Planning Period 2014 - 2034

Regional Wastewater Facilities Plan

City of Brodhead, KY

GRW Project No. 3929-01

July 2015

engineering | architecture | geospatial

GRW | 801 Corporate Drive | Lexington, KY 40503 | 859.223.3999

WASTEWATER FACILITIES PLAN UPDATE
CITY OF BRODHEAD, KENTUCKY

Mayor

Walter Lee Cash

Council Members

Ronnie Cash

Keith Graves

Ricky Kirby

Dallas Todd

WASTEWATER FACILITIES PLAN UPDATE
CITY OF BRODHEAD, KENTUCKY

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WASTEWATER FACILITIES PLAN UPDATE
CITY OF BRODHEAD, KENTUCKY

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Section 1

SECTION 1
REGIONAL FACILITIES PLAN SUMMARY

A. Purpose of the Facilities Plan

The purpose of this Regional Wastewater Facilities Plan is to develop a cost effective and environmentally sound strategy for improving the wastewater collection and treatment systems in the City of Brodhead's Planning Area, to accommodate existing needs and projected growth during the Planning Period of 2014 to 2034.

The City of Brodhead was notified by the Division of Water of an update to regulation 401 KAR 5:006 "Wastewater Planning Requirement for Regional Planning Agencies" which requires either an update to their existing Facilities Plan (because it is over ten years old), or the submission of an Asset Inventory Plan. Because the City is currently planning an expansion (of greater than 30% of their existing averaged daily design capacity) to their Wastewater Treatment Plant, which also requires the Facilities Plan be updated, the City elected to proceed with the full Facilities Plan update. GRW Engineers was selected and contracted by Brodhead to prepare the update to their Facilities Plan.

The major areas (or goals) to be considered in this Facilities Plan include:

- Review and evaluation of the City's wastewater collection system and wastewater treatment plant to assess their current physical condition, capacity and improvement needs;

- Review of current compliance with U.S. EPA Clean Water Act regulations, KPDES permit discharge limitations as well as with future anticipated limits and other associated requirements;

- Evaluate impacts of wastewater loads on the City's wastewater collection and treatment facilities from areas outside of the current wastewater Planning Area;

- Study alternatives to expand and improve the capacity and effectiveness of the wastewater treatment facilities to meet current and future requirements;

- Ensure that public participation is included in the development of the recommended plan for wastewater collection and treatment system improvements;

- Address anticipated adverse environmental impacts of the proposed improvements, as identified by state and federal agencies that have reviewed this Plan.

B. Background

The existing Brodhead Wastewater Treatment Plant (WWTP) in Brodhead, Kentucky is located at 131 Chestnut Grove Road on the northern side of the City. The plant discharges at mile point 78.0 (Longitude 84°25'16.5"W, Latitude 37°24'29.3"N) of the Dix River which is a tributary to the Kentucky River. The plant currently has an average treatment capacity of 150,000 gallons per day (GPD) with a peak hydraulic capacity of 375,000 GPD. The plant was originally constructed in 1972 and was upgraded in 1994 with the addition of a Flow Splitter Box, a Final Clarifier, a Sludge Holding Tank, two (2) Sand Drying Beds and a RAS/WAS Pumping Station.

The Brodhead wastewater collection system is considered "separate" as opposed to a "combined" system, which means that there are separate pipes dedicated to transporting storm and sanitary flows. Due to the topography of Brodhead, the system is primarily gravity flow, with three (3) pump stations collecting flow and pumping into trunk sewers which carry the wastewater to the treatment plant.

One previous wastewater Facilities Plan has been prepared for the City of Brodhead. The original Brodhead 201 Facility Plan was completed in 1994. The original plans were prepared for a wastewater Planning Area that encompassed the City of Brodhead.

Following multiple Notices of Violation and a Letter of Warning, the City entered into a Conference Agreement with the Division of Water London Regional Office on April 5, 2012. The result of this Agreement required the City of Brodhead to submit a Plan of Action to the Division of Water to address the issues of I&I and a Wastewater Treatment Plant upgrade. This also included performing a Sanitary Sewer Overflow Prevention Plan (SSOP) and a Sewer System Evaluation Survey (SSES) which the City has completed and submitted to the Division of Water.

Since the Conference Agreement, the City of Brodhead has been maintaining proper records and notifying the Energy and Environment Cabinet of spills, bypasses or other discharges as outlined. While the City of Brodhead has made progress in inspections of their facilities, they have continued to receive Notice of Violations (NOV) from the Commonwealth of Kentucky. The two (2) most recent NOV's were received in January and October of 2014 for their Wastewater Treatment Plant not meeting permit limits (see Appendix A).

On February 5, 2015 the City of Brodhead received a letter from the Division of Water's Enforcement branch stating that the City has been assigned to Case No. DOW150019 and that the DOW would soon be scheduling an Enforcement Conference to discuss

resolution to all outstanding issues. This meeting was held on April 2, 2015 and was followed by the April 7, 2015 letter summarizing the meeting which is included in Appendix A.

The treatment plant is expected to receive increased flows during the Planning Period due to increased residential and commercial/industrial growth within the Planning Area. By 2034, the treatment plant is expected to receive an average daily flow of 250,000 GPD and a peak flow of 600,000 GPD.

C. Recommended Alternatives Chosen

This Regional Wastewater Facilities Plan includes projects in the wastewater collection system and at the treatment plant in order to provide increased capacity for current and future wastewater flows from customers within the Planning Area.

The Recommended Plan calls for construction of projects at the wastewater treatment plant and a wet weather detention basin in order to provide increased treatment capacity. Four (4) alternatives for upgrading and expanding the plant (including a No Action Alternative) were evaluated, along with two (2) viable disinfection alternatives. Both monetary (present worth) and non-monetary factors were considered. The non-monetary analysis included five (5) factors: Environmental Impact, Engineering Evaluation, Implementability, Regionalization and Public Support. The improvements to the wastewater treatment plant are included within the 0-10 year planning period.

In regards to the two (2) disinfection alternatives compared, **Disinfection Alternative 2 – Sodium Hypochlorite** is recommended due to its low present worth cost and its proven history of reliability. Other advantages of using Sodium Hypochlorite disinfection include the elimination of multiple 150-pound cylinders of chlorine gas and associated health hazards in the area of the wastewater treatment plant.

Regarding the four (4) treatment alternatives evaluated, **Treatment Alternative 1 – Oxidation Ditch** was selected as the preferred treatment alternative due to its lower present worth cost, its non-monetary analysis and its proven history of reliability. The recommended Treatment Alternative 1 – Oxidation Ditch includes the following components:

- New 500,000 gallon Wet Weather Detention Basin & Pump Station with return flow meter vault.
- New 600,000 GPD Influent Pump Station including submersible pumps, wet well, valve vault and flow meter.

- New Preliminary Treatment Building:
  - Approximately 1,600-square feet.
  - Offices for WWTP personnel.
  - Electrical equipment.
  - New screening removal system with static screen.

- Two (2) new Oxidation Ditches with mixers and two (2) 15 HP surface aerators with VFD's. The new Oxidation Ditches will be approximately 100 LF x 24 LF wide, each.

- One (1) new concrete Oxidation Ditch Flow Splitter Box

- One (1) new concrete Clarifier Flow Splitter Box

- Demolition of existing "Old" clarifier and its mechanical equipment

- Modification of the existing "New" 22-ft clarifiers with new density current baffles.

- One (1) new 22-ft clarifier. Clarifier includes mechanical equipment, launder covers, current density baffles, effluent weirs and scum baffles. New Clarifier to have similar configuration to the renovated existing "New" Clarifier.

- New Chemical Disinfection Feed Building. Approximately 680-square feet. Includes new scale & feed equipment.

- New Sodium Hypochlorite Disinfection Contact & Dechlorination Basin. Basin would replace existing basin and would include a new effluent flow meter.

- Existing Aeration Basins to be converted to Aerated Sludge Holding/Aerobic Digestion Basins. Modifications include the installation of a telescopic valve, new post mooring aerators and the installation of access steps and a platform.

- Modifications of the Return Activated Sludge (RAS) Pumping Station with new pumps.

- Existing office building to be converted to storage.

- Existing sludge drying beds to be dewatered and backfilled with soil. Existing sludge to be hauled away.

- New Emergency Power Generator and Transfer Switch

- Site piping, site grading and miscellaneous equipment.
- Solids removal via third party hauling and disposal.

Presently, the City of Brodhead utilizes a private hauling company to transport sludge from the WWTP to a private land farm. GRW evaluated four (4) sludge management alternatives for the WWTP. The evaluation can be found in Section 8. GRW recommends the City of Brodhead to continue to utilize a private hauling company to transport sludge to a private land farm as a result of presenting the lowest estimated annual cost as well as the familiarity that wastewater treatment personnel have with this process.

D. Summary of Estimated Cost

The Estimated Project Costs for the Recommended Plan are outlined in Table 1-1. The Estimated Project Costs include estimated construction, engineering, administrative and legal costs, expressed in 2015 dollars.

Table 1-1
Estimated Project Costs
Recommended Plan

Project	Estimated Cost
Treatment Plant Improvement – Oxidation Ditch, Wet Weather Detention Facilities, Sodium Hypochlorite Disinfection	*$4,774,693*

E. Environmental Impacts

Correspondence was exchanged with various state and federal agencies that relate to potential adverse impacts of the Recommended Plan. The responses from these agencies indicate that the Recommended Plan does not have a negative impact on surface and groundwater, threatened or endangered species, air quality, floodplains and wetlands, historical or archaeological sites, important prime farmland, or any other applicable environmentally sensitive areas. See Chapter 9 for additional documentation.

F. Institutional Structure

There are no changes required to the existing institutional structure of the City of Brodhead as a result of the Recommended Plan. Other than a revised user charge system for paying debt service and the annual operating and maintenance costs for the

Recommended Plan, no new ordinances or regulations are needed to implement the Recommended Plan.

G. Funding Plan

A preliminary funding plan has been prepared for the Recommended Plan. This includes an assessment of potential funding sources and preliminary estimates for potential user rates. The funding plans are based on the estimated projects costs and annual operating and maintenance costs of the projects in this plan. These costs are evaluated against a combination of funding options to provide estimated annual debt service and annual O&M costs that must be paid by the wastewater system customers as monthly sewer service rates. It should be noted that the calculations presented in the funding plan are preliminary and will require revision once the actual construction costs are known (from contractor's bids for the projects in this Plan) and the amounts and availability of grants and loans have been confirmed. Therefore, this information is presented to provide a preliminary order of magnitude for sewer service rates, and the City will need to conduct a separate User Charge Study to determine the actual rates needed to pay for the Recommended Plan.

As outlined in Table 1-1, the estimated cost for the Recommended Plan is $4,774,693. Three (3) funding options were considered in this Recommended Plan. Funding Options 1 & 2 evaluate a 30-year payback period, and Funding Option 3 evaluates a 40-year payback period. Options 1 & 2 evaluate funding through Kentucky Infrastructure Authority State Revolving Fund (KIA SRF) at the non-standard hardship interest rate of 0.75%. Option 1 considers a 30% principal forgiveness from KIA SRF, whereas Option 2 considers a 50% principal forgiveness. Option 3 evaluates funding from USDA Rural Development (RD). Option 3 considers a 30% principal forgiveness at a poverty interest rate of 2.125%.

Additionally all three funding options also have assumed that grant funding would be available through the Community Development Block Grant (CDBG) and the Appalachian Regional Commission (ARC) grant programs.

The shorter payback period will require larger annual debt service costs than the longer periods, but will result in total interest costs being lower. For the Funding Option 1, user rates will have to increase by approximately 94.43%. Funding Option 2 will require rates to be increased by approximately 78%. Lastly, Funding Option 3 requires a rate increase of 92.78%. Detailed discussion of these options is included in Section 10.

H. Schedule and Method of Implementation

The schedule for implementation of the Recommended Plan is a function of factors, such as the timing of approval of this Regional Facilities Plan by the KDOW, the dates when

funds are secured for the projects within this plan, and the respective dates for completion of design and construction of the projects.

At the time that this Regional Facilities Plan was prepared, these dates were not known. However, for the purpose of this Plan, the preliminary schedule has been developed. This schedule is subject to revision over time as the estimated dates of the aforementioned factors are updated. Table 1-2, located below, outlines the preliminary implementation schedule for the Recommended Plan.

Table 1-2
Preliminary Implementation Schedule for
Brodhead Regional Wastewater Facilities Plan

Estimated Date	Event
July 31, 2015	Submit Draft Plan to KDOW for review and comment
September 14, 2015	Public Hearing for Plan, Approval of Plan by City of Brodhead
October 2015	Submit Final Plan to KDOW for review and comment
March 2016	Approval of Plan by KDOW
June 2016	Apply for Interim Funding for Design (Kentucky Rural Water)
October 2016	Initiate Design of WWTP & Proposed Improvements
August 2016 – December 2016	Complete Funding Applications for KIA, CDBG & ARC
April 2017 – June 2017	Secure Funding from KIA, CDBG & ARC
July 2017	Complete Design of WWTP & Proposed Improvements
July 2017	Submit Design of WWTP & Proposed Improvements to KDOW
September 2017	Approval of WWTP & Proposed Improvements Design by KDOW
September 2017	Approval of Environmental Review for WWTP & Proposed Improvements
September 2017	Finalize all easements
September 2017	Finalize Project Funding (KIA, CDBG & ARC)
October 2017	Advertisement for Bids for WWTP & Proposed Improvements
December 2017	Receipt of Bids, Securing of Funds for WWTP & Proposed Improvements
January 2018	Award of Construction Contract for WWTP & Proposed Improvements
February 2019	Complete Construction of WWTP & Proposed Improvements

Section 2

SECTION 2
STATEMENT OF PURPOSE AND NEED

A. Need for the Facilities Plan

The purpose of this report is to evaluate the current and future wastewater collection and treatment needs for the City of Brodhead Planning Area in accordance with Section 401 of the Kentucky Administrative Regulation (KAR) 5:006.

The City of Brodhead elected to update their facilities plan to meet the new requirements as outlined by 401 KAR 5:006 for the following reasons:

- The current Facilities Plan is over 10 years old and new requirements indicate a Facilities Plan (or asset inventory) must be completed.
- The City is planning an expansion to their existing wastewater treatment facility that will increase their average daily flow by more than 30%.

B. Compliance Background

The City of Brodhead has received multiple Notice of Violations (NOV) from the Commonwealth of Kentucky Department of Environmental Protection, Division of Water's Enforcement Branch (DOW) for their Treatment Plant. It is noted in the violation that the Wastewater Treatment Plant (WWTP) and City's sewer collection system experience excessive wastewater flows as a result of excessive Inflow and Infiltration (I&I). The extreme I&I results in peak flows at the plant, thus, exceeding the rated capacity of the WWTP, disrupting treatment process as well as causing sanitary sewer overflows within the collection system.

Following multiple Notices of Violation and a Letter of Warning, the City entered into a Conference Agreement with the Division of Water London Regional Office on April 5, 2012. The result of this Agreement required the City of Brodhead to submit a Plan of Action to the Division of Water to address the issues of I&I and a Wastewater Treatment Plant upgrade. This also included performing a Sanitary Sewer Overflow Prevention Plan (SSOP) and a Sewer System Evaluation Survey (SSES) which the City has completed and submitted to the Division of Water.

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Commonwealth of Kentucky. The two (2) most recent NOV's being received in January and October of 2014 for their Wastewater Treatment Plant not meeting permit limits (see Appendix A).

On February 5, 2015 the City of Brodhead received a letter from the Division of Water's Enforcement branch stating that the City has been assigned to Case No. DOW150019 and that the DOW would soon be scheduling an Enforcement Conference to discuss resolution to all outstanding issues. This meeting was held on April 2, 2015 and was followed by the April 7, 2015 letter summarizing the meeting which is included in Appendix A.

C. Purpose

This study will develop a plan for the most environmentally sound, cost-effective and implementable wastewater collection and treatment system improvements. This planning document will investigate the effectiveness of the existing treatment plant, treatment alternatives, the proposed treatment plant expansion and the ability of the collection system to meet all applicable Federal, State and local requirements. Specifically, this planning document shall objectively evaluate the combined effect of a two component analysis: 1) Cost Effective Analysis and 2) Non-monetary Effectiveness Analysis.

Each alternative under consideration was evaluated using a systematic approach to obtain a ranking for each of the two analysis components. The systematic approach for evaluating alternatives within the framework of each component consisted of:

1. **Cost Effective Analysis**

   The Cost Effective Analysis involved comparing the cost associated with each alternative based on the present-worth cost analysis method.

2. **Non-monetary Effectiveness Analysis**

   The Non-monetary Effectiveness Analysis includes both the Environmental Impact Analysis and the Implementation Analysis.

   The Facilities Plan will develop a recommended course of action for wastewater service for the City of Brodhead and its wastewater system customers for the period of 2014 to 2034.

Section 8 contains the evaluation of alternates considered in the Planning document.

Section 3

SECTION 3
PHYSICAL CHARACTERISTICS OF THE PLANNING AREA

A. Purpose

The purpose of this section is to delineate the planning area boundaries and describe the key geographic, topographic and natural (or man-made) features within the planning area.

B. Geographic Area

The City of Brodhead is geographically located approximately 60 miles south of Lexington, Kentucky, and approximately 30 miles northeast of Somerset, Kentucky. Brodhead is a part of the Richmond-Berea Micropolitan Statistical Area. A map of the Rockcastle County is shown in Exhibit 3-1. The county, is located in the Eastern Coal Field area of the state, and is bounded on the north by Garrard and Madison Counties, the south by Laurel and Pulaski Counties, the west by Lincoln County and the east by Jackson County. Rockcastle County has an area of 318 square miles (203,519 acres). The City of Brodhead is located in the western portion of the county and has an incorporated area of approximately 2.2 square miles (1,408 acres).

The Brodhead Planning Area was established as the City limits. Exhibit 3-2 illustrates the City of Brodhead's city limits and 20-year planning area.

C. Topography of the Area and Geographic Features

The terrain of the county is generally hilly and the topography is commonly described as rugged. A tableland of low local relief, located between Brodhead and Renfro Valley, contrasts with the hill country to the north and the mountainous terrain to the south. Karst features such as sinkholes and streamless valleys are located in the central part of the county. The highest elevation in the county is approximately 1,640-feet on a ridge near the Rockcastle-Jackson County line.

Rockcastle County lies in the Upper Cumberland River Basin. Exhibit 3-3 is a 7.5-minute USGS topographic map of the area. Exhibit 3-3 identifies the locations of the Brodhead Wastewater Treatment Plant, the Mt. Vernon Water Treatment Plant and the master meter water purchase point along KY-150.

As would be expected, the existing Brodhead sanitary sewer collection and treatment systems were designed to work with the natural terrain and follow the existing drainage

patterns of the area. Due to sinkholes and smaller drainage basins within the planning area, lift stations and force mains are used to aid the gravity sewers. The majority of the gravity lines flow to the center of Brodhead along Main Street and are then pumped north to flow to the treatment plant. The western part of the collection system flows directly north to the treatment plant by gravity sewers. The highest elevations in the system are approximately 1,185-feet with the downtown area of Brodhead having typical elevations of around 960-feet. The discharge from the treatment plant (approximately 919.5-feet in elevation) flows northwest via Dix River to the Kentucky River.

The Planning Area can be divided into four subwatersheds or drainage basins, and are Boone Fork, Dix River, Negro Creek and Little Negro Creek.

The Planning Area is primarily underlain by the Borden Rock Formation with various limestone members as well as Alluvium and Fluvial deposits. The Renfro and Burnside Members of the Slade Formation compose the majority of the limestone present within the Planning Area.

D. Floodplains

Floodplains are of significance to wastewater systems since it is common for sewers to convey wastewater to larger collection and interceptor sewers located along the banks of streams. These sewers often convey the wastewater to treatment facilities that are also located along stream banks. During periods of flooding of low-lying areas, such sewers and treatment facilities are subject to flooding, which impairs their performance if flood protection is not provided. In planning wastewater system improvements, it is necessary to identify floodplains in order to avoid the costly need to provide flood protection for the system and plant.

Flood hazard areas within Rockcastle County are shown on Exhibit 3-4. Additionally, flood hazard areas within the Planning Area are shown on Exhibit 3-5. This exhibit indicates that the area along Boone Fork, Dix River, Negro Creek and Little Negro Creek have been identified by the Federal Emergency Management Agency (FEMA) as being within the 100-year floodplain. The FEMA flood mapping also indicates that the Brodhead Wastewater Treatment Plant is located outside the 100-year floodplain.

According to the Kentucky Division of Water (KDOW) the 100-year flood water surface elevation is approximately 926.3-feet (NAVD88) on the northern side of the WWTP. Nevertheless, the existing WWTP site is graded such that the ground elevation is approximately 930-feet (NAVD88) in order to prevent flooding.

E. Existing and Proposed Land Use

An understanding of current and projected land use is important in wastewater system planning in order to analyze the anticipated wastewater flows that are expected to be received by the collection system and treatment plant. The most significant land use category for wastewater system planning is residential land use because, in most communities, residential wastewater discharge to the collection system is the majority of flow in the community. The remaining flow handled by a wastewater system is generally from industries, commercial establishments, schools and other customers that use significant amounts of water. Knowing where residential areas, industries and other significant water users are located – and will be built in the future based on land use designations – is vital to properly planning for the capacity of the wastewater collection and treatment facilities.

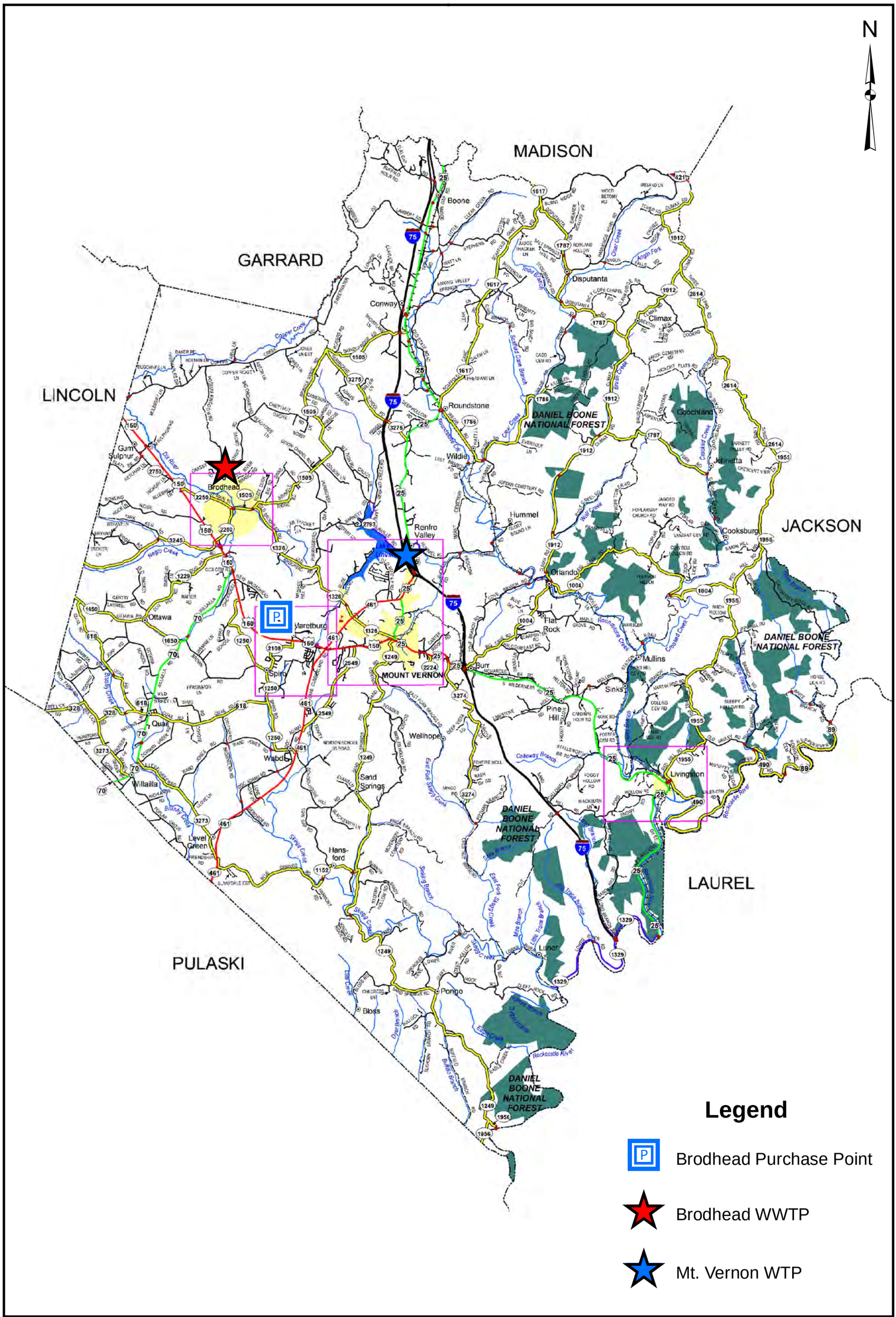
The existing land use for the City of Brodhead is predominately residential with a small mix of commercial, public and institutional. As a result of the City and County not having planning and zoning departments, we were unable to discover any published existing land use data. Therefore, with no published data available, the City has estimated the land use within their planning boundary. Table 3-1 summarizes the estimated area for each of the existing land use designations and Exhibit 3-6 depicts these land use areas.

Table 3-1
Existing Land Use

Existing Land Use Designation	Existing Acreage	% of Total Area
Residential	510.21	85.78%
Multi-Family Residential	13.77	2.31%
Public	45.05	7.57%
Commercial	25.79	4.34%
Total Area	**594.82**	**100.0%**

Likewise, there are no future land use recommendations documented. The City is not expecting much change in the land use areas within the 20-year planning timeframe. Any proposed development in these areas will be processed through the typical review by the City, which will be approved on a case-by-case basis.

Additional information regarding these efforts to project the future sewage demand can be found in Section 7.



GRW PROJECT NO. 3929-01	CLIENT PROJECT NO.			DESIGNED:	EXHIBIT 3-1 ROCKCASTLE COUNTY MAP WASTEWATER FACILITIES PLAN CITY OF BRODHEAD, KENTUCKY	engineering | architecture | geospatial www.grwinc.com	DATE: May, 2015
REVISIONS				DRAWN:			SCALE 1" = 12,000'
NO.	DESCRIPTION	DATE	BY	REVIEWED:			SHEET NO.
							3-1
				APPROVED:			
SCALE: 1" = 12,000'							

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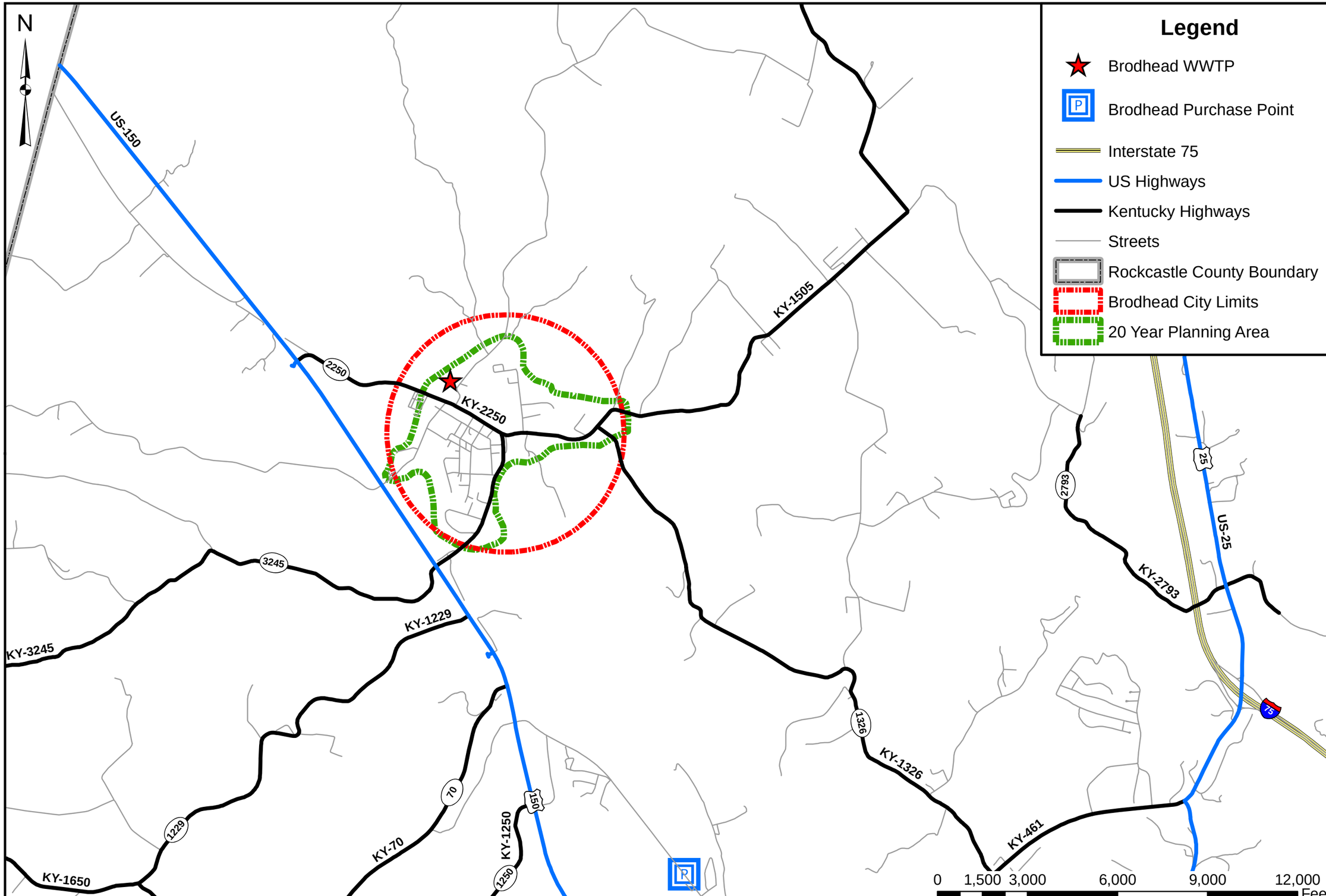
City of Brodhead: Planning Area



Legend

- Brodhead WWTP
- Brodhead Purchase Point
- Interstate 75
- US Highways
- Kentucky Highways
- Streets
- Rockcastle County Boundary
- Brodhead City Limits
- 20 Year Planning Area

DATE: May, 2015

SCALE 1" = 3,000'

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EXHIBIT 3-2
PLANNING AREA MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

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APPROVED:

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City of Brodhead: USGS Topographic Map

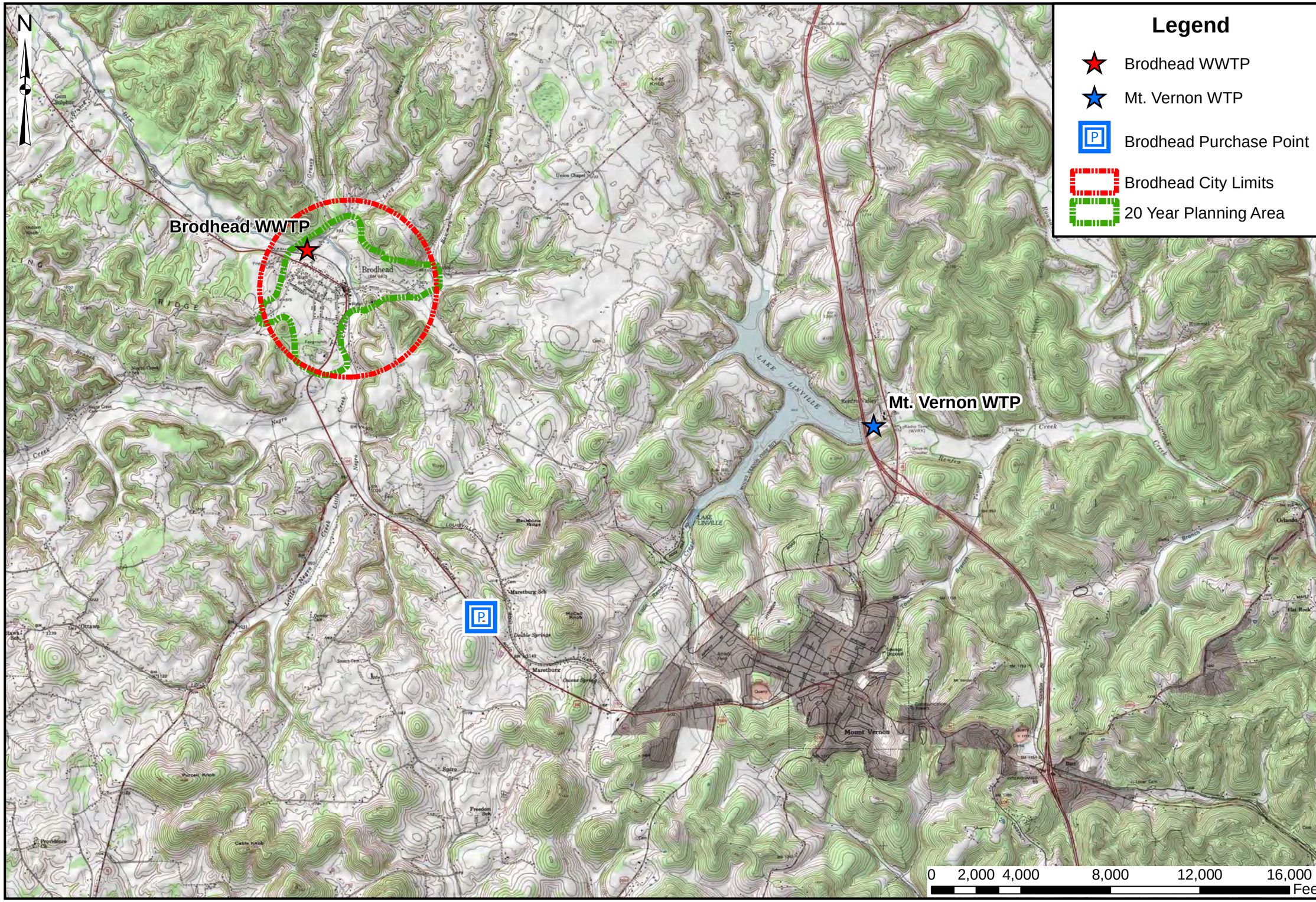

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EXHIBIT 3-3
USGS TOPOGRAPHIC MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

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CLIENT PROJECT NO.

