow/ Maximum solids** **2,819**

D. Sample Sink and Analyzers - Discharged to Wastewater Clarifier assuming sample pumps operated 24 hrs per day

1.	Total estimated flow, gpd	57,600

E. Plant Overflow - Discharged to Wastewater Clarifier

1.	Maximum flow rate, 40 mgd, 10+/- min	278,000

F. Basin Drainage and Cleaning

Assume clean and drain each basin once per year

1.	Flocculation Basin Volume, gal	153,000
2.	Sedimentation Basin Volume, gal	156,000

NOTE: Each cleaning will drain one train of Flocculation/sedimentation basin unit and discharge 309,000 gallons to waste.

G. Plant Floor Drains

1. Sources
   - a. Cleaning and flushing of chemical storage or feed area floors - discharged to sanitary waste system via sump pumps.
   - b. Operations and administrative areas - discharged to sanitary waste system.
   - c. Process pipe gallery - discharged to process wastewater system.
   - d. Pump lubrication water - discharged to process wastewater system.

2.	Average estimated daily flow to process wastewater system, gpd	100
3.	Maximum estimated daily flow to process wastewater system, gpd	200

H. Chemical Unloading Area Drain

Stormwater - discharged to stormwater catchment through a bypass.

Chemical Spills - maximum discharged to chemical spill containment, gal.	7,000

I. Sanitary Waste - Discharged to sanitary waste system.

1.	Average, 5 persons @ 60 gallons/person	300
2.	Maximum, 10 persons @ 60 gallons/person	600

J. Analyzer Waste Containing Reagent - Discharged to sanitary waste system

1.	Chlorine analyzer flow (5 analyzers), mL/min	1,500
2.	Ammonia analyzer flow (1 analyzer), mL/min	300
3.	Total estimated flow to sanitary waste system, gpd	685

K. Stormwater - Separate system.

L. Total Wastewater Volumes, gpd.

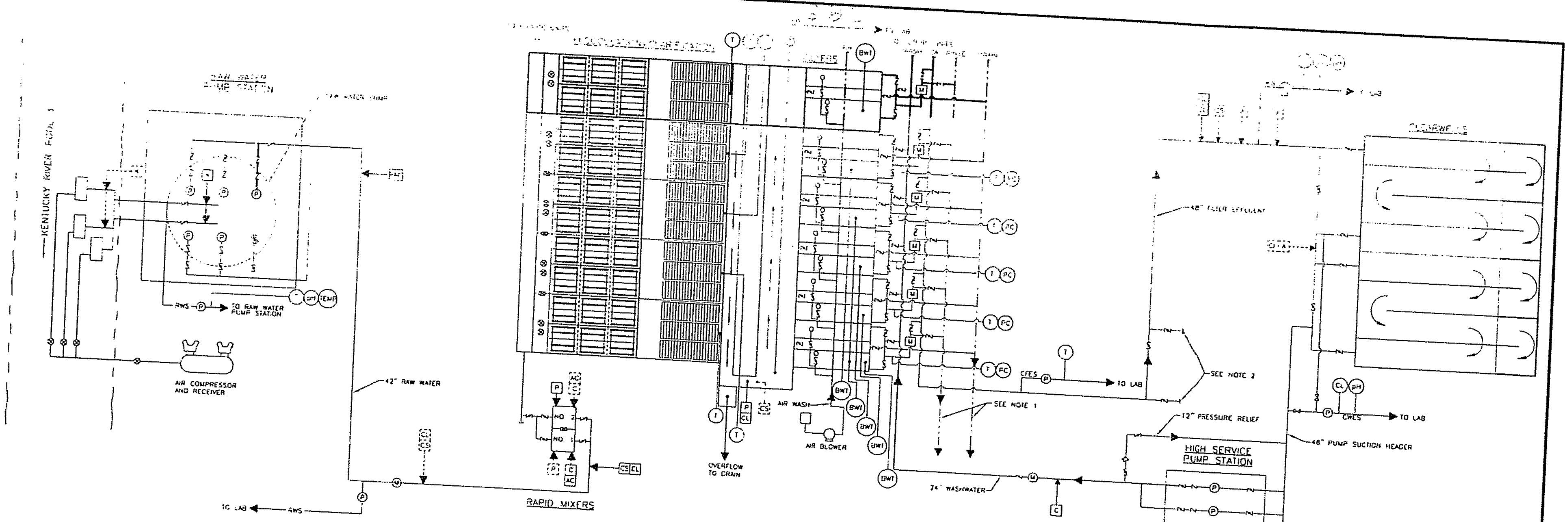
Items	**Winter Average**	**Summer Average**	**Maximum**	**Ultimate Maximum**
1. Wastewater directed to wastewater clarifiers				
a. Filter backwash and filter to waste water	**471,740**	**707,610**	**1,415,220**	1,651,100
b. Sample sink and analyzers	57,600	57,600	57,600	57,600
c. Basin cleaning and drainage(1)	0	0	259,400	309,000
d. Plant overflow	0	0	138,890	208,330
e. Plant floor drains	100	100	1,000	1,000
Subtotal	**529,440**	**765,310**	**1,872,110**	1,918,030
2. Wastewater directed to residuals thickener				
a. Sedimentation basin sludge	57,700	**177,000**	**1,795,000**	2,155,000
b. Wastewater clarifier sludge	6,410	**19,700**	**199,500**	239,400
Subtotal	64,110	**196,700**	**1,994,500**	2,394,400
3. Sludge directed to belt filter presses				
a. Residuals thickener sludge	21,400	53,700	**179,900**	179,900
Subtotal	21,400	53,700	**179,900**	179,900
3. Process wastewater directed to sanitary system				
a. Plant floor drains	100	100	200	200
b. Sanitary waste	300	300	600	600
c. Analyzer waste	685	685	685	685
Subtotal	1,085	1,085	1,485	1,485
4. Process wastewater directed to spill containment basin				
a. Unloading area drain	0	0	7,000	7,000
Subtotal	0	0	7,000	7,000
5. Clarified wastewater directed to Kentucky River				
a. Wastewater clarifier supernatant	**523,030**	**745,610**	**1,672,610**	1,679,000
b. Residuals thickener supernatant	42,710	**143,000**	**1,814,600**	2,214,500
Subtotal	**565,740**	**888,610**	**3,487,210**	3,893,500

