5.1 POTENTIAL WASTEWATER TREATMENT ALTERNATIVES

Rules and regulations pertaining to the content of Act 537 plans are contained in Title 25 Pennsylvania Code Chapter 71. These rules and regulations require that each Act 537 plan present and evaluate alternatives for sewage service within the project area. The following sections present several alternatives available to the Region for meeting the wastewater planning needs identified in Chapter 4. The topics covered in this chapter include the following:

1. Conventional collection, conveyance and treatment systems.
2. Community On-lot Disposal Systems (COLDS).
3. Continued use of on-lot disposal systems.
4. Small flow or package treatment facilities.
5. Holding tanks.
6. Sewage management programs.
7. Non-structural/Planning activities.
8. No action alternative.

These broad alternatives are then applied to areas of the Borough currently served by OLDS. Initially, many alternatives were considered; however, some were dismissed immediately and eliminated from further consideration in the Plan due to cost and technical feasibility. Five (5) focused alternatives to provide public sewer service to these areas of the Borough are presented and evaluated to determine whether they are cost-effective, environmentally sound and structurally feasible:

1A. Low pressure collection system to serve Park Avenue and Karr Hollow area;

1B. Low pressure collection system to serve Park Avenue area;

2A. Low pressure collection system to serve Horse Run Road area;

3A. Low pressure collection system to serve High Street area;

3B. Gravity sewer collection system to serve High Street area.

The existing wastewater treatment system owned and operated by the Shinglehouse Borough was constructed in 1966 and is mostly original equipment. Small repairs and modifications have been made over the past 50 years to keep the facility in operation and in compliance with the NPDES Permit; however, all major equipment is now currently in need of replacement.

The WWTP's current annual permitted discharge flow is 0.160 MGD, with a peak wet weather flow or maximum monthly average flow (MMAF) of 0.160 MGD and a peak hourly flow of 0.25 MGD. As discussed in Chapter 4, the service area is not projected to expand in the 20-year planning window and the upgraded WWTP will maintain the current design flows. The primary reasons for upgrading the WWTP is to replace aged equipment and 1966 technology with more efficient advanced technology, enhance treatment during the harsh winter months, and provide treatment flexibility within the system.

Several alternatives for addressing aged equipment within the WWTP are developed in the following sections of this report.

5.2 NEW COLLECTION AND CONVEYANCE FACILITIES

Presently, public sewer exists to over 99% of sewer-generating lots within the Borough of Shinglehouse (see Map 10 in Appendix B). Public sewer is available to all developed areas south of the Honeoye Creek.

5.2.1 Conveyance Alternatives

New collection and conveyance facilities were evaluated to extend public sewer are not required to serve the sewer service areas identified by this Act 537 Plan. If in the 20-year planning window new development occurs adjacent to the existing sewer service area, the developer will be responsible for construction of the conveyance facilities.

Conventional Gravity Sewers

Conventional gravity sewers convey wastewater by using gravity or the differential elevations between the upstream and downstream points in the system. The sewers must be set deep enough to receive flows from individual buildings. The building sewer or lateral is typically comprised of 4-inch or 6-inch diameter pipe laid at a minimum slope of 1%. Building sewers connect directly to the collecting sewers. Where financially feasible, the collecting sewer is set at a depth that is capable of receiving basement flows. Conventional gravity sewers are constructed to meet minimum state and local requirements. Generally, they are constructed of 8-inch diameter or larger pipe with access manholes spaced a maximum of 400 feet apart and at each change of direction. Conventional systems are connected directly to existing or proposed conveyance and treatment systems. The feasibility of conventional gravity sewers is dependent on factors such as topography, presence of rock, high groundwater tables, and density of homes. The costs of a conventional gravity system can vary dramatically depending on these factors.

Low-pressure Systems

Low-pressure systems including Grinder Pump (GP) systems are an alternative to conventional gravity systems. GP systems shred or reduce the size of raw wastewater solids, producing pumpable slurry which is conveyed to the treatment plant through low-pressure sewer lines. Pressure sewers are most cost-effective in areas where the terrain is rolling, or the line needs to be close to the surface due to low depth to bedrock or a high water table. Pressure sewers have the disadvantage that the material is highly septic and odor problems may arise.

When discussing GP systems, it is necessary to consider both the on-lot element as well as the collection system elements. The on-lot elements of a GP system consist of 4-inch or 6-inch building sewer that conveys household sewage to an on-lot pump station. On existing homes, either a new connection is made to the existing plumbing system or the existing building sewer is intercepted by the new building sewer and directed to the pump station. The on-lot pump station typically consists of a fiberglass basin with a minimum capacity of 50 gallons. The pumps are either centrifugal or semi-positive displacement units with 1-2 HP motors. The basin includes appropriate valves for isolation of the pumps. Each basin package is provided with a pump control panel, which can either be located remotely at the house or locally at the pump station.

The second component of any GP system is the collection system. A typical low-pressure sewer system consists of small diameter, plastic, pressure piping. All piping downstream of the grinder pump is under low pressure, usually 60 psi or less. The low-pressure collection system is arranged as a branch network with no loops in the system. Appurtenances of a low-pressure system consist of in-line and terminal clean-outs located at 400'-600' intervals, at changes in direction or at changes in pipe size. Air release valves are located within the system at all high points. Isolation valves are installed strategically throughout the system to facilitate maintenance. Discharge from the low-pressure system can be directly routed to a treatment plant provided the difference in elevation is not significant, or to a conventional collection or conveyance system. GP systems have been most applicable in areas where the topography is very flat, has rolling hills, significant rock may be present, high groundwater table is present, or where the system outfall is at a higher elevation than the service area.

Collection System Construction Costs
Typically, an authority or municipality would be responsible for the construction and funding of an extension of public facilities to a previously developed area. In the case of a new development, sewage facilities are generally extended by the developer at their cost and dedicated to the authority or municipality under a written agreement. Estimates of construction cost, overall project cost and present worth of annual operating costs are included in the focused assessment of the unsewered areas in Section 5.10.

5.2.2 Repair or Replacement of Existing Collection and Conveyance System Components

No alternatives are anticipated which would facilitate the need for repair or replacement of existing collection or conveyance system components. The Borough should continue to maintain its existing collection and conveyance systems and perform routine inspections to detect and repair sources of infiltration and inflow. The existing pump stations have sufficient capacities that will facilitate projected infill and development within the existing sewer service area.

5.3 UPGRADE OF EXISTING WASTEWATER TREATMENT

As discussed in Chapter 4, the service area is not projected to expand in the 20-year planning window and the WWTP is expected to maintain the current design flows. As previously discussed, the WWTP was constructed in 1966 with much of the equipment being original. Due to the age and condition of the equipment, issues with rags and other non-dispersables, and advances in wastewater treatment technology; major improvements at the WWTP are required to be completed.