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City of Brodhead: Floodplain Map

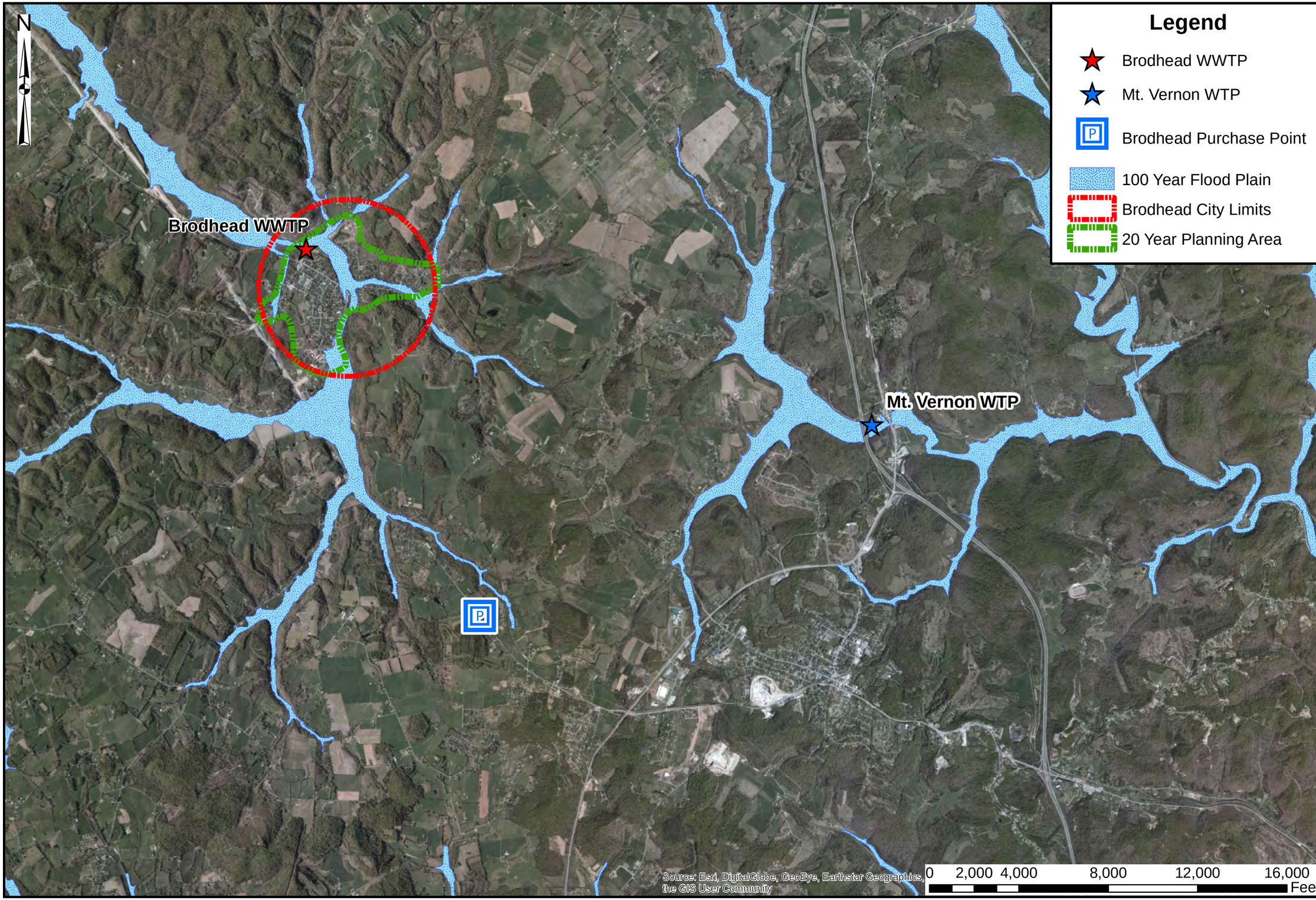

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EXHIBIT 3-4
FLOODPLAIN MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

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City of Brodhead: Service Area Floodplain Map

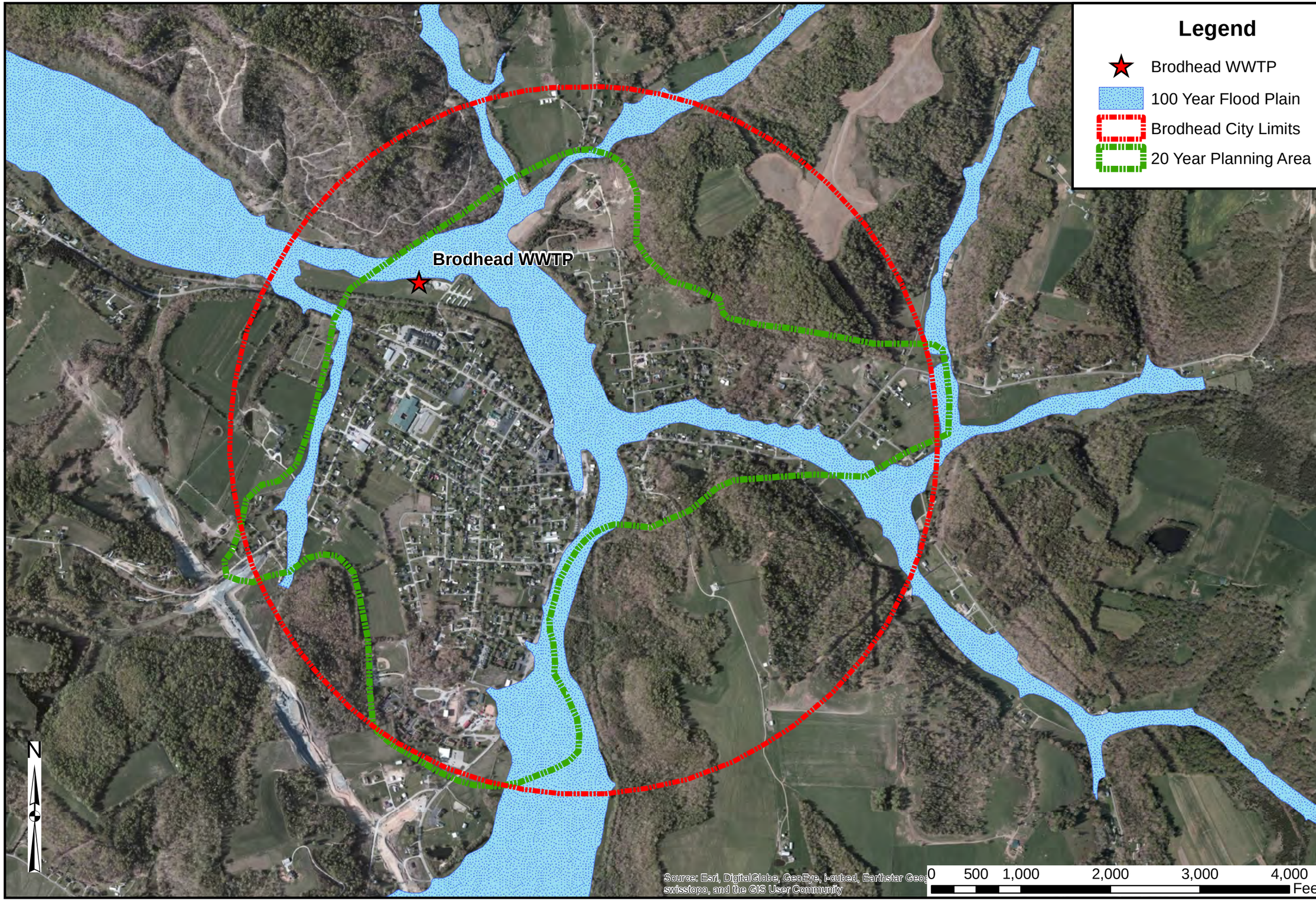

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EXHIBIT 3-5
SERVICE AREA FLOODPLAIN MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

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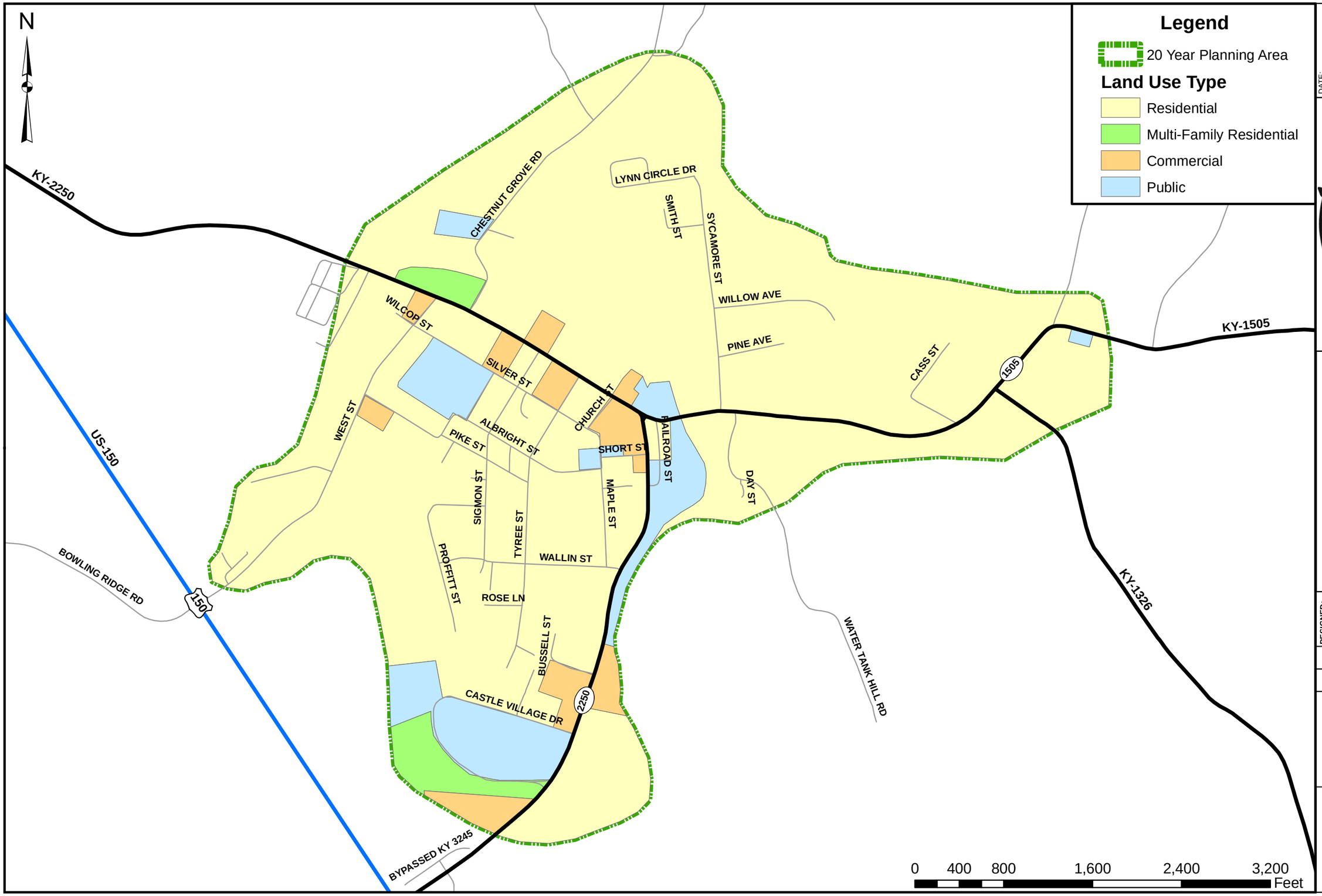
SCALE: 1" = 1,000'

City of Brodhead: Existing Land Use



DATE: May, 2015

SCALE 1" = 800'

SHEET NO. 3-6

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EXHIBIT 3-6
EXISTING LAND USE MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

NO.	DESCRIPTION	DATE	BY

REVISIONS

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SCALE: 1" = 800'

Section 4

SECTION 4
SOCIOECONOMIC CHARACTERISTICS OF THE PLANNING AREA

A. Purpose

The purpose of this section is to review the current population trends in the Brodhead Wastewater Planning Area and summarize future population projections for the Planning Period of 2014 to 2034.

The current socioeconomic conditions, labor force, income and poverty conditions are also presented.

B. Population Trends within the Planning Area

Population projections are important, as estimated flows for the wastewater collection system and treatment plant are based on the population served. A completely accurate procedure to develop long-term population projections does not exist, as factors such as changes in economic development can alter long-range estimates. The standard procedure for projecting population estimates is to review past population growth patterns (trends) for the area in question and utilize these patterns, along with expected land use designations and specific development knowledge, to project future growth. Population trends have been developed based on census data for Rockcastle County and the City of Brodhead, as well as forecasts from the Kentucky State Data Center (KSDC). Table 4-1 includes historic population data as well as the percent of change in population for Rockcastle County, and the City of Brodhead.

Table 4-1
Population Trends In Brodhead and Rockcastle County
1980 – 2010

	Population				Percent Change			Avg % Change
Area	**1980**	**1990**	**2000**	**2010**	**'80-'90**	**'90-'00**	**'00-'10**	
Brodhead	684	1,140	1,193	1,211	66.7	4.7	1.5	24.3
Rockcastle County	13,973	14,803	16,582	17,056	5.9	12.0	2.9	6.9

As seen in Table 4-1, the City of Brodhead experienced substantial growth (+66.7%) between 1980 & 1990. However, from 1990 to 2010 Brodhead has only seen an average growth of +6.3%. The average growth of Rockcastle County is approximately 6.9%.

Therefore, despite the substantial growth between 1980 & 1990, it is assumed that Brodhead will grow at the same rate as Rockcastle County.

The 2000 U.S. Census reported a population of 1,193 for the City of Brodhead. The 2000 Brodhead population predicted by the 1994 Brodhead 201 Facility Plan Update was 1,197, so the City grew at a slower rate than what was previously predicted in 1994. Nevertheless, the growth is expected to continue in the City at rates comparable to those of Rockcastle County.

The U.S. Census Bureau Population Division, via the Kentucky State Data Center, has also issued population projections for five-year intervals at the State and County level through the year 2050. The 2010 Census population data and the five-year population projections were used to develop population projections for the State of Kentucky, Rockcastle County and the City of Brodhead for each year through 2040.

The estimates for the years between the five-year State and County population projections were interpolated with each year growing by the same number of people. The population estimates for the City of Brodhead were determined by applying the growth percentages for Rockcastle County to the City through 2040, which assumes that Brodhead will grow at the same rate as the county for this time period. The population projections are provided in Exhibit 4-1.

Additional information regarding flow projection based on these population trends will be discussed in Section 7.

C. Socioeconomic Conditions

Employment

The U.S. Department of Labor provides employment statistics for Rockcastle County. According to the U.S. Department of Commerce in 2010, only 38 percent of Rockcastle County residents worked within Rockcastle County.

The county's civilian labor force was estimated as 6,843 persons by the U.S. Census Bureau for 2010. Of the total, 6,219 were employed and 624 were unemployed, for an unemployment rate of 9.1 percent. The City of Brodhead civilian labor force (for the same time period) was estimated as 482 persons with 394 employed and 88 unemployed, for an unemployment rate of 18.3 percent.

Table 4-2 reflects the number of employees in Rockcastle County in 2000 and 2010 for eight employment classifications (numbers provided by the U.S. Department of Labor, Bureau of Labor Statistics). Table 4-2 also illustrates the forecasted number of employees for each classification for 2020 and 2030 using a 2 percent rate of growth.

Table 4-2 Employment in Rockcastle County Actual 2000 & 2010 Forecasted 2020 & 2030				
	Actual		Forecasted	
Industry	**2000**	**2010**	**2020**	**2030**
Agriculture, Forestry, Fishing, Mining	344	116	118	120
Construction	686	547	558	569
Manufacturing	1,615	1,118	1,140	1,163
Transportation Comm Utilities	447	417	425	434
Wholesale and Retail Trade	808	1,014	1,034	1,055
Finance, Insurance Real Estate	232	172	175	179
Services	2,269	2,440	2,489	2,539
Government	215	395	403	411
Total	**6,616**	**6,219**	**6,342**	**6,470**

Source: U.S. Census Bureau, 2006-2010 American Community Survey

Major Employers in the Planning area

Table 4-3 lists the major employers in the planning area based on discussions with City personnel.

Table 4-3 Major Employers in the Planning Area		
Employer/Company	**Product**	**Employees**
Rockcastle Health & Rehab	Health & Rehabilitation	140
Rockcastle Board of Education	Education	75
EST Tool & Machine	Tools, Hardware, Agriculture/Industrial Machinery	30

Income

The 2010 census reported that Rockcastle County had a per capita income of $15,621 with 28.1 percent of the people living below the poverty rate. In 2010, Brodhead had a poverty rate of 26.4 percent with a per capita income of $22,161. This poverty rate is greater than the State of Kentucky's rate of 17.7 percent.

D. Economic and Social Benefit to the Community

The availability of a well operated and maintained wastewater system, with available capacity that allows for the community's projected growth during the next 20 years, provides the backbone for economic growth and development. When combined with the implementation of other infrastructure and social projects, the Wastewater Facilities Plan establishes a means to attract new businesses to the Planning Area, which in turn equates to improved socioeconomic conditions and to an environment that supports expanded residential growth.

Exhibit 4-1
Kentucky, Rockcastle County and City of Brodhead Population Estimates and Projections

Year	Kentucky		Rockcastle County*		City of Brodhead	
	Population	% Change	Population	% Change	Population	% Change
2010	4,339,367 [1]		17,056 [1]		1,211 [1]	
		0.78%		0.37%		0.37%
2011	4,373,379 [3]		17,119 [3]		1,215 [4]	
		0.78%		0.37%		0.37%
2012	4,407,392 [3]		17,182 [3]		1,220 [4]	
		0.77%		0.37%		0.37%
2013	4,441,404 [3]		17,244 [3]		1,224 [4]	
		0.77%		0.36%		0.36%
2014	4,475,417 [3]		17,307 [3]		1,229 [4]	
		0.76%		0.36%		0.36%
2015	4,509,429 [2]		17,370 [2]		1,233 [4]	
		0.72%		0.26%		0.26%
2016	4,542,094 [3]		17,415 [3]		1,236 [4]	
		0.72%		0.26%		0.26%
2017	4,574,759 [3]		17,459 [3]		1,240 [4]	
		0.71%		0.26%		0.26%
2018	4,607,424 [3]		17,504 [3]		1,243 [4]	
		0.71%		0.25%		0.25%
2019	4,640,089 [3]		17,548 [3]		1,246 [4]	
		0.70%		0.25%		0.25%
2020	4,672,754 [2]		17,593 [2]		1,249 [4]	
		0.63%		0.14%		0.14%
2021	4,702,281 [3]		17,617 [3]		1,251 [4]	
		0.63%		0.14%		0.14%
2022	4,731,808 [3]		17,641 [3]		1,253 [4]	
		0.62%		0.13%		0.13%
2023	4,761,336 [3]		17,664 [3]		1,254 [4]	
		0.62%		0.13%		0.13%
2024	4,790,863 [3]		17,688 [3]		1,256 [4]	
		0.62%		0.13%		0.13%
2025	4,820,390 [2]		17,712 [2]		1,258 [4]	
		0.54%		0.00%		0.00%
2026	4,846,548 [3]		17,713 [3]		1,258 [4]	
		0.54%		0.00%		0.00%
2027	4,872,705 [3]		17,714 [3]		1,258 [4]	
		0.54%		0.00%		0.00%
2028	4,898,863 [3]		17,714 [3]		1,258 [4]	
		0.53%		0.00%		0.00%
2029	4,925,020 [3]		17,715 [3]		1,258 [4]	
		0.53%		0.00%		0.00%
2030	4,951,178 [2]		17,716 [2]		1,258 [4]	
		0.45%		-0.15%		-0.15%
2031	4,973,609 [3]		17,689 [3]		1,256 [4]	
		0.45%		-0.15%		-0.15%
2032	4,996,039 [3]		17,662 [3]		1,254 [4]	
		0.45%		-0.15%		-0.15%
2033	5,018,470 [3]		17,635 [3]		1,252 [4]	
		0.45%		-0.15%		-0.15%
2034	5,040,900 [3]		17,608 [3]		1,250 [4]	
		0.44%		-0.15%		-0.15%
2035	5,063,331 [2]		17,581 [2]		1,248 [4]	
		0.39%		-0.30%		-0.30%
2036	5,083,123 [3]		17,528 [3]		1,245 [4]	
		0.39%		-0.30%		-0.30%
2037	5,102,915 [3]		17,476 [3]		1,241 [4]	
		0.39%		-0.30%		-0.30%
2038	5,122,708 [3]		17,423 [3]		1,237 [4]	
		0.39%		-0.30%		-0.30%
2039	5,142,500 [3]		17,371 [3]		1,233 [4]	
		0.38%		-0.30%		-0.30%
2040	5,162,292 [2]		17,318 [2]		1,230 [4]	

* Rockcastle County population estimates and projections include City of Brodhead population

[1] 2010 Census Data, U.S. Census Bureau

[2] Total Population, Census 2000 and 2010 with Projections 2015 - 2040, Kentucky State Data Center, University of Louisville, as of 2014

[3] Interpolated

[4] Extrapolated from Rockcastle County projected growth rates

Section 5

SECTION 5
EXISTING ENVIRONMENT IN THE PLANNING AREA

A. Purpose

This chapter provides information on the existing physical, biological, cultural and other resource features within the planning area, and also reviews data on land features, floodplains, general climate and precipitation conditions, wetlands, air quality, and archaeological resources as it relates to the Facilities Plan.

B. Physical Features

Topography & Physiography

The topography of Rockcastle County can vary significantly depending on location. The topography ranges from the hill country in the north and the nearly mountainous terrain to the south to the low conspicuous tableland between Brodhead and Renfro Valley to the gently rolling hills in the west. The elevation of the tableland is approximately 1,200-feet. The highest elevation in the county is approximately 1,640-feet on a ridge near the Rockcastle-Jackson County line. Differences in elevations between the valley bottoms and adjacent uplands are 400-feet or more in many places. The valley sides are steep and abrupt cliffs may be present.

According to the Kentucky Geological Survey, the Planning Area includes parts of both the Mississippian Plateaus (and Pennyroyal region) and Cumberland Plateau physiographic regions. The Mississippian Plateau consists of limestone plains characterized by countless sink holes, sinking streams, streamless valleys, springs and caverns. The Eastern Kentucky Coal Field region is a part of the Cumberland Plateau. The interior of the Eastern Kentucky Coal Field is dominated by forested hills and v-shaped valleys. The inner Eastern Kentucky Coal Field consists of the outcrop of areas of the Pennsylvanian formation strata that extends from Pennsylvania to Alabama.

Geology and Soils

The Planning Area is underlain primarily by the shale of the Mississippian age. However, siltstone and clay are present within the Planning Area as well. To the east of the Planning Area, limestone of the Mississippian age is present.

According to the National Resources Conservation Service (NRCS), the Planning Area is primarily composed of two (2) soils: Weikert channery silt loam and Newark silt loam.

The Weikert series consists of shallow, well-drained soils with rapid permeability. Weikert channery silt loam is generally found along ridges and hilltops. The Newark series consists of very deep, somewhat poorly drained soils formed in mixed alluvium from limestone, shale, siltstone and loess. Newark silt loams are generally found on nearly level floodplains and in depressions.

Floodplains and Wetlands

Floodplains within the Planning Area were discussed in detail in Section 3. Exhibits 3-4 and 3-5 shows these floodplain areas as have been identified by the Federal Emergency Management Agency (FEMA). These areas are important to identify as gravity sewer systems tend to parallel these natural drainage paths just out of the flooding limits. These flood prone areas are also generally prohibited from development which is important when planning for future sewer flows. For parts of the system that are already in the floodplain, measures need to be incorporated in the facility plan to protect them from flood-impaired operation.

Wetlands are those areas that are not deep enough to be referred to as lakes, but are either covered with water or have saturated soil at least part of the year. A wetlands area which supports shrubs and/or trees is considered a swamp. Those wet areas that are treeless but support grasses, rushes and sedges are referred to as marshes. Other areas which are included in the wetlands category are bogs, sloughs, potholes, backwaters and mud flats.

The National Wetlands Inventory Maps were reviewed for the presence of wetlands in the Planning Area. According to the National Wetlands Inventory Map, a small number of freshwater emergent & forested/shrub wetlands exist in the both the northwest and southern portions of the Planning Area. Furthermore, a riverine wetland is located in the northwest portion of the Planning Area. However, this study did not locate any wetland that would be impacted within the Planning Area.

Water Sources and Supply

The City of Brodhead owns and operates a water distribution system that serves its customers. The City of Brodhead purchases its water from the Mt. Vernon Water Treatment Plant (WTP), which is rated to a capacity of 4 MGD. The purchase point is located along KY-150. The City of Brodhead provides its customers with potable water via a well-gridded, looped system consisting of water mains and water storage tanks.

Surface Water and Groundwater

The Planning Area can be divided into three drainage basins; Boone Fork, Dix River and Negro Creek. Additional drainage occurs at sinkholes which are scattered throughout the Planning Area.

Rockcastle County has fourteen (14) water bodies on the 2012 303(d)/305(b) list of Integrated Reports to Congress on Water Quality in Kentucky: Brush Creek, Clear Creek, Cooper Creek, Crooked Creek, Dix River, Dry Fork, Little Negro Creek, Negro Creek, Renfro Creek, Rockcastle River, Roundstone Creek, Skegg Creek, White Oak Creek and Lake Linville. However, as shown in Exhibit 5-1, the Dix River is the only body of water classified as an Impaired Streams within the Planning Area. According to the United States Environmental Protection Agency (USEPA), Negro Creek & Little Negro Creek are not considered threatened or impaired bodies of water. The existing wastewater treatment plant (WWTP) discharges to the Dix River at approximate mile point 78.0 (Longitude 84°25'16.5"W, Latitude 37°24'29.3"N). The existing WWTP's Kentucky Pollutant Discharge Elimination System (KPDES) Permit number is KY0047431. The permit became effective April 1, 2013 and expires on March 31, 2018. According to the USEPA, the Dix River, from mile points 73.9 to 79.3, is listed as an impaired stream due to Escherichia Coli (E. Coli) levels restricting primary contact for recreation with the water. The Total Maximum Daily Load (TMDL) of E. Coli for the Dix River is 240 colonies per 100 mL as directed by the EPA and by the KPDES permit.

The ground water supply availability varies directly with the type of rock formation or aquifer from which it is obtained. The water is considered hard or very hard, and may contain noticeable amounts of iron as well as salt (chlorides) or hydrogen sulfide. Ground water contamination can occur when faulty septic tanks or sewers leak raw sewage into the soil. Currently, no ground water contamination is known to exist in the Brodhead Planning Area, therefore, no remedial measures are being taken. According to the Kentucky Geological Survey, approximately 2,900 people in Rockcastle County rely on private domestic water supplies: 1,100 use wells and 1,800 use other sources. The majority of the wells are drilled on hillsides and are adequate for a domestic supply.

National & State Parks

There are no Kentucky State Parks located within Rockcastle County. The Daniel Boone National Forest, London Ranger District, is the only National Park in Rockcastle County. However, Daniel Boone National Forest is outside of the Planning area. Currently, no State or National Parks will be impacted by the proposed projects within the Planning Area.

Climate & Precipitation

The Planning Area's climate is temperate with moderately cold winters and warm, humid summers. Periods of dry or wet weather do occur. Annual snowfall is variable from year to year, however, the average annual snowfall is approximately 8.5-inches. The average annual number of days with one (1) inch or more of snow is approximately seven (7) days.

Precipitation is fairly well-distributed throughout the year with October having the least rainfall and May the most. Total annual precipitation is approximately forty-seven (47) inches.

The annual mean temperature is 56°F with an average daily high of 65°F and an average daily low of 46°F. The 2013 maximum high was 91°F, whereas, the 2013 minimum low was 9°F.

Air Quality

Air quality in the Planning Area is not categorized as a problem. Air quality problems are normally associated with urban areas or certain industrial sites. The Planning Area does not have the traffic congestion problems or any significant industrial polluters that could seriously affect the areas air quality.

Currently, the State of Kentucky has only two (2) non-attainment areas: Northern Kentucky/Greater Cincinnati (Kenton, Boone & Campbell Counties) and the Greater Louisville area (Jefferson & Bullitt Counties).

C. Biological Features

Plant and animal life in the Planning Area are typical of the Eastern Coal Field region of Kentucky. The three (3) major types of plant communities in the Planning Area are open areas, woodlands and wetlands.

Open areas are composed of well-kept grazing areas on farms, row crop lands and abandoned pastures. The abandoned pastures are in various stages of succession and are composed of a variety of herbaceous plants, scrub woodland trees, and woody vines and briers. There are no known vascular plants which are rare or endangered.

The woodlands are generally of the oak-hickory type. There are three variations of this type and are the rolling upland woodland, the steep slope woodland and the swampy woodland.

The wetlands areas are saturated with water, either permanently or seasonally. These areas are generally considered shallow water areas, with depths no more than a couple

feet deep. Wetland plants are those that grow on moist to wet sites, exclusive of submerged or floating aquatics. The common wetland plants are smartweed, bulrush, pondweed, duckweed, cattails and wetland grasses.

The wildlife population of the Planning Area is composed of those typical of the Eastern Coal Field region of Kentucky. However, Table 5-1 outlines the species of plants and animals that are classified as endangered, threatened or candidate species that must be kept in mind during the planning process.

Table 5-1
Endangered, Threatened and Candidate Species

Group	Species	Common Name	Status
Clams	*Villosa trabalis*	Cumberland Bean	Endangered
Clams	*Pegias fabula*	Littlewing pearlymussel	Endangered
Clams	*Alasmidonta atropurpurea*	Cumberland elktoe	Endangered
Clams	*Ptychobranchus subtentum*	Fluted kidneyshell	Endangered
Flowering Plants	*Spiraea virginiana*	Virginia spiraea	Threatened
Mammals	*Myotis sodalist*	Indiana bat	Endangered
Mammals	*Corynorhinus townsendii virginianus*	Virginia big-eared bat	Endangered

Sources: U.S. Fish and Wildlife Service, Environmental Conservation Online System (07/23/2014)

The more abundant species of animals present in the Planning Area are:

- Hawk
- Owl
- Big Brown Bat
- Geese
- Duck
- Snake
- White-tail Deer
- Thrush
- Gray Squirrel
- Flying Squirrel
- Raccoon
- Chipmunk
- Muskrat
- Shrew
- Turtle
- White-tail Deer
- Cottontail Rabbit
- Mourning Dove
- Wild Turkey

D. Cultural Features

Historic Districts

Rockcastle County has a rare combination of historic and cultural resources. A number of these historic buildings and districts are listed on the National Park Service's National Register of Historic Districts and Places. Presently, four (4) sites are listed as Historic with the National Register. They are as follows:

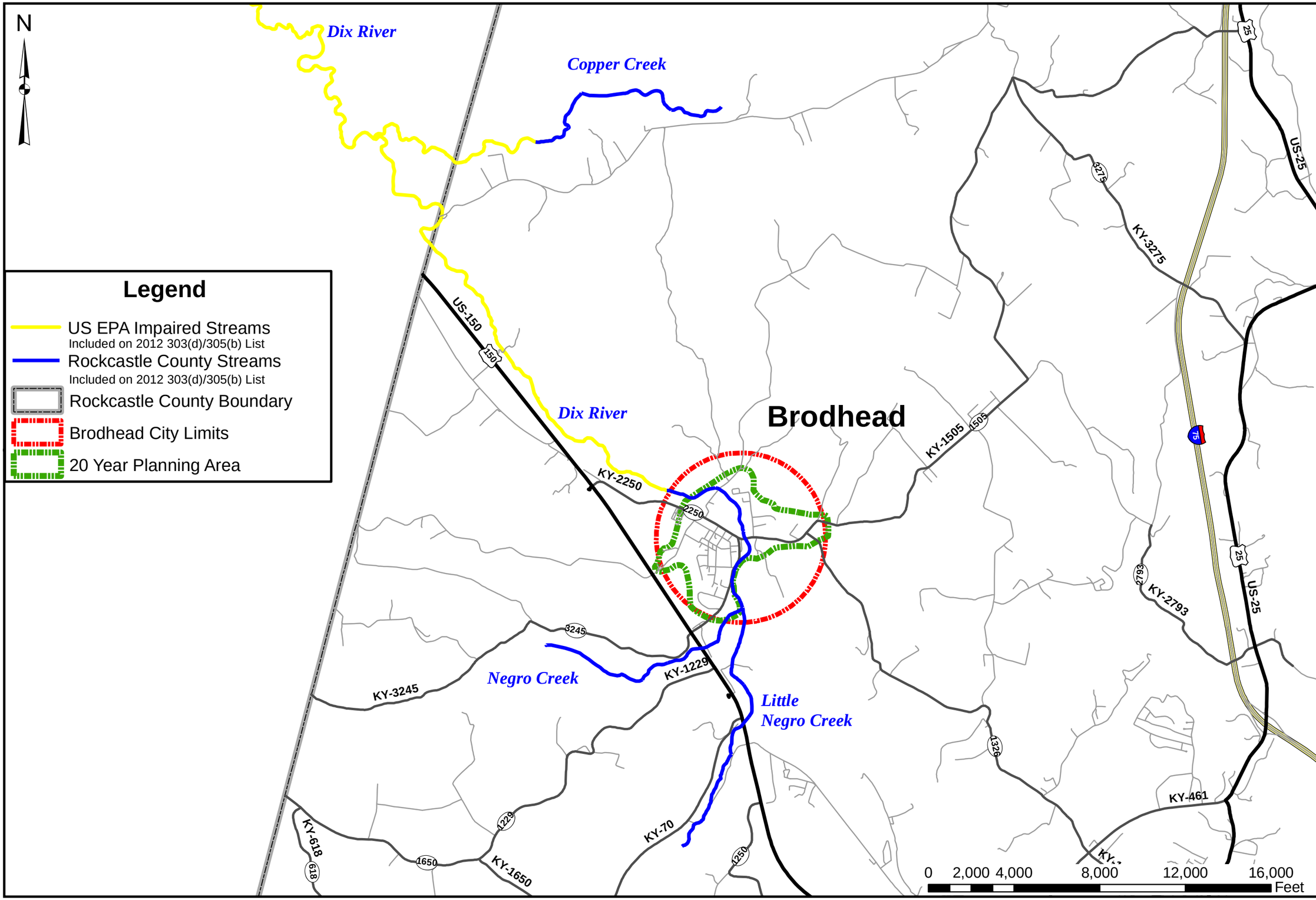
- Bennett Hiatt Log House
- Great Saltpetre Cave
- John Lair House & Stables
- Mount Vernon Commerical District

Currently, none of the listed historic sites will be impacted by the proposed projects within the Planning Area.