(1) Flocculator/sedimentation basin would not be drained during maximum wastewater flow event.

IV Sludge Volume

				Design	Ultimate
A.	Average dried solids production				
	1.	Solids generated per day, lbs/day			
		a.	Winter average flow	5,530	8,300
		b.	Summer average flow	**16,375**	20,100
	2.	Solids generated per year, lbs/year (4 months at summer average flow, 8 months at winter average flow)		**3,319,850**	4,470,000
B.	Sludge volume, ft^3/year				
	1.	15% solids		**351,300**	478,000
	2.	20% solids		**263,500**	358,000

Exhibits



CHEMICALS

PAC	CARBON
K	POTASSIUM PERMANGANATE
CL	CHLORINE
C	COAGULANT
CS	CAUSTIC SODA
P	POLYMER
F	FLUORIDE
CI	CORROSION INHIBITOR
A	AMMONIA
→	PRIMARY CHEMICAL FEED POINT
- - →	SECONDARY CHEMICAL FEED POINT
AC	ALTERNATE COAGULANT

LEGEND

PIPING/PUMPS

- AIR BLOWER
- PUMP
- METER
- VALVE
- BUTTERFLY VALVE
- MUD VALVE
- CHECK VALVE
- RELIEF VALVE
- [illegible]
- [illegible] VALVE
- [illegible]
- [illegible]
- [illegible]
- REQUIRED FOR 25 MGD

SAMPLES

RWS	RAW WATER SAMPLE
MWS	MIXED WATER SAMPLE
FIS	FILTER INFLUENT SAMPLE
CFES	COMBINED FILTER EFFLUENT SAMPLE
CWIS	CLEARWELL INFLUENT SAMPLE
CWES	CLEARWELL EFFLUENT SAMPLE
FES	PLANT EFFLUENT SAMPLE
WWS	WASTEWATER SAMPLE

ONLINE ANALYTICAL INSTRUMENTS

T	TURBIDIMETER
pH	pH MONITOR
TEMP	TEMPERATURE
SCD	STREAMING CURRENT DETECTOR
BWT	BACKWASH TURBIDIMETER
CL	CHLORINE ANALYZER
TCL	TOTAL CHLORINE ANALYZER
F	FLUORIDE ANALYZER
A	AMMONIA ANALYZER
[illegible]	[illegible] COUNTER
[illegible]	[illegible]

NOTES:

REVISIONS			
	DESCRIPTION		

DESIGNED	CHECKED	SCALE
CHECKED	APPROVED	AS NOTED
		APPROVED G.C.K.