Additionally, it is considered to be good practice that when evaluating new treatment technologies, that consideration be given for the technology to be adapted, at the lowest cost, to be able to meet new water quality requirements, should they be imposed. While no new water quality requirements have been proposed, consideration for meeting nutrient reduction has been considered in the treatment evaluation due to the water quality requirements being imposed in other areas including the Susquehanna River Basin and Delaware River Basins.

A Wastewater Treatment Plant Evaluation Study (Study) was completed in October 2016 (included in Appendix E) to evaluate the existing treatment process facilities and provide a recommendation for improvements based on existing record drawings, site visits, personal communications with Borough Staff, equipment manufacturers, and other documents provided by the Borough.

Three (3) wastewater treatment alternatives were evaluated in the Study. The alternatives considered include the following:

1. Alternative 1 - Existing WWTP Upgrade
2. Alternative 2 – Modified-Ludzack Ettinger (MLE)
3. Alternative 3 – Sequential Batch Reactor (SBR)

Table 5.3 provides the basis of design criteria used for the evaluation of the respective wastewater treatment alternatives.

Table 5.3 – Wastewater Alternatives Basis of Design

Parameter	Influent	Effluent	Units
Influent Flow Rate (MMAF)	0.16		MGD
BOD_5 Concentration	220	10	mg/L
TSS Concentration	220	10	mg/L
TKN [1] Concentration	40		mg/L
NH_3-N Concentration	NA [3]	1.0	mg/L
TN Concentration [2]	NA [3]	6.0	mg/L
TP Concentration	8.0	0.8	mg/L
Wastewater Temp Min/Max	10/20		°C
Primary Clarifier BOD/TSS Removal	45/67 @ 20°C		%
Secondary Clarifier TSS Removal	67 @ 20°C		%

Notes: [1] Total Kjeldahl Nitrogen; [2] Used TN ≤ 28 mg/L, BOD/TSS = 10 mg/L, and Nitrates = 23 mg/L for influent Denitrification Filter System influent condition; [3] Not Available.

5.3.1 EXISTING WWTP UPGRADE (ALTERNATIVE 1)

The following process unit equipment were considered as part of this alternative to warrant a reliable and sustainable treatment process that would meet the design criteria stated in Table 5.3:

1. Headworks. Upgrades to include:
    a. Provision of a Raw Wastewater Influent Screen
    b. Replacement of existing raw sewage pumps
    c. Replacement of existing level control instrumentation
2. Grit Removal System:
    a. None considered due to existing site and hydraulic limitations
3. Primary Clarifier. Upgrades to include:
    a. Replacement of existing scraper mechanism and drive in kind
    b. Replacement of existing primary sludge pump
4. Trickling Filters. Upgrades to include:
    a. Replacement of the existing filters' media
    b. Replacement of the existing cover and addition of a cover
    c. Replacement of the recirculation pumps
5. Secondary Clarifier. Upgrades to include:
    a. Replacement of the existing scraper mechanism and drive in kind
    b. Replacement of the existing secondary sludge pump
6. New Denitrification Filter System BNR System
7. Inclusion of existing Chlorine Disinfection System (no upgrades to the existing system)
8. Effluent Pump Station. Upgrades to include:
    a. Replacement of existing effluent pumps
    b. Replacement of existing level control instrumentation
9. Inclusion of existing Aerobic Digesters
10. Use of existing chemical feed system located at the Control Building

The following sections provide a more detailed description of the for the respective unit processes' upgrades.

Headworks

Table 5.3.1(a) identifies the existing Headworks' process equipment:

Table 5.3.1(a) – Headworks Equipment

Equipment	Number	Type	Capacity
Grinder	1	Single Shafted Barrel	1/3 hp
Raw Influent Pumps	2	Shafted Dry Pit Centrifugal	10 hp, 500 gpm @ 35 TDH
Level Instrumentation	1	Bubbler	NA [1]

Notes: [1] Not Applicable

Table 5.3.1(b) provides a brief description of the proposed equipment as part of the Headworks' improvements.

Table 5.3.1(b) – Headworks Improvements Equipment

Equipment	Number	Type	Capacity
Influent Screen	1	Vertical Basket, ¼-inch	1.04 MGD, 2.0 hp
Raw Influent Pumps	2	Dry Pit Submersible	10 hp, 500 gpm @ 35 TDH
Level Instrumentation	1	Pressure Transducer	NA [1]
Level Instrumentation	2	Non-Mercury Float Switch	NA [1]

Notes: [1] Not Applicable

Primary Clarifier

Due to the age and conditions of the existing Primary Clarifier's scraper/rake mechanisms, it is recommended to replace it in kind. The budgetary quote for the rake mechanism was obtained from Monroe Environmental. In addition, it was also recommended to replace in kind the existing primary sludge pump also shown in Table 5.3.1(c).

Table 5.3.1(c) – Primary Clarifier's Retrofit Equipment

Equipment	Number	Description
Rake Mechanism	1	Coated Carbon Steel Construction · DBS Precision Fabricated Drive (Bridge Mount) · Access Bridge Walkway & Handrails (Full Diameter) · Inlet Well · Inlet Pipe · Drive Shaft · Skimmer Arm & Scum Box · Two (2) Rake Arms · FRP Weirs & Scum Baffle
Primary Sludge Pump	1	Chicago Centrifugal, 5 hp, 80 gpm @ 32 TDH

It should be noted that due to the age and condition of the existing primary clarifier, concrete repair and re-grouting of the floor for balancing of the scraper assembly may be required. Those costs are not currently represented in this alternative.

Trickling Filters

From the Study, it was concluded that the existing Trickling Filters provide little or no nitrification. In attached growth systems, most of the BOD has to be removed before nitrifying aerobic autotrophic bacteria is well established. With a higher biomass yield, the carbonaceous heterotrophic bacteria can dominate over nitrifying by covering more fixed film surface area. Because of this, it is highly recommended to replace both of the Trickling Filters' media with greater specific surface area that will allow for higher organic loadings facilitating the nitrification process to occur within the trickling filters. The recommended media budgetary quote was based on the CF-1900 as manufactured by Brentwood Industries.

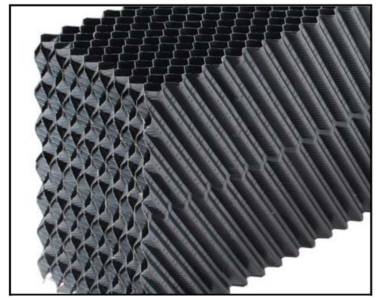

Figure 5.3.1(c)
Brentwood's CF-1900 Media

Brentwood's cross flow media is made of sheets formed with alternating corrugations, which are solvent-welded to each other to form modules for easy stacking. The CF-1900 is specifically designed for shallow-depth BOD roughing and polishing, nitrification and denitrification. The liquid flowing downward is redistributed at each cross point creating 720 mixing points per foot of depth. The modules are fabricated from rigid PVC sheets, which are UV-protected and resistant to rot, fungi, bacteria, acids, and alkalis commonly present in municipal wastewater. Table 5.3.1(d) provides a comparison of the existing Trickling Filters' media and the proposed media.