E. Other Resource Features

There are no national or state parks or recreational areas within the Planning Area. The Planning Area does not include USDA-designated important Farmland or other environmentally sensitive areas.

City of Brodhead: Rockcastle County Impaired Streams Map



DATE: May, 2015

SCALE 1" = 4,000'

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EXHIBIT 5-1
IMPAIRED STREAMS MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

REVISIONS

NO.	DESCRIPTION	DATE	BY

SCALE: 1" = 4,000'

Section 6

SECTION 6
EXISTING WASTEWATER SYSTEM

A. Purpose

The purpose of this section is to describe the existing wastewater collection and wastewater treatment plant (WWTP) in the Planning Area. Also included is information on existing on-site disposal systems (septic tanks and tile fields), the methods of disposal of by-products from wastewater treatment and a description of problems with operation, maintenance and compliance of the wastewater system.

B. Existing Sewage Collection System

The Brodhead wastewater collection system was originally constructed in 1972. The collection system is considered "separate" as opposed to "combined", which means that there are separate pipes dedicated to transporting storm and sanitary flows. Due to the topography within Brodhead, the collection system consists primarily of gravity flow. The collection system generally flows north to the Wastewater Treatment Plant (WWTP) or to the lift station near City Hall where it is pumped to the WWTP. A full size map of the collection system is located in Appendix B.

In general, the collection system, including gravity sewer lines, pump stations and force mains, is aging. Portions of the collection system are deteriorating and will need to be replaced or rehabilitated in the near future. The system performs well during dry weather, but struggles with inflow and infiltration (I&I) issues during wet weather events. The City has been cited by the Kentucky Division of Water with Notices of Violations (NOVs) relating to the excessive amounts of I&I entering their collection system.

The City completed a Sanitary Sewer Overflow Plan (SSOP) in 2014, which identifies troublesome wet weather problem areas within the collection system. The SSOP report also provides a response plan in the event of a sanitary sewer overflow. A copy of the SSOP report is included in Appendix C.

The City has also completed a Sewer System Evaluation Survey (SSES) in 2014, which outlines the City's plan to rehabilitate or replace portions of their collection sewer system. Included in Appendix D is a portion of this report, which covers the summary, recommendation and schedule for repairs. The City has currently applied for funding from the Kentucky Infrastructure Authority (KIA) and the Community Development Block Grant program (CDBG) to address the sewer system deficiencies identified within the SSES and SSOP.

The wastewater collection system within the Planning Area consists of the following components:

1. **Sewers Manholes**

   The wastewater collection system consists of approximately 166 manholes. The City recently completed a system wide manhole inspection project which included Global Positioning System (GPS) locations of their manholes. This data has been included in the City's base Geographic Information Systems (GIS) mapping.

   The majority of the manholes inspected were constructed of precast concrete and are in relatively good shape. The inspections did reveal a few of the manholes were constructed with coated brick chimneys. There were also some manholes that appeared to have been installed over the existing gravity sewer line, "doghouse" style, however, the carrier sewer pipe was never broken out to allow access to the sewers from the manhole.

   The manhole defects that were identified during this investigation have been included in the SSES report and corrective actions will be addressed per the SSES recommendations.

2. **Gravity Sewers**

   The wastewater collection system consists of approximately 37,500 linear feet of predominantly 8-inch gravity sewer. The majority of the gravity sewer lines are vitrified clay pipes and were constructed in the early 1970's. There are newer sections of sewers that were constructed of either PVC or ductile iron pipes. Table 6-1 shows a summary of the sewer system pipe footage and materials.

Table 6-1
Brodhead Collection System
Pipe Material Summary

Pipe Material	Length (LF)	% of Total Length
Clay	27,000	72%
PVC	9,750	26%
Ductile Iron	750	2%
Total Length	**37,500**	**100%**

Source: CCTV Inspections Reports

   The City has completed a Closed Circuit Television (CCTV) inspection of nearly all of their sewer system. The 37,425-feet of CCTV inspections took place between February 2014 and September 2014. The small sections that were not inspected were due to blockages in the sewers and limited access to the sewers.

A half-sized map of the system is presented in Exhibit 6-1, with a full size map located in Appendix B.

3. Pump Stations

The City currently operates three (3) wastewater pump stations as summarized in the following Table 6-2 and is also shown in Exhibit 6-1.

Table 6-2
Brodhead Wastewater Pump Stations

Pump Station Name	Station Design Capacity (gpm)	Motor Size Horsepower (HP)	Drawdown Pump Test Capacity (gpm)
City Hall Pump Station	**250**		
Pump One (Rehabilitated in 2014)		**5**	200
Pump Two		**5**	30
Rose's 1 Stop Pump Station	**Unknown**		
Pump One		**3**	30
Pump Two		**3**	*
Both Pumps Operating			50
Shaffer Pump Station	**Unknown**	**2**	**

*Controls for Rose's 1 Stop Station will not allow pump 2 to operate independently
**Not enough flow in Shaffer Station to perform drawdown test.

The SSES report identified two (2) of the pump stations as needing rehabilitation work; City Hall & Rose's 1 Stop. The renovation of these pump stations will be included in wastewater treatment plant expansion project per the latest schedule included at the end of the SSES report in Appendix D. Below is a brief description of the condition of each of the City's pump stations:

a. **City Hall Pump Station** was constructed in 1972. The pump station is composed of a 6-foot diameter wet well that is 11.7-feet deep with approximately 1,840 LF of 6-inch force main. The pump station experiences heavy flows during wet weather events as a result of I&I, thus, causing manhole overflows upstream. The station does not have a valve vault; rather the check valves are mounted to the discharge piping within the wet well and the isolation valves are buried underground just outside the wet well. The isolation valves are accessed via valve boxes and tee wrench. To access the check valves, the wet well and station must be taken out of service and drained. Structurally, the wet well is in good

condition. The station piping and valves are in poor condition. Emergency power (i.e., generator) is not provided nor does the force main have a quick connection for emergency pumping. The station does not have an alarm system notifying the City personnel of high water levels. Additionally, the station does not have security fencing. The pump guide rails do not connect to the top slab of the station and are only socketed at the bottom of the station which makes pump maintenance difficult. A final item noted was the inlet sewer from the east enters the wet well near the invert of the station, and thus, the sewer line stays surcharged at all times.

According to a drawdown test conducted on September 10th, 2014, the current pumping capacity of the station is approximately 200 GPM. This flow comes predominately from a recently rebuilt pump that was installed. The second pump in the station contributed very little to the stations discharge, as can be seen in the Table 6-2.

b. **Rose's 1 Stop Pump Station** was constructed around 1983. The pump station is composed of a 5-foot diameter, 14.9-feet deep wet well and two (2) 3-HP pumps with approximately 940 LF of 4-inch force main. The station is experiencing heavy flows during wet weather events as a result of I&I. The station piping and valves are in poor condition. The station does not have a valve vault; rather the check valves are mounted directly to the pumps in the wet well, and are lifted out when the pumps are pulled for service. There are no isolation valves at this station, so when a pump is pulled out of the wet well flow from within the force main backflows into the station wet well. Emergency power (i.e., generator) is not provided nor does the force main have a quick connection for emergency pumping. Furthermore, the station does not have an alarm system notifying WWTP personnel of high water levels. A minor item noted at this pump station is the lack of security fencing.

   According to a drawdown test conducted on September 10th, 2014, the maximum pumping capacity of the station is approximately 50 GPM. The City noted that they are not able to control pump 2 individually and they have to turn both pumps on to energize the pump.

c. **Shaffer Pump Station** was constructed in 2003 by the City. The station appears to be in fair condition and is operating adequately. The station consists of a small 2-HP grinder pump with approximately 580 LF of 4-inch force main. The station currently serves only two (2) customers. The station is located in the front yard of homeowner with trees and shrubbery surrounding it on three sides. Furthermore, the station does not have an alarm system notifying City personnel of high water levels.

   No drawdown test was performed on this station as there was no flow entering the station at the time the City was performing drawdown testing.

Additionally, it was noted that a majority of these stations had similar electrical issues such as, broken electrical conduit, corroded control enclosure, unsealed conduits, no surge or transient voltage surge suppression (TVSS) in the panel and no emergency standby power provision.

C. Existing Wastewater Treatment Facilities

The existing Wastewater Treatment Plant (WWTP) in Brodhead is located in the northern portion of the City off Chestnut Grove Road. The existing plant is a two (2) stage extended aeration activated sludge wastewater treatment plant. The treatment plant was originally constructed in 1972 with a capacity of 150,000 gallons per day (GPD) average daily flow (ADF) and a hydraulic peak of 375,000 GPD. Between 1972 and 1994, the City added a 55,000 gallon surge tank and an intermediate clarifier; however the City no longer has records of that project. In 1995, the City of Brodhead upgraded the WWTP by adding a Flow Splitter Box, a second Final Clarifier, an Aerated Sludge Holding Tank, two (2) Sand Drying Beds, and a RAS/WAS Pumping Station.

The wastewater treatment plant's Kentucky Pollutant Discharge Elimination System (KPDES) Permit No. is KY 0047431, a copy of which can be found in Appendix E. The permit became effective April 1, 2013 and expires on March 31, 2018. The wastewater treatment plant discharge is located at approximate mile point 78.0 (Longitude 84°25'16.5"W, Latitude 37°24'29.3"N) of the Dix River.

Table 6-3, located on the following page, gives a summary of the Discharge Permit limits. Table 6-4 gives a summary of the City's actual Monthly Operating Reports (MOR's) for the 2012 through 2014 time period.

Table 6-3 Brodhead Wastewater Pump KPDES Permit Current Discharge Limitations and Monitoring Requirements (Expires March 31, 2018)						
Effluent Characteristics	**Discharge Limitations**				**Monitoring Requirements**	
	Monthly Average	**Weekly Avg**	**Monthly Average**	**Weekly Avg**	**Measurement Frequency**	**Sample Type**
Effluent Flow (Design 0.150 MGD)	Report	Report	N/A	N/A	Continuous	Recorder
Influent Flow (MGD)	Report	Report	N/A	N/A	1/Week	Instantaneous
	lbs/day	**lbs/day**	**mg/l**	**mg/l**		
Effluent $CBOD_5$	12.5	18.8	10	15	1/Week	24 Hr Composite
Influent $CBOD_5$	Report	Report	Report	Report	1/Week	24 Hr Composite
Percent Removal $CBOD_5$	N/A	N/A	85% or Greater	N/A	1/Month	Calculated
Effluent TSS	37.5	56.3	30	45	1/Week	24 Hr Composite
Influent TSS	Report	Report	Report	Report	1/Week	24 Hr Composite
Percent Removal TSS (%)	N/A	N/A	85% or Greater	N/A	1/Month	Calculated
Ammonia Nitrogen						
May 1 – October 31	5.01	7.51	4.0	6.0	1/Week	24 Hr Composite
November 1 – April 30	12.5	18.8	10.0	15.0	1/Week	24 Hr Composite
Dissolved Oxygen (Min.)	N/A	N/A	Not less than 7.0	N/A	1/Week	Grab
Total Residual Chlorine	N/A	N/A	0.011	0.019	1/Week	Grab
Total Phosphorus	N/A	N/A	Report	Report	1/Week	24 Hr Composite
Total Nitrogen	N/A	N/A	Report	Report	1/Week	24 Hr Composite
Escherichia Coli (N/100 ml)	N/A	N/A	130	240	1/Week	Grab
PH (Standard Units)	N/A	N/A	6.0 (min)	9.0 (max)	1/Week	Grab

Table 6-4
Performance Characteristics
City of Brodhead Wastewater Treatment Plant

Year	Month	Effluent Flow			Influent TSS			Effluent TSS		Influent BOD			Effluent BOD		Effluent pH		AVG NH_3-N		AVG Phosphorus		AVG Eff. DO	AVG Eff. E. Coli
		AVG	MAX	Peak	AVG	MAX	AVG	AVG	AVG	AVG	MAX	AVG	AVG	AVG	MAX	MIN	Inf.	Eff.	Inf.	Eff.		
		(MGD)		Factor	(mg/l)		(lbs/day)	(mg/l)	(lbs/day)	(mg/l)		(lbs/day)	(mg/l)	(lbs/day)	(SU)		(mg/l)		(mg/l)		(mg/l)	(#/100ml)
2012	January	0.309	0.573	1.85	47	64	148	1	3.2	89	109	273	2	5	7.36	6.97	5.0	0.25	--	0.81	7.5	1
2012	February	0.250	0.429	1.72	81	180	167	2	3.0	145	209	290	2	4	7.43	6.93	7.8	0.25	--	0.99	7.5	1
2012	March	0.280	0.543	1.94	77	140	165	3	7.1	121	145	222	3	7	7.16	7.04	8.8	0.26	--	1.06	7.5	3
2012	April	0.135	0.359	2.66	114	138	114	2	2.1	221	293	216	4	5	7.17	7.04	17.7	0.46	--	2.07	7.5	37
2012	May	0.242	0.522	2.16	50	80	90	38	70.4	64	95	114	61	123	7.14	6.84	8.0	1.58	--	1.23	7.5	2
2012	June	0.091	0.145	1.59	258	388	190	4	2.9	245	298	178	2	2	7.14	6.72	19.4	0.26	--	1.89	7.5	2
2012	July	0.148	0.407	2.75	276	536	219	4	3.1	271	366	253	2	2	7.34	6.80	15.7	4.00	--	2.40	7.5	2
2012	August	0.102	0.168	1.65	169	195	157	5	4.3	267	327	250	3	3	7.27	6.87	21.3	0.55	--	2.37	7.5	2
2012	September	0.156	0.407	2.61	250	318	291	4	4.9	244	282	275	5	5	7.01	7.32	14.4	0.62	--	1.67	7.5	2
2012	October	0.183	0.566	3.09	128	170	172	5	7.4	130	218	160	2	3	7.14	6.96	15.8	0.25	--	1.27	7.5	1
2012	November	0.158	0.471	2.98	154	178	242	4	6.3	140	176	211	2	3	7.37	7.05	11.8	0.25	--	1.28	7.5	1
2012	December	0.288	0.600	2.08	99	126	230	4	9.0	54	80	113	2	5	7.31	6.92	5.1	0.25	--	0.68	7.5	1
2013	January	0.382	0.669	1.75	646 ‡	1490 ‡	2012 ‡	4	14.4	265 ‡	527 ‡	1033 ‡	2	6	7.45	7.05	12.7	0.25	--	0.34	7.5	1
2013	February	0.278	0.632	2.27	479 ‡	856 ‡	981 ‡	4	8.1	157 ‡	224 ‡	309 ‡	2	5	7.31	6.93	8.8	0.25	--	0.86	7.5	1
2013	March	0.404	0.576	1.43	882 ‡	1370 ‡	3537 ‡	4	17.5	622 ‡	1040 ‡	2483 ‡	2	7	7.38	7.02	17.4	0.25	--	0.59	7.5	1946 †
2013	April	0.315	0.680	2.16	515 ‡	870 ‡	1592 ‡	4	10.7	352 ‡	794 ‡	1017 ‡	15	39	7.36	7.02	12.4	0.91	--	1.13	7.5	4
2013	May	0.306	0.602	1.97	237 ‡	652 ‡	613 ‡	9	16.6	160 ‡	409 ‡	286 ‡	51	130	7.34	7.06	8.5	1.98	--	1.58	7.5	5
2013	June	0.160	0.400	2.50	214	470	320	7	7.9	220	427	240	66	88	7.37	6.97	13.0	2.25	--	1.32	7.5	1
2013	July	0.268	0.593	2.21	74	112	105	4	7.7	98	142	150	52	116	7.22	6.98	--*	1.44	--	0.64	7.5	1
2013	August **	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2013	September	0.139	0.395	2.84	130	188	136	5	5.3	134	224	124	15	17	7.18	6.83	--	1.49	--	2.18	7.5	4
2013	October	0.139	0.431	3.10	197	34	244	4	7.2	168	255	186	48	56	7.36	6.92	--	0.99	--	2.06	7.5	4
2013	November	0.265	0.474	1.79	439 ‡	1010 ‡	813 ‡	3	5.3	217 ‡	481 ‡	400 ‡	4	9	7.43	7.03	--	0.60	--	0.92	7.6	3
2013	December	0.265	0.601	2.27	793 ‡	2890 ‡	1305 ‡	3	6.5	211 ‡	628 ‡	364 ‡	10	22	7.56	7.03	--	4.29	--	0.98	7.6	231
2014	January	0.159	0.335	2.11	596 ‡	1060 ‡	894 ‡	8	9.7	440 ‡	776 ‡	652 ‡	42	37	8.02	6.68	--	0.72	--	0.73	7.0	1
2014	February	0.328	0.568	1.73	478 ‡	520 ‡	1734 ‡	6	22.6	549 ‡	694 ‡	2033 ‡	229	676	7.64	7.02	--	0.49	--	0.57	7.0	1
2014	March	0.283	0.538	1.90	823 ‡	1340 ‡	1968 ‡	11	25.5	1105 ‡	1540 ‡	2794 ‡	415	999	7.24	6.73	--	0.32	--	1.10	7.1	1
2014	April	0.227	0.558	2.46	196 ‡	1490 ‡	1343 ‡	5	8.9	782 ‡	1390 ‡	1404 ‡	63	118	7.36	6.85	--	2.46	--	0.86	7.1	1
2014	May	0.190	0.585	3.08	2453 ‡	5900 ‡	7229 ‡	29	41.0	1220 ‡	1850 ‡	2764 ‡	300	532	7.11	6.46	--	3.33	--	0.76	7.0	1
2014	June	0.097	0.172	1.77	952 ‡	2140 ‡	1070 ‡	41	30.5	531 ‡	926 ‡	554 ‡	193	152	6.82	6.35	--	7.49	--	2.15	7.2	6
2014	July	0.102	0.317	3.11	259 ‡	518 ‡	300 ‡	5	5.3	300 ‡	430 ‡	312 ‡	139	131	7.29	5.92	--	1.51	--	2.28	7.1	3
2014	August	0.143	0.321	2.24	76	102	94	4	5.0	214	291	267	95	88	7.47	6.19	--	0.35	--	1.18	7.0	1
2014	September	0.148	0.576	3.89	78	166	98	3	3.5	209	286	219	57	82	7.31	6.72	--	4.00	--	1.44	7.0	1
2014	October	0.241	0.616	2.56	110	290	138	2	3.0	171	382	227	34	76	6.40	7.31	--	0.73	--	1.19	7.0	4
2014	November	0.290	0.520	1.79	51	70	140	2	6.5	109	145	327	61	162	6.92	7.23	--	0.37	--	0.79	7.0	1
2014	December	0.225	0.571	2.54	72	178	81	13	32.0	163	365	188	79	181	7.09	7.97	--	0.32	--	0.75	7.2	2
Avg (2012-2014)		**0.22**	**0.48**	**2.30**	**129**	**196**	**169**	**7**	**12.1**	**166**	**244**	**213**	**59**	**111**	**7.3**	**6.9**	**12.4**	**1.3**	**--**	**1.26**	**7.35**	**9.8**

* City stopped testing for influent ammonia between July 2013 - December 2014
** City was unable to locate DMR records for August 2013.
† Number not included in Average calculation. City experienced an issue with the chlorination equipment.
‡ Number not included in Average calculations. Influent samples were misrepresented due to solids buildup at sampling point within the Surge tank. Influent sampling point has been relocated.

Exhibit 6-2 depicts the flow schematic of the existing wastewater treatment facilities.

Major treatment components include:

1. **Coarse Bar Screen**

   The wastewater treatment plant has a fixed coarse bar screen located in the influent wet well approximately 2-feet from the inlet of the gravity sewer. The screen is used to protect downstream processes. The bar screen spacing is believed to be 0.5-inch wide; however the City has limited design information on the screen. The City seldom inspects the screen due to it being in a confined space. Cleaning of the screen is also done on a very infrequent basis.

2. **Influent Pumping Station**

   The plant influent pumping station has two (2) dry-pit centrifugal raw sewage pumps and one (1) dry-pit centrifugal return sludge pump. The station piping and valves are in poor condition. According to a drawdown test conducted on September 10th, 2014, the influent pumping station has a capacity of approximately 330 GPM during average wet well depths. The location of the dry pit pumps is in a small confined basement making servicing pumps difficult.

   The station also experiences clogging of pumps due to rags & disposable wipes being flushed by the Rockcastle Health & Rehabilitation Center (nursing home). This ragging issue is worse on one pump who's intake pipe is believed to be pumping water from the front side of the bar screen. The station also has electrical controls and starter issues causing occasional operational issues with the station.

2. **Surge Tank**

   The Raw Sewage Pump Station pumps to a Comminutor (sewage grinder) which is located at the inlet to an existing Surge Tank. The Surge Tank was not part of the original 1970's wastewater plant project but was added prior to the 1995 improvements (the City has no design drawings for this addition).

   The 60,000 gallons welded steel Surge Tank was designed to provide flow equalization during wet weather events. The tank was equipped with dual 33 URAI Roots blowers (5-HP each), air piping and a diffuser system. Two effluent submersible (0.5-HP) pumps are utilized to pump out of the tank into a head box which drains to the first aeration basin. As part of the 1995 project, the City added one foot of concrete to the bottom of the tank to address flotation issues with the tank in high groundwater events. This reduced the capacity of the tank to approximately 55,000 gallons.

At the current peak wet weather flows (ranging from 300,000 to 680,000 gpd), the surge tank is too small to provide significant temporary storage. In addition to the limited size of the Surge Tank, it is in very poor condition. The walls of the tank are badly rusted and pitted, such that welders will no longer make repairs to the tank walls due to the thin wall steel. The aeration system is inoperable with one of the blowers out of service, parts of the air header piping corroded through above the normal water level and the diffusers clogged. The City has recently started by passing flow around the surge tank altogether.

3. Aeration Basins

The existing Brodhead wastewater plant is a two (2) stage extended aeration activated sludge treatment plant. The first stage aeration basin (carbonaceous BOD removal) and the second stage aeration basin (nitrogenous BOD removal) are both 30' x 30' square aeration basins with a side water depth of 12-feet. The volume of the each basin is approximately 81,000 gallons. Each basin is aerated by an existing 8-HP floating mechanical aerator. Aerators are controlled by timers. Both basins appear to be well-mixed and operating normally.

4. Intermediate Clarifier

The Aeration Basin No.1 effluent flows to an intermediate clarifier. The intermediate clarifier was not part of the original 1970's wastewater plant project but was added prior to the 1995 improvements (the City has no design drawings for this addition).

The intermediate clarifier is a 10' x 31.5' x 10.8' welded steel structure with a side water depth of 9.5-feet (approximately 22,380 gallons). The intermediate clarifier is currently operational but is not appropriately sized for the amount of flow it experiences. In addition, the steel shell is rusted and pitted. Return sludge from the intermediate clarifier is pumped back to the first aeration basin via two (2) 0.5-HP submersible pumps. These pumps have experienced operational issues for the City during the past few years, however, the City has recently rebuilt these pumps and had the pump control panel serviced resulting in better operation of the pumps.

5. Final Clarifiers

The effluent from Aeration Basin No. 2 flows to a flow splitter box designed to splits flow between the two (2) existing Final Clarifiers.

The "Old" Final Clarifier was constructed in the original 1970 construction and is 25-feet in diameter with side water depth of 8-feet. This clarifier drive unit has been out of operation for several years requiring all current wastewater flow to be treated by the "New" Final Clarifier. Due to the shallow construction and limited effectiveness of the "Old Clarifier" the City has no plans to reinstate this unit.

The "New" Final Clarifier was constructed in 1995 and is 22-feet in diameter with a side water depth of 12-feet. The structure is in good conditions and the drive unit is functioning normally.

6. Return Activated Sludge (RAS/WAS) Pump Station

Sludge enters the RAS/WAS pump station concrete wet well through a 4-inch ductile iron gravity sewer fed by the telescoping valve located at each clarifier. The RAS/WAS is then lifted by one of two submersible pumps (3-HP and 105 gpm at 27 ft TDH) to either of the aeration basins through a 4-inch force main.

The existing Return/Waste Sludge Pumping Station consists of a 6-foot diameter precast concrete wet well that is 20-feet deep. The station is reported to be in good condition and operating well.

7. Chlorine Contact Basin & Dechlorination (Sulfur Dioxide) Basin

Clarifier effluent flows to the existing Chlorine Contact Basin via 8-inch diameter lines. The chlorine contact basin is a 7-feet by 10-feet concrete chamber with a side water depth of 8-feet (4,189 gallons). Chlorine gas is stored in two (2) one hundred-fifty pound cylinders. Disinfection utilizes a chlorinator that disperses chlorine as a solution to the disinfection basin.

The wastewater treatment plant has experienced problems with the chlorine disinfection system in the past. The chlorine feed system is not flow paced and currently both the existing chlorine and sulfur dioxide cylinder scales are not operational. A previous leak in the chlorine solution line was reported to be the cause of previous failed Escherichia Coli tests as can be seen in previous "Notice of Violations" (see Appendix A).

8. Dechlorination (Sulfur Dioxide) and Post Aeration Basin

Flow exits the chlorine contact basin through a V-notch weir, used for effluent flow measurement, into another channel which allows for post aeration and dechlorination. The dechlorination/post aeration basin is a 7-feet by 8-feet concrete chamber with a side water depth of 7-feet (2,400 gallons).

Dechlorination utilizes sulfur dioxide to reduce chlorine concentrations in the final effluent to acceptable levels. The sulfur dioxide is stored in one hundred-fifty pound cylinders and supplied through a sulfonator to a feed point at the end of the dechlorination basin.

The dissolved oxygen concentration in the final effluent is increased by utilizing a Roots positive displacement blower with diffused aeration.

9. Effluent Flow Measurement

Effluent flow monitoring is provided by a triangular V-notch weir with an ultrasonic flow meter. The V-notch weir is located after the Chlorine Contact Basin and before the Post Aeration/dechlorination basin.

10. Aerated Sludge Holding /Aerobic Digester & Sludge Dewatering (Drying Beds)

The plant solids are wasted to an existing aerated Sludge Holding Tank (Aerobic Digester). This concrete structure is 28-square feet by 12-feet deep (70,376 gallons) and was constructed in the 1995 improvements project. The tank contains a 10-HP post moored floating aerator. The sludge holding tank was designed with a 2-HP submersible pump and 4-inch force main to waste sludge to one of four (4) existing Sand Drying Beds; however, none of the existing Sand Drying Beds are currently operational. The City's current method of sludge disposal is to contract with a private sludge hauling company to convey and dispose of the liquid sludge from the tank.

Table 6-5 compares the current operating conditions, the original design conditions and the design criteria for the existing wastewater treatment plant.

The comparison of the existing operating conditions to the design criteria can be summarized as follows:

- The average day flow hydraulic capacity is exceeded by 0.07 MGD on average for the 2012 – 2014 timeframe with the largest peak flow event exceeding the peak capacity by 0.305 MGD.
- The aeration basins operations exceed the design criteria.
- The surface overflow rate of the final clarifiers exceed the design criteria, with only the one clarifier operational.
- The chlorine contact basin operations exceed the design criteria during peak flow events.
- The sludge holding tank does not operate within the design criteria.

Table 6-5
Evaluation of Existing Wastewater Treatment Plant

	Existing Conditions		Design Conditions		Design Criteria	
Influent Characteristics:						
Flows Avg	0.22	MGD	0.15	MGD	0.15	MGD
Peak	0.68	MGD	0.375	MGD	0.375	MGD
Existing dry weather flows range between 0.08 and 0.13 MGD						
BOD (Avg)	166	mg/L (ADF)	200	mg/L (ADF)	200	mg/L (ADF)
	304	lbs/Day	250	lbs/Day	250	lbs/Day
TSS (Avg)	129	mg/L (ADF)	200	mg/L (ADF)	200	mg/L (ADF)
	237	lbs/Day	250	lbs/Day	250	lbs/Day
NH_3-N (Avg)	12.4	mg/L (ADF) *	25	mg/L (ADF)	25	mg/L (ADF)
	22.8	lbs/Day	31.3	lbs/Day	31.3	lbs/Day
* The City stopped testing for influent ammonia NH_3-N in June of 2013.						
Primary Treatment:						
Manual Bar Screen (Unknown Size)	0.68	MGD (Peak)	0.375	MGD (Peak)	0.375	MGD (Peak)
Biological Treatment:						
Extended Aeration (2) Stage Treatment						
(2@ 30' x30'x 12' or 10,800 cft each)						
Total Volumn in Gallons =	161,568					
Hydraulic Loading at ADF						
Detention Time	17.6	Hrs	25.9	Hrs	24	Hrs
Organic Loading at ADF	14.1	lbs of BOD/1000 CF	11.6	lbs of BOD/1000 CF	18	lbs of BOD/1000 CF
Aeration						
(1 Aerator / Basin @ 5 HP Each)						
Intermediate Clarification:						
1 - 10' x 31.5' Rectangular Clarifier, 9.5' Deep						
Total Surface Area in S.F. =	315					
Surface Overflow Rate, Peak Hour	2,159	GPD/SF	1,190	GPD/SF	800	GPD/SF
Solids Loading Rate, Peak Hr + RAS	80.22	lbs/Day/SF	47.66	lbs/Day/SF	35	lbs/Day/SF
Final Clarification:						
1 - 25' Dia. Circular Clarifier, 8' Deep						
1 - 22' Dia. Circular Clarifier, 12' Deep						
Initial Design Conditions - 25' Clarifier Only						
Surface Overflow Rate, Peak Hour	Not currently in use		764	GPD/SF	800	GPD/SF
Solids Loading Rate, Peak Hr + RAS	Not currently in use		30.58	lbs/Day/SF	35	lbs/Day/SF
Current Normal Conditions - 22' Clarifier Only						
Surface Overflow Rate, Peak Hour	1,789	GPD/SF	987	GPD/SF	800	GPD/SF
Solids Loading Rate, Peak Hr + RAS	66.48	lbs/Day/SF	39.49	lbs/Day/SF	35	lbs/Day/SF
Both Clarifier Operating *						
Surface Overflow Rate, Peak Hour	781	GPD/SF **	431	GPD/SF	800	GPD/SF
Solids Loading Rate, Peak Hr + RAS	29.01	lbs/Day/SF **	17.24	lbs/Day/SF	35	lbs/Day/SF
** This assumes that the City repaired the 25' clarifier and returned it to service						

Table 6-5 (Continued) Evaluation of Existing Wastewater Treatment Plant						
	Existing Conditions		Design Conditions		Design Criteria	
Disinfection:						
Chlorine Contact Basin						
1- 10' x 7' x 8' deep or total volumn =	4,188.80	Gallons				
Hydraulic Detention Time	8.9	Min (Peak)	16.1	Min (Peak)	15	Min (Peak)
Post Aeration:						
Dechlorination/Post Aeration Basin						
1- 8.35' x 7' x 6.9' deep or total volumn	3,016.72	Gallons				
1 - Roots Blower with two diffusers						
Dissolved Oxygen	7.35	mg/L	7.0	mg/L	7.0	mg/L
Aerated Sludge Holding /Aerobic Digestion:						
1-Aerated Sludge Holding Basins 28' x28' 12'						
Vol = 70,376 Gal						
Detention Time @ 2.0% Solids	39	Days	47	Days	60	Days
Volume/Population Equivalent	7.5	CF/PE	7.5	CF/PE	4.5	CF/PE
Aeration						
1 - 10 H.P. Post Moored Floating Aerator						
Dissolved Oxygen	>2	mg/l	2	mg/l	2	mg/l
Sludge Dewatering Drying Beds:						
2 - Beds 20' x 25'-8"						
2 - Beds 20' x 37'-6"						
Total Area in (S.F.) = 2527	2.02	S.F./P.E.	2.02	S.F./P.E.	2.5	S.F./P.E.