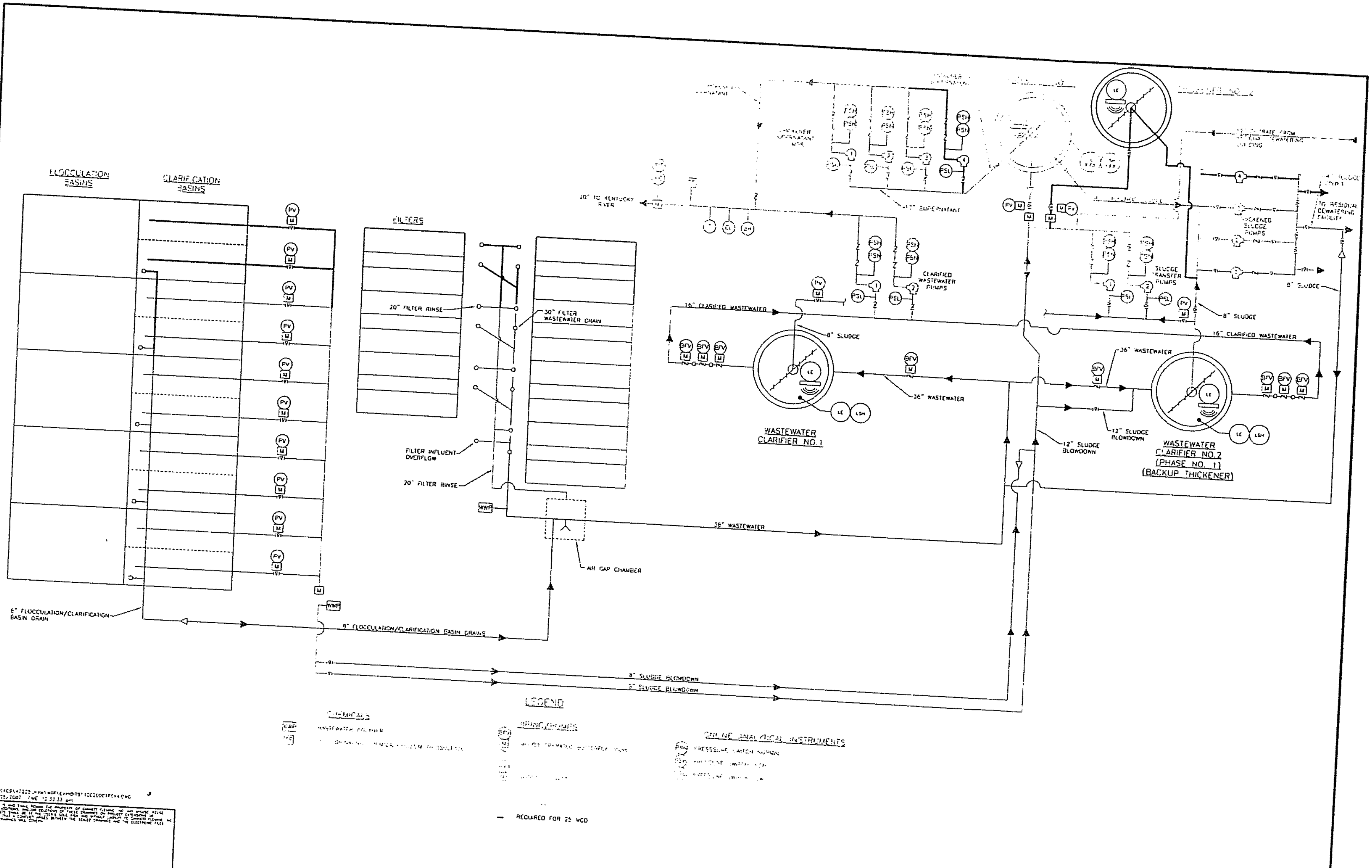
Gannett Fleming
HARRISBURG, PENNSYLVANIA

KENTUCKY-AMERICAN WATER COMPANY
LEXINGTON, KENTUCKY

KENTUCKY RIVER POOL 3
WATER TREATMENT PLANT

WATER TREATMENT PLANT
PROCESS
PROCESS FLOW DIAGRAM

JOB NO. 47225
DATE MARCH 2007
SHEET NO. EX3



REVISIONS

DESIGNED	CHKD	SCALE AS NOTED				
CHECKED	APPROVED	APPROVED G.C.K.	**Gannett Fleming** HARRISBURG, PENNSYLVANIA	KENTUCKY-AMERICAN WATER COMPANY LEXINGTON, KENTUCKY KENTUCKY RIVER POOL 3 WATER TREATMENT PLANT	WATER TREATMENT PLANT PROCESS WASTEWATER PROCESS FLOW DIAGRAM	JOB No. 47225 DATE MARCH 2007	SHEET No. EX4