Table 5.3.1(d) provides a loading comparison between the existing and the proposed media for the Trickling Filters' media retrofit.

Table 5.3.1(d) Trickling Filters' Media Retrofit Loading Comparison

Parameter	**Trickling Filter No.1**	**Trickling Filter No.2**	**Units**
Existing			
Type of Media	River Rock/Slag (Large)	Plastic Random Packing	NA
Approximate Surface Area	18	30	ft^2/ft^3
BOD_5 Loading per TF (@ MMAF)	13.28	10.74	lb/day/1,000 ft^3
NH_3-N Loading per TF(@ MMAF)	0.75	0.70	lb/day/1,000 ft^3
Recycle Ratio	60	40	%
Proposed			
Type of Media	Structured Sheet Media	Structured Sheet Media	NA
Approximate Surface Area	48	48	ft^2/ft^3
BOD_5 Loading per TF (@ MMAF)	11.0	11.0	lb/day/1,000 ft^3
NH_3-N Loading per TF(@ MMAF)	0.26	0.26	lb/day/1,000 ft^3
Recycle Ratio	50	50	%

Notes: [1] MMAF = Maximum Monthly Average = 0.160 MGD; [2] PHF_D = Peak Hourly Flow Dry Weather = 0.25 MGD; [3] DEP's Domestic Wastewater Facilities, Publication No. 362-0300-001, 10/97, Section 62.

Per Table 5.3.1.(d), by using a higher surface area media, the ammonia-nitrogen loadings per unit volume (lb/day/1,000 ft^3) can be greatly reduced thus inducing the nitrification process to occur. Per communications with Brentwood Industries' engineers, effluent ammonia values of 2.0 mg/L or less can be expected with the media retrofit. Yet, it is important to note that nitrification is inhibited at 10°C or less. This means that in addition to the media retrofit, the Trickling Filters will have to be covered and actively ventilated to provide air as this is an aerobic reaction.

The recommended budgetary quote for the covers was based on Ultraflote LLC. This company specializes in all aluminum geodesic domes. Table 5.3.1(e) provides a general scope of work for the Trickling Filters' cover retrofit.

Table 5.3.1(e) – Trickling Filters' Cover Retrofit Equipment

Equipment	Number	Description
Cover	2	Ventilation System: . Comprised of Louver and a Fan . Fan capacity of 600 SCFM at p = 1.0 – 1.5 in W.C. [1] Nominal 8.0 feet high vertical side wall system with: . 7.0 feet high by 3.0 feet wide entrance 10.0 feet diameter center hatch for equipment removal

Notes: [1] Water Column

Secondary Clarifier

Similar to the Primary Clarifier, it is also recommended to replace the Secondary Clarifier's rake mechanism in kind. The budgetary quote for the rake mechanism was also obtained from Monroe Environmental. Table 5.3.1(f) provides in detail what encompasses this budgetary proposal. In addition, it was also recommended to replace in kind the existing primary sludge pump also shown in Table 5.3.1(f).

Table 5.3.1(f) – Secondary Clarifier's Retrofit Equipment

Equipment	Number	Description
Rake Mechanism	1	Coated Carbon Steel Construction · DBS Precision Fabricated Drive (Bridge Mount) · Access Bridge Walkway & Handrails (Full Diameter) · Inlet Well · Inlet Pipe · Drive Shaft · Skimmer Arm & Scum Box · Two (2) Rake Arms · FRP Weirs & Scum Baffle
Secondary Sludge Pump	1	Chicago Centrifugal, 5 hp, 80 gpm @ 32 TDH

Effluent Pump Station

It is proposed to replace the existing effluent pumps in kind with new level control instrumentation (i.e. submersible transducer and back-up float level switches). Table 5.3.1(h) provides the process equipment to for the Effluent Pump Station's retrofit.

Table 5.3.1(g) – Effluent Pump Station's Retrofit Equipment

Equipment	Number	Type	Capacity
Effluent Pumps	2	Submersible Centrifugal	5 hp, 700 gpm @ 15 TDH
Level Instrumentation	1	Level Transducer	NA [1]
Level Instrumentation	2	Non-Mercury Float Switches	NA [1]

Notes: [1] Not Applicable

It should be noted, that disadvantages of this alternative include:
1) maintaining only one (1) primary and final clarifier (no-redundancy)
2) treatment during construction as there is currently no redundancy
3) ability to consistently meet water quality effluent goals during cold weather months
4) lack of flexibility of treatment process to meet any future nutrient reduction goals

5.3.2 MODIFIED LUDZACK-ETTINGER (ALTERNATIVE 2)

The following process unit equipment were considered as part of this alternative to warrant a reliable and sustainable treatment that would meet the design criteria stated in Table 5.3:

1. Inclusion of existing Headworks (Option A). Similar to Alternative 1, the following upgrades will be included:
    a. Provision of a Raw Wastewater Influent Screen
    b. Replacement of existing raw sewage pumps
    c. Replacement of existing level control instrumentation

2. New Headworks Building (Option B) to include the following equipment:
    a. One (1) Raw Wastewater Influent Screen
    b. Two (2) Submersible raw sewage pumps
    c. Level control instrumentation
    d. Wet Well
    e. Electrical Room
3. New Grit Removal System
4. Elimination of the existing Primary Clarifier
5. Elimination of the existing Trickling Filters
6. Inclusion of the Secondary Clarifier. Similar to Alternative 1, the following upgrades will be included:
    a. Replacement of the existing rake mechanism in kind
    b. Replacement of the existing secondary sludge pump
7. New Oxidation Ditch (MLE) System
8. Inclusion of existing Chlorine Disinfection System (with no upgrades)
9. Inclusion of existing Effluent Pump Station. Similar to Alternative 1, the following upgrades will be included:
    a. Replacement of existing effluent pumps
    b. Replacement of existing level control instrumentation
10. Inclusion of existing Aerobic Digesters
11. Use of existing chemical feed system with minor improvements

<u>Headworks (Option B)</u>
It is proposed this equipment in a new Headworks building to be located in the vicinity of MH #A. The new headworks will be comprised of two operating floors; with the wet well, submersible pumps, and bar screen equipment located on the lower operating floor, and the washer/compactor equipment, and the electrical room located in the upper operating room. The building will have an approximate area of 600 ft^2. The proposed headworks raw influent screen was based on the Flex Rake® - Front Clean Front-Return (FPFS) fine screen as manufactured by Duperon®. Table 5.3.2(a)

provides a general summary of the scope of work.