D. Wastewater System Staff

The City of Brodhead currently has a wastewater system staff of two (2) full-time employees to operate and maintain the wastewater treatment plant and collection system. At the present time, each of the two (2) staff members are working toward their required certifications. Until such time that the staff member obtains their certifications, the City of Brodhead has contracted with Mr. Devon Shelton, a licensed operator, to train and oversee the work being performed by the City's full-time wastewater system employees per 401 KAR5:010. A table presenting the operators, their title, classification and their certification number is shown below.

Table 6-6
Brodhead WWTP and
Wastewater Collection System Staff

Name	Title	Cert. No.	Cert. Level
Wastewater Treatment Plant Certification			
Devon H. Shelton	Trainer (Temporary Superintendent)	25333	II
Shannon Cash	Operator	N/A	In Training
Brian Mullins	Operator	N/A	In Training
Collections System Certifications			
Devon H. Shelton	Trainer (Temporary Superintendent)	25334	II
Shannon Cash	Operator	N/A	In Training
Brian Mullins	Operator	N/A	In Training

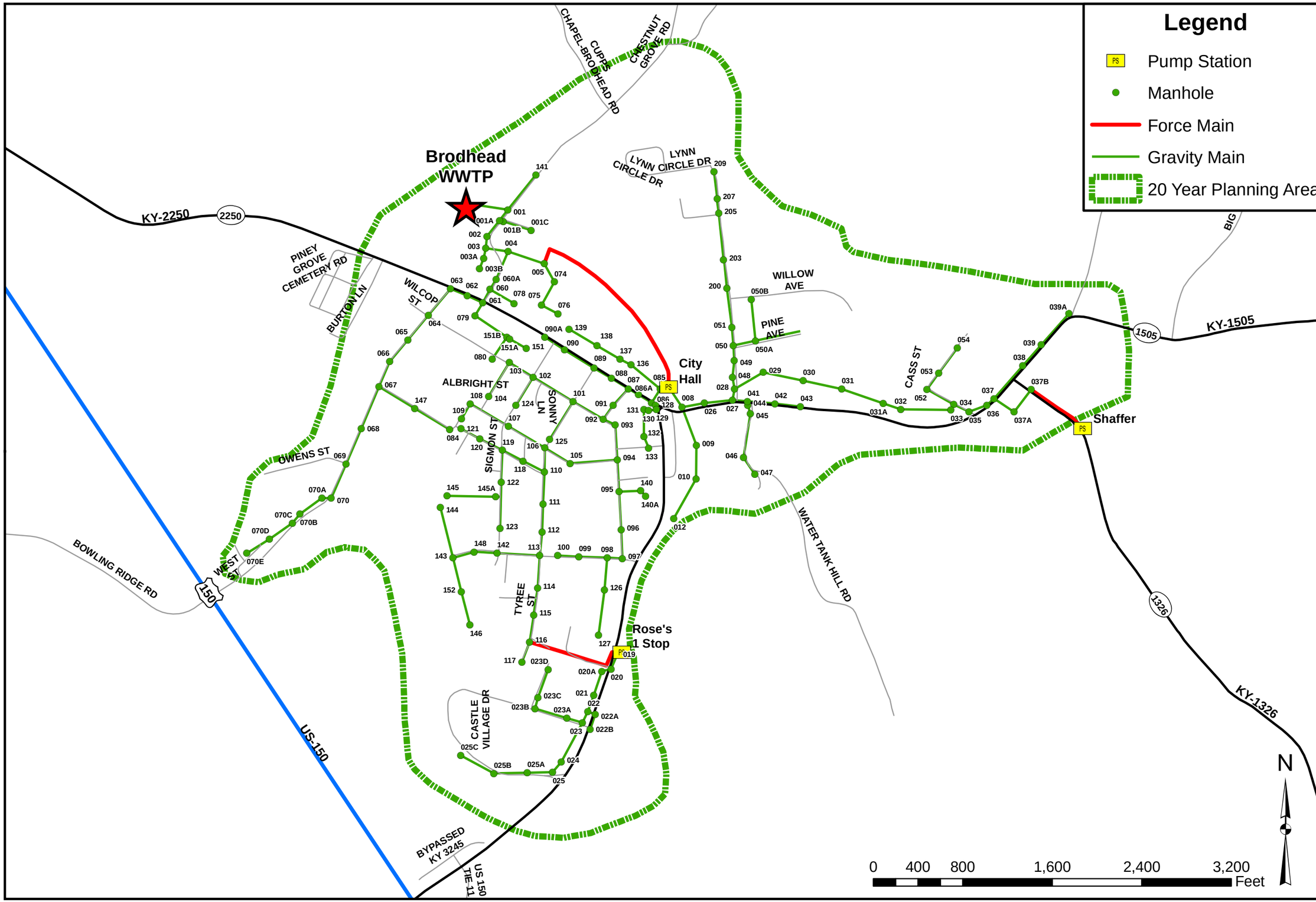
E. On-Site Disposal within the Planning Area (septic tanks)

The Rockcastle County Health Department was contacted to discuss the existence and condition of septic tanks in the Brodhead Planning Area. Ms. Clara Patton with the Health Department said she was unaware of any septic tanks or straight pipe discharges located within the City's existing service area. She further indicated that she had not received any complaints regarding septic tank failures nor been called out to inspect any septic tanks.

Ms. Patton indicated that it would be fair to assume that those customers which are currently being served by City water, but are in areas where sewers have not yet been installed, would be on septic tanks. Based on the current aerial mapping it would appear there are approximately 42 homes located just outside of the City limits that would fall into this category.

Exhibit 6-3 depicts these existing residential areas where it has been assumed customers are currently operating on a septic tank sewer systems.

City of Brodhead: Sewage Collection System Map



DATE: May, 2015
SCALE: 1" = 800'
SHEET NO. 6-1

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EXHIBIT 6-1
SEWAGE COLLECTION SYSTEM MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:
DRAWN:
REVIEWED:
APPROVED:

NO.	DESCRIPTION	DATE	BY
	REVISIONS		

GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

SCALE: 1" = 800'

City of Brodhead: Existing WWTP Flow Diagram

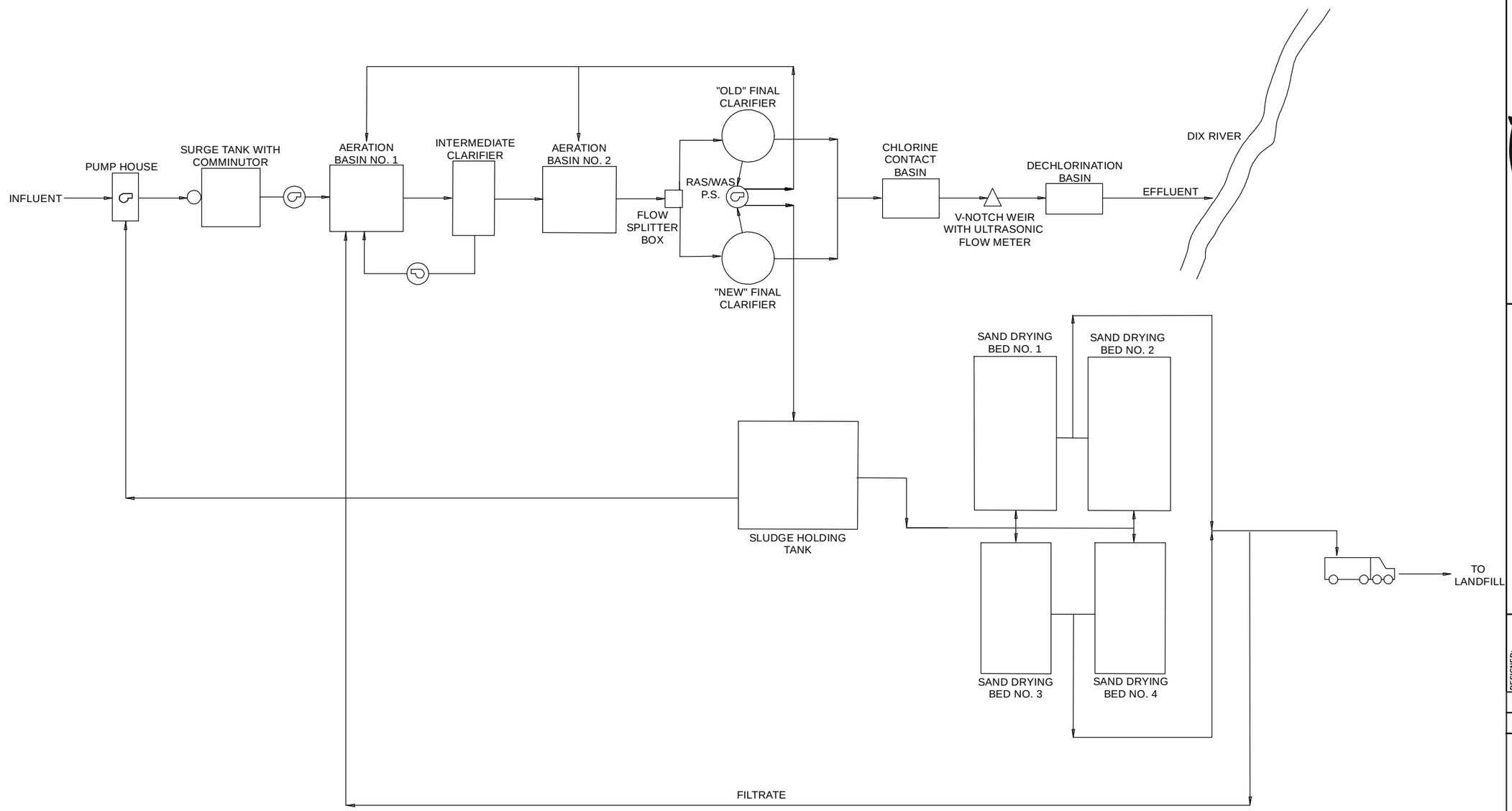

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EXHIBIT 6-2
FLOW DIAGRAM FOR THE EXISTING WASTEWATER TREATMENT PLANT
CITY OF BRODHEAD, KENTUCKY

DESIGNED:
DRAWN:
REVIEWED:
APPROVED:

NO.	DESCRIPTION	DATE	BY

REVISIONS

CLIENT PROJECT NO.

GRW PROJECT NO. 3929-01

SCALE: N/A

City of Brodhead: Existing Septic System Currently on City Water Service

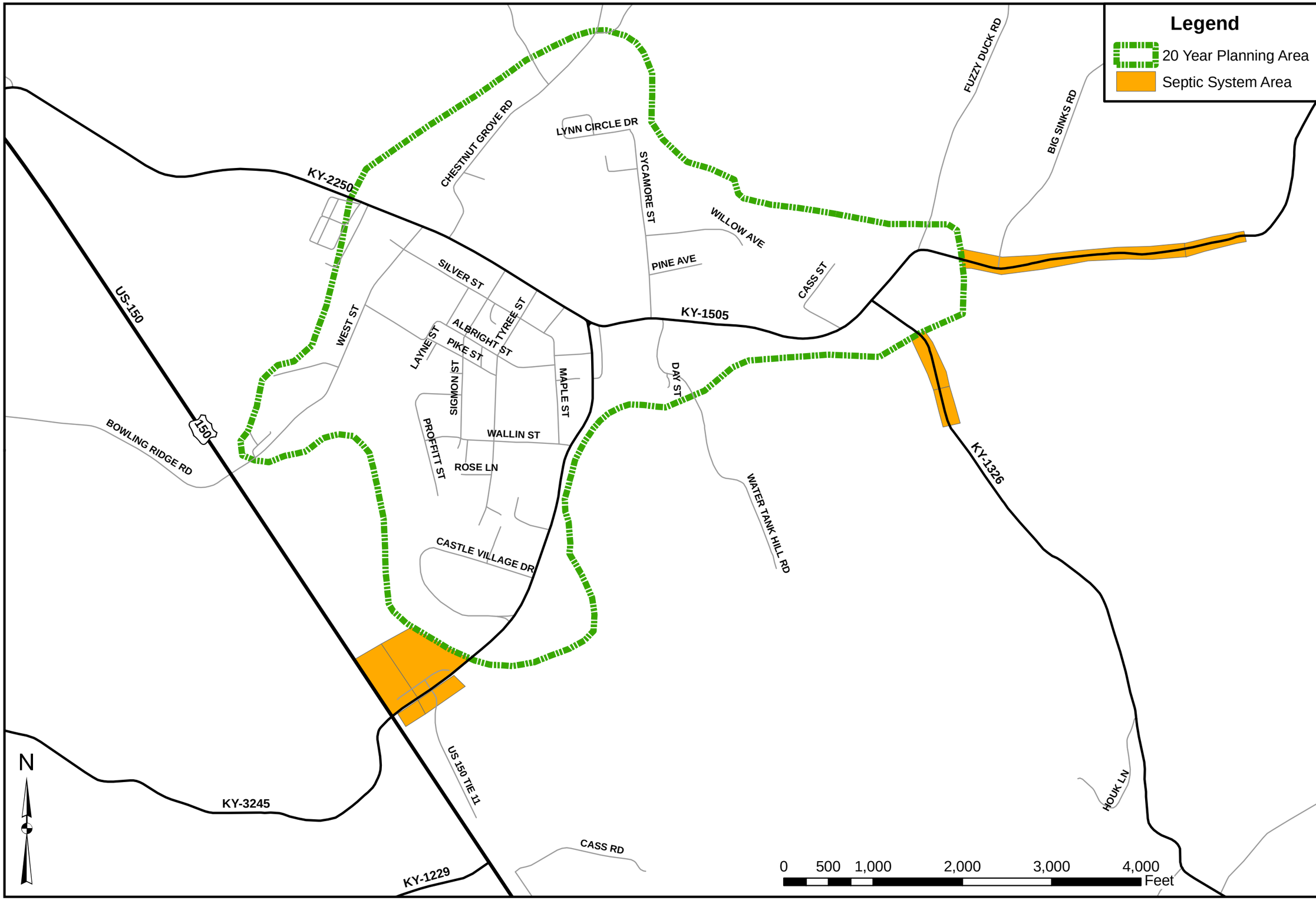

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EXHIBIT 6-3
EXISTING SEPTIC SYSTEMS
CURRENTLY ON CITY WATER SERVICE
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

NO.	DESCRIPTION	DATE	BY

REVISIONS

GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

SCALE: 1" = 1000'

Section 7

SECTION 7
FORECASTED WASTEWATER FLOWS AND LOADS IN THE PLANNING AREA

A. Purpose

The purpose of this section is to project the flows and characteristics of wastewater generated within the Detailed Planning Area for the Planning Period from 2014 through 2034. These flow rates and characteristics will be used in the analysis and design of wastewater collection and treatment systems to meet Kentucky Pollutant Discharge Elimination System (KPDES) permit requirements and discharge limitations throughout the Planning Period. This section details the existing and projected wastewater flows and characteristics.

B. Existing Wastewater Flows

Wastewater in the City of Brodhead is treated at the Brodhead Wastewater Treatment Plant (WWTP) in the northern portion of the City. The Brodhead WWTP is currently rated for an average daily treatment capacity of 150,000 gallons per day (GPD) and a peak hydraulic capacity of 375,000 GPD.

The average daily flow (ADF) to the Brodhead WWTP over the last five years (January 2010 through 2014) is 221,150 GPD and the peak day flow (PDF) during the same time period was 680,000 GPD in April 2013. Wet weather periods have also led to higher ADFs, for example in March of 2013, the ADF was 404,000 GPD which is 269% of the rated plant hydraulic capacity of 150,000 GPD. Plant flows are significantly influenced by wet weather infiltration/inflow. During dry weather periods, plant flows typically average 100,000 ± GPD.

ADFs and PDFs for the last five years are provided in Table 7-1. The WWTP performance data for the past three years is tabulated in Table 6-4 from the previous section.

Table 7-1
Average and Peak Day Flows
Brodhead WWTP

Year	Average Daily Flow (GPD)	Peak Day Flow (GPD)
2010	146,000	461,000
2011	272,000	578,000
2012	196,000	573,000
2013*	266,000	680,000
2014	202,750	616,000

* Note – Records for August 2013 unavailable

The City of Brodhead has twelve (12) commercial sewer customers. Furthermore, City of Brodhead has one (1) active permitted industrial dischargers to the City's wastewater system: EST Tool & Machine. Table 7-2 lists the five largest sewer customers.

Table 7-2
Five Largest Sewer Customers

Industry	Flow (GPD)
Rockcastle Health & Rehab	6,550
Brodhead Elderly Apartments	1,400
Rockcastle Board of Education	1,400
EST Tool & Machine	450
Brodhead Car Wash	400
Total	**10,200**

C. Projected Wastewater Flows

To project the wastewater flows for this study, the planning area was divided into two categories: inside the existing service area and projected growth areas outside the existing service area.

1. Existing Service Areas Projected Wastewater Flows

The City of Brodhead's average number of customers for the past five years have been as follows: 453 in 2010, 452 in 2011, 469 in 2012, 465 in 2013 and 460 in 2014. These customers represent all types of customers within the service area limits. All customers are located within the City limits, with the exception of EST Tool & Machine, which is located just outside the City Limit and has a private lift station and force main which pumps to the City's sewer facilities.

The average daily flow per customer (based on all customer types, residential, commercial and industrial) was calculated for each of the last five years based on actual WWTP flows and customer counts provided by the City. These numbers were then averaged to produce the average daily flow per customer of 466.3 GPD. It is known that the City of Brodhead experiences heavy amounts of inflow & infiltration (I&I) in their sewer collection system resulting in higher than normal (peak) flows at their treatment plant. A Sanitary Sewer Evaluation Survey (SSES) has been completed which includes recommended improvements to reduce the amount of I&I that the system experiences. Therefore, the calculated flow rate was then reduced by 10 percent to account for the estimated reduction in I&I resulting from the City's proposed Sewer Rehabilitation Project. This equated to an average daily flow of 420 GPD per customer. This flow rate was then multiplied by the number of projected

customers to obtain the projected average wastewater flows inside the existing service area. These projections are reflected in the "Average Wastewater Flow" column of Exhibit 7-1.

2. Projected Wastewater Flows from Future Growth Areas

In order to project wastewater flows in the areas outside the existing service area, GRW consulted with the City to determine areas of potential growth. Presently, the City of Brodhead and Rockcastle County do not have Planning and Zoning departments. Therefore, GRW relied on discussions with City personnel to determine areas of future residential and commercial growth. These meetings resulted in estimated timeframes for each undeveloped area to develop within 3-10 years or 11-20 years. No industrial growth is expected. The results from the discussions can be visually seen on Exhibit 7-2. Table 7-3 illustrates the total area of future growth for each land use type.

Table 7-3
Future Land Use Development Area Per Period

Land Use	Expected Area (Ac) for 0-2 Year	Expected Area (Ac) for 3-10 Year	Expected Area (Ac) for 11-20 Year
Residential	0	21	10
Commercial	0	2	1
Industrial	0	0	0

The total area of these developments will result in increased flow. It has been assumed that 70 percent of the total area is "usable area" for development, that is, will produce wastewater flow. The remaining 30 percent of these developable areas are assumed to be areas that will not produce wastewater flow, such as paved areas, retention basins, etc. Several sources are available for guidance on converting from area to wastewater flow, such as, The Louisville and Jefferson County Metropolitan Sewer District's (MSD's) Design Manual. The following conversions were used to estimate wastewater flow from the different types of protected land use areas; 1,000 gal/day/acre for residential and 1,500 gal/day/acre for commercial. This resulted in a total anticipated future flow outside the existing service area as shown in Table 7-4.

Table 7-4 Future Land Use Projected Flows Per Planning Period				
Land Use	**Expected Area (Ac)**	**Useable Area (Ac)**	**Flow (Gal/Day/Acre)**	**Expected Average Flow (GPD)**
3 to 10 Years				
Residential	21	14.7	1,000	14,700
Commercial	2	1.4	1,500	2,100
			Total 3-10 Yrs	**16,800**
11 to 20 Years				
Residential	10	7.0	1,000	7,000
Commercial	1	0.7	1,500	1,050
			Total 11-20 Yrs	**8,050**
Total Projected Flow from Future Growth				**24,850**
Note – Residential growth within the existing service area is accounted for in the population projections.				

Exhibit 7-1, Wastewater Flow Projections, contains the flow rates (average and peak) projected from the present through 2034 (the end of the Planning Period). The average wastewater flow per day for the year 2034 is estimated to be 221,400 GPD. To allow the City some reserve capacity for unforeseen growth and to remain below the ninety percent of design capacity at the end of the planning period, an average design flow rate of 250,000 GPD was projected to be an appropriate expansion size for the wastewater plant.

As stated above, the City of Brodhead experiences heavy amounts of inflow & infiltration (I&I) in their sewer collection system resulting in higher than normal (peak) flows at their treatment plant. A Sewer Rehabilitation Project, included as part of the Sanitary Sewer Evaluation Survey (SSES), will reduce the amount of I&I that the system experiences. The correlation between average flows and the peak flow is known as the peaking factor.

To determine the appropriate peaking factor to be used for projecting peak day flows throughout the planning period, a review of the historical wastewater flows recorded at the treatment plant was conducted. It should also be noted that the years of 2011 and 2013 were both extremely wet years for rainfall in Kentucky. Actual yearly average flows were calculated for the past five (5) years (2010 -2014). The recorded peak day flow was also noted for each of these years. By dividing the actual peak day flows by the yearly averages, the peaking factor for each year was determined. These peaking factors were then averaged resulting in an average peaking factor of 2.8. This factor was then used to project future peak day flows for the planning

period. The resulting 2034 peak hourly flow, as shown in Exhibit 7-1, has been calculated at approximately 620,000 GPD.

The SSES recommendations include a 500,000 gallon wet weather detention basin to be located on the WWTP site. The wet weather detention basin will provide the City of Brodhead operational flexibility during peak wet weather events as to how much of the flow should be allowed to be treated at the plant during the rain event or temporarily stored and treated after the flow has decreased. Therefore, the calculated 620,000 GPD flow could be reduced for design purposes. However, to address the concerns of multiple day storms where wastewater would need to be stored for several days, the City elected to assume a peak day flow of 600,000 GPD.

Evaluations of treatment alternatives, to be discussed in Section 8, will be based on the following projected flows:

- Average Daily Flow = 250,000 GPD
- Peak Hourly Flow = 600,000 GPD

D. Waste Load Projections

From the plant's Monthly Operating Reports for 2012-2014 (Table 6-4), the historical daily average concentrations of CBOD, TSS, and NH3-N received at the treatment plant have been 166 mg/l, 129 mg/l and 12.4 mg/l respectively. It is not expected that these concentrations will change significantly over the planning period due to the addition of flows from future residential and commercial customers.

On that basis, the following waste load projections for the design year average daily conditions will be used in Chapter 8 for evaluating alternative treatment approaches:

- CBOD load at 200 mg/l for 250,000 GPD = 418 pounds/day
- TSS at 200 mg/l for 250,000 GPD = 418 pounds/day
- NH3-N at 20 mg/l for 250,000 GPD = 42 pounds/day

E. Waste Load Allocation

As part of this Facilities Plan, the City requested that the Kentucky Division of Water (KDOW) perform a waste load allocation analysis for the future limits of the proposed wastewater treatment plant capacities of 250,000 GPD (ADF) and 600,000 GPD (PHF).

The KDOW responded to this request on November 6, 2014. Their proposed KPDES permit effluent limits and reliability requirements based on the waste load allocation analysis are presented in Appendix F. A summary of the proposed KPDES permit effluent limits and reliability requirements are presented in Table 7-5.

Table 7-5

Proposed Monthly Average KPDES Permit Limits and Reliability Requirements

Effluent Parameter	Value
CBOD5	10 mg/l
TSS	30 mg/l
Ammonia-Nitrogen	4/8[A] mg/l
Total Phosphorus	Monitor[B]
Dissolved Oxygen (min.)	7 mg/l
Total Residual Chlorine	0.011/0.019[C] mg/l
Total Nitrogen	Monitor[B]
Reliability Classification	Grade C

Note A: 4 mg/l limit from May 1 to October 31, and 8 mg/l limit from November 1 to April 30.
Note B: Limits not determined by KDOW. Effluent must be monitored by City.
Note C: 0.011 mg/l limit from May 1 to October 31, and 0.019 mg/l limit from November 1 to April 30.

The proposed wastewater treatment plant upgrade will be designed to comply with the proposed KPDES effluent limits and reliability requirements. The plant does not currently have a Total Nitrogen or Phosphorus limit, but is required to monitor plant effluent levels. In the event that a Total Nitrogen or Phosphorus limit be added to the permit, additional treatment facilities not included in this Facilities Plan will be required.

Exhibit 7-1
Wastewater Flow Projections
Planning Period 2014-2034

Year	City of Brodhead Population	% Change[A]	No. of Customers	Avg. Flow Per Customer[B] (gpd)	3-10 Year Expansion Area (gpd)	11-20 Year Expansion Area (gpd)	Avg. Wastewater Flows[C] (gpd)	Peak Day Flows[D] (gpd)
2010[E]	1,211		453	322.3	-	-	146,000	461,000
		0.37%						
2011[E]	1,215		452	601.8	-	-	272,000	578,000
		0.37%						
2012[E]	1,220		469	417.9	-	-	196,000	573,000
		0.37%						
2013[E]	1,224		465	572.0	-	-	266,000	680,000
		0.36%						
2014[E]	1,229		460	417.4	-	-	192,000	616,000
		0.36%						
2015	1,233		462	420.0	-	-	194,000	543,200
		0.26%						
2016	1,236		463	420.0	-	-	194,400	544,320
		0.26%						
2017	1,240		464	420.0	2,100	-	197,000	551,600
		0.26%						
2018	1,243		465	420.0	4,200	-	199,600	558,880
		0.25%						
2019	1,246		466	420.0	6,300	-	202,200	566,160
		0.25%						
2020	1,249		468	420.0	8,400	-	204,800	573,440
		0.14%						
2021	1,251		468	420.0	10,500	-	207,200	580,160
		0.14%						
2022	1,253		469	420.0	12,600	-	209,500	586,600
		0.13%						
2023	1,254		469	420.0	14,700	-	211,900	593,320
		0.13%						
2024	1,256		470	420.0	16,800	-	214,300	600,040
		0.13%						
2025	1,258		471	420.0	16,800	805	215,300	602,840
		0.00%						
2026	1,258		471	420.0	16,800	1,610	216,100	605,080
		0.00%						
2027	1,258		471	420.0	16,800	2,415	217,000	607,600
		0.00%						
2028	1,258		471	420.0	16,800	3,220	217,800	609,840
		0.00%						
2029	1,258		471	420.0	16,800	4,025	218,600	612,080
		0.00%						
2030	1,258		471	420.0	16,800	4,830	219,400	614,320
		-0.15%						
2031	1,256		470	420.0	16,800	5,635	219,900	615,720
		-0.15%						
2032	1,254		469	420.0	16,800	6,440	220,400	617,120
		-0.15%						
2033	1,252		469	420.0	16,800	7,245	220,900	618,520
		-0.15%						
2034	1,250		468	420.0	16,800	8,050	221,400	619,920
					Design Criteria[F]		**250,000**	**600,000**

Notes:

[A] It is assumed that growth of the City and the amount served by the City's wastewater facilities will grow at the same rate as the County.

[B]The Average Flow Per Custumer in the existing service area is based on historical data (Jan 2010 through Dec 2014), and includes all customers types (residential, commercial, industrial, etc.). The calculated average flow was then reduced by 10% to account for the expected I&I flow reduction that is a anticipated from the City's Proposed Rehabilitation Project.

[C]Average WW Effluent Flow for 2010-2014 from MOR's. Brodhead does not have an Influent Flow Meter. Flows after 2014 are based on projected population growth in Existing Service Area

[D] The Peaking Factor, 2.8, was derived by calculating the average of the average actual peaking factors for each year between 2010 - 2014.

[E]Number of Customers, Average Wastewater Flows and Peak Day flows are based on actual record data from the City of Brodhead

[F]Peak Flow Design Criteria includes 500,000 GPD Wet Weather Detention Basin and reduction in I&I due to City's Sewer Rehabilitation Project. See Paragraph C-2 in Section 7 for additional information.

City of Brodhead: Future Growth Areas

Future Growth Areas

Planning Area	Description	Planning Period	Area (Acres)
Outside Future	Residential	3-10	21
Outside Future	Commercial	3-10	2
Outside Future	Residential	11-20	10
Outside Future	Commercial	11-20	1
		Total Acres	34

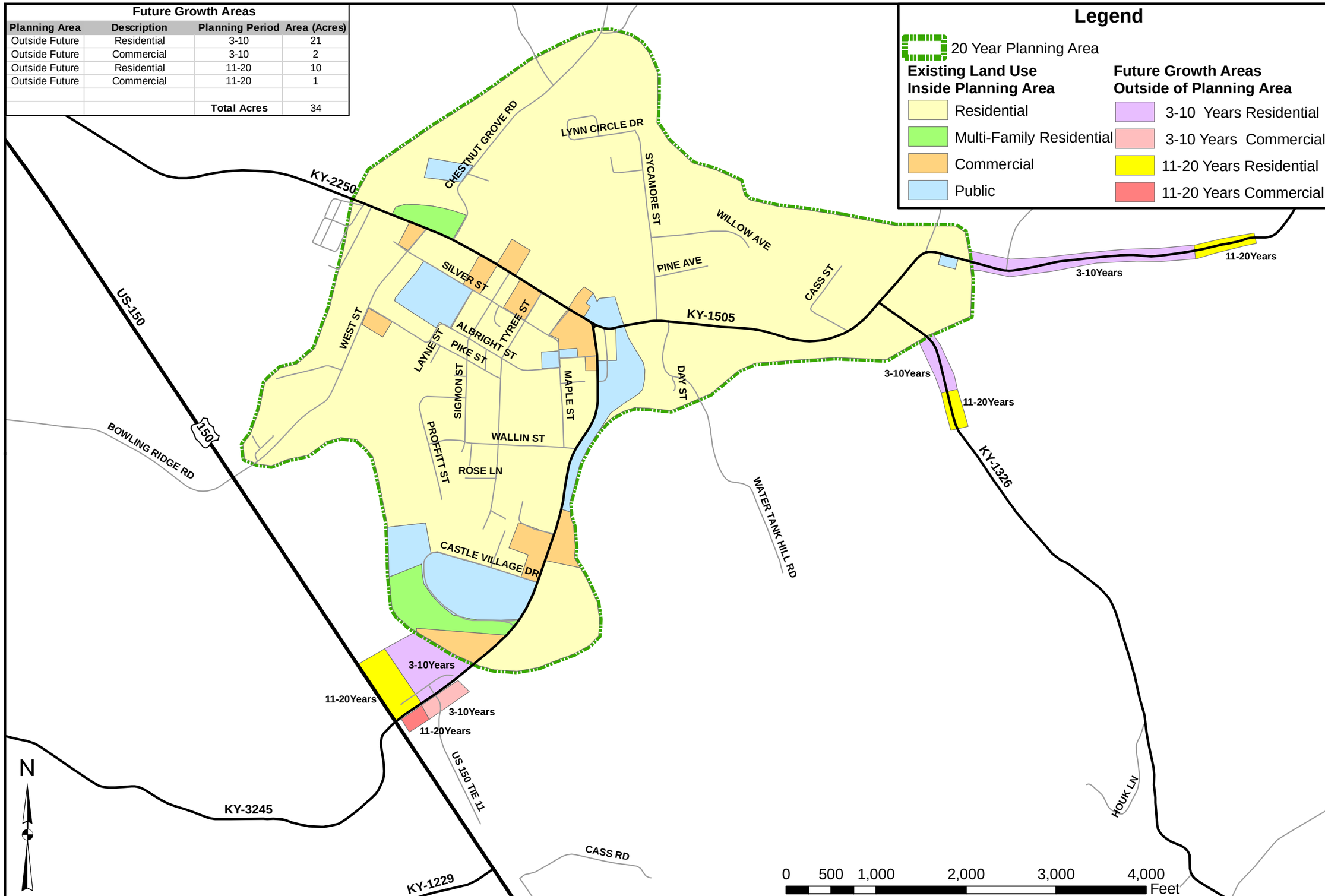

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EXHIBIT 7-2
EXISTING LAND USE AND FUTURE GROWTH AREA MAP
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:
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Section 8

SECTION 8
EVALUATION OF ALTERNATIVES

A. Purpose

The purpose of this section is to define and evaluate alternatives for the City of Brodhead to address their wastewater treatment and collection system needs for the projected wastewater demands for the 2014 to 2034 Planning Period. This planning document shall objectively evaluate the combined effect of a two component analysis: 1) Cost Effective Analysis and 2) Non-monetary Effectiveness Analysis.

The cost effective analysis is based on a present worth analysis method and evaluates the cost effectiveness of the various alternatives. For the purposes of determining salvage values for structures, equipment, and piping, it was assumed that: structures were 40% of their original value after 20 years, equipment was 0% of its original value after 20 years, and piping was 50% of its original value after 20 years. A discount rate of 6% was used in the present worth analysis as set annually by the Department of the Interior's Bureau of Reclamation.

The non-monetary effectiveness criteria used in evaluating these alternatives includes environmental impact, engineering evaluation, implementability, public support and regionalization.

Evaluations were completed on the treatment process at the wastewater treatment.

B. Disinfection Alternatives

Three disinfection alternatives were evaluated for the projected 250,000 GPD effluent flow from the expanded Brodhead Wastewater Treatment Plant. The disinfection options that were evaluated are:

1. Disinfection Alternative 1 – Chlorine Gas Disinfection

This alternative involves installation of a new chlorine and sulfur dioxide disinfection system. The chemical feed system would be housed in a new building which would include all pumps, metering equipment, piping, fire suppression, etc. The new chlorine & dechlorination building would also provide adequate room for storage of the chlorine and sulfur dioxide cylinders. Furthermore, this alternative includes a new chlorine contact and dechlorination basin with a v-notch weir and ultrasonic flow measurement. The cost estimates and present worth analysis for the chlorine gas and sulfur dioxide disinfection alternative are contained in Exhibits 8-1 to 8-4.

2. **Disinfection Alternative 2 – Sodium Hypochlorite Disinfection**

This alternative involves installation of new sodium hypochlorite and sulfur dioxide disinfection system. This system would be housed in a new building and would include all new pumps, metering equipment, tanks, piping, etc. The new chemical feed building would also provide adequate room for storage of the sodium hypochlorite totes and sulfur dioxide cylinders. Similar to Disinfection Alternative 1 (Chlorine Gas), this alternative includes a new contact basin with a v-notch weir and ultrasonic flow measurement. The cost estimates and present worth analysis for the sodium hypochlorite and sulfur dioxide disinfection alternative are contained in Exhibits 8-5 to 8-8.

3. **Disinfection Alternative 3 – No Action to Disinfection**

This alternative involves continuing to utilize the existing Chlorine gas system. This option would require the continued use and storage of chlorine gas and sulfur dioxide and the existing feed equipment. Presently, the chlorine and sulfur dioxide scales are in poor shape and require attention. Due to the poor quality of the existing chlorine and sulfur dioxide equipment, the City of Brodhead has indicated that they would prefer to discontinue the use of the existing chlorine and sulfur dioxide feed system, thus the "No Action" alternative was eliminated from further consideration.

4. **Monetary (Present Worth) Analysis of Disinfection Alternative**

Table 8-1 provides a cost summary of the present worth analysis of the disinfection alternatives that were evaluated.

Table 8-1
WWTP Disinfection Alternates
Monetary Analysis Summary

Analysis	Chlorine Gas Disinfection	Sodium Hypochlorite Disinfection
Construction Cost	$276,942	$220,192
Annual Operation & Maintenance Costs	$10,978	$18,404
Salvage Value	$47,873	$55,073
Present Worth	**$387,942**	**$414,192**

5. **Non-Monetary Analysis of Disinfection Alternative**

In the planning process, non-monetary effectiveness issues as well as monetary criteria need to be used in determining the preferred disinfection alternative.

This section includes a general evaluation of the two proposed disinfection alternatives to determine which solution will maximize non-monetary effectiveness. The discussion will focus on the following categories:

- Environmental Impact
- Engineering Evaluation
- Implementability
- Public Support

The following is a brief discussion of each of the above categories:

a. Environmental Impact

Each alternative was selected on the basis of its ability to achieve the planning area's wastewater treatment and water quality goals and objectives, and the ability to comply with requirements of the Kentucky Division of Water. The two primary periods when the environment could be damaged are during construction or during startup of the new treatment process.

Both alternatives will result in the construction of additional structures. Disinfection Alternatives 1 – Chlorine Gas & Disinfection Alternative 2 – Sodium Hypochlorite require the construction of a new chemical feed building and chlorine contact & dechlorination basin.

Disinfection Alternative 1 – Chlorine Gas will require a slightly smaller chemical feed building than Disinfection Alternative 2 – Sodium Hypochlorite. However, both buildings will require the same depth of excavation. The chlorine contact & dechlorination basins will require the same amount of construction for both alternatives. Furthermore, the installation of piping is required from the proposed chemical feed buildings to the chlorine contact & dechlorination basin in each alternative. Both construction alternatives would take place on the existing City owned WWTP site.

Construction procedures for both alternatives would include methods to safeguard the environment such as silt fences and proper material storage. The wastewater treatment plant is a reasonable distance from residential and commercial facilities and construction noise, dust, odor and traffic are not anticipated to be problems.

Disinfection Alternative 1 – Chlorine Gas and Disinfection Alternative 2 - Sodium Hypochlorite are both well-established disinfection processes. As stated above, chlorine gas is the existing disinfection process used at the WWTP. Therefore, plant operators are familiar with the processes involved with Disinfection Alternative 1 – Chlorine Gas.

Overall, there is not expected to be a significant difference between each of the disinfection alternatives to be evaluated regarding environmental impact.

b. Engineering Evaluation

The primary goal of the engineering evaluation is to provide the most cost effective, environmentally sound and implementable wastewater treatment plant disinfection alternative capable of achieving the Brodhead Planning Area's water quality and service goals. The cost effectiveness of these disinfection alternatives were discussed earlier (see Table 8-1). The functionalization and environmental soundness of these options are discussed below.

Disinfection Alternatives 1 and 2 are both fully capable of meeting the requirements of the Planning Area. Disinfection Alternative 1 – Chlorine Gas and Disinfection Alternative 2 - Sodium Hypochlorite have a proven history of reliability with multiple successful installations across the state.

The reliability of each of the alternatives is based on the long term operation of the various components of the mechanical systems which comprise the treatment process. The reliability of these systems is dependent on the quality of the manufacturer's equipment, the quality of initial installation and the implementation of satisfactory maintenance and preventive maintenance programs by the City of Brodhead. Assuming that each of these considerations is addressed, each alternative will have the capability of long term reliability for the design life of the project.

As a result of Disinfection Alternative 1 – Chlorine Gas and Disinfection Alternative 2 - Sodium Hypochlorite having long-term reliability based on the multiple installations within Kentucky, it is believed that both disinfection alternatives will function properly and meet the Planning Area’s water quality and service goals.

c. Implementation Capability

The ability to implement each alternative from both a constructability and a operational perspectives was considered in the evaluation of each of the respective alternatives.

From a constructability perspective, the implementation of Disinfection Alternative 1 – Chlorine Gas and Disinfection Alternative 2 - Sodium Hypochlorite would both result in similar amounts of construction as well as minimal disruption to the current plant operations. In each alternative, construction would need to be completed before flow can be diverted from the existing chlorine contact basin to the new disinfection system.

Both disinfection alternatives provide the operators the ability to slowly transition from their existing disinfection process to the new disinfection process.

Implementation of Disinfection Alternative 2 – Sodium Hypochlorite would be very similar to the startup and operation of Disinfection Alternative 1 – Chlorine Gas. However, the operators are less familiar with handling this chemical and would require additional training at startup. Therefore, plant operators may require additional training regarding Disinfection Alternative 2 – Sodium Hypochlorite.

d. Public Support

In order to address the public's interest, the City will conducted a public meeting on September 14, 2015 to inform the public of the needs of the disinfection system and to discuss the proposed alternatives. At the meeting, projected construction and operations costs and their projected effect on sewer rates will be presented. The minutes and attendance roster of the public meeting will be included in Appendix G.

6. Summary of Non-monetary Effectiveness Analysis

Table 8-2 provides non-monetary effectiveness rankings for each disinfection alternative and compares the alternatives based on non-monetary effectiveness units (NEUs).

Table 8-2
Disinfection Process Selection Analysis

Non- Monetary Factor		**Alternative 1 – Chlorine Gas**		**Alternative 2 - Sodium Hypochlorite**	
	Weight	*Rating*	*Score*	*Rating*	*Score*
Environmental Impact	1.0	9	9	9	9
Engineering Evaluation	1.0	9	9	10	10
Implementability	0.9	10	9	10	9
Public Support	0.8	7	5.6	10	8
Total Score		32.6		36	
Total Present Worth		$387,942.00		$414,192	
NEU		11,900.06		11,505.33	

The **Weight** of each factor is a measure of the City's relative concerns of that factor compared to other factors, on a scale of 0 to 1, with the highest weight given to those that are considered the most critical.

The **Rating** is a measure of the relative implementation concern of that alternative compared to other alternatives on a scale of 0 to 10, with the highest rating given to the alternative that best satisfies that factor.

The **NEU** (Non-monetary Effectiveness Unit) is a measure of the relative implementation concern due to construction and operation of each alternative. The NEU is the Total

Present Worth divided by the Total Score. The alternative with the lowest NEU is the most capable of implementation.

7. **Disinfection Process Alternative Selection**

Disinfection Alternative 2 – Sodium Hypochlorite was selected as the preferred disinfection alternative due to its low NEU, proven history of reliability and its comparable present worth cost to Alternative 1 – Chlorine Gas. Other advantages of using Sodium Hypochlorite disinfection include the elimination of 150 pound cylinders of chlorine and associated health hazards in the area of the wastewater treatment plant. The costs for the selected disinfection method will be included in the total cost of each of the following treatment alternatives considered in this report.

C. Sludge Management Facilities

Presently, the City of Brodhead utilizes a private hauling company to transport sludge from the WWTP to a private land farm. GRW evaluated four (4) sludge management alternatives for the WWTP. The evaluation can be found in Appendix H. It is recommended that the City of Brodhead to continue to utilize a private hauling company to transport sludge to a private land farm as a result of presenting the lowest estimated annual cost as well as the familiarity that wastewater treatment personnel have with this process.

D. Treatment Process Alternatives

The following four (4) treatment process alternatives were evaluated:

- Treatment Alternative 1 – Oxidation Ditch
- Treatment Alternative 2 – Extended Aeration
- Treatment Alternative 3 – Sequencing Batch Reactor (SBR)
- Treatment Alternative 4 – No Action

Included in each alternative is the cost of construction of a new wet weather detention facility, which includes a pump station, force main, flow meter and a 500,000 gallon detention basin; and the plant's headworks facility, consisting of a new influent pump station, a flow meter and a screening & grit removal system. In addition to the wet weather detention facilities and headworks, each alternative also includes the cost of the selected disinfection method, discussed above, as well as costs of sludge management.

The treatment alternatives considered should meet the anticipated discharge limitations indicated in Section 7. Table 8-3 below summarizes the treatment discharge limits represented in the Department for Environmental Protection's November 6, 2014 waste load allocation letter for the proposed design average daily discharge rate of 250,000 GPD and the hydraulic peak flow rate of 600,000 GPD.

Table 8-3 Proposed Monthly Average KPDES Permit Limits and Reliability Requirements	
Effluent Parameter	**Value**
CBOD5	10 mg/l
TSS	30 mg/l
Ammonia-Nitrogen	4/8[A] mg/l
Total Phosphorus	Monitor[B]
Dissolved Oxygen (min.)	7 mg/l
Total Residual Chlorine	0.011/0.019[C] mg/l
Total Nitrogen	Monitor[B]
Reliability Classification	Grade C

Note A: 4 mg/l limit from May 1 to October 31, and 8 mg/l limit from November 1 to April 30.
Note B: Limits not determined by KDOW. Effluent must be monitored by City.
Note C: 0.011 mg/l limit from May 1 to October 31, and 0.019 mg/l limit from Nov. 1 to April 30.

1. Treatment Alternative No. 1 – Oxidation Ditch

Treatment Alternate No. 1 – Oxidation Ditch consists of the construction of two (2) new oxidation ditches and one (1) new clarifier. The new oxidation ditches would allow the plant to treat the projected future flows. Additionally, the new ditches would include an area for future construction of separate anaerobic and anoxic chambers upstream of the oxidation ditches in order for the plant to provide Biological Nutrient Removal (BNR) to meet future anticipated effluent limits. Phosphorous removal would be accomplished primarily with biological treatment, but polishing with chemical feed could also be required. The existing "Old" clarifier and its equipment will be completely demolished. A new 22-ft clarifier will be constructed to replace the existing "Old" clarifier. The existing "New" clarifier will be modified with new density current baffles.

The proposed oxidation ditches would be located in the southern area of the existing treatment plant site. The new clarifier will be constructed at the site of the existing sludge drying beds. The existing sludge drying beds are to be dewatered and backfilled with soil as well as the sludge will need to be hauled away.

See Appendix I for more information on the Oxidation Ditch equipment. Exhibit 8-9 shows the demolition plan, Exhibit 8-10 shows the plant layout and Exhibits 8-11 to

8-14 provide the financial analysis for treatment Alternative 1 - Oxidation Ditch. Treatment Alternative 1 - Oxidation Ditch includes the following components:

- New 500,000 gallon Wet Weather Detention Basin & Pump Station with return flow meter vault.

- New 600,000 GPD Influent Pump Station including submersible pumps, wet well, valve vault and flow meter.

- New Preliminary Treatment Building:
  - Approximately 1,600-square feet.
  - Offices for WWTP personnel.
  - Electrical equipment.
  - New screening removal system with static screen.

- Two (2) new Oxidation Ditches with mixers and two (2) 15 HP surface aerators with VFD's. The new Oxidation Ditches will be approximately 100 LF x 24 LF wide, each.

- One (1) new concrete Oxidation Ditch Flow Splitter Box

- One (1) new concrete Clarifier Flow Splitter Box

- Demolition of existing "Old" clarifier and its mechanical equipment

- Modification of the existing "New" 22-ft clarifiers with new density current baffles.

- One (1) new 22-ft clarifier. Clarifier includes mechanical equipment, launder covers, current density baffles, effluent weirs and scum baffles. New Clarifier to have similar configuration to the renovated existing "New" Clarifier.

- New Chemical Disinfection Feed Building. Approximately 680-square feet. Includes new scale & feed equipment.

- New Sodium Hypochlorite Disinfection Contact & Dechlorination Basin. Basin would replace existing basin and would include a new effluent flow meter.

- Existing Aeration Basins to be converted to Aerated Sludge Holding/Aerobic Digestion Basins. Modifications include the installation of a telescopic valve, new post mooring aerators and the installation of access steps and a platform.

- Modifications of the Return Activated Sludge (RAS) Pumping Station with new pumps.

- Existing office building to be converted to storage.

- Existing sludge drying beds to be dewatered and backfilled with soil. Existing sludge to be hauled away.

- New Emergency Power Generator and Transfer Switch

- Site piping, site grading and miscellaneous equipment.

- Solids removal via third party hauling and disposal.

2. Treatment Alternative No. 2 – Extended Aeration

Treatment Alternate No. 2 – Extended Aeration consists of the modification of the existing two (2) aeration basins and the construction of two (2) new aeration basins. The combination of the modified aeration basins and the new aeration basins would allow the plant the treat the projected future flows. Each aeration basin would be equipped with a fine-bubble diffused air grid system. A fine-bubble diffused air grid system is more efficient than mechanical aerators and coarse bubble aeration. Additionally, the existing "Old" clarifier and its equipment will be completely demolished. A new 22-ft clarifier will be constructed to replace the existing "Old" clarifier. The existing "New" clarifier will be modified with new density current baffles.

This alternative is the simplest option from an operations standpoint based on the fact that the existing plant already employs extended aeration technology.

See Appendix I for more information on the Extended Aeration equipment. Exhibit 8-15 shows the demolition plan, Exhibit 8-16 shows the plant layout and Exhibits 8-17 to 8-20 provide the financial analysis for treatment Alternative 2 – Extended Aeration. Treatment Alternative 2 – Extended Aeration includes the following components:

- New 500,000 gallon Wet Weather Detention Basin & Pump Station with return flow meter vault.

- New 600,000 GPD Influent Pump Station including submersible pumps, wet well, valve vault and flow meter.

- New Preliminary Treatment Building:
  - Approximately 1,600-square feet.
  - Offices for WWTP personnel.
  - Electrical equipment.
  - New screening removal system with static screen.

- Modifications to Existing Aeration Basins include the installation of a fine-bubble diffused air grid system and the removal of existing aeration equipment.

- Two (2) new Aeration Basins with fine-bubble diffused air grid systems. The new Aeration Basin will be approximately 30 LF x 30 LF x 12 LF, each.

- One (1) new Blower Building for the Aeration Basins. The Blower Building will be 24 LF x 24 LF.

- One (1) new concrete Aeration Basin Flow Splitter Box

- One (1) new concrete Clarifier Flow Splitter Box

- Demolition of existing "Old" clarifier and its mechanical equipment

- Modification of the existing "New" 22-ft clarifiers with new density current baffles.

- One (1) new 22-ft clarifier. Clarifier includes mechanical equipment, launder covers, current density baffles, effluent weirs and scum baffles. New Clarifier to have similar configuration to the renovated existing "New" Clarifier.

- New Chemical Disinfection Feed Building. Approximately 680-square feet. Includes new scale & feed equipment.

- New Sodium Hypochlorite Disinfection Contact & Dechlorination Basin. Basin would replace existing basin and would include a new effluent flow meter.

- One (1) new Aerated Sludge Holding/Aerobic Digestion Basins. Includes the installation of a telescopic valve, new post mooring aerators and the installation of access steps and a platform.

- Modifications of the Return Activated Sludge (RAS) Pumping Station with new pumps.

- Existing office building to be converted to storage.

- Existing sludge drying beds to be dewatered and backfilled with soil. Existing sludge to be hauled away.

- New Emergency Power Generator and Transfer Switch

- Site piping, site grading and miscellaneous equipment.

- Solids removal via third party hauling and disposal.

3. Treatment Alternative No. 3 – Sequencing Batch Reactor (SBR)

A Sequencing Batch Reactor (SBR) provides both biological treatment and clarification in the same tanks. The proposed SBR for the City of Brodhead consists of two (2) separate basins. The basins cycle between filling, mixing, aerating, settling and decanting modes on a timed basis to provide the necessary secondary biological treatment. One (1) new concrete SBR tank will need to be constructed. The SBR tank would include two (2) basins utilizing a shared interior wall. Fine bubble diffusers would be installed in each SBR basin and new blowers would be installed to provide oxygen to the diffusers. The necessary piping, valves, WAS pumps, mixers, decanters, weirs, scum skimmers and controls would also be installed in each SBR basin as required.

Enhanced Biological Nutrient Removal (EBNR) to remove phosphorus and nitrogen in the future, if needed, could be accomplished in the SBR system by controlling the amount of aeration in the various cells of the SBR. SBRs eliminate the need for conventional clarifiers and thus eliminate the need of a RAS pump station.

See Appendix I for more information on the Sequencing Batch Reactor (SBR). Exhibit 8-21 shows the demolition plan, Exhibit 8-22 illustrates the plant layout and Exhibits 8-23 to 8-26 provides the financial analysis for Treatment Alternative 3 - Sequencing Batch Reactor. Treatment Alternative 3 – Sequencing Batch Reactor includes the following components:

- New 500,000 gallon Wet Weather Detention Basin & Pump Station with return flow meter vault.

- New 600,000 GPD Influent Pump Station including submersible pumps, wet well, valve vault and flow meter.

- New Preliminary Treatment Building:
  - Approximately 1,600-square feet.
  - Offices for WWTP personnel.
  - Electrical equipment.
  - New screening removal system with static screen.

- One (1) new concrete SBR tank split into two (2) basins using common wall construction, one (1) new blower building with appropriate piping for distribution to the SBR basins. The SBR system includes mixers, WAS pumps, decanters, blowers, diffusers, valves and control system.

- Demolition of existing “Old” clarifier and its mechanical equipment. Existing “New” clarifier to be abandoned. Conventional clarifiers are no longer needed

with SBR technology.

- New Chemical Disinfection Feed Building. Approximately 680-square feet. Includes new scale & feed equipment.

- New Sodium Hypochlorite Disinfection Contact & Dechlorination Basin. Basin would replace existing basin and would include a new effluent flow meter.

- Existing Aeration Basins to be converted to Aerated Sludge Holding/Aerobic Digestion Basins. Modifications include the installation of a telescopic valve, new post mooring aerators and the installation of access steps and a platform.

- Existing Sludge Holding Tank to be converted to a Flow Equalization Basin. The cycle pattern of the SBR system will have times where no flow is leaving treatment (one basin is mixing while the other is settling). Flow Equalization will allow for the plant to be disinfecting continuously, thus, preventing large fluctuations in the amount of flow to be discharged. Flow Equalization Basin will include a flow equalization pump station.

- Existing office building to be converted to storage.

- Existing sludge drying beds to be dewatered and backfilled with soil. Existing sludge to be hauled away.

- New Emergency Power Generator and Transfer Switch

- Site piping, site grading and miscellaneous equipment.

- Solids removal via third party hauling and disposal.

4. Treatment Alternative 4 – No Action

Treatment Alternative 4 - No Action, would not provide any treatment improvements during the Planning Period. As seen in Table 6-4 in Section 6, the plant is experiencing flow greater than its current rated capacity (150,000 GPD). If no action is taken, the plant will continue to experience flows greater than it can treat resulting in permit violations. These conditions would likely lead to the Division of Enforcement imposing legal action which would require corrective action by the City, necessitating the expenditure of funds for design and construction at a later point in the Planning Period.

5. Monetary (Present Worth) Analysis of Treatment Alternative

Table 8-4 provides a cost summary of the present worth analysis of the treatment alternatives that were evaluated.

Table 8-4 WWTP Treatment Alternates Monetary Analysis Summary			
Analysis	**Oxidation Ditch**	**Extended Aeration**	**Sequencing Batch Reactor (SBR)**
Project Cost	$4,774,693	$4,740,943	$5,059,693
Annual Operation & Maintenance Costs	$207,697	$215,017	$208,689
Salvage Value	$809,387	$775,986	$773,863
Present Worth	**$6,904,693**	**$6,964,943**	**$7,212,693**

6. Non-Monetary Effectiveness Analysis

In planning new wastewater treatment facilities, non-monetary effectiveness issues as well as monetary criteria are used in determining the preferred alternative.

This section includes a general evaluation of the proposed biological treatment alternatives to determine which solution will maximize non-monetary effectiveness. The discussion will focus on the following categories:

- Environmental Impact
- Engineering Evaluation
- Implementability
- Regionalization
- Public Support

The non-monetary effectiveness ratings for each of the three biological treatment alternatives can be found in Table 8-5. Following is a brief discussion of each of the above categories:

a. Environmental Impact

Each treatment alternative evaluated was selected on the basis of its ability to achieve the planning area's wastewater treatment and water quality goals and objectives, and the ability to comply with requirements of the Kentucky Division of Water. The two primary periods when the environment could be damaged are during construction or during a major treatment process upset (assuming all alternatives considered will consistently meet permit discharge limits). Treatment Alternatives 1, 2 and 3 require approximately the same amount of construction and all construction for these three options would take place on the existing plant site.

For all treatment alternatives, construction procedures would include methods to safeguard the environment, such as silt fences and proper material storage. The wastewater treatment plant is a reasonably close to residential and commercial facilities and construction noise, dust, odor and traffic will be somewhat of an inconvenience for the nearby residents. These items will need to be addressed prior to construction with these residents as well as with the selected Contractor to minimize the impact. The existing treatment facilities would remain fully operational during construction of all three Treatment Alternatives.

Regarding plant upsets, Treatment Alternative 2 – Extended Aeration is a process that the plant operators are familiar with and plant upsets are not expected to pose a significant problem. Treatment Alternative 1 – Oxidation Ditch is a well-established process that is similar to the existing treatment process. Plant operators are familiar with the flow through process of Treatment Alternative 1 – Oxidation Ditch, therefore, plant upsets are not expected to pose a significant problem. Treatment Alternative 3 - Sequencing Batch Reactor (SBR) is a process that plant operators are not as familiar with and this unfamiliarity could result in more frequent upsets.

Overall, there is not expected to be a significant difference between Treatment Alternative 1 - Oxidation Ditch and Treatment Alternative 2 – Extended Aeration regarding environmental impact, with Treatment Alternative 3 - SBR having a slightly higher risk.

b. Engineering Evaluation

The primary goal of the selected alternative is to provide the most cost effective, environmentally sound and implementable wastewater treatment plant capable of achieving the Brodhead Planning Area's water quality and service goals.

Treatment alternatives 1 through 3 are all fully capable of meeting the requirements of the Planning Area. Each treatment alternative is based on a proven process. Treatment Alternative 1 – Oxidation Ditch and Treatment Alternative 3 - SBR have more built-in flexibility than the other alternative for compliance with new/future effluent parameters and/or more stringent effluent limits on existing parameters.

The reliability of each of the treatment alternatives is based on the long term operation of the various components of the mechanical systems which comprise the treatment process. The reliability of these systems is dependent on the quality of the manufacturer's equipment, the quality of initial installation and the implementation of satisfactory maintenance and preventive maintenance programs by the City of Brodhead. Assuming that each of these considerations is addressed, each treatment alternative will have the capability of long-term reliability for the design life of the project.

Treatment Alternative 1 - Oxidation Ditch has a proven history of reliability with many successful installations at similar sized wastewater treatment plants (WWTP) in other areas. The WWTP operators are familiar with the flow through process of the Oxidation Ditch, therefore requiring minimal training.

Treatment Alternative 2 – Extended Aeration has an inconsistent history of reliability at this facility. Nevertheless, the WWTP operators are very comfortable with the process and the operation.

Treatment Alternative 3 - SBR is considered to be equally as reliable as Treatment Alternative 1 & 2, with successful installations at similar sized WWTP in other areas. The SBR process here would require training for the plant operators who are not as familiar with this batch operated process, as opposed to the flow through processes represented by Treatment Alternative 1 - Oxidation ditch and Treatment Alternative 2 – Extended Aeration.

c. Implementability

The ability to implement each alternative from both constructability and operational perspectives was considered in the evaluation of each of the respective alternatives. From a constructability perspective, the implementability of Treatment Alternative 1 – Oxidation Ditch is considered to be the best as the existing system could operate without any hindrances until the construction of the new Oxidation Ditches are completed. Once the construction is finalized, flow will then be sent to the new Oxidation Ditches and the existing Aeration Basins will then be modified to Aerated Sludge Holding/Aerobic Digestion Basins.

Treatment Alternative 2 – Extended Aeration is considered to be the next most implementable alternative from a constructability standpoint. The existing system would continue to operate until the construction of the new Aeration Basins are completed. After construction of the new Aeration Basins, one of the existing Aeration Basins would be taken out of service for repairs. Once repairs are finalized, the renovated Aeration Basin would be put back into service and the other existing Aeration Basin would be removed from service for repairs. After all repairs are completed, the system would operate as planned with all four Aeration Basins. Treatment Alternative 2 – Extended Aeration is more difficult to implement than Treatment Alternative 1 – Oxidation Ditch due to the phasing of repairs and construction.

Treatment Alternative 3 – SBR is considered to be less implementable than the other alternatives as a result of the necessary modifications to the Existing Sludge Holding Tank and Aeration Basins. The existing Sludge Holding Tank is to be converted to a Flow Equalization Basin. The existing Aeration Basins are to be converted to Aerated Sludge Holding/Aerobic Digestion Basins, thus replacing the converted existing Sludge Holding Tank. Therefore, construction would need to be phased such that the existing plant continues to operate as each of these

basins gets modified. This may result in a limited treatment capacity until the existing basin are converted. Therefore, Treatment Alternative 3 - SBR is considered to be least implementable due to phasing of the construction and the limitation on the treatment capacity.

From an operational perspective, Treatment Alternative 1 - Oxidation Ditch and Treatment Alternative 2 – Extended Aeration are all highly implementable as there will be little to no limitation on capacity during construction. However, Treatment Alternative 3 - SBR is considered to be slightly less implementable from an operational perspective due to the limitation of capacity during construction.

d. Regionalization

The existing plant provides wastewater treatment for customers within the Planning Area as well as for other customers within Rockcastle County. The plant will continue to serve as a regional treatment facility during the Planning Period. All alternatives contribute to regionalization by providing wastewater collection and treatment service to the regional Planning Area. All alternatives are considered equivalent for this category.

e. Public Support

In order to address the public's interest, the City will conducted a public meeting on September 14, 2015 to inform the public of the needs of the treatment system and to discuss the proposed alternatives. At the meeting, projected construction and operations costs and their projected effect on sewer rates will be presented. The minutes and attendance roster of the public meeting will be included in Appendix G.

The public acceptability of Treatment Alternatives 1 to 3 are similar because the City's wastewater infrastructure needs would be met by all three options.

7. Summary of Non-Monetary Effectiveness Analysis

Table 8-5, located on the following page, provides non-monetary effectiveness rankings for each treatment alternative and compares the alternatives based on non-monetary effectiveness units (NEUs).

Table 8-5 Treatment Process Selection Analysis							
Non- Monetary Factor		**Alternative 1 - Oxidation Ditch**		**Alternative 2 – Extended Aeration**		**Alternative 3 – Sequencing Batch Reactor**	
	Weight	*Rating*	*Score*	*Rating*	*Score*	*Rating*	*Score*
Environmental Impact	1.0	9	9	9	9	8	8
Engineering Evaluation	1.0	10	10	9	9	9	9
Implementability	0.9	10	9	9	8.1	7	6.3
Regionalization	0.7	10	7	10	7	10	7
Public Support	0.8	9	7.2	9	7.2	8	6.4
Total Score		42.2		40.3		36.7	
Total Present Worth		$6,904,693		$6,964,943		$7,212,693	
NEU		163,618.32		172,827.37		196,531.14	

The **Weight** of each factor is a measure of the City's relative concerns of that factor compared to other factors, on a scale of 0 to 1, with the highest weight given to those that are considered the most critical.

The **Rating** is a measure of the relative implementation concern of that alternative compared to other alternatives on a scale of 0 to 10, with the highest rating given to the alternative that best satisfies that factor.

The **NEU** (Non-monetary Effectiveness Unit) is a measure of the relative implementation concern due to construction and operation of each alternative. The NEU is the Total Present Worth divided by the Total Score. The alternative with the lowest NEU is the most capable of implementation.

8. Treatment Process Alternative Selection

Regarding the four treatment alternatives presented above, only Treatment Alternative 4 - No Action could be eliminated from further consideration due to reasons stated earlier. Without action by the City regarding the treatment facilities, the City will become non-compliant with their KPDES permit. Of the remaining alternatives, **Treatment Alternative 1 – Oxidation Ditch** was selected as the preferred treatment alternative due to its low present worth cost, its non-monetary analysis and its proven history of reliability.

Exhibit 8-27 shows the plant layout of the selected treatment alternative, Treatment Alternative 1 – Oxidation Ditch.