Table 5.3.2(a) – Headworks (Option B) Equipment

Equipment	Number	Type	Capacity
Raw Wastewater Pumps			
Raw Influent Pumps	2	Dry Pit Submersible	10 hp, 500 gpm TDH[1]
Level Instrumentation	1	Pressure Transducer	NA [1]
Level Instrumentation	2	Non-Mercury Float Switch	NA [1]
Raw Wastewater Screen			
Influent Screen	1	Bar Screen, ¼-inch, 1.66 channel width	1.04 MGD, 2.0 hp
Washer Compactor	1	Shafted Auger	0.75 hp
Conveyor	1	Shafted Auger	1.0 hp
Main Control Panel	1	PLC/Relay Based – NEMA4X	NA [2]

Notes: [1] To be determined; [2] Not Applicable

Grit Removal System

As the treatment processes of a wastewater plant have become more sophisticated, the performance of the headworks has also been emphasized. The function of a grit removal system is to remove undesirable grit and sand from the wastewater stream to protect and reduce wear on the downstream process equipment. Without the inclusion of a primary clarifier in neither of Alternatives 2, and 3, grit will eventually accumulate in the process tanks presenting with an operational cost and maintenance challenge cost over time. One proponent of this technology is the Grit King® as manufactured by Hydro International ®. The Grit King® is an all-hydraulic/non-mechanical vortex separator designed to remove grit, sediment and sand from wastewater, raw water and other liquids using vortex motion and boundary layer effects to aid gravitational settlement. The unit can be installed into the flow line, downstream of the screens, of any system where limited head is available. The unit requires no external power source, has no internal moving parts, is self-cleaning, has a compact modular construction and is virtually maintenance free. This unpowered grit management system can remove 95% of 106 µm particles or larger, preventing the expensive impacts grit abrasion and deposition.

The accumulated grit in the grit concentrator is transported to a Grit Classifier. The Grit Classifier separates and dewaters the concentrated grit underflow from the grit concentrator, or Grit King®, producing relatively dry, dewatered solids with low organic content suitable for landfill disposal. Using a settling area and a screw conveyor, the dewatered grit is transported up an inclined trough for disposal into a dumpster. The organics, which remain in suspension, are discharged over a weir and delivered back to the Headworks for treatment.

Table 5.3.2(b) provides a summary and scope of supply for the proposed Grit King® for both Alternative 2 and 3.

The proposed location of the Grit King® would be adjacent to the respective biological treatment tanks. A grit building also located nearby the Grit King®'s grit concentrator will house the grit classifier equipment and the control enclosure.

Table 5.3.2(b) Alternative 2, 3 – Grit King® Removal System; Summary/Scope of Supply

Parameter	**Value**
Grit King® Grit Concentrator	
Number of Tanks	1
Tank Diameter	5.0 ft
Configuration	Free Standing with Structural Support
Removal Capacity	95% removal of all grit (specific gravity 2.65) ≥ 75 microns @ average flow
Tank Construction	304 SS
Grit Classifier	
Number of Units	1
Maximum Grit Load	0.16 cy/hr @ 1 rpm
Screw Diameter	9.0 inch
Screw Drive	1.0 hp, TENV, 480V/3 phase/60 Hz
Maximum Flow Rate	100 gpm
Construction	304 SS Body
Controls	
Control Panel	1
Construction	NEMA 4X
Control Logic	Programmable Relay

MLE Description

The MLE process consists of the modification of a conventional activated sludge process where an anoxic zone is created or added upstream of the aerobic zone. The process uses an internal recycle that carries nitrates created in the nitrification process in the aerobic zone along with the mix liquor to be mixed in the influent to the anoxic zone. The amount of nitrates potentially removed in the anoxic zone depends on the recycle flow and availability of influent BOD. Figure 5.3.2(d) provides a typical process configuration.

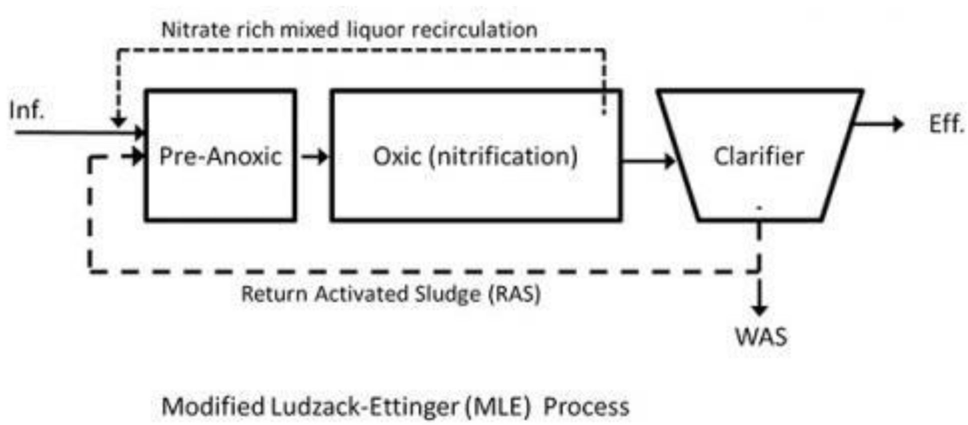

Figure 5.3.2(d) Modified Ludzack-Ettinger (MLE) Typical Process Configuration

Among manufacturing companies that represent an MLE process, the Bio-Denipho™ Oxidation Ditch System as manufactured by Kruger Inc. (owned by Veolia Water Solutions and Technologies) was evaluated as part of this alternative. It should be noted that additional oxidation ditch manufacturers should be evaluated during preliminary design of the WWTP upgrade. The

BioDenipho™ system consists of two stage anaerobic selector followed by a dual oxidation ditch train. The system has the flexibility to meet future nutrient reduction goals without the addition of supplemental carbon, internal recycle streams, and/or post anoxic zones. An anaerobic selector would need to be provided in the future to meet biological phosphorous removal goals, if required. The aeration rotors are sized to meet the AOR requirements should one rotor fail and a ditch need be removed from service. Additionally, should one ditch be removed from service, the process volume of a single ditch is sufficient to meet treatment objectives at minimum design temperature and up to 75% of design load. Tables 5.3.2(c) and 5.3.2(d) provide a summary and scope of supply for the proposed Alternative 2 – MLE system while Figure 5.3.2(e) provides a process flow diagram.