Exhibit 8-1
Disinfection Facilities
Alternative 1
Chlorine Gas Disinfection
Construction Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost
Equipment:				
Chlorine Gas/Sulfur Dioxide Feed Equipment	1	LS	$20,000	$20,000
Chlorine Gas Scrubber System	1	EA	$50,000	$50,000
Fire Suppression System	1	LS	$7,500	$7,500
Handwheel Operated Slide Gate 2' Wide x 6' High	4	EA	$4,500	$18,000
V-Notch Weir & Ultrasonic Flow Measurement	1	LS	$15,000	$15,000
Equipment Installation (15%)	1	LS	$16,575	$16,575
Site Piping	110	LF	$25	$2,750
Structure:				
Chemical Feed Building	560	SF	$150	$84,000
Reinforced Concrete Slab	25	CY	$450	$11,300
Reinforced Concrete Walls	29	CY	$600	$17,194
Reinforced Elevated Slab	5	CY	$750	$3,750
Soil Excavation	150	CY	$15	$2,249
Rock Excavation	110	CY	$75	$8,267
Crushed Stone	38	Ton	$25	$942
1-1/2" Diameter Handrail	50	LF	$40	$2,000
1-1/2" Fiberglass Grating	84	SF	$10	$840
Subtotal				**$260,367**
Contractor OH&P (15% of Equipment)	1	LS	$16,575	**$16,575**
Total Construction Cost				**$276,942**

Exhibit 8-2 Disinfection Facilities Alternative 1 Chlorine Gas Disinfection *Operation and Maintenance Cost*			
Design Conditions:			
Average Flow	0.250	MGD	
Peak Flow	0.600	MGD	
Influent Fecal Coliform	10,000,000	/ 100 mL	
Effluent Fecal Coliform	200	/ 100 mL	
Chlorine Gas Usage at Average Flow:			
Chlorine Feed Rate	8	mg/L	
Daily Chlorine Gas	16.7	lb/day	
Chlorine Gas Cost	$0.69	/ gal	
Days in Operation	365	days	
Total Annual Chlorine Gas Cost			**$4,216**
Sulfur Dioxide Usage at Average Flow:			
Effluent Chlorine Residual	10.4	mg/L	
Sulfur Dioxide/Chlorine Ratio	0.99		
Sulfur Dioxide Concentration	10.3	mg/L	
Daily Sulfur Dioxide Usage	21	lb/day	
Sulfur Dioxide Cost	$0.86	/ lb	
Days in Operation	365	days	
Total Annual Sulfur Dioxide Cost			**$6,762**
Total Annual Operating and Maintenance Cost			**$10,978**

Exhibit 8-3
Disinfection Facilities
Alternative 1
Chlorine Gas Disinfection
Salvage Value

Description	Cost	Salvage Value
Chlorine Gas/Sulfur Dioxide Feed Equipment	$20,000	$0
Chlorine Gas Scrubber System	$50,000	$0
Fire Suppression System	$7,500	$0
Handwheel Operated Slide Gate 2' Wide x 6' High	$18,000	$0
V-Notch Weir & Ultrasonic Flow Measurement	$15,000	$0
Site Piping	$2,750	$1,375
Chemical Feed Building	$84,000	$33,600
Reinforced Concrete Slab	$11,300	$4,520
Reinforced Concrete Walls	$17,194	$6,878
Reinforced Elevated Slab	$3,750	$1,500
1-1/2" Diameter Handrail	$2,000	$0
1-1/2" Fiberglass Grating	$840	$0
Total Salvage Cost		**$47,873**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 8-4 Disinfection Facilities Alternative 1 Chlorine Gas Disinfection *Present Worth Analysis*			
Capital Cost:			**$276,942**
Present Worth of Annual Operating Cost Calculation:			
Annual Operating Cost	$10,978	per year	
Discount Rate	6.0%		
Life of Project	20	years	
Total Present Worth of Annual Operating Cost			**$126,000**
Present Worth of Salvage Value:			
Salvage Value	$47,873		
Discount Rate	6.0%		
Life of Project	20	years	
Total Present Worth of Salvage Value			**$15,000**
Total Present Worth			**$387,942**

Exhibit 8-5
Disinfection Facilities
Alternative 2
Sodium Hypochlorite Disinfection
Construction Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost
Equipment:				
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	1	LS	$20,000	$20,000
Handwheel Operated Slide Gate 2' Wide x 6' High	4	EA	$4,500	$18,000
V-Notch Weir & Ultrasonic Flow Measurement	1	LS	$15,000	$15,000
Equipment Installation (15%)	1	LS	$7,950	$7,950
Site Piping	110	LF	$25	$2,750
Structure:				
Chemical Feed Building	680	SF	$150	$102,000
Reinforced Concrete Slab	25	CY	$450	$11,300
Reinforced Concrete Walls	29	CY	$600	$17,194
Reinforced Elevated Slab	5	CY	$750	$3,750
Soil Excavation	150	CY	$15	$2,249
Rock Excavation	110	CY	$75	$8,267
Crushed Stone	38	Ton	$25	$942
1-1/2" Diameter Handrail	50	LF	$40	$2,000
1-1/2" Fiberglass Grating	84	SF	$10	$840
Subtotal				**$212,242**
Contractor OH&P (15% of Equipment)	1	LS	$7,950	**$7,950**
Total Construction Cost				**$220,192**

Exhibit 8-6 Disinfection Facilities Alternative 2 Sodium Hypochlorite Disinfection *Operation and Maintenance Cost*			
Design Conditions:			
Average Flow	0.250	MGD	
Peak Flow	0.600	MGD	
Influent Fecal Coliform	10,000,000	/ 100 mL	
Effluent Fecal Coliform	200	/ 100 mL	
Sodium Hypochlorite Usage at Average Flow:			
Chlroine Feed Rate	8	mg/L	
Daily Sodium Hypochlorite Dosage @ 12.5%	16.0	gpd	
Sodium Hypochlorite Cost	$2.00	/ gal	
Days in Operation	365	days	
Total Annual Sodium Hypochlorite Cost			**$11,708**
Sulfur Dioxide Usage at Average Flow:			
Effluent Chlorine Residual	10.4	mg/L	
Sulfur Dioxide/Chlorine Ratio	0.99		
Sulfur Dioxide Concentration	10.2	mg/L	
Daily Sulfur Dioxide Usage	21	lb/day	
Sulfur Dioxide Cost	$0.86	/ lb	
Days in Operation	365	days	
Total Annual Sulfur Dioxide Cost			**$6,696**
Total Annual Operating and Maintenance Cost			**$18,404**

Exhibit 8-7
Disinfection Facilities
Alternative 2
Sodium Hypochlorite Disinfection
Salvage Value

Description	Cost	Salvage Value
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	$20,000	$0
Handwheel Operated Slide Gate 2' Wide x 6' High	$18,000	$0
V-Notch Weir & Ultrasonic Flow Measurement	$15,000	$0
Site Piping	$2,750	$1,375
Chemical Feed Building	$102,000	$40,800
Reinforced Concrete Slab	$11,300	$4,520
Reinforced Concrete Walls	$17,194	$6,878
Reinforced Elevated Slab	$3,750	$1,500
1-1/2" Diameter Handrail	$2,000	$0
1-1/2" Fiberglass Grating	$840	$0
Total Salvage Cost		**$55,073**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 8-8 Disinfection Facilities Alternative 2 Sodium Hypochlorite Disinfection *Present Worth Analysis*			
Capital Cost:			**$220,192**
Present Worth of Annual Operating Cost Calculation:			
Annual Operating Cost	$18,404	per year	
Discount Rate	6.0%		
Life of Project	20	years	
Total Present Worth of Annual Operating Cost			**$211,000**
Present Worth of Salvage Value:			
Salvage Value	$55,073		
Discount Rate	6.0%		
Life of Project	20	years	
Total Present Worth of Salvage Value			**$17,000**
Total Present Worth			**$414,192**

Treatment Alternate No. 1 - Demolition Plan

DATE: May, 2015

SCALE 1" = 50'

SHEET NO. 8-9

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EXHIBIT 8-9
TREATMENT ALTERNATE NO. 1
OXIDATION DITCH
DEMOLITION PLAN
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

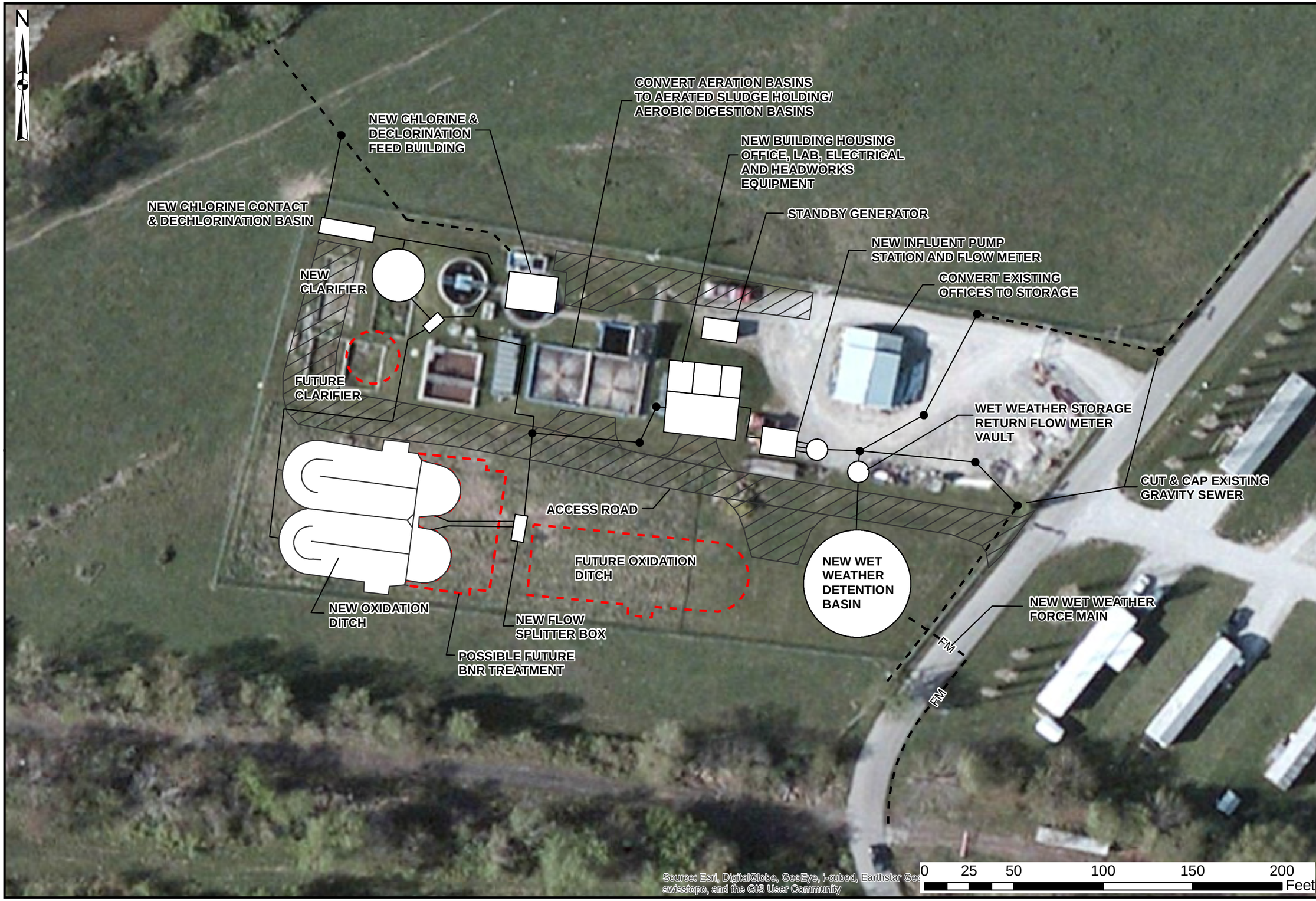
GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

REVISIONS

NO.	DESCRIPTION	DATE	BY

SCALE: 1" = 50'

Treatment Alternate No. 1 - Oxidation Ditch



DATE: May, 2015

SCALE 1" = 50'

SHEET NO. 8-10

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EXHIBIT 8-10
TREATMENT ALTERNATE NO.1
OXIDATION DITCH
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

NO.	DESCRIPTION	DATE	BY

REVISIONS

GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

SCALE: 1" = 50'

Exhibit 8-11
Brodhead WWTP Expansion
Treatment Alternative 1
Oxidation Ditch with Existing WWTP Modifications
Total Project Cost Estimate

Note: All Equipment Prices Include 15% for Contractor OH&P

Description	Quantity	Unit	Unit Cost	Cost	Sum
Wet Weather Detention Facilities					
Wet Weather Pump Station - Wet Well, Valve Vault, Pumps & Piping. (note: Does Not include Electrical Cost - See below)	1	LS	$200,000	$200,000	
Precast Wet Weather Detention Basin with Aeration	1	LS	$350,000	$350,000	
Site Grading / tank subgrade	1	LS	$20,000	$20,000	
Return Flow Meter Vault and Piping	1	LS	$20,000	$20,000	
Post Mooring Aerator	1	LS	$23,000	$23,000	
Equipment Installation (10%)	1	LS	$24,300	$24,300	
Subtotal					**$637,000**
Influent Pump Station (0.6 MGD Capacity)					
Influent Pump Station (0.6 MGD Capacity) Wet well and Vault	1	LS	$240,000	$240,000	
Influent Flow Meter - 6 inch Diameter	1	LS	$10,000	$10,000	
Subtotal					**$250,000**
Preliminary Treatment Building					
Screening Building (note: Does NOT include mechanical/electrical cost)	1,600	SF	$150	$240,000	
Handrail	1	LS	$2,000	$2,000	
Crushed Stone	125	CY	$25	$3,133	
Reinforced Concrete Slab	75	CY	$450	$33,573	
Reinforced Concrete Walls	20	CY	$600	$12,000	
Reinforced Elevated Concrete Slab	25	CY	$750	$18,917	
Soil Excavation	60	CY	$15	$904	
Backfill - Earthwork	45	CY	$5	$227	
Subtotal					**$310,754**
Screening Equipment					
Static Screen	1	LS	$40,850	$40,850	
Grating	1	LS	$8,000	$8,000	
Equipment Installation (15%)	1	LS	$6,128	$6,128	
Subtotal					**$55,000**

Exhibit 8-11
(Continued)

Oxidation Ditch Flow Splitter Box					
Gates	2	EA	$7,500	$15,000	
Equipment Installation (15%)	1	LS	$2,250	$2,250	
Reinforced Concrete Slab	4	CY	$450	$1,600	
Reinforced Concrete Walls	5	CY	$600	$3,200	
Reinforced Elevated Concrete Slab	2	CY	$750	$1,500	
Soil Excavation	25	CY	$15	$376	
Rock Excavation	19	CY	$75	$1,408	
Crushed Stone	14	Ton	$25	$352	
Grating	1	LS	$1,500	$1,500	
Handrail	1	LS	$2,000	$2,000	
Subtotal					**$29,000**
Oxidation Ditch (with space for future Biological Nutrient Removal)					
Proposed Equipment - (2) 15 HP Surface Aerators, (2) DO Controllers & Probes and VFD's.	1	LS	$229,900	$229,900	
Handrail	200	LF	$60	$11,981	
Equipment Installation (10%)	1	LS	$22,990	$22,990	
Soil Excavation	279	CY	$15	$4,192	
Rock Excavation (Structural)	1,693	CY	$50	$84,674	
Crushed Stone	267	CY	$25	$6,667	
Reinforced Concrete Slab	245	CY	$450	$110,217	
Reinforced Concrete Walls	250	CY	$600	$150,000	
Reinforced Elevated Concrete Slab	55	CY	$750	$41,250	
Subtotal					**$662,000**
Clarifier Flow Splitter Box					
Gates (New Splitter Box)	2	EA	$7,500	$15,000	
Equipment Installation (15%)	1	LS	$2,250	$2,250	
Reinforced Concrete Slab	4	CY	$450	$1,600	
Reinforced Concrete Walls	5	CY	$600	$3,200	
Reinforced Elevated Concrete Slab	2	CY	$750	$1,500	
Soil Excavation	25	CY	$15	$376	
Rock Excavation	19	CY	$75	$1,408	
Crushed Stone	14	Ton	$25	$352	
Grating	1	LS	$1,500	$1,500	
Handrail	1	LS	$2,000	$2,000	
Subtotal					**$29,000**
Modifications to Clarifier No. 1 (22-ft Diameter)					
Density Current Baffles	1	LS	$12,000	$12,000	
Subtotal					**$12,000**

Exhibit 8-11
(Continued)

New Clarifier No. 2 (25-ft Diameter)					
New Mechanical Equipment	1	EA	$57,500	$57,500	
Equipment Installation (25%)	1	LS	$18,250	$18,250	
Reinforced Concrete Slab	30	CY	$450	$13,581	
Reinforced Concrete Walls	125	CY	$600	$74,962	
Soil Excavation	170	CY	$15	$2,550	
Rock Excavation (Structural)	525	CY	$50	$26,252	
Crushed Stone	65	Ton	$25	$1,623	
Effluent Weirs and Scum Baffles (FRP)	1	LS	$4,000	$4,000	
Density Current Baffles	1	LS	$11,500	$11,500	
Subtotal					**$210,000**
Disinfection Facilities - Chemical Feed Building/Chlorine Contact Basin					
Chlorine Feed Building	680	SF	$150	$102,000	
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	1	LS	$20,000	$20,000	
V-Notch Weir & Ultrasonic Flow Measurement	1	LS	$15,000	$15,000	
Handwheel Operated Slide Gate 2' Wide x 6' High	4	EA	$4,500	$18,000	
Equipment Installation (15%)	1	LS	$7,950	$7,950	
Reinforced Concrete Slab	25	CY	$450	$11,300	
Reinforced Concrete Walls	29	CY	$600	$17,194	
Reinforced Elevated Slab	5	CY	$750	$3,750	
Soil Excavation	150	CY	$15	$2,249	
Rock Excavation	110	CY	$75	$8,267	
Crushed Stone	38	Ton	$25	$942	
1-1/2" Diameter Handrail	50	LF	$40	$2,000	
1-1/2" Fiberglass Grating	84	SF	$10	$840	
Yard Piping between Feed Building and Contact Tank	110	LF	$25	$2,750	
Subtotal					**$212,000**
RAS Pumping Station Modifications					
RAS Pumps (submersible)	2	EA	$10,000	$20,000	
Equipment Installation (15%)	1	LS	$3,000	$3,000	
6-Inch Force Main	100	LF	$50	$5,000	
Subtotal					**$28,000**
Convert Existing Aeration Basins to Aerated Sludge Holding/Aerobic Digestion Basins					
Install Telescoping Valve	2	EA	$7,500	$15,000	
New Post Mooring Aerator	2	EA	$15,000	$30,000	
Install Access Steps and Platform	1	LS	$7,500	$7,500	
1-1/2" Diameter Handrail	45	LF	$40	$1,800	
1-1/2" Fiberglass Grating	100	SF	$10	$1,000	
Equipment Installation (15%)	1	LS	$6,750	$6,750	
Decant Drain Line Modifications	1	LS	$5,000	$5,000	
Subtotal					**$67,000**

Exhibit 8-11
(Continued)

Miscellaneous					
Modifications to Roses 1 Stop and the City Hall Lift Stations	1	LS	$350,000	$350,000	
Site Grading - Flood Protection	1	LS	$50,000	$50,000	
Emergency Generator (100 KW) and transfer Switch	1	LS	$60,000	$60,000	
Demolition of Existing Steel Surge Tank	1	LS	$15,000	$15,000	
Demolition of Existing Intermediate Clarifier	1	LS	$7,500	$7,500	
Demolition of Existing Final Clarifier	1	LS	$10,000	$10,000	
Demolition Existing Chlorine Contract Basin	1	LS	$5,000	$5,000	
Demolition Existing Drying Beds	1	LS	$5,000	$5,000	
10-Inch Yard Piping (0' to 10' Deep)	530	LF	$75	$39,750	
8-Inch Yard Piping (0' to 10' Deep)	420	LF	$50	$21,000	
6-Inch Force Main - Yard Piping	100	LF	$45	$4,500	
6-Inch Wet Weather Force Main	2,500	LF	$35	$87,500	
6" Water Main Extension	500	LF	$50	$25,000	
New 4' Diameter Manhole	8	EA	$5,000	$40,000	
Subtotal					**$720,000**
Construction Cost Subtotal				***$3,221,754***	
Additional Yard Piping (10%) of the miscellaneous piping above	1	LS	$18,000	**$18,000**	
Mechanical, Electrical, & Instrumentation (18%)	1	LS	$580,000	**$580,000**	
Total Construction Cost Estimate for Alternative No. 1				***$3,819,754***	
Construction Contingencies (10%)				**$381,975**	
Engineering, Legal, Administration (15%)				**$572,963**	
Total Project Cost Estimate for Alternative No. 1				***$4,774,693***	

Exhibit 8-12
Brodhead WWTP Expansion
Treatment Alternative 1
Oxidation Ditch with Existing WWTP Modifications
Annual Operation and Maintenance Cost

Item					Annual Cost
Labor Cost					
Salaries (1 Employee)	$60,000				
Contractual Services	$6,500				
Employee Insurance	$5,000				
Total Annual Labor Cost					**$71,500**
General Cost					
Materials & Supplies	$45,000				
Utilities & Telephone	$1,000				
Miscellaneous	$17,000				
Total Annual General Cost					**$63,000**
Electrical Power Usage (avg flow / normal operation)	hp/unit	units	hrs/day	hp*hrs/day	
Influent Pumping Station (600,000 GPD Capacity)	6	1	8	48	
Wet Weather Pumping Station (500,000 GPD Capacity)	4	1	5	20	
Aerated Sludge Holding/Aerobic Digestion Basin Aerator	12	2	8	192	
Oxidation Ditch Aerators	11	2	24	528	
Oxidation Ditch Anoxic Mixers	1	2	24	48	
Clarifiers	0.5	2	24	24	
RAS Pumping Station	5	1	24	120	
WAS Pumping Station	3	1	2	6	
Total Horsepower-Hours/Day				*986*	
Daily Power Usage	736		kw-hr/day		
Annual Power Usage	268,478		kw-hr/yr		
Power Cost	$0.07		per kw-hr		
Total Annual Power Cost					**$18,793**
Disinfection Cost - Sodium Hypochlorite (See Disinfection Alt. 2)					
Annual Sodium Hypochlorite Cost	$11,708				
Annual Sulfur Dioxide Cost	$6,696				
Total Annual Disinfection Cost					**$18,404**
Solids Disposal Cost - Transportation to Land Farm (Private Sludge Hauling Company)					
Sludge Volume	150,000	gallons at 2% solids per 6 months			
Sludge Hauling Cost	$0.12	/gallons of sludge hauled			
Cost	$18,000	per 6 months			
Total Annual Solids Disposal Cost					**$36,000**
Total Annual Operating and Maintenance Cost					**$207,697**

Exhibit 8-13
Brodhead WWTP Expansion
Treatment Alternative 1
Oxidation Ditch with Existing WWTP Modifications
20- Year Salvage Value

Description	Cost	Salvage Value
Wet Weather Detention Facilities		
Wet Weather Pump Station - Wet Well and Valve Vault Structures (Assumed to be 60% of Total Station Cost)	$120,000	$48,000
Wet Weather Pump Station - Pumping Equipment and Controls (Assumed to be 40% of Total Station Cost)	$80,000	$0
Precast Wet Weather Detention Basin with Aeration	$350,000	$140,000
Return Flow Meter Vault and Piping	$20,000	$8,000
Post Mooring Aerator	$23,000	$0
Influent Pump Station (0.6 MGD Capacity)		
Influent Pump Station - Wet Well and Valve Vault Structures (Assumed to be 60% of Total Station Cost)	$144,000	$57,600
Influent Pump Station - Pumping Equipment and Controls (Assumed to be 40% of Total Station Cost)	$96,000	$0
Influent Flow Meter - 6 inch Diameter	$10,000	$5,000
Preliminary Treatment Building		
Screening Building (note: Does NOT include mechanical/electrical cost)	$240,000	$96,000
Handrail	$2,000	$0
Reinforced Concrete Slab	$33,573	$13,429
Reinforced Concrete Walls	$12,000	$4,800
Reinforced Elevated Concrete Slab	$18,917	$7,567
Screening Equipment		
Static Screen	$40,850	$0
Grating	$8,000	$0
Oxidation Ditch Flow Splitter Box		
Gates	$15,000	$0
Reinforced Concrete Slab	$1,600	$640
Reinforced Concrete Walls	$3,200	$1,280
Grating	$1,500	$0
Handrail	$2,000	$0
Oxidation Ditch (with space for future Biological Nutrient Removal)		
Proposed Equipment - (2) 15 HP Surface Aerators, (2) DO Contrc	$229,900	$0
Handrail	$11,981	$0
Reinforced Concrete Slab	$110,217	$44,087
Reinforced Concrete Walls	$150,000	$60,000
Reinforced Elevated Concrete Slab	$41,250	$16,500

Exhibit 8-13
(Continued)

Clarifier Flow Splitter Box		
Gates (New Splitter Box)	$15,000	$0
Reinforced Concrete Slab	$1,600	$640
Reinforced Concrete Walls	$3,200	$1,280
Reinforced Elevated Concrete Slab	$1,500	$600
Grating	$1,500	$0
Handrail	$2,000	$0
Modifications to Clarifier No. 1 (22-ft Diameter)		
Density Current Baffles	$12,000	$0
New Clarifier No. 2 (25-ft Diameter)		
New Mechanical Equipment	$57,500	$0
Reinforced Concrete Slab	$13,581	$5,432
Reinforced Concrete Walls	$74,962	$29,985
Effluent Weirs and Scum Baffles (FRP)	$4,000	$1,600
Density Current Baffles	$11,500	$0
Disinfection Facilities - Chemical Feed Building/Chlorine Contact Basin		
Chlorine Feed Building	$102,000	$40,800
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	$20,000	$0
V-Notch Weir & Ultrasonic Flow Measurement	$15,000	$6,000
Handwheel Operated Slide Gate 2' Wide x 6' High	$18,000	$0
Reinforced Concrete Slab	$11,300	$4,520
Reinforced Concrete Walls	$17,194	$6,878
Reinforced Elevated Slab	$3,750	$1,500
1-1/2" Diameter Handrail	$2,000	$0
1-1/2" Fiberglass Grating	$840	$0
Yard Piping between Feed Building and Contact Tank	$2,750	$1,375
RAS Pumping Station Modifications		
RAS Pumps (submersible)	$20,000	$0
6-Inch Force Main	$5,000	$2,500
Convert Existing Aeration Basins to Aerated Sludge Holding/Aerobic Digestion Basins		
Install Telescoping Valve	$15,000	$0
New Post Mooring Aerator	$30,000	$0
Install Access Steps and Platform	$7,500	$3,000
1-1/2" Diameter Handrail	$1,800	$0
1-1/2" Fiberglass Grating	$1,000	$0
Decant Drain Line Modifications	$5,000	$2,500

Exhibit 8-13
(Continued)

Miscellaneous		
Modifications to Roses 1 Stop and the City Hall Lift Stations (Assumed to be that 60% of the Total Station Cost is Structural)	$210,000	$84,000
Emergency Generator (100 KW) and transfer Switch	$60,000	$0
10-Inch Yard Piping (0' to 10' Deep)	$39,750	$19,875
8-Inch Yard Piping (0' to 10' Deep)	$21,000	$10,500
6-Inch Force Main - Yard Piping	$4,500	$2,250
6-Inch Wet Weather Force Main	$87,500	$43,750
6" Water Main Extension	$25,000	$12,500
New 4' Diameter Manhole	$40,000	$16,000
Additional Yard Piping (10%) of the miscellaneous piping above	$18,000	$9,000
Total Salvage Value		**$809,387**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 8-14
Brodhead WWTP Expansion
Treatment Alternative 1
Oxidation Ditch with Existing WWTP Modifications
Present Worth Analysis

Total Project Cost			**$4,774,693**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$207,697	per year	
Discount Rate	6.0%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$2,382,000**
Present Worth of Salvage Value			
Salvage Value	$809,387		
Discount Rate	6.0%		
Life of Project	20	years	
Present Worth of Salvage Value			**$252,000**
Total Present Worth			**$6,904,693**

Treatment Alternate No. 2 - Demolition Plan

DATE: May, 2015

SCALE 1" = 50'

SHEET NO. 8-15

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EXHIBIT 8-15
TREATMENT ALTERNATE NO. 2
EXTENDED AERATION
DEMOLITION PLAN
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

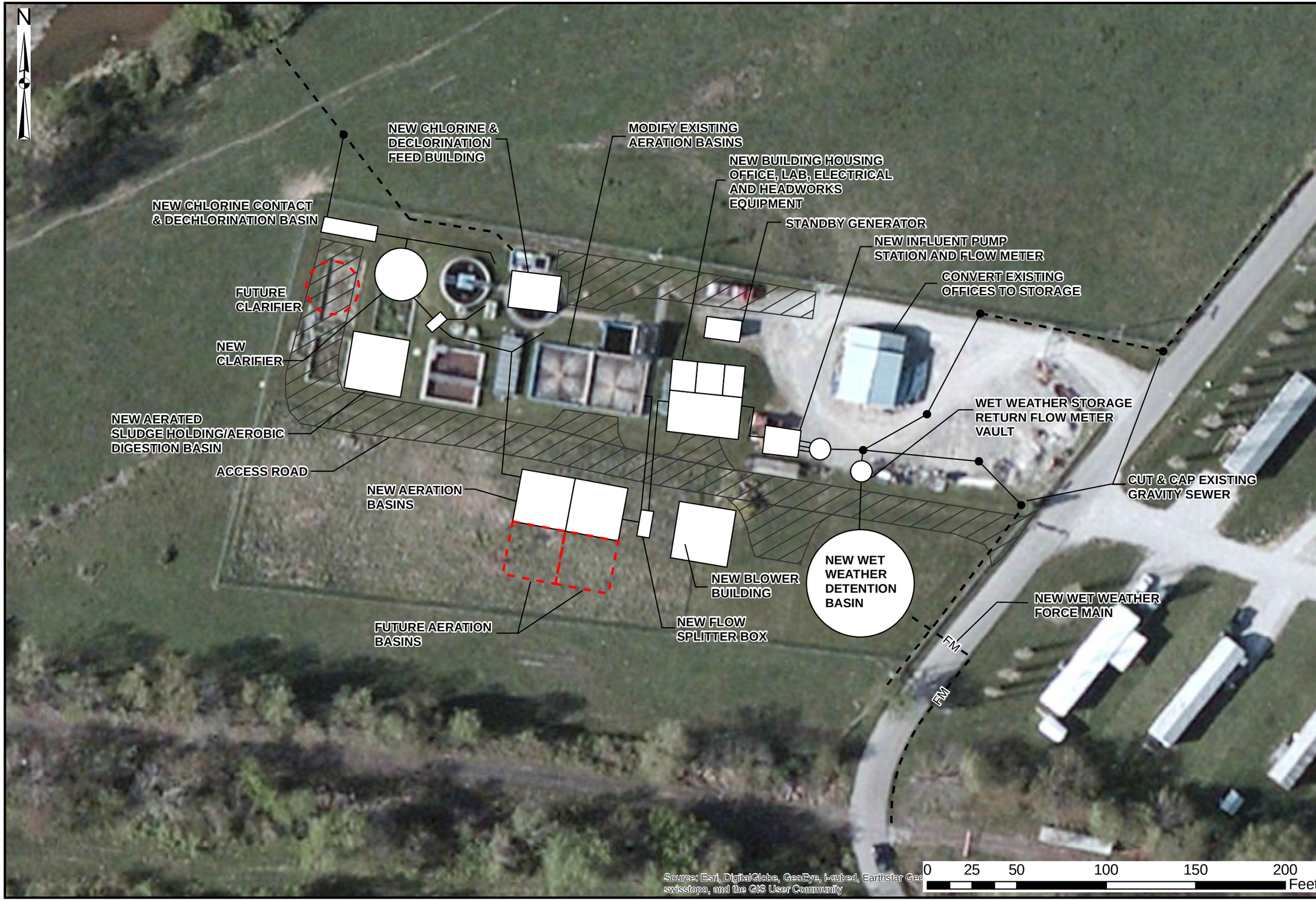
GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

REVISIONS

NO.	DESCRIPTION	DATE	BY

SCALE: 1" = 50'

Treatment Alternate No. 2 - Extended Aeration



DATE: May, 2015

SCALE 1" = 50'

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EXHIBIT 8-16
TREATMENT ALTERNATE NO. 2
EXTENDED AERATION
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

REVISIONS

NO.	DESCRIPTION	DATE	BY

SCALE: 1" = 50'

Exhibit 8-17
Brodhead WWTP Expansion
Alternative 2
Extended Aeration Basins with Existing WWTP
Total Project Cost Estimate

Note: All Equipment Prices Include 15% for Contractor OH&P

Description	Quantity	Unit	Unit Cost	Cost	Sum
Wet Weather Detention Facilities					
Wet Weather Pump Station - Wet Well, Valve Vault, Pumps & Piping. (note: Does Not include Electrical Cost - See below)	1	LS	$200,000	$200,000	
Precast Wet Weather Detention Basin with Aeration	1	LS	$350,000	$350,000	
Site Grading / tank subgrade	1	LS	$20,000	$20,000	
Return Flow Meter Vault and Piping	1	LS	$20,000	$20,000	
Post Moring Aerator	1	LS	$23,000	$23,000	
Equipment Installation (10%)	1	LS	$24,300	$24,300	
Subtotal					**$637,000**
Influent Pump Station (0.6 MGD Capacity)					
Influent Pump Station (0.6 MGD Capacity) Wet well and Vault	1	LS	$240,000	$240,000	
Influent Flow Meter - 6 inch Diameter	1	LS	$10,000	$10,000	
Subtotal					**$250,000**
Preliminary Treatment Building					
Screening Building (note: Does NOT include mechanical/electrical cost)	1,600	SF	$150	$240,000	
Handrail	1	LS	$2,000	$2,000	
Crushed Stone	125	CY	$25	$3,133	
Reinforced Concrete Slab	75	CY	$450	$33,573	
Reinforced Concrete Walls	20	CY	$600	$12,000	
Reinforced Elevated Concrete Slab	25	CY	$750	$18,917	
Soil Excavation	60	CY	$15	$904	
Backfill - Earthwork	45	CY	$5	$227	
Subtotal					**$310,754**
Screening Equipment					
Static Screen	1	LS	$40,850	$40,850	
Grating	1	LS	$8,000	$8,000	
Equipment Installation (15%)	1	LS	$6,128	$6,128	
Subtotal					**$55,000**

Exhibit 8-17
(Continued)

Aeration Basin Flow Splitter Box					
Gates	4	EA	$7,500	$30,000	
Equipment Installation (15%)	1	LS	$4,500	$4,500	
Reinforced Concrete Slab	7	CY	$450	$3,200	
Reinforced Concrete Walls	11	CY	$600	$6,400	
Reinforced Elevated Concrete Slab	4	CY	$750	$3,000	
Soil Excavation	50	CY	$15	$751	
Rock Excavation	38	CY	$75	$2,817	
Crushed Stone	28	Ton	$25	$704	
Grating	1	LS	$3,000	$3,000	
Handrail	1	LS	$2,750	$2,750	
Subtotal					**$57,000**
Modify Existing Aerations Basins					
Proposed Equipment - Diffused Air Grid System	2	EA	$35,000	$70,000	
Equipment Installation (20%)	1	LS	$14,000	$14,000	
Subtotal					**$84,000**
New Aerations Basins - (2) at 30' x 30' x 12' each					
Proposed Equipment - Diffused Air Grid System	2	EA	$35,000	$70,000	
Equipment Installation (20%)	1	LS	$14,000	$14,000	
Reinforced Concrete Slab	114	CY	$450	$51,200	
Reinforced Concrete Walls	109	CY	$600	$65,333	
Reinforced Elevated Concrete Slab	2	CY	$750	$1,500	
Soil Excavation	415	CY	$15	$6,222	
Rock Excavation	622	CY	$75	$46,667	
Crushed Stone	78	Ton	$25	$1,944	
Subtotal					**$257,000**
New Blower Building for Aerations Basins					
Blower Building (Elec. & Mech. Not Included)	576	SF	$150	$86,400	
Centrifugal Blowers & Controls	3	EA	$30,000	$90,000	
Air Piping and Valves	1	LS	$15,000	$15,000	
Reinforced Concrete Slab	23	CY	$450	$10,417	
Soil Excavation	29	CY	$15	$434	
Crushed Stone	15	Ton	$25	$377	
Equipment Installation (15%)	1	LS	$15,750	$15,750	
Subtotal					**$218,000**

Exhibit 8-17
(Continued)