Table 5.3.2(c) Alternative 2 – MLE; Kruger's BIO-DENIPHO Reactor Summary

Parameter	Value
Bio-Denipho Tanks	
Number of Oxidation Ditches	2
Internal Length per Ditch	64 ft
Internal Width per Ditch	28 ft
Average Side Water Depth	7.5 ft
Total System Volume	0.186 MG
Design Anoxic / Aerobic Operating Time	30% / 70%
System HRT	27 hrs
System SBR	16 days
MLSS at 10°C	3,000 mg/L
System F/M Ratio (days-1)	0.09 $days^{-1}$
Design Sludge Yield	0.9 lbs MLSS/lb BOD_5
Waste Activated Sludge	260 lb WAS/day
Total Tankage Surface Area	4,118 ft^2

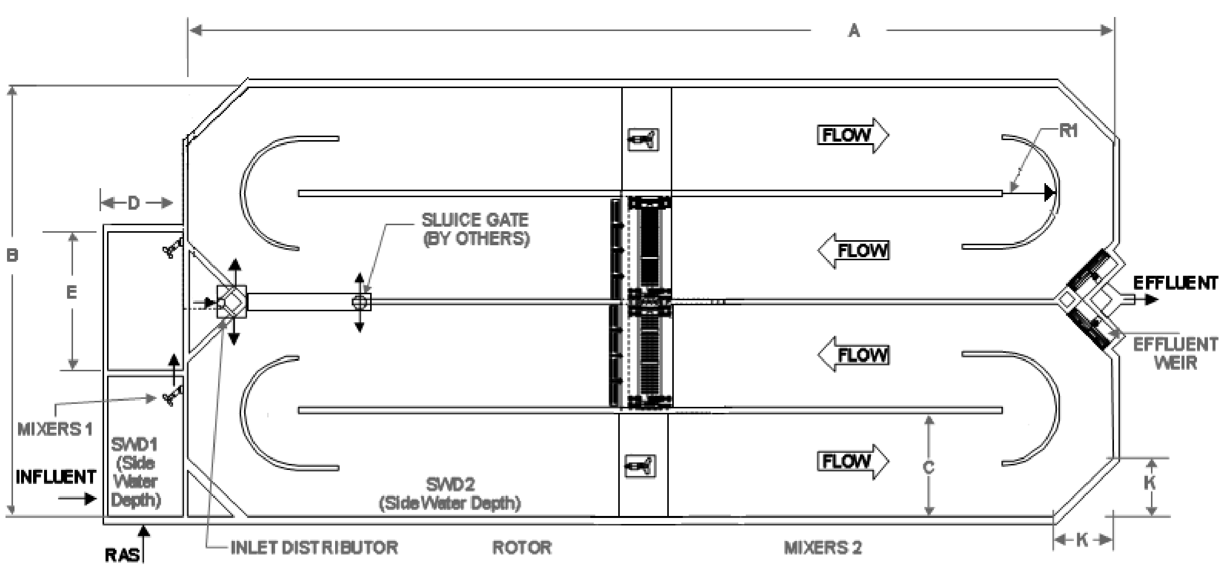

Figure 5.3.2(e) Kruger's BIO-DENIPHO™ Process Flow Diagram for Shinglehouse Borough WWTP

Table 5.3.2(d) Alternative 2 – MLE; Kruger's BIO-DENIPHO Scope of Supply

Equipment	Number	Description	Capacity
Influent Flow Distributors	1	Type 200 Actuated Influent Distributor	1/12 hp
Anaerobic Selector Mixers	1	TR 21. Submersible Mixer, 304 SS Rails w/ Hoist	0.7 hp
Oxidation Ditch Mixers	2	TR 60 Submersible Mixer, 304 SS Rails w/ Hoist	2.7 hp
Brush Rotors	2	3.0 meter MIDI Rotor, 304SS Center Tube with HDG Rotor Blades	15 hp
Effluent Flow Control Weirs	2	2.5 meter automated HDG Weir	0.5 hp
Submersible Pressure Transducer	2	Ditch Liquid Level Measurement	NA
Dissolved Oxygen Probe	2	Hach LDO w/ SC200 Transmitter	NA
PLC Control Cabinet	1	NEMA 12; ControlLogix PLC; Panelview	NA

5.3.3 SEQUENTIAL BATCH REACTOR (ALTERNATIVE 3)

The following process unit equipment was considered as part of this alternative to warrant a reliable and sustainable treatment that would meet the design criteria stated in Table 5.3:

1. Inclusion of existing Headworks (Option A). Similar to Alternative 1, the following upgrades will be included:
    a. Provision of a Raw Wastewater Influent Screen
    b. Replacement of existing raw sewage pumps
    c. Replacement of existing level control instrumentation
2. New Headworks Building (Option B) to include the following equipment:
    a. One (1) Raw Wastewater Influent Screen
    b. Two (2) Submersible raw sewage pumps
    c. Level control instrumentation
    d. Wet Well
    e. Electrical Room
3. New Grit Removal System
4. Elimination of the existing Primary Clarifier
5. Elimination of the existing Trickling Filters
6. Elimination of the Secondary Clarifier.
7. New Sequential Batch Reactor (SBR) System
8. Inclusion of existing Chlorine Disinfection System (with no upgrades)
9. Inclusion of existing Effluent Pump Station. Similar to Alternative 1, the following upgrades will be included:
    a. Replacement of existing effluent pumps
    b. Replacement of existing level control instrumentation
10. Inclusion of existing Aerobic Digesters
12. Use of existing chemical feed system yet relocated to Grit Building

<u>SBR Description</u>

The sequencing batch reactor (SBR) process is a sequential suspended growth (activated sludge) process in which all major steps occur in the same tank in sequential order (please refer to Figure

5.3.3(a)). There are two process configurations for SBRs: the intermittent flow (IF), depicted in Figure 5.3.3(a), and the continuous flow (CF) system, which does not follow any of the steps shown in Figure 5.3.3(a). SBRs can be designed and operated to enhance removal of nitrogen, phosphorus, and ammonia, in addition to removing TSS and BOD. The intermittent flow SBR accepts influent only at specified intervals and, in general, follows the five-step sequence. There are usually two IF units in parallel. Because this system is closed to influent flow during the treatment cycle, two units may be operated in parallel, with one unit open for intake while the other runs through the remainder of the cycles. In the continuous inflow SBR, influent flows continuously during all phases of the treatment cycle. To reduce short-circuiting, a partition is normally added to the tank to separate the turbulent aeration zone from the quiescent area.

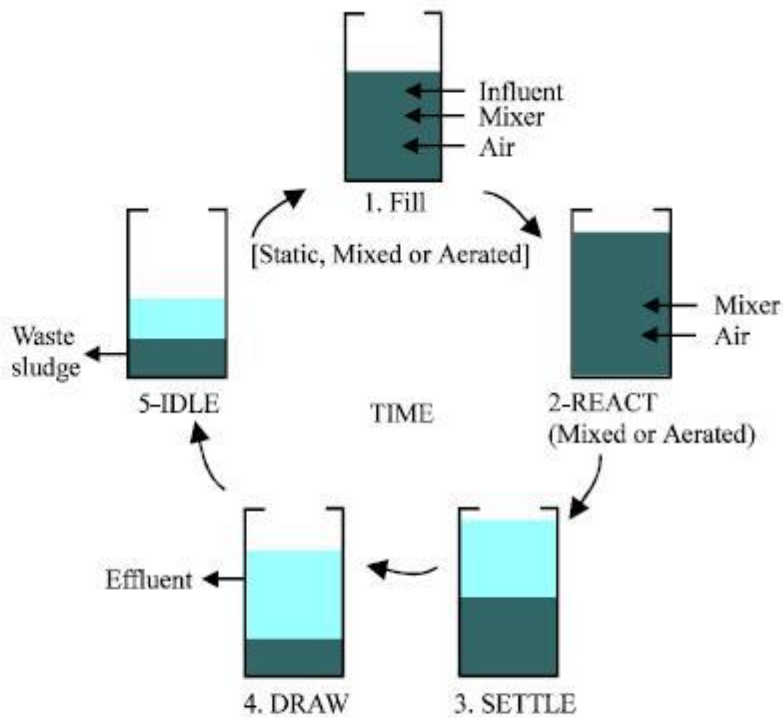

Figure 5.3.3(a) Sequential Batch Reactor (SBR) Typical Process Configuration

The major components of this system are a batch tank(s), aerators, mixers, decanter devices, process control system (including timers), pumps, piping, and appurtenances. Aeration may be provided by diffused air or mechanical devices. SBRs are often sized to provide mixing as well and are operated by the process control timers. Mechanical aerators have the added value of potential operation as mixers or aerators. The decanter is a critical element in the process. Several decanter configurations are available, including fixed and floating units. At least one commercial package employs a thermal processing step for the excess sludge produced and wasted during the "idle" step. The key to the SBR process is the control system, which consists of a combination of level sensors, timers, and microprocessors. Programmable logic controllers can be configured to suit the owner's needs. This provides a precise and versatile means of control.

The type of SBR system considered for Alternative 3 is of the intermittent flow as manufactured by Aqua-Aerobics Systems, Inc. It should be noted that additional SBR manufacturers should be evaluated during preliminary design of the WWTP upgrade. Tables 5.3.3(a) and 5.3.3(b) provide a summary and scope of supply for the proposed Alternative 3 – SBR system.

Table 5.3.3(a) Alternative 3 – SBR; Aqua-Aerobics Reactor Summary

Parameter	**Value**
SBR Tanks	
Number of Tanks	2
Length/Width per Tank	27 ft / 27 ft
Side Water Depth	20.6 ft
Total Volume	0.112 MG
System HRT	1.1 days
System SBR	21.3 days
MLSS at 10°C	4,500 mg/L
System F/M Ratio (days-1)	0.057 $days^{-1}$
Design Sludge Yield	0.78 lbs MLSS/lb BOD_5
Waste Activated Sludge	229 lb WAS/day
Equalization Tank	
Number of Tanks	2
Length/Width per Tank	27 ft / 15 ft
Side Water Depth	11.1 ft
Total System Volume	33,700 gal
Total Tankage Surface Area	2,001 ft^2

Table 5.3.3(b) Alternative 3 – SBR; Aqua-Aerobics Scope of Supply

Equipment	**Number**	**Description**	**Capacity**
SBR Tanks			
Influent Flow Valves	2	6-inch Electrically Actuated Plug Valves	115 V
Mixers	2	Endura Series Model FSS DDM Mixer	3.0 hp
Decanters	2	6x4 with fiberglass float, 304 SS Weir	2.7 hp
Transfer Pumps	2	Submersible, with Lifting Mechanism	2.4 hp
Diffusers	4	Fine Bubble, Tube Type, Retrievable	NA
Blowers	3	Sutorbilt 4H PD Blower Package	10 hp
Air Valves	2	3-inch Electrically Actuated Butterfly Valves	115 V
Dissolved Oxygen Probes	2	Hach LDO with SC200 Controller	115 V
Level Controllers	2	Pressure Transducers	115V
Level Controllers	4	Float Switches (as Back-Up)	115V
Equalization Tanks			
Transfer Pumps	3	Submersible, with Lifting Mechanism	2.4 hp
Diffusers	1	Coarse Bubble, PVC, Floor Mounted	NA
Blowers	1	Sutorbilt 3H PD Blower Package	5 hp
Level Controllers	1	Pressure Transducers	115V
Level Controllers	2	Float Switches (as Back-Up)	115V
System Control	1	NEMA 12 Control Panel, Compactlogix	

5.3.4 DISINFECTION SYSTEM IMPROVEMENTS

Based on the evaluation of the existing disinfection system, this system is capable of providing adequate disinfection treatment for the proposed Max Month (MMF) and Peak Hourly (PHF) Flows.

However, various recommendations were made in order to improve the efficiency of the disinfection system and extend the use of the existing CCT. A summary of these recommendations is included in Table 5.3.4 and further discussed in the paragraphs below.

Table 5.3.4 – Summary of Disinfection System Recommendations

No.	Recommendation
1	Modify High Flow Effluent Pump Control Strategy
2	Repairs to CCT
3	Chlorine Feed Pump Control
4	Future Provision for De-chlorinating
5	Future Provision for Additional Chemical Storage
6	Future Consideration for Ultraviolet Disinfection

1. Modify High Flow Effluent Pump Control Strategy

The current control strategy for the high flow effluent pump station is to operate the pumps on a continuous basis, regardless of the water level in the receiving stream. The operators shall consider revising the pump control strategy and operate the pumps manually, based the water level of the receiving stream and/or, a high water level in the CCT. This revision will increase the contact time in the CCT by reducing the flow rate though the tanks. This scenario would be typical for most flow conditions experienced at the plant. Additionally, most effluent pumps are operated after the CCT, and thus are only used when pump flow is required to ensure the system does not back-up due to rising water levels at the outfall structure.

2. Repairs to CCT

A visual inspection of the CCT concrete walls indicated areas that may require some minor non-structural concrete repairs due to spalling and deterioration on the concrete surface. It is likely that these non-structural repairs can be made as spot grout repairs.

3. Chlorine Feed Pump Control

Improved optimization of the chlorine disinfection system can be achieved by adding a simple chemical feed loop strategy. This control strategy can be achieved by flow pacing the pumps off of the plant flow meter or, by targeting the pump flow rate based on maintaining a chlorine residual set-point. Equipment that would be required to achieve this level of process control would include an on-line chlorine analyzer, an analogue signal from a flow meter, a pump controller, and/ or chemical feed pumps capable of receiving an analogue signal.

4. Future Provision for dechlorinating

Currently, the WWTP is in compliance with effluent Total Chlorine Residual (TRC) limits and requires no further need to de-chlorinate. However, should future WWTP upgrades include the conversion to a new activated sludge system, the current chlorine demand on the wastewater may change requiring the need to add more chlorine for adequate disinfection. Based on the amount of additional chlorine that may be added, the ability to de-chlorinate may be required in order to achieve compliance with the effluent TRC limit.