Clarifier Flow Splitter Box					
Gates (New Splitter Box)	2	EA	$7,500	$15,000	
Equipment Installation (15%)	1	LS	$2,250	$2,250	
Reinforced Concrete Slab	4	CY	$450	$1,600	
Reinforced Concrete Walls	5	CY	$600	$3,200	
Reinforced Elevated Concrete Slab	2	CY	$750	$1,500	
Soil Excavation	25	CY	$15	$376	
Rock Excavation	19	CY	$75	$1,408	
Crushed Stone	14	Ton	$25	$352	
Grating	1	LS	$1,500	$1,500	
Handrail	1	LS	$2,000	$2,000	
Subtotal					**$29,000**
Modifications to Clarifier No. 1 (22-ft Diameter)					
Density Current Baffles	1	LS	$12,000	$12,000	
Subtotal					**$12,000**
New Clarifier No. 2 (25-ft Diameter)					
New Mechanical Equipment	1	EA	$57,500	$57,500	
Equipment Installation (25%)	1	LS	$18,250	$18,250	
Reinforced Concrete Slab	30	CY	$450	$13,581	
Reinforced Concrete Walls	125	CY	$600	$74,962	
Soil Excavation	170	CY	$15	$2,550	
Rock Excavation (Structural)	525	CY	$50	$26,252	
Crushed Stone	65	Ton	$25	$1,623	
Effluent Weirs and Scum Baffles (FRP)	1	LS	$4,000	$4,000	
Density Current Baffles	1	LS	$11,500	$11,500	
Subtotal					**$210,000**
Disinfection Facilities- Chemical Feed Building/Chlorine Contact Basin					
Chlorine Feed Building	680	SF	$150	$102,000	
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	1	LS	$20,000	$20,000	
V-Notch Weir & Ultrasonic Flow Measurement	1	LS	$15,000	$15,000	
Hand wheel Operated Slide Gate 2' Wide x 6' High	4	EA	$4,500	$18,000	
Equipment Installation (15%)	1	LS	$7,950	$7,950	
Reinforced Concrete Slab	25	CY	$450	$11,300	
Reinforced Concrete Walls	29	CY	$600	$17,194	
Reinforced Elevated Slab	5	CY	$750	$3,750	
Soil Excavation	150	CY	$15	$2,249	
Rock Excavation	110	CY	$75	$8,267	
Crushed Stone	38	Ton	$25	$942	
1-1/2" Diameter Handrail	50	LF	$40	$2,000	
1-1/2" Fiberglass Grating	84	SF	$10	$840	
Yard Piping between Feed Building and Contact Tank	110	LF	$25	$2,750	
Subtotal					**$212,000**

Exhibit 8-17
(Continued)

RAS Pumping Station Modifications					
RAS Pumps (submersible)	2	EA	$10,000	$20,000	
Equipment Installation (15%)	1	LS	$3,000	$3,000	
6-Inch Force Main	100	LF	$50	$5,000	
Subtotal					**$28,000**
New Aerated Sludge Holding/Aerobic Digestion Basins					
Install Telescoping Valve	2	EA	$7,500	$15,000	
New Post Mooring Aerator	2	EA	$15,000	$30,000	
Equipment Installation (15%)	1	LS	$6,750	$6,750	
Install Access Steps and Platform	1	LS	$7,500	$7,500	
1-1/2" Diameter Handrail	45	LF	$40	$1,800	
1-1/2" Fiberglass Grating	100	SF	$10	$1,000	
Reinforced Concrete Slab	40	CY	$450	$18,150	
Reinforced Concrete Walls	17	CY	$600	$9,956	
Soil Excavation	171	CY	$15	$2,569	
Rock Excavation	471	CY	$75	$35,322	
Crushed Stone	56	Ton	$25	$1,396	
Subtotal					**$129,000**
Miscellaneous					
Modifications to Roses 1 Stop and the City Hall Lift Stations	1	LS	$350,000	$350,000	
Site Grading - Flood Protection	1	LS	$50,000	$50,000	
Emergency Generator (100 KW) and transfer Switch	1	LS	$60,000	$60,000	
Demolition of Existing Steel Surge Tank	1	LS	$15,000	$15,000	
Demolition of Existing Intermediate Clarifier	1	LS	$7,500	$7,500	
Demolition of Existing Final Clarifier	1	LS	$10,000	$10,000	
Demolition Existing Chlorine Contract Basin	1	LS	$5,000	$5,000	
Demolition Existing Drying Beds	1	LS	$5,000	$5,000	
10-Inch Yard Piping (0' to 10' Deep)	600	LF	$75	$45,000	
8-Inch Yard Piping (0' to 10' Deep)	400	LF	$50	$20,000	
6-Inch Force Main - Yard Piping	100	LF	$45	$4,500	
6-Inch Wet Weather Force Main	2,500	LF	$35	$87,500	
6" Water Main Extension	500	LF	$50	$25,000	
New 4' Diameter Manhole	5	EA	$5,000	$25,000	
Subtotal					**$710,000**
Construction Cost Subtotal				***$3,198,754***	
Additional Yard Piping (10%) of the miscellaneous piping above	1	LS	$18,000	**$18,000**	
Mechanical, Electrical, & Instrumentation (18%)	1	LS	$576,000	**$576,000**	
Total Construction Cost Estimate				***$3,792,754***	
Construction Contingencies (10%)				**$379,275**	
Engineering, Legal, Administration (15%)				**$568,913**	
Total Project Cost Estimate				***$4,740,943***	

Exhibit 8-18
Brodhead WWTP Expansion
Alternative 2
Extended Aeration Basins with Existing WWTP
Annual Operation and Maintenance Cost

Item					Annual Cost
Labor Cost					
Salaries (1 Employee)	$60,000				
Contractual Services	$6,500				
Employee Insurance	$5,000				
Total Annual Labor Cost					**$71,500**
General Cost					
Materials & Supplies	$45,000				
Utilities & Telephone	$1,000				
Miscellaneous	$17,000				
Total Annual General Cost					**$63,000**
Electrical Power Usage (avg flow / normal operation)	hp/unit	units	hrs/day	hp*hrs/day	
Influent Pumping Station (600,000 GPD Capacity)	6	1	8	48	
Wet Weather Pumping Station (500,000 GPD Capacity)	4	1	5	20	
Aerated Sludge Holding/Aerobic Digestion Basin Aerators	12	2	8	192	
Fine-Bubble Aeration Grid System Blowers	20	4	12	960	
Clarifiers	0.5	2	24	24	
RAS Pumping Station	5	1	24	120	
WAS Pumping Station	3	1	2	6	
Total Horsepower-Hours/Day				*1,370*	
Daily Power Usage	1,022		kw-hr/day		
Annual Power Usage	373,037		kw-hr/yr		
Power Cost	$0.07		per kw-hr		
Total Annual Power Cost					**$26,113**
Disinfection Cost - Sodium Hypochlorite (See Disinfection Alt. 2)					
Annual Sodium Hypochlorite Cost	$11,708				
Annual Sulfur Dioxide Cost	$6,696				
Total Annual Disinfection Cost					**$18,404**
Solids Disposal Cost - Transportation to Land Farm (Private Sludge Hauling Company)					
Sludge Volume	150,000	gallons at 2% solids per 6 months			
Sludge Hauling Cost	$0.12	/gallons of sludge hauled			
Cost	$18,000	per 6 months			
Total Annual Solids Disposal Cost					**$36,000**
Total Annual Operating and Maintenance Cost					**$215,017**

Exhibit 8-19
Brodhead WWTP Expansion
Alternative 2
Extended Aeration Basins with Existing WWTP
20- Year Salvage Value

Description	Cost	Salvage Value
Wet Weather Detention Facilities		
Wet Weather Pump Station - Wet Well and Valve Vault Structures (Assumed to be 60% of Total Station Cost)	$120,000	$48,000
Wet Weather Pump Station - Pumping Equipment and Controls (Assumed to be 40% of Total Station Cost)	$80,000	$0
Precast Wet Weather Detention Basin with Aeration	$350,000	$140,000
Return Flow Meter Vault and Piping	$20,000	$8,000
Post Moring Aerator	$23,000	$0
Influent Pump Station (0.6 MGD Capacity)		
Influent Pump Station - Wet Well and Valve Vault Structures (Assumed to be 60% of Total Station Cost)	$144,000	$57,600
Influent Pump Station - Pumping Equipment and Controls (Assumed to be 40% of Total Station Cost)	$96,000	$0
Influent Flow Meter - 6 inch Diameter	$10,000	$5,000
Preliminary Treatment Building		
Screening Building (note: Does NOT include mechanical/electrical cost)	$240,000	$96,000
Handrail	$2,000	$0
Reinforced Concrete Slab	$33,573	$13,429
Reinforced Concrete Walls	$12,000	$4,800
Reinforced Elevated Concrete Slab	$18,917	$7,567
Screening Equipment		
Static Screen	$40,850	$0
Grating	$8,000	$0
Aeration Basin Flow Splitter Box		
Gates	$30,000	$0
Reinforced Concrete Slab	$3,200	$1,280
Reinforced Concrete Walls	$6,400	$2,560
Reinforced Elevated Concrete Slab	$3,000	$1,200
Grating	$3,000	$0
Handrail	$2,750	$0

Exhibit 8-19
(Continued)

Modify Existing Aerations Basins		
Proposed Equipment - Diffused Air Grid System	$70,000	$0
New Aerations Basins - (2) at 30' x 30' x 12' each		
Proposed Equipment - Diffused Air Grid System	$70,000	$0
Reinforced Concrete Slab	$51,200	$20,480
Reinforced Concrete Walls	$65,333	$26,133
Reinforced Elevated Concrete Slab	$1,500	$600
New Blower Building for Aerations Basins		
Blower Building (Elec. & Mech. Not Included)	$86,400	$34,560
Centrifugal Blowers & Controls	$90,000	$0
Air Piping and Valves	$15,000	$7,500
Reinforced Concrete Slab	$10,417	$4,167
Clarifier Flow Splitter Box		
Gates (New Splitter Box)	$15,000	$0
Reinforced Concrete Slab	$1,600	$640
Reinforced Concrete Walls	$3,200	$1,280
Reinforced Elevated Concrete Slab	$1,500	$600
Grating	$1,500	$0
Handrail	$2,000	$0
Modifications to Clarifier No. 1 (22-ft Diameter)		
Density Current Baffles	$12,000	$0
New Clarifier No. 2 (25-ft Diameter)		
New Mechanical Equipment	$57,500	$0
Reinforced Concrete Slab	$13,581	$5,432
Reinforced Concrete Walls	$74,962	$29,985
Effluent Weirs and Scum Baffles (FRP)	$4,000	$1,600
Density Current Baffles	$11,500	$0
Disinfection Facilities- Chemical Feed Building/Chlorine Contact Basin		
Chlorine Feed Building	$102,000	$40,800
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	$20,000	$0
V-Notch Weir & Ultrasonic Flow Measurement	$15,000	$6,000
Hand wheel Operated Slide Gate 2' Wide x 6' High	$18,000	$0
Reinforced Concrete Slab	$11,300	$4,520
Reinforced Concrete Walls	$17,194	$6,878
Reinforced Elevated Slab	$3,750	$1,500
1-1/2" Diameter Handrail	$2,000	$0
1-1/2" Fiberglass Grating	$840	$0
Yard Piping between Feed Building and Contact Tank	$2,750	$1,375

Exhibit 8-19
(Continued)

RAS Pumping Station Modifications		
RAS Pumps (submersible)	$20,000	$0
6-Inch Force Main	$5,000	$2,500
Miscellaneous		
Modifications to Roses 1 Stop and the City Hall Lift Stations (Assumed to be that 60% of the Total Station Cost is Structural)	$210,000	$84,000
Emergency Generator (100 KW) and transfer Switch	$60,000	$0
10-Inch Yard Piping (0' to 10' Deep)	$45,000	$22,500
8-Inch Yard Piping (0' to 10' Deep)	$20,000	$10,000
6-Inch Force Main - Yard Piping	$4,500	$2,250
6-Inch Wet Weather Force Main	$87,500	$43,750
6" Water Main Extension	$25,000	$12,500
New 4' Diameter Manhole	$25,000	$10,000
Additional Yard Piping (10%) of the miscellaneous piping above	$18,000	$9,000
Total Salvage Value		**$775,986**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 8-20
Brodhead WWTP Expansion
Alternative 2
Extended Aeration Basins with Existing WWTP
Present Worth Analysis

Total Project Cost			**$4,740,943**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$215,017	per year	
Discount Rate	6.0%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$2,466,000**
Present Worth of Salvage Value			
Salvage Value	$775,986		
Discount Rate	6.0%		
Life of Project	20	years	
Present Worth of Salvage Value			**$242,000**
Total Present Worth			**$6,964,943**

Treatment Alternate No. 3 - Demolition Plan

DATE: May, 2015

SCALE 1" = 50'

SHEET NO. 8-21

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EXHIBIT 8-21
TREATMENT ALTERNATE NO. 3
SBR
DEMOLITION PLAN
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

GRW PROJECT NO. 3929-01

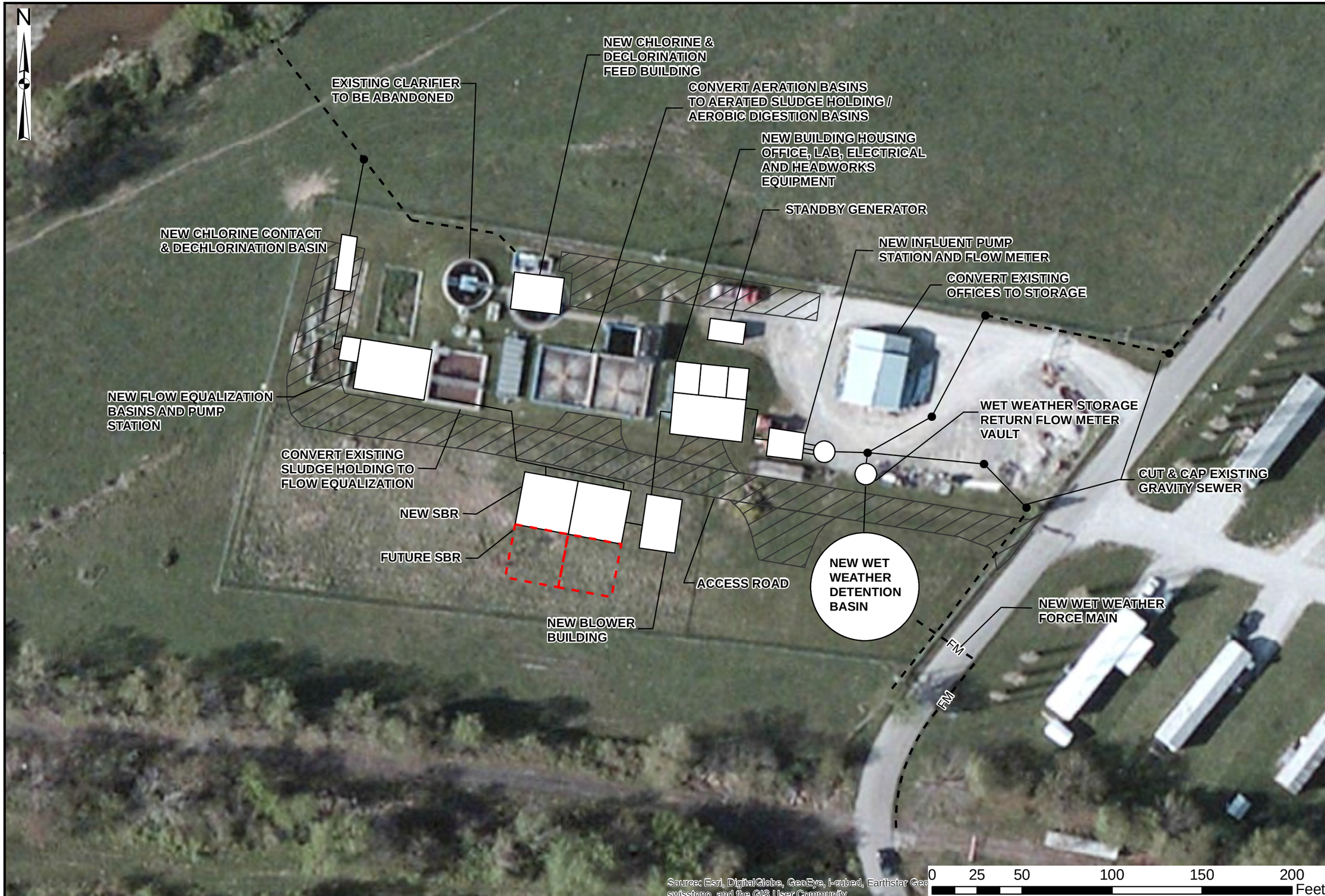
CLIENT PROJECT NO.

REVISIONS

NO.	DESCRIPTION	DATE	BY

SCALE: 1" = 50'

Treatment Alternate No. 3 - SBR



DATE: May, 2015

SCALE 1" = 50'

SHEET NO. 8-22

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EXHIBIT 8-22
TREATMENT ALTERNATE NO. 3
SBR
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

NO.	DESCRIPTION	DATE	BY
	REVISIONS		

GRW PROJECT NO. 3929-01 CLIENT PROJECT NO.

SCALE: 1" = 50'

Exhibit 8-23
Brodhead WWTP Expansion
Treatment Alternative 3
SBR with Existing WWTP Modifications
Total Project Cost Estimate

Note: All Equipment Prices Include 15% for Contractor OH&P

Description	Quantity	Unit	Unit Cost	Cost	Sum
Wet Weather Detension Facilities					
Wet Weather Pump Station - Wet Well, Valve Vault, Pumps & Piping. (note: Does Not include Electrical Cost - See below)	1	LS	$200,000	$200,000	
Precast Wet Weather Detension Basin with Aeration	1	LS	$350,000	$350,000	
Site Grading / tank subgrade	1	LS	$20,000	$20,000	
Return Flow Meter Vault and Piping	1	LS	$20,000	$20,000	
Post Mooring Aerator	1	LS	$23,000	$23,000	
Equipment Installation (10%)	1	LS	$24,300	$24,300	
Subtotal					**$637,000**
Influent Pump Station (0.6 MGD Capacity)					
Influent Pump Station (0.5 MGD Capacity) Wet Well and Vault	1	LS	$240,000	$240,000	
Influent Flow Meter - 6 inch Diameter	1	LS	$10,000	$10,000	
Subtotal					**$250,000**
Preliminary Treatment Building					
Screening Building (note: Does NOT include mechanical/electrical cost)	1,600	SF	$150	$240,000	
Handrail	1	LS	$2,000	$2,000	
Crushed Stone	125	CY	$25	$3,133	
Reinforced Concrete Slab	75	CY	$450	$33,573	
Reinforced Concrete Walls	20	CY	$600	$12,000	
Reinforced Elevated Concrete Slab	25	CY	$750	$18,917	
Soil Excavation	60	CY	$15	$904	
Backfill - Earthwork	45	CY	$5	$227	
Subtotal					**$310,754**
Screening Equipment					
Static Screen	1	LS	$40,850	$40,850	
Grating	1	LS	$8,000	$8,000	
Equipment Installation (15%)	1	LS	$6,128	$6,128	
Subtotal					**$49,000**

Exhibit 8-23
(Continued)

SBR & Blower Building					
SBR Equipment (Blowers, Mixers, Decanters, etc.)	1	LS	$396,687	$396,687	
Modulating Valves & Equipment for Blowers	1	LS	$50,000	$50,000	
Equipment Installation (15%)	1	LS	$67,003	$67,003	
Soil Excavation	300	CY	$15	$4,500	
Rock Excavation (Structural)	1,110	CY	$50	$55,500	
Crushed Stone	180	CY	$25	$4,500	
Reinforced Concrete Walls	180	CY	$600	$108,000	
Reinforced Concrete Slab	67	CY	$450	$30,000	
Blower Building (30' by 20')	600	SF	$150	$90,000	
Grating	1	LS	$10,000	$10,000	
1-1/2" Diameter Handrail	25	LF	$40	$1,000	
Subtotal					**$817,000**
Disinfection Facilities- Chemical Feed Building/Chlorine Contact Basin					
Chlorine Feed Building	680	SF	$150	$102,000	
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	1	LS	$20,000	$20,000	
V-Notch Weir & Ultrasonic Flow Measurement	1	LS	$15,000	$15,000	
Hand wheel Operated Slide Gate 2' Wide x 6' High	4	EA	$4,500	$18,000	
Equipment Installation (15%)	1	LS	$7,950	$7,950	
Reinforced Concrete Slab	25	CY	$450	$11,300	
Reinforced Concrete Walls	29	CY	$600	$17,194	
Reinforced Elevated Slab	5	CY	$750	$3,750	
Soil Excavation	150	CY	$15	$2,249	
Rock Excavation	110	CY	$75	$8,267	
Crushed Stone	38	Ton	$25	$942	
1-1/2" Diameter Handrail	50	LF	$40	$2,000	
1-1/2" Fiberglass Grating	84	SF	$10	$840	
Yard Piping between Feed Building and Contact Tank	110	LF	$25	$2,750	
Subtotal					**$212,000**
Convert Existing Aeration Basins to Aerated Sludge Holding/Aerobic Digestion Basins					
Install Telescoping Valve	2	EA	$7,500	$15,000	
New Post Mooring Aerator	2	EA	$15,000	$30,000	
Install Access Steps and Platform	1	LS	$7,500	$7,500	
1-1/2" Diameter Handrail	45	LF	$40	$1,800	
1-1/2" Fiberglass Grating	100	SF	$10	$1,000	
Equipment Installation (15%)	1	LS	$6,750	$6,750	
Decant Drain Line Modifications	1	LS	$5,000	$5,000	
Subtotal					**$67,000**

Exhibit 8-23
(Continued)

Expand Existing Sludge Holding Basins & Convert to Flow Equalization					
Demolitision of Existing Equipment	1	LS	$25,000	$25,000	
Misc Concrete Modifications	1	LS	$15,000	$15,000	
Pumps, Guide Rails and Controls	1	LS	$75,000	$75,000	
Precast Valve Vault, Piping, Valves and Fittings	1	LS	$24,000	$24,000	
Equipment Installation (15%)	1	LS	$14,850	$14,850	
Reinforced Concrete Slab	75	CY	$450	$33,775	
Reinforced Concrete Walls	58	CY	$600	$34,533	
Reinforced Elevated Slab	5	CY	$750	$3,583	
Soil Excavation	245	CY	$15	$3,680	
Rock Excavation	368	CY	$75	$27,600	
Crushed Stone	130	Ton	$25	$3,256	
1-1/2" Diameter Handrail	20	LF	$40	$800	
Subtotal					**$261,000**
Miscellaneous					
Modifications to Roses 1 Stop and the City Hall Lift Stations	1	LS	$350,000	$350,000	
Site Grading - Flood Protection	1	LS	$50,000	$50,000	
Emergency Generator (100 KW) and transfer Switch	1	LS	$60,000	$60,000	
Demolition of Existing Steel Surge Tank	1	LS	$15,000	$15,000	
Demolition of Existing Intermediate Clarifier	1	LS	$7,500	$7,500	
Demolition of Existing Final Clarifier	1	LS	$10,000	$10,000	
Demolition Existing Chlorine Contract Basin	1	LS	$5,000	$5,000	
Demolition Existing Drying Beds	1	LS	$5,000	$5,000	
10-Inch Yard Piping (0' to 10' Deep)	405	LF	$75	$30,375	
8-Inch Yard Piping (0' to 10' Deep)	420	LF	$50	$21,000	
6-Inch Force Main - Yard Piping	200	LF	$45	$9,000	
6-Inch Wet Weather Force Main	2,500	LF	$35	$87,500	
6" Water Main Extension	500	LF	$50	$25,000	
New 4' Diameter Manhole	5	EA	$5,000	$25,000	
Subtotal					**$700,000**
Construction Cost Subtotal				**$3,303,754**	
Additional Yard Piping (10%) of the miscellaneous piping above	1	LS	$17,000	**$17,000**	
Mechanical, Electrical, & Instrumentation (22%)	1	LS	$727,000	**$727,000**	
Total Construction Cost Estimate for Alternative No. 3				***$4,047,754***	
Construction Contingencies (10%)				**$404,775**	
Engineering, Legal, Administration (15%)				**$607,163**	
Total Project Cost Estimate				***$5,059,693***	

Exhibit 8-24
Brodhead WWTP Expansion
Treatment Alternative 3
SBR with Existing WWTP Modifications
Annual Operation and Maintenance Cost

Item					Annual Cost
Labor Cost					
Salaries (1 Employee)	$60,000				
Contractual Services	$6,500				
Employee Insurance	$5,000				
Total Annual Labor Cost					**$71,500**
General Cost					
Materials & Supplies	$45,000				
Utilities & Telephone	$1,000				
Miscellaneous	$17,000				
Total Annual General Cost					**$63,000**
Electrical Power Usage (avg flow / normal operation)	hp/unit	units	hrs/day	hp*hrs/day	
Influent Pumping Station (600,000 GPD Capacity)	6	1	8	48	
Wet Weather Pumping Station (500,000 GPD Capacity)	4	1	5	20	
Aerated Sludge Holding/Aerobic Digestion Basin Aerators	12	2	8	192	
SBR 24" Modulating Valves	0.5	1	24	12	
SBR Mixers	5	2	15	150	
SBR Blowers	10	4	12	480	
Flow Equalization Pump Station (600,000 GPD Capacity)	5	1	20	100	
WAS Pumping Station	3	1	12	36	
Total Horsepower-Hours/Day				*1,038*	
Daily Power Usage	774		kw-hr/day		
Annual Power Usage	282,637		kw-hr/yr		
Power Cost	$0.07		per kw-hr		
Total Annual Power Cost					**$19,785**
Disinfection Cost - Sodium Hypochlorite (See Disinfection Alt. 2)					
Annual Sodium Hypochlorite Cost	$11,708				
Annual Sulfur Dioxide Cost	$6,696				
Total Annual Disinfection Cost					**$18,404**
Solids Disposal Cost - Transportation to Land Farm (Private Sludge Hauling Company)					
Sludge Volume	150,000	gallons at 2% solids per 6 months			
Sludge Hauling Cost	$0.12	/gallons of sludge hauled			
Cost	$18,000	per 6 months			
Total Annual Solids Disposal Cost					**$36,000**
Total Annual Operating and Maintenance Cost					**$208,689**

Exhibit 8-25
Brodhead WWTP Expansion
Treatment Alternative 3
SBR with Existing WWTP Modifications
20- Year Salvage Value

Description	Cost	Salvage Value
Wet Weather Detension Facilities		
Wet Weather Pump Station - Wet Well and Valve Vault Structures (Assumed to be 60% of Total Station Cost)	$120,000	$48,000
Wet Weather Pump Station - Pumping Equipment and Controls (Assumed to be 40% of Total Station Cost)	$80,000	$0
Precast Wet Weather Detension Basin with Aeration	$350,000	$140,000
Return Flow Meter Vault and Piping	$20,000	$8,000
Post Mooring Aerator	$23,000	$0
Influent Pump Station (0.6 MGD Capacity)		
Influent Pump Station - Wet Well and Valve Vault Structures (Assumed to be 60% of Total Station Cost)	$144,000	$57,600
Influent Pump Station - Pumping Equipment and Controls (Assumed to be 40% of Total Station Cost)	$96,000	$0
Influent Flow Meter - 6 inch Diameter	$10,000	$5,000
Preliminary Treatment Building		
Screening Building (note: Does NOT include mechanical/electrical cost)	$240,000	$96,000
Handrail	$2,000	$0
Reinforced Concrete Slab	$33,573	$13,429
Reinforced Concrete Walls	$12,000	$4,800
Reinforced Elevated Concrete Slab	$18,917	$7,567
Screening Equipment		
Static Screen	$40,850	$0
Grating	$8,000	$0
SBR & Blower Building		
SBR Equipment (Blowers, Mixers, Decanters, etc.)	$396,687	$0
Modulating Valves & Equipment for Blowers	$50,000	$0
Reinforced Concrete Walls	$108,000	$43,200
Reinforced Concrete Slab	$30,000	$12,000
Blower Building (30' by 20')	$90,000	$36,000
Grating	$10,000	$0
1-1/2" Diameter Handrail	$1,000	$0

Exhibit 8-25
(Continued)

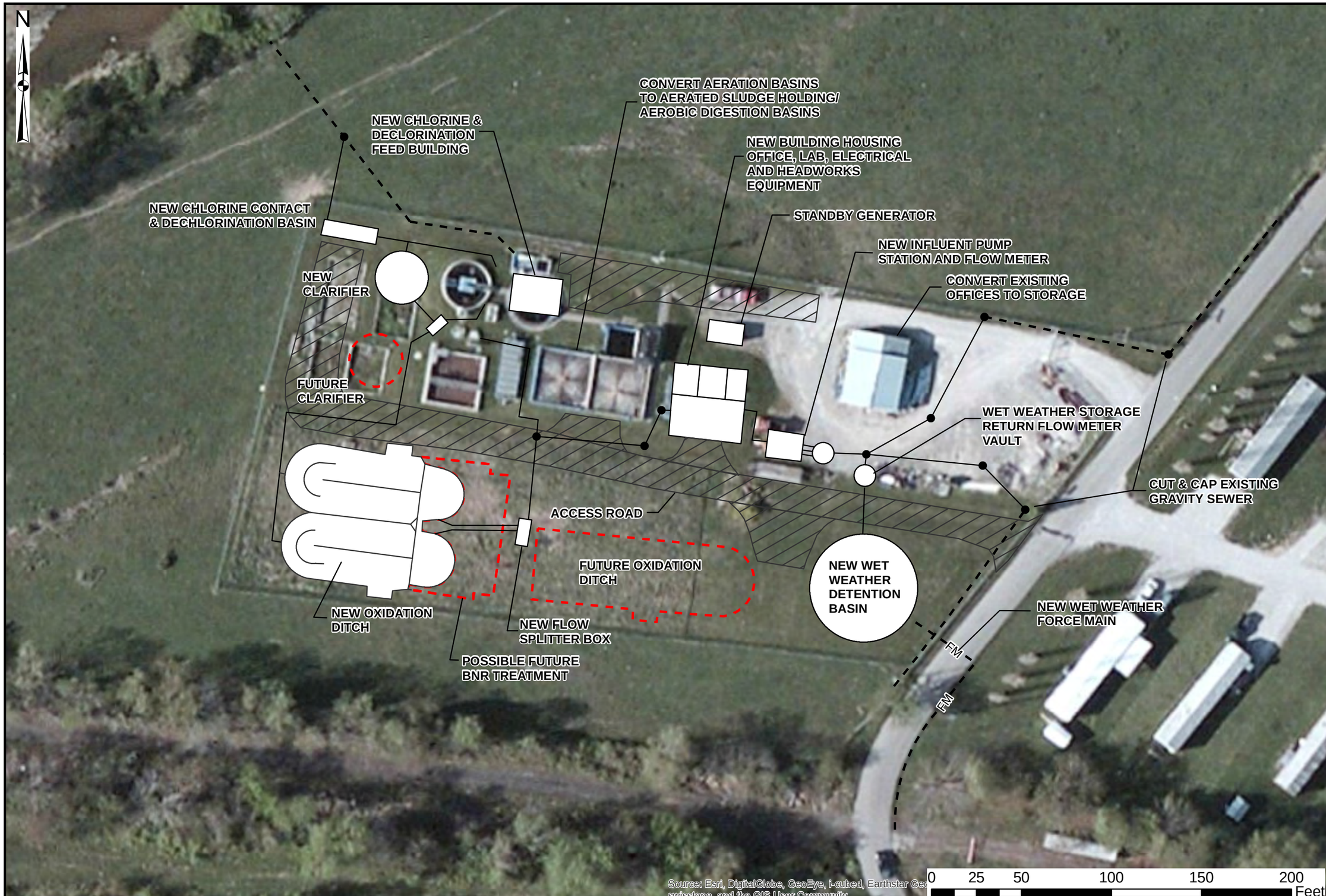
Disinfection Facilities- Chemical Feed Building/Chlorine Contact Basin		
Chlorine Feed Building	$102,000	$40,800
Sodium Hypochlorite/Sulfur Dioxide Feed Equipment	$20,000	$0
V-Notch Weir & Ultrasonic Flow Measurement	$15,000	$6,000
Hand wheel Operated Slide Gate 2' Wide x 6' High	$18,000	$0
Reinforced Concrete Slab	$11,300	$4,520
Reinforced Concrete Walls	$17,194	$6,878
Reinforced Elevated Slab	$3,750	$1,500
1-1/2" Diameter Handrail	$2,000	$0
1-1/2" Fiberglass Grating	$840	$0
Yard Piping between Feed Building and Contact Tank	$2,750	$1,375
Convert Existing Aeration Basins to Aerated Sludge Holding/Aerobic Digestion Basins		
Install Telescoping Valve	$15,000	$0
New Post Mooring Aerator	$30,000	$0
Install Access Steps and Platform	$7,500	$3,000
1-1/2" Diameter Handrail	$1,800	$0
1-1/2" Fiberglass Grating	$1,000	$0
Decant Drain Line Modifications	$5,000	$2,500
Expand Existing Sludge Holding Basins & Convert to Flow Equalization		
Demolitision of Existing Equipment	$25,000	$0
Misc Concrete Modifications	$15,000	$6,000
Pumps, Guide Rails and Controls	$75,000	$0
Precast Valve Vault, Piping, Valves and Fittings	$24,000	$12,000
Reinforced Concrete Slab	$33,775	$13,510
Reinforced Concrete Walls	$34,533	$13,813
Reinforced Elevated Slab	$3,583	$1,433
1-1/2" Diameter Handrail	$800	$0
Miscellaneous		
Modifications to Roses 1 Stop and the City Hall Lift Stations (Assumed to be that 60% of the Total Station Cost is Structural)	$210,000	$84,000
Emergency Generator (100 KW) and transfer Switch	$60,000	$0
10-Inch Yard Piping (0' to 10' Deep)	$30,375	$15,188
8-Inch Yard Piping (0' to 10' Deep)	$21,000	$10,500
6-Inch Force Main - Yard Piping	$9,000	$4,500
6-Inch Wet Weather Force Main	$87,500	$43,750
6" Water Main Extension	$25,000	$12,500
New 4' Diameter Manhole	$25,000	$10,000
Additional Yard Piping (10%) of the miscellaneous piping above	$17,000	$8,500
Total Salvage Value		**$773,863**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 8-26
Brodhead WWTP Expansion
Treatment Alternative 3
SBR with Existing WWTP Modifications
Present Worth Analysis

Total Project Cost			**$5,059,693**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$208,689	per year	
Discount Rate	6.0%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$2,394,000**
Present Worth of Salvage Value			
Salvage Value	$773,863		
Discount Rate	6.0%		
Life of Project	20	years	
Present Worth of Salvage Value			**$241,000**
Total Present Worth			**$7,212,693**

Selected Treatment Alternative



DATE: May, 2015

SCALE 1" = 50'

SHEET NO. 8-27

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EXHIBIT 8-27
SELECTED TREATMENT ALTERNATIVE
ALTERNATIVE NO.1
OXIDATION DITCH
WASTEWATER FACILITIES PLAN
CITY OF BRODHEAD, KENTUCKY

DESIGNED:

DRAWN:

REVIEWED:

APPROVED:

NO.	DESCRIPTION	DATE	BY

REVISIONS

CLIENT PROJECT NO.