5. Future Provision for Additional Chemical Storage

As stated in the paragraph above, future upgrades to the biological process may require the need to add more chlorine for adequate disinfection. The operators currently add chlorine at a rate of 1 gallon per day. Future estimates indicate a dosage rate of up to 10 gallons a day may be required. Therefore, the need evaluate the provision for additional chemical storage may be required in the future.

6. Future Consideration for Ultraviolet disinfection

Future consideration for using an alternate disinfection process (such as ultraviolet disinfection) may be required if future upgrades to the WWTP include processes that require the use of additional utility water. Typically, this utility water demand is supplied by plant effluent water, or a potable water supply. In the event plant effluent water is used, the UV disinfection process may limit the inclusion of algae or other particulates that are often associated with chlorine contact tanks and require the use of downstream filters to eliminate clogging of valves, nozzles, etc.

5.3.5 PRESENT WORTH ANALYSIS

A 20-year present worth analysis was completed for alternatives 2 and 3 of the WWTP Alternatives including Headworks Option B. The estimated opinion of probable construction costs are shown in Table 5.3.5(a), including a thirty (30) percent contingency and a fifteen (15) percent for engineering and administrative costs associated with the preliminary design. It does not include an allowance for the contractor's overhead and profit. The operation and maintenance costs are shown in Table 5.3.5(b). Alternative 1 was not considered a viable alternative and therefore was not included below.

Table 5.3.5(a) Alternatives' Estimated Opinion of Probable Construction Costs

Alternative 2 (Option A)	Alternative 2 (Option B)	Alternative 3 (Option A)	Alternative 3 (Option B)
$2,795,000	$3,438,000	$3,115,000	$3,763,000

Table 5.3.5(b) Alternatives' Annual Operation and Maintenance Costs [1]

Description	Alternative 2 (Options A, B)	Alternative 3 (Options A,B)
Power [2]	$71,270	$58,900
Chemicals [3]	$11,320	$17,450
Labor [4]	$4,680	$4,680
Maintenance [5]	$6,118	$4,976
Total O&M	$93,390	$86,010
20-Year O&M PW [6]	**$1,550,000**	**$1,420,000**

Notes: [1]Disposal cost of dewatered sludge was not considered as part of the PW analysis; [2] Electric costs were based on $0.14 per kW-hr per Shinglehouse Borough Staff; [3] Based following chemical cost: MicroC $2.0/lb$_{wet}$, DelPAC $0.2/lb$_{wet}$, Sodium Hypochlorite (12.5% Solution) $3.0/gal; [4] Operator labor costs were estimated to be $30.00 per hour including benefits; [5] Assumed as a percentage of their total equipment cost using a fixed value of 0.5%; [6] Present worth costs were developed with an annual rate of inflation of 3% and an annual interest rate of 4% in Year 2017 US Dollars.

Table 5.3.5(c) Alternatives' Total Present Worth Comparison

Description	Alternative 2 (Option A)	Alternative 2 (Option B)	Alternative 3 (Option A)	Alternative 3 (Option B)
Capital Cost	$2,795,000	$3,438,000	$3,115,000	$3,763,000
20-Year O&M	$1,550,000	$1,550,000	$1,420,000	$1,420,000
Total PW	**$4,345,000**	**$4,988,000**	**$4,535,000**	**$5,183,000**

From Table 5.3.5(a) we learned that Alternative 2, Option A, provides with the lowest capital cost and with the second lowest operation and maintenance cost ranking it No.1 with the lowest present worth. Yet, with an estimated tankage total tankage of 4,118 ft^2, this alternative requires the largest footprint among all of the alternatives. Furthermore, this alternative integrates the secondary clarifier as part of its process configuration potentially presenting a hydraulic challenge during the design and construction phases of the project. Provision of new final clarifier(s) should be considered during preliminary design of the WWTP Upgrade Project.

Alternative 3, Option B, provides with the second lowest capital cost and with the lowest operation and maintenance cost ranking it No.2. Opposite to Alternative 2, the proposed SBR is almost an independent treatment plant from the existing one by just integrating its chlorine disinfection system along with the aerobic digestion system.

Table 5.3.5(d) Alternatives' Total Present Worth Comparison

Description	Alternative 2 (Option A)	Alternative 3 (Option A)
Capital Cost	$2,795,000	$3,115,000
20-Year O&M	$1,550,000	$1,420,000
Total P&W	**$4,345,000**	**$4,535,000**

5.4 CONTINUED USE OF ON-LOT DISPOSAL SYSTEMS

On-lot disposal systems (OLDS) are not being considered as an option in this Act 537 Planning Effort for areas where public sewer is currently available. Because the proposed growth within the Planning Area is confined to the lots within the existing public sewer service area, no additional soil, slope and/or hydrogeological evaluations are required. It is anticipated that the 28 existing OLDS will remain in use while non-failing and permissible.

5.4.1 – Repair, Replacement or Upgrade of Existing Malfunctioning Systems

The Borough's certified SEO is authorized to require the repair of any on-lot malfunction by the following methods approved by Title 25, Chapter 73 of the Pennsylvania Code: cleaning, repair or replacement of components of the existing system, adding capacity or otherwise altering or replacing the system's treatment tank, expanding the existing disposal area, replacing the existing disposal area, replacing the gravity distribution system with a pressurized system, replacing the system with a holding tank, or other alternatives as appropriate for the specific site.

It is recommended that the two confirmed malfunctions be repaired by providing a suitably sized drainage bed and elimination of the piped discharge to Honeoye Creek. Through the completion of the surveys and review of the mapping provided in this Act 537 Plan, it appears that suitable soils and lot size is available for a drainage bed for both properties.

5.4.2 – Water Conservation

Another method for improving the operation of on-lot systems is to encourage the use of water conservation devices. In lieu of repair by methods mentioned above, the SEO may require the installation of water conservation equipment and the institution of water conservation practices in structures served. Water using devices and appliances in the structure may be required to be retrofitted with water saving appurtenances or they may be required to be replaced by water conserving devices and appliances. Wastewater generation in the structure may also be reduced by requiring changes in water use patterns in the structure served. The use of laundry facilities may be limited to one load per day or discontinued altogether. Shinglehouse Borough has implemented a water conservation public education program which can be viewed on their website.

5.5 COMMUNITY ON-LOT, SMALL FLOW OR PACKAGE TREATMENT

There are no Community On-Lot Disposal Systems, Small Flow Treatment Facilities or Package Wastewater Treatment Facilities located within the Borough of Shinglehouse. These alternatives are not being considered in this planning effort as options to provide additional wastewater treatment.

5.6 HOLDING TANKS

Holding tanks are vessels designed and constructed to store sewage prior to ultimate disposal at another site. Pumper trucks are the preferred method of conveyance of holding tank wastes. Due to the high maintenance costs resulting from frequent pumping, holding tanks are not considered to be a viable long-term alternative for typical residential demands. However, they may be viable solutions for transient residential, commercial or industrial sites with minimal wastewater flow.

Installation of a holding tank may be required by the Borough's certified SEO as a rehabilitative measure to repair an OLDS. In the event that rehabilitative or replacement measures are not feasible or do not prove effective, the Borough may require the owner to apply for a permit to construct a holding tank. It is recommended that the Borough continue to issue holding tank permits only as required for the temporary repair of malfunctioning OLDS. The issuance of holding tank permits shall continue in accordance with DEP regulations and requirements of the Borough Code.

5.7 SEWAGE MANAGEMENT PROGRAMS

To ensure the proper operation and maintenance of OLDS within the Borough currently not proposed to be served by public sewer systems, Shinglehouse Borough shall adopt an ordinance governing municipal management of OLDS to provide management of the Borough's OLDS systems. A draft copy of the Ordinance is included as Appendix G and will be finalized after the adoption of the Act 537 Plan. This Ordinance provides requirements for the permitting, inspection, operation, maintenance, and rehabilitation of OLDS within the Borough. Select items from the Ordinance include the following:

- No person shall install, construct, or request bid proposals for construction, or alter an individual sewage system or community sewage system or construct or request bid proposals for construction or install or occupy any building or structure for which an individual sewage system or community sewage system is to be installed without first obtaining a permit from the Borough's Sewage Enforcement Officer, which permit shall indicate that the site and the plans and specifications of such system are in compliance with the provisions of the Clean Streams Law and the Pennsylvania Sewage Facilities Act and the regulations adopted pursuant to those Acts.
- Applicants for sewage permits may be required to notify the Sewage Enforcement Officer of the schedule for construction of the permitted On-lot Sewage Disposal System so that inspection(s)

in addition to the final inspection required by the Sewage Facilities Act may be scheduled and performed by the Sewage Enforcement Officer.

- Any On-lot Sewage Disposal System may be inspected by an authorized agent at any reasonable time as of the effective date of the Ordinance. Such inspection may include a physical tour of the property, the taking of samples from surface water, wells, other groundwater sources, the sampling of the contents of the sewage disposal system itself and/or the introduction of a traceable substance into the interior plumbing of the structure served to ascertain the path and ultimate destination of wastewater generated in the structure.
- An authorized agent shall inspect systems known to be, or alleged to be, malfunctioning. Should said inspections reveal that the system is indeed malfunctioning; the authorized agent shall order action to be taken to correct the malfunction.
- Each person owning a building served by an On-lot Sewage Disposal System which contains a septic tank shall have the septic tank pumped by an authorized pumper/hauler within three years of the effective date of this Ordinance. Thereafter that person shall have the tank pumped at least once every five years or whenever an inspection reveals that the septic tank is filled with solids or scum in excess of 1/3 of the liquid depth of the tank. Justification, including sufficient evidence that the septic tank does not require pumping every five years, may be submitted to the SEO for review and approval. Receipts from the authorized pumper/hauler shall be submitted to the Borough within the prescribed one and five year pumping periods.
- The required pumping frequency may be increased at the discretion of the Borough if the septic tank is undersized, if solids buildup in the tank is above average, if the hydraulic load on the system increases significantly above average, if a garbage grinder is used in the building, if the system malfunctions or for other good cause shown.
- Within seven (7) days of notification by the Borough that a malfunction has been identified, the property owner shall make application to the Sewage Enforcement Officer for a permit to repair or replace the malfunctioning system. Within 30 days of initial notification by the Borough, construction of the permitted repair or replacement shall commence.

Please refer to Appendix G for a complete description of Shinglehouse Borough's Draft On-Lot Sewage Management Ordinance.

5.7.1 Public Education

The Borough will publically advertise and make the Plan available at both the Oswayo Valley Public Library and the Borough Office, where the public will have an opportunity to review and comment on the Plan during a 30-day public comment period. The Plan is also proposed to be posted on the Borough's website. Following adoption of the Plan by the Township, a copy will remain on file at the Township Office.

5.8 NON-STRUCTURAL/PLANNING ACTIVITIES

Non-structural alternatives were not evaluated as part of this Act 537 planning effort, as the existing needs were focused on the current performance of the WWTP. Establishment of joint municipal sewage management programs were not considered as part of the Act 537 planning process.

5.9 NO ACTION ALTERNATIVE

The no action alternative is the continued use of residential on-lot systems and the currently failing Borough WWTP. The impacts of no action to address existing, short-term, and long-term sewage facilities include several considerations. Most of the discussion within this Plan has focused on the environmental and public health and safety concerns associated with the functioning of the

Borough WWTP. The obvious impacts of no action to improve any adverse conditions encountered include degradation of public water supplies, disease, loss of recreational use of waterways, environmental hazards, such as fish kills, and other tragedies. Economically, the no action alternative could result in substantial fines and/or penalties and restrict or prohibit growth to the County's Rural Growth Areas. The No Action Alternative (Alternative 4) was briefly considered and rejected.

5.10 STRUCTURAL ALTERNATIVES FOR UN-SEWERED AREAS

Alternatives to provide public sewer service to the un-sewered areas of the Borough are provided in the sections below.

Five (5) focused alternatives for providing public sewer service to the areas defined above are presented below and are evaluated on the basis of cost-effectiveness, environmental soundness, and structural feasibility. Cost estimates for the five (5) alternatives are provided in Appendix H. Due to the extremely high estimated construction costs (with the lowest cost of $79,300 per EDU) these alternatives were not evaluated further. Maps of each of the structural alternatives which identified proposed facilities are presented in Appendix I.

5.11 CONCLUSIONS

Based on the discussion above, the following are recommendations for the wastewater planning needs enumerated in Chapter 4.

1. **It is recommended that the Borough proceed with implementation of Alternative 2a (WWTP Upgrade) which has the lowest estimated 20-year present worth cost.**

This alternative includes installation of a vertical fine screen and rehabilitation of the influent pump station and control building; new grit removal system; new oxidation basin that would replace the existing primary clarifier and trickling filters; rehabilitation of the final clarifier; and rehabilitation of the disinfection system.

The recommended alternative should be completed in multiple phases in order to capitalize on existing grant programs and minimize the impact to the small rate base. Water Quality Management Part II Permitting through the Pennsylvania Department of Environmental Protection (PaDEP) is required for the recommended improvements.

2. **Shinglehouse Borough shall adopt an Ordinance governing the management of on-lot disposal systems (OLDS) within the Borough.**

Based on reports by the Borough's SEO and completion of the sanitary surveys, there is not immediate need to provide improved wastewater collection, conveyance or treatment systems to areas of the Borough utilizing on-lot systems. Further, it is not financially feasible to extend public sanitary sewer service to these areas of the Borough. As a result, these areas will continue to utilize on-lot disposal systems while permissible and non-failing. Repairs to the two malfunctioning systems should be made a priority and a Sewage Management Ordinance should be adopted to protect the existing OLDS against future failure.