GRW PROJECT NO. 3929-01

SCALE: 1" = 50'

Section 9

SECTION 9
CROSS-CUTTER CORRESPONDENCE AND MITIGATION

A. Introduction

During the preparation of this Facilities Plan, an exchange of correspondence was completed with several agencies responsible for environmental concerns related to the construction and operation of wastewater collection and treatment facilities. Termed "Cross-Cutter" correspondence, the associated agencies were:

- Threatened and Endangered Species: The U.S. Fish and Wildlife Service, Kentucky Ecological Services Field Station, and the Kentucky Department of Fish and Wildlife Resources.
- Historical Resources: The Kentucky Heritage Council (State Historic Preservation Office)
- Aquatic Resources: The U.S. Army Corps of Engineers (Louisville District)
- Agricultural Resources: The Natural Resources Conservation Service

Copies of the "Cross-Cutter" correspondence are provided in Appendix J. The letter to each agency contained a detailed description of the proposed projects, supported by location maps and other information. A summary of the results of this exchange of correspondence is provided in this chapter. When an agency's response indicates the potential adverse impact on a resource as a result of the proposed project, and an alternate method of installation or implementation cannot be used, a mitigation approach is presented to compensate for the adverse impact.

B. Threatened and Endangered Species

The U.S. Fish and Wildlife Service reviewed the areas that are anticipated to be affected by future projects that are discussed in this Facilities Planning document. Their response indicated the possible presence of three (3) federally listed species. These are the Indiana bat (Myotis sodalist) and the Virginia big-eared bat (Corynorphinus townsendii viginianus), both of which are endangered, and the Northern long-eared bat, which is considered threatened. According to the U.S. Fish and Wildlife Kentucky Field Office, the project does not occur within known bat habitats.

The agency advised a more detailed review of the various project areas when the projects were imminent in order to determine the need for further surveys, protection methods and/or possible mitigation requirements.

The Kentucky Department of Fish and Wildlife Resources stated that there are two (2) federally-listed species within 10 miles of the project area: the Northern long-eared bat (Myotis septentrionalis) and the Cumberland Bean (Villosa trabalis). Additionally, Kentucky Department of Fish and Wildlife Resources stated that there are two (2) state-listed species that are known to be present in the planning area, but will not be impacted by the proposed projects. These are the Barn Owl (Tyto alba) and Dark-eyed Junco (Junco hyemalis).

Both agencies advised the use of strict erosion control measures during and after construction in order to protect aquatic habitats.

C. Historical Resources

The State Historic Preservation Office of the Kentucky Heritage Council stated that the proposed project areas have not been surveyed for archaeological resources. Therefore, the proposed project areas that extend outside previously disturbed areas are to be surveyed by a professional archaeologist and the resulting report should be submitted to the State Historic Preservation Office for review. Approval from the State Historic Preservation Office must be obtained prior to construction.

D. Aquatic Resources

The Department of the Army, US Army Corps of Engineers stated that "waters of the United States" are located within the planning area. They recommended submittal of detailed information for each project prior to construction in order to determine if a Department of the Army Permit will be required.

E. Agricultural Resources

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) review of the proposed projects concluded that the proposed projects will not affect prime, unique or statewide important farmlands. However, they stated that the determination does not apply to any lands beyond the boundary of existing right-of-way, areas not already previously disturbed, or lands outside of urban areas.

SECTION 10
EVALUATION OF RECOMMENDED REGIONAL FACILITY PLAN

A. Introduction

This chapter summarizes the critical components of the Recommended Plan, including environmental impacts, institutional structure requirements, the funding plan and the implementation schedule.

B. Environmental Impacts

Section 9 refers to Cross-Cutter Correspondence with various state and federal agencies that relate to potential adverse impacts of the Recommended Plan. The responses from these agencies (included in Appendix J) indicated that the Recommended Plan does not have a negative impact on surface and groundwater, threatened or endangered species, air quality, floodplains and wetlands, historical or archaeological sites, important prime farmland, or any other applicable environmentally sensitive areas. The implementation of the projects in the Recommended Plan will have a positive impact on water quality in the Dix River.

C. Institutional Structure

There are no changes to the existing institutional structure of the City of Brodhead as a result of the Recommended Plan. Other than a revised user charge system for paying debt service and annual Operation and Maintenance costs for the recommended plan, no new ordinances or regulations are needed to implement the recommended plan.

D. Funding Plan

The purpose of this section is to provide a preliminary funding plan for the Recommended Plan. This includes an assessment of potential funding sources and a preliminary estimate of potential user rates. This funding plan is based on the estimated project cost and annual operating and maintenance cost of the plan, as presented in Section 8. These costs are then evaluated against a combination of funding options (i.e., grants and loans) to provide estimated annual debt service and annual O&M costs that must be paid by the wastewater system customers as monthly sewer service rates. It should be noted that the calculations presented in this section are preliminary and will

require revision once the actual construction costs are known (from contractor's bids for the projects in this Plan) and the sources, amounts and availability of grants and loans have been confirmed. Therefore, this information is presented to provide a preliminary order of magnitude for sewer service rates, and the City will need to conduct a separate User Charge Study to determine the actual rates needed to pay for the Recommended Plan.

The following paragraphs describe the City's current wastewater system revenue and funding, as well as the revenue and funding for the 0-10 year proposed improvements.

Current Wastewater System Revenue and Funding

In January, 2015 the City of Brodhead passed an ordinance (Ordinance No. 2015-0101) that adjusted the sewer service rates for its customers. Table 10-1 summarizes the current sewer service rates.

Table 10-1
Brodhead Monthly Sewer Service Rates
(Effective January 19, 2015)

Monthly Water Use (in Gal.)	**Monthly Charge**
<2,000* (Min. Rate)	$25.64*
>2,000 (per thousand)	$4.61

* Minimum Quantity Measured & Charged

The selected treatment plan, Alternative 1 – Oxidation Ditch is recommended to be implemented in the 0-10 year planning phase. The estimated total project cost and therefore, the total amount needed to be funded is $4,774,693.

GRW compared the City's 2013 (annual) sewer operation and maintenance (O&M) budget with the projected O&M budget for the selected alternative. The replacement of the chlorine disinfection process with sodium hypochlorite will result in a slight increase in chemical costs, but with a large reduction in risk due to the dangerous nature of chlorine gas. The increased effectiveness of the new oxidation ditch treatment process will result in a greater amount of solids removal, so the cost of sludge disposal will increase. The total estimated O&M cost for the selected alternative results in an increase of $62,214 to the annual O&M budget. This amount will be added to the debt service required to fund the project to obtain the amount of additional required revenue needed.

As requested, GRW analyzed three (3) different options for project funding. Options 1 & 2 evaluate a 30-year payback period, whereas Option 3 evaluates a 40-year payback periods. Additionally, each Funding Option includes $1,500,000 in grant money

($1,000,000 from CDBG and $500,000 from ARC). Due to the median household income of the City of Brodhead and the nature of the project, grant money and principal forgiveness are reasonable assumptions to make for the payback analysis. The projected rate increase calculations can be found in Exhibits 10-1 through 10-3.

Funding Option 1 considers a 30-year payback period for a bond issue at hardship rates through KIA SRF and a 10% debt service coverage as well as the $62,214 increase in O&M costs. Additionally, Funding Option 1 considers a 30% principal forgiveness from KIA SRF. The total additional annual revenue required in Option 1 is $159,206, resulting in an increase of 94.43% in required revenue. The rates for an average usage of 4,000 gallons per month will need to be increased from $34.86 to $67.78 for customers to cover the projected required additional revenue.

Similarly to Funding Option 1, Funding Option 2 considers a 30-year payback period for a bond issue at hardship rates through KIA SRF and a 10% debt service coverage as well as the $62,214 increase in O&M costs. However, Funding Option 2 considers a 50% principal forgiveness from KIA SRF as compared to the 30% in Funding Option 1. The total additional annual revenue required in Option 2 is $131,494, resulting in an increase of 78% in required revenue. The rates for an average usage of 4,000 gallons per month will need to be increased from $34.86 to $62.05 for customers to cover the projected required additional revenue.

Funding Option 3 considers a 40-year payback period, a 2.125% interest rate and 10% debt service coverage as well as the $62,214 increase in O&M costs. Additionally, Funding Option 3 considers a 30% principal forgiveness from RD. The total additional annual revenue required in Option 3 is $156,422. Therefore, an increase of 92.78% is needed to obtain the required revenue. The rates for an average usage of 4,000 gallons per month will need to be increased from $34.86 to $67.20 for customers to cover the projected required additional revenue.

It is noted that the funding scenarios and projected rate increases discussed in this section are conceptual and will need to be revised once the recommended projects are designed and the funding agencies have been involved in determining the availability of loans and grants.

E. Traditional Financing Methods

As mentioned earlier, there are traditional methods of financing that the City of Brodhead will also need to explore. These include, but are not limited to, State Revolving Fund loans, Appalachian Regional Commission grants, Community Development Block Grant programs, USDA Rural Development loans, general obligation bonds, and revenue bonds.

1. SRF Loans

Basic infrastructure — water, sewer, solid waste facilities, etc. — is a necessity for economic growth. Many Kentucky communities do not have that infrastructure available to their citizens, due in large part to the high costs of these services. The Kentucky Infrastructure Authority (KIA) was created in 1988 to provide the mechanism for funding construction of local public works projects. The Federally Assisted Wastewater Revolving Loan, or Fund A, is the program administered through KIA that is applicable to wastewater.

Fund A currently has a standard interest rate of 2.75%, a non-standard interest rate of 1.75%, and non-standard hardship interest rate of 0.75%. Hardship rates require a community to be below the state median household income, be considered regional, or the project must assist the system to achieve compliance with an order or judgment addressing environmental non-compliance. If a project is only going to service a portion of the community, the hardship rate requirements apply only to that portion. Due to the median income of the City of Brodhead, the interest rate would be the hardship rate of 0.75%. Fund A also has a loan service fee of 0.20% of the unpaid loan balance to be paid annually.

Repayment must be within 20 years of completion of a project, and must commence within one year of project completion. Priority of loan awards is based on project rankings from the water management council, and eligible projects must be for wastewater treatment facilities that comply with the Clean Water Act. An approved Facilities Plan must include the project for which funding is requested. Communities wishing to apply must submit an application along with a preliminary engineering report (PER).

2. Appalachian Regional Commission (ARC)

The Appalachian Regional Commission (ARC) awards grants to projects that address one or more of the four goals identified by ARC in its strategic plan and that can demonstrate measurable results. Typically, ARC project grants are awarded to state and local agencies and governmental entities, local governing boards and non-profit organizations. Most ARC project grants originate at the state level. ARC expects grantees to contribute matching resources to projects, to the extent that they are able to do so, and to seek additional non-ARC funding assistance in a diligent manner. Eligible projects for ARC grants are of the following variety: business development, education & training, healthcare, physical infrastructure and leadership and civic capacity. In regards to physical infrastructure, ARC provides funds for basic infrastructure services, including water and sewer facilities, which enhance economic development opportunities or address serious health issues for residential customers.

3. Community Development Block Grant (CDBG) Program

Under the Community Development Block Grant (CDBG) Program, States award grants to smaller units of general local government that develop and preserve decent affordable housing, to provide services to the most vulnerable in our communities, and to create and retain jobs. Annually, each State develops funding priorities and criteria for selecting projects. CDBG funds may be used for activities which include, but are not limited to:

- Acquisition of real property
- Relocation or demolition
- Rehabilitation of residential and non-residential structures
- Construction of public facilities and improvements, such as water & sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes
- Public services, within certain limits
- Activities relating to energy conservation and renewable energy resources
- Provision of assistance to non-profit and profit-motivated businesses to carry out economic development and job creation/retention activities.

Each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention, or elimination of sums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health for welfare of the community for which other funding is not available. A

4. USDA Rural Development (RD) Loan

Formerly known as the "Farmers Home Administration Program" (FmHA), the RD program is administered by the United States Department of Agriculture (U.S.D.A.). The RD program is primarily for rural residents, small cities, and towns with populations of 10,000 or less. The program uses low interest loan funds and grant funds to assist in the funding of water and sanitary sewer projects. Interest rates are adjusted quarterly and may be obtained from any RD office. Due to the median income of the City of Brodhead, the interest rate would be the poverty rate of 2.125%. If awarded, grant assistance, in some instances, can be up to 75% of eligible project costs. In actuality, grant funds would typically be much lower than the 25% limit, particularly for large projects, and due to the City's median household income level, the probability of obtaining grant funds is feasible. Eligibility requirements for grant assistance are the same as for direct loans. Payback periods for debt service can be as long as 40 years; however, no repayment period will exceed State statutes or the useful life of the facility.

Similar to the SRF program, RD requires an application submittal along with a Preliminary Engineering Report (PER). Upon approval, a financing package of loans and grants is developed based on the community's income level and its ability to meet a

certain user rate. The RD program estimates an acceptable user rate for the community based on median income levels and rates of similar systems. Consequently, the program typically does not provide grant assistance to projects that would have rates below the acceptable user rate.

The RD program is allocated a certain amount of money each year. Once the demand has exhausted the supply, the applicants are prioritized based on several factors including income levels, service population, health hazards, and violations of local health ordinances.

5. General Obligation Bonds

General obligation bonds offer investors a relatively safe vehicle for investment, while providing the necessary funds for community improvements to local governments. These bonds are backed by the full faith and credit of the issuing municipality, meaning that the municipality commits its full resources to paying bondholders. This includes general taxation and the ability to raise more funds through credit. The ability to back up these types of bond payments with tax funds is what makes them distinct from revenue bonds, which are repaid using the revenue generated by the specific project the bonds are issued to fund (i.e. sewer use fees).

The default risk of general obligation bonds is low due to the fact that the municipality has the option of raising taxes to meet its obligations. In addition, it is possible for municipalities to repay bondholders by borrowing more money. By calling a bond issue when interest rates fall, the municipality is stating that they will repay the principal before the bond matures. They can then re-fund the debt by making a new bond issue at a lower rate of interest, saving money in the process.

General obligation bonds give municipalities a tool with which to raise funds for projects that will not provide direct sources of revenue. As a result, they are typically used to fund projects that will serve an entire community. Revenue bonds, on the other hand, are used to fund projects that serve specific populations, who provide the revenue to repay the debt through user fees.

6. Revenue Bonds

Revenue bonds make up the vast majority of municipal bonds, and are available in a variety of issues. They are a type of municipal bond that is secured by a specific income of the issuer, which distinguishes them from general obligation bonds.

These types of bonds finance income-producing projects, and the income generated by these projects pays revenue bondholders their interest and principal. Projects funded by these types of bonds serve only that portion of a community that pays for it. In contrast,

general obligation bonds do not produce income, but provide services for the entire community.

Most revenue bonds are sold in $5,000 units and mature in 20 to 30 years. However, not all the bonds in an issue necessarily mature at the same time — they may be staggered. The types of bonds with staggered maturity dates are called serial bonds.

Income from a municipal enterprise is placed into a revenue fund. From this fund, operations expenses are paid first. Only after this has occurred do revenue bondholders receive their payments.

Unlike general obligation bonds, revenue bonds are secured by specific collateral — the income produced by the projects they fund. The revenues (i.e. sewer use fees) produced are then used to pay investors.

Revenue bonds offer higher interest rates than general obligation bonds. This is because the income from the projects they fund cannot be predicted with absolute certainty, which adds to the perception of lower safety. If the projects do not produce enough revenue, the bonds may default.

Ratings firms rate revenue bond issuers for their ability to pay back both interest and principal. Bond analysts study the issuer's ability to produce income sufficient enough to make payments. They also evaluate the cash flow of the income source, since the success of a bond ultimately depends on the project's ability to produce revenue.

F. Implementation Schedule

The schedule for implementation of the Recommended Plan is a function of factors, such as the timing of approval of this Regional Facilities Plan by the KDOW, the dates when funds are secured for the projects within this plan, and the respective dates for completion of design and construction of the projects.

At the time that this Regional Facilities Plan was prepared, these dates were not known. However, for the purpose of this Plan, the preliminary schedule, located below, has been developed. This schedule is subject to revision over time as the estimated dates of the aforementioned factors are updated.

Table 10-2 Preliminary Implementation Schedule for Brodhead Regional Wastewater Facilities Plan	
Estimated Date	**Event**
July 31, 2015	Submit Draft Plan to KDOW for review and comment
September 14, 2015	Public Hearing for Plan, Approval of Plan by City of Brodhead
October 2015	Submit Final Plan to KDOW for review and comment
March 2016	Approval of Plan by KDOW
June 2016	Apply for Interim Funding for Design (Kentucky Rural Water)
October 2016	Initiate Design of WWTP & Proposed Improvements
August 2016 – December 2016	Complete Funding Applications for KIA, CDBG & ARC
April 2017 – June 2017	Secure Funding from KIA, CDBG & ARC
July 2017	Complete Design of WWTP & Proposed Improvements
July 2017	Submit Design of WWTP & Proposed Improvements to KDOW
September 2017	Approval of WWTP & Proposed Improvements Design by KDOW
September 2017	Approval of Environmental Review for WWTP & Proposed Improvements
September 2017	Finalize all easements
September 2017	Finalize Project Funding (KIA, CDBG & ARC)
October 2017	Advertisement for Bids for WWTP & Proposed Improvements
December 2017	Receipt of Bids, Securing of Funds for WWTP & Proposed Improvements
January 2018	Award of Construction Contract for WWTP & Proposed Improvements
February 2019	Complete Construction of WWTP & Proposed Improvements

Exhibit 10-1
Brodhead Facilities Plan
Proposed Rate Schedules
Funding Option 1 - 30 year Payback Schedule w/ 30% Loan Forgiveness
0-10 Year Planning Period

Total Project Cost - Alternative 1 (Oxidation Ditch)		$4,774,693
Grant Money:		
CDBG		$1,000,000
ARC		$500,000
Loan Principal Forgiveness (30%)		$982,408
Proposed Bond Amount		$2,292,285
Annual Debt Service (KIA SRF Loan) 30 years @ 0.95%		$88,174
Loan Debt Service Coverage (10 % of Annual Debt Service)		$8,817
	Total Debt Service	*$96,992*
Estimated Annual O & M Increase		$62,214
Total Additional Annual Revenue Required		**$159,206**

Total Additional Annual Revenue Required		$159,206
2013 Total Billed Revenue	÷	$168,590
Percentage Rate Increase		***94.43%***

	2015 Existing Rates	Proposed Rates
Min. Rate (2,000 gal. or less)	$25.64	**$49.85**
> 2,000 gal. (per thousand)	$4.61	**$8.96**

	Current	**Proposed**
Charge for 4,000 gallons/month (average customer)	$34.86	**$67.78**

Exhibit 10-2
Brodhead Facilities Plan
Proposed Rate Schedules
Funding Option 2 - 30 year Payback Schedule w/ 50% Loan Forgiveness
0-10 Year Planning Period

Total Project Cost - Alternative 1 (Oxidation Ditch)	$4,774,693
Grant Money:	
CDBG	$1,000,000
ARC	$500,000
Loan Principal Forgiveness (50%)	$1,637,347
Proposed Bond Amount	$1,637,347
Annual Debt Service (KIA SRF Loan) 30 years @ 0.95%	$62,982
Loan Debt Service Coverage (10 % of Annual Debt Service)	$6,298
Total Debt Service	*$69,280*
Estimated Annual O & M Increase	$62,214
Total Additional Annual Revenue Required	**$131,494**

Total Additional Annual Revenue Required		$131,494
2013 Total Billed Revenue	÷	$168,590
Percentage Rate Increase		***78.00%***

	2015 Existing Rates	Proposed Rates
Min. Rate (2,000 gal. or less)	$25.64	**$45.64**
> 2,000 gal. (per thousand)	$4.61	**$8.21**

	Current	**Proposed**
Charge for 4,000 gallons/month (average customer)	$34.86	**$62.05**

Exhibit 10-3
Brodhead Facilities Plan
Proposed Rate Schedules
Funding Option 3 - 40 year Payback Schedule w/ 30% Loan Forgiveness
0-10 Year Planning Period

Total Project Cost - Alternative 1 (Oxidation Ditch)	$4,774,693
Grant Money:	
CDBG	$1,000,000
ARC	$500,000
Loan Principal Forgiveness (30%)	$982,408
Proposed Bond Amount	$2,292,285
Annual Debt Service (RD Loan) 40 years @ 2.125%	$85,644
Loan Debt Service Coverage (10 % of Annual Debt Service)	$8,564
Total Debt Service	*$94,208*
Estimated Annual O & M Increase	$62,214
Total Additional Annual Revenue Required	**$156,422**

Total Additional Annual Revenue Required		$156,422
2013 Total Billed Revenue	÷	$168,590
Percentage Rate Increase		***92.78%***

	2015 Existing Rates	Proposed Rates
Min. Rate (2,000 gal. or less)	$25.64	**$49.43**
> 2,000 gal. (per thousand)	$4.61	**$8.89**

	Current	Proposed
Charge for 4,000 gallons/month (average customer)	$34.86	**$67.20**

Section 11

SECTION 11
DOCUMENTATION OF PUBLIC PARTICIPATION

Below is a DRAFT and will be edited following the meeting

A. Purpose

The purpose of this chapter is to discuss the efforts by the City of Brodhead to encourage public participation throughout the course of the plan preparation. The City considers the input of the public vital to the development of a functional plan consistent with the goals and objectives discussed in previous chapters. This chapter also presents the City's resolution adopting the plan and the Statement of Authority and Resources for the plan.

B. Facilities Plan Development

The City of Brodhead has actively participated throughout the development of this study. In an effort to secure maximum participation, various agencies including the Kentucky Division of Water, US Fish and Wildlife, Kentucky Fish and Wildlife, US Army Corps of Engineers, State Historic Preservation Office, US Natural Resource Conservation Service, the Local Health Department and Planning and Zoning were contacted to assist in the evaluation of the planning area.

Meetings were held regularly, throughout the development of the Plan with the City of Brodhead's Council and Wastewater Treatment Plant Operators. The public support ratings for the Non-Monetary Effectiveness calculations used in Chapter 8 were results of these meetings.

Presentation regarding the progress of the Facilities Plan was made to the Brodhead's Council throughout the development of the plan.

C. Public Meeting

On September 14, 2015 a public meeting was also held at the Brodhead City Council chambers to present and discuss the Wastewater Facilities Plan update. Public meeting notices were published in the local newspaper and on the Division of Water's web site (www.water.ky.gov) in order to secure public participation. Appendix G contains the public meeting presentation, minutes, questions and answers, sign-in sheet, newspaper notices and affidavits from the newspaper showing the notice dates.

Section 12

SECTION 12
REGIONAL FACILITIES PLAN
COMPLETENESS CHECKLIST AND FORMS

A. Introduction

This section includes the Facilities Plan Checklist, indicating the page numbers related to items that are addressed in the Plan (Exhibit 12-1). This section also includes summaries of the unit process design criteria (Exhibit 12-2) and of the design flows and concentrations for the treatment plant (Exhibit 12-3).

This Plan is submitted in two (2) hard copies, one (1) copy of the Plan certified by a professional engineer licensed in Kentucky and one (1) non-certified copy of the Plan and the Planning Area shapefile on a Compact Disc (CD).

Section 12: Regional Facility Plan Completeness Checklist and Forms

Requirements: Two (2) hard copies, one certified by a professional engineer licensed in Kentucky and one (1) non-certified digital copy of the regional facility plan and the planning area shapefile on a Compact Disc (CD) shall be submitted to the Cabinet. This completeness checklist should be completed and submitted with each regional facility plan.

Regional Planning Agency Name: City of Brodhead

Date: June 2015

		PAGE #
SECTION 1		
REGIONAL FACILITY PLAN SUMMARY- This section shall provide a brief summary of the information provided in the facility plan, including the following:		
1.	Purpose of the plan and major problems evaluated in the plan.	Pg. 1-1
2.	Recommended alternative chosen to remediate or correct the problems and/or serve the area of need identified in the plan. Also, include any institutional arrangements necessary to implement the recommended alternative(s).	Pg. 1-3
3.	Estimated cost of implementing the proposed plan (including user fees) and the proposed funding method to be used.	Pg. 1-5
4.	Planning agency commitments necessary to implement the plan.	Pg. 1-6
5.	Schedule of implementation for projects.	Pg. 1-6, 7
SECTION 2		
STATEMENT OF PURPOSE AND NEED- This section shall contain a brief description of the purpose and need for a submitting the facility plan.		Pg. 2-1 Pg. 2-2
SECTION 3		
PHYSICAL CHARACTERISTICS OF THE PLANNING AREA- This section shall delineate the planning area boundaries and describe key topographic, geographic and pertinent natural or man-made features of the area. Digital or electronic submission of the planning area boundary shapefile in a standard GIS format shall also be included. This section shall also include the following maps:		
1.	One (1) up-to-date map, suitable for photocopying, indicate the planning area boundary, service area boundary, watershed boundaries, county lines, populated places, cities and/or towns and project areas or proposed planning period phases.	Exh. 3-1 Exh. 3-2
2.	One (1) up-to-date map, suitable for photocopying, include locations of wastewater treatment facilities (including package treatment plants), discharge location(s), collection lines (gravity, force main, interceptors), pump stations, public drinking water intake points and groundwater supply areas [Source Water Area Protection Plans (SWAPP) and/or Wellhead Protection Areas (WHPA)].	Exh. 3-3 Exh. 6-1 App. B
3.	One (1) seven and one-half (7 ½) minute USGS topographic map including the location of wetlands, delineation of the 100-year floodplain, surface water(s), and topography.	Exh. 3-4 Exh. 3-5

4.	If available, a local planning and zoning land use map.	Exh. 3-6
	SECTION 4	
SOCIOECONOMIC CHARACTERISTICS OF THE PLANNING AREA- The following characteristics of the planning area shall be discussed:		
1.	Historical, current, and projected population in the planning area including wastewater contributions from industrial and commercial sources.	Pg. 4-1 Exh. 4-1
2.	Current and projected population in the existing service area and unsewered parts of the planning area	Exh. 4-1
3.	Economic or social benefit to the affected community	Pg. 4-4
	SECTION 5	
EXISTING ENVIRONMENT IN THE PLANNING AREA- Describe existing physical, biological, cultural, and other resource features within the planning area with an emphasis on those that may be impacted by the proposed plan or projects, including the following:		
1.	Physical features such as surface and groundwater quality, water sources and supply, wetlands, lakes, streams, air pollution, floodplains, soils, geology, and topography	Pg. 5-1
2.	Biological: Identify plant and animal communities in the planning area with an emphasis upon endangered and threatened species likely to be impacted	Pg. 5-4
3.	Cultural: Describe archaeological and historical resources that may be affected by the proposed project	Pg. 5-6
4.	Other Resource Features such as national and state parks, recreational areas, USDA Designated Important Farmland, and any other applicable environmentally sensitive areas	Pg. 5-6
	SECTION 6	
EXISTING WASTEWATER SYSTEM- This section shall be prepared by a Professional Engineer licensed in Kentucky. A description of the existing facilities within the planning area shall include the following:		
1.	On-site systems in the planning area Pg. 6-16 &	Exh. 6-3
2.	Physical condition of the existing wastewater treatment plant(s) including the type, age, design capacity, process units, peak and average wastewater flows, current discharge permit limits, schematic layout of treatment plant. Include a narrative description of the capacity of the treatment plant to meet reliability and redundancy requirements as outlined in regulation 401 KAR 5:005, Section 13.	Pg. 6-5 Exh. 6-2
3.	Existing collection and conveyance system and its condition Pg. 6-1 &	Exh. 6-1
4.	Existing biosolids disposal method	Pg. 6-11
5.	Existing operation, maintenance and compliance issues Pg. 6-1 &	Pg. 6-10
	SECTION 7	
FORECASTS OF FLOWS AND WASTE LOADS IN THE PLANNING AREA- This section shall be prepared by a professional engineer licensed in Kentucky and shall include:		
1.	Current and projected commercial, industrial and residential growth for the proposed planning period	Pg. 7-1 Exh. 7-1
2.	A copy of the waste load allocation (WLA) issued by the DOW for new or expanded treatment plant projects	App. F

SECTION 8		
EVALUATION OF ALTERNATIVES- This section shall be prepared by a professional engineer licensed in Kentucky and include an assessment of alternatives to determine the appropriate facilities that will meet the wastewater needs of the planning area and provide benefits that are cost-effective and environmentally sound. The section shall include:		
1.	No-action alternative	Pg. 8-12
2.	Optimization of existing facilities	Pg. 8-6
3.	Regionalization	Pg. 8-6
4.	Other alternatives	Pg. 8-6
5.	Detailed cost analysis along with 20 year present worth analysis for each alternative	Pg. 8-13, Exh. 8-1 to Exh. 8-26
6.	Recommended alternative	Pg. 8-17 + Exh. 8-27
SECTION 9		
CROSS-CUTTER CORRESPONDENCE AND MITIGATION- Each facility plan shall include cross-cutter correspondences to and from each agency related to the following four environmental and cultural concerns:		
1.	Threatened and Endangered Species: The U.S. Fish and Wildlife Service- Kentucky Ecological Services Field Station and the Kentucky Department of Fish and Wildlife Resources	Pg. 9-1 App. I
2.	Historical Resources: The Kentucky Heritage Council State Historic Preservation Office	Pg. 9-2 + App. I
3.	Aquatic Resources: The US. Army Corps of Engineers (Louisville, Nashville, or Huntington Districts).	Pg. 9-2 App. I
4.	Agricultural Resources: The local office of the Natural Resources Conservation Service (NRCS) or USDA Service Center	Pg. 9-2 App. I
SECTION 10		
EVAULATION OF RECOMMENDED REGIONAL FACILITY PLAN- This section of the facility plan shall summarize the critical components of the recommended plan.		
1.	Environmental impacts	Pg. 10-1
2.	Institutional structure	Pg. 10-1
3.	Funding plan	Pg. 10-1
4.	Current and projected residential user charge rate based on 4,000 gallon usage per month	Pg. 10-2 + Exh. 10-1,2,3
5.	Implementation schedule	
SECTION 11		
DOCUMENTATION OF PUBLIC PARTICIPATION- The section shall include a copy of the newspaper advertisement/proof of publication, attendance sheet, and public comments.		Pg. 11-1

Exhibit 12-2 Brodhead WWTP Expansion Process Unit Design Criteria			
Process	**Number of Units**	**Flow / Unit**	**Design Criteria**
Wet Weather Detention Basin with Aeration	1	0.5 MGD	Wet Weather Storage
Wet Weather Pump Station	2 Pumps (1 Backup Pump)	0.5 MGD	Pump Peak Flow of 1.0 MGD
Influent Pump Station	2 Pumps (1 Backup Pump)	0.5 MGD	Pump Peak Flow of 1.0 MGD
Static Screen	1	1.0 MGD	Treat Peak flow of 1.0 MGD
Oxidation Ditch	2	0.15 MGD	Treat Average Flow of 0.25 MGD Treat Peak Flow of 0.6 MGD Organic Loading: 15 lbs of BOD_5/d/1000 ft^3 F/M Ration: 0.05- 0.1 BOD5/d/lb MLSS: 3000 mg/l
Clarifiers	2	0.15 MGD	Treat Average Flow of 0.25 MGD Treat Peak Flow of 0.6 MGD Surface Loading Rate 35 lb/day/ft^2 Surface Overflow Rate at Peak Hour Flows = 1000 gpd/ft^2
Sodium Hypochlorite & Sulfur Dioxide Disinfection	2	0.6 MGD	Treat Average Flow of 0.25 MGD Treat Peak Flow of 0.6 MGD Minimum of 15 minutes contact time at Peak Hourly Flow
RAS Pump Station	2	0.45 MGD	Pumping Rates: 50-150% of average daily flow
WAS Pump Station	2	100 gpm	> 25% of Average Daily Flow
Aerated Sludge Holding/Aerobic Digestion Basin	3	232,500 Gal (1)	Vol based on 3.0 ft^3/P.E. Plus 25%

(1) Available Storage - Convert (2) existing aeration basins plus the existing sludge holding basin

Exhibit 12-3 Brodhead WWTP Expansion Design Flow & Concentration Form											
Design Flows & Organic Concentrations	**Flows (MGD)**	**BOD_5 (mg/l)**	**BOD_5 (lb/day)**	**SS (mg/l)**	**SS (lb/day)**	**NH_3-N (mg/l)**	**NH_3-N (lb/day)**	**TKN (mg/l)**	**TKN (lb/day)**	**P (mg/l)**	**P (lb/day)**
Average Daily											
Domestic Portion	0.25	200	417	200	417	20	42	40	83	8	17
Industrial Portion	0.00	200	0	200	0	20	0	40	0	8	0
Total	**0.25**	**200**	**417**	**200**	**417**	**20**	**42**	**40**	**83**	**8**	**17**
Population Equivalent	**0.0025**										
Peak Hourly											
Domestic Portion	0.6	83	417	83	417	8	42	17	83	3	17
Industrial Portion	0	0	0	0	0	0	0	0	0	0	0
Total	**0.6**	**83**	**417**	**83**	**417**	**8**	**42**	**17**	**83**	**3**	**17**
Peak Daily	**0.6**										
Peak Instantaneous	**0.6**										