# TOWN OF BEECH MOUNTAIN

## WATER AND SEWER STUDY

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July 28, 2011

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The Town of Beech Mountain is located in the Blue Ridge Mountains of North Carolina. It is partly within Avery County and partly in Watauga County at elevations ranging from about 3450 to 5506.

The Town of Beech Mountain began as a private resort development in the early to mid 1960's. The original resort developer built most of the present day Beech Mountain water and sewer systems. In 1974 the original developer filed for bankruptcy. The Town of Beech Mountain was incorporated in May 1981. Upon incorporation into a "town" all of the water, sewer, streets, etc. became the responsibility of the new town to operate and maintain. The Town of Beech Mountain has a very high amount of infrastructure for its very small population base. The U.S. Census shows the population to be 190 in 1980 and growing to 310 in 2000. The Census was 345 in 2010.

This study, even though it will cover both water and sewer, will be divided into a water section and a sewer section.

GIS SYSTEM

In 2001 the Town hired Hobbs, Upchurch and Associates, PA to conduct a complete mapping of streets, water and wastewater systems, for the Town of Beech Mountain. According to the report from August 2001 all of the information gathered, at that time, was entered into a GIS system and was to sub meter accuracy. This gave the Town a tremendous amount of information. The problem which now exists is that the information has not been kept up to date. This means that much of the data now existing in the GIS program is not correct and therefore one must assume none of the information except for the location, is of any value. As an example, none of the sewer work done in 2003/2004 was updated and still shows the 2001 data including pictures, etc. The GIS system can and should be a tremendous asset to the Utility Department, Public Works and Fire Departments in particular. However unless this data is updated with current information EVERY time something is repaired, replaced, modified, or checked, the GIS system loses its value over time. This is already true, to a great extent, with the GIS system for Beech Mountain. I recommend that Beech Mountain immediately obtain a sub meter GPS unit for use by Public Works and the Utility Departments. For instance, EVERY time a water valve is hunted, until it is found, it should be located, all information obtained and the data recorded. The GIS system should be updated not less than once each month, every two weeks would be better. This should apply to every single time anything in the water, sewer, roads, or fire protection system is worked on. If this becomes "second nature" it will add very little time to each job but will pay vast dividends down the road. Over time it will lead to the departments being proactive rather than reactive toward repairs and maintenance.

WATER

In January 2009 Hobbs, Upchurch and Associates prepared a preliminary engineering report for the Grassy Gap Sewer System. As a part of that report they stated that the average water loss from 2003-2008 was calculated to be 61%. In 2009 the Rural Water Association did a study which put the loss at over 80%. An analysis by Rothrock Engineering using the Town of Beech Mountain's water records for 2009 arrived at 70.65% loss. In late 2010, following the replacement of about 370 meters, the loss was estimated at about 65%. An acceptable loss would be below 15% with a goal of below 10%.

Starting with replacement of all meters in mid 2010 the Town also bought 8 leak detectors and has been systematically moving these around the system. At the time they were purchased, it was expected that possibly several significant leaks would be located and then repaired. Thus far this has not been the case. Actually to date no significant leak has been detected by the leak detectors.

As of April 30, 2011 about 450 new meters have been installed replacing the old meters. Many of these old meters, when they are dug out, show signs of small leaks. In 2010 a total of 39,631,000 gallons of water was billed with 119,663,000 gallons being delivered from the water plant to the distribution system (66.88% loss). This is 80,032,000 gallons of water lost. If the old meters are operating at an estimated 85% then the actual volume of water used would have been 46,625,000 gallons or an additional 6,994,000 gallons. This would get the loss down to about 61.04% or 73,038,000 gallons. Records show that approximately 1,200,000 gallons can be accounted for in water breaks and leaks. Hydrant flushing accounts for another 679,000 and billing adjustments another 3,925,000 gallons leaving 67,234,000 gallons or 56.19% unaccounted for in 2010.

The distribution system, constructed in the 1960's, used galvanized steel pipe and victaulic couplings. Some 53 miles of that original pipe still exists. The system now consists of 42,642 L.F. 2" (original) 149,586 L.F. 4" (original) 127,757 L.F. 6", 5,129 L.F. 8", 3,884 L.F. 6" PVC, 6,257 L.F. 8" D.I. and 15,584 L.F. 12" D.I. The D.I. and PVC are not a part of the original pipe.

Concentrated efforts to locate leaks over the past several months have shown that the Town of Beech Mountain has a water system which is systematically leaking throughout the entire system. The water loss is not coming from larger or significant leaks.

Assume the average length of a joint of pipe is 20 feet. With 53 miles (279,840 L.F.) of old victaulic coupling pipe there would be some 14,000 joints. We know that the couplings were put together using plain steel bolts and when they are dug up many of the bolts are rusted thru. Also many of the joints show signs of seepage type leaks. In addition all of the 1965 or so taps use screwed, galvanized, steel pipe with swing joints. This has at least six screwed joints for each tap for a minimum of 11,790. Again reports are that most of these show signs of leakage when dug out. This results in a minimum of 25,790 joints for potential leaks. Assume only 50% have any leak at all. With the 67,234,000 gallons per year, the leakage rate would only be 0.0050 gpm/joint (0.635 oz/min/joint). Small leaks like this cannot be detected by the leak detectors and will most likely never come to the surface.

With 67,230,000 gallons/yr lost, the system is losing about 7,675 gal/hr. Based on standards used today, if this was a new system and it was being tested, the maximum acceptable rate for the entire system would be 200.41 gal/hour or only 2.61% of what is actually being lost. Even though present loss is very excessive, point repairs to fix this type leak is not likely to be successful.

We have not dug up any of the PVC or D.I. pipe, but because it is newer, of modern design, and assumed to have been properly pressure tested, for this study, it will be assumed that the leakage rate for this pipe itself is within an acceptable range. However, this still is not the case for the taps. This leaves 53 miles of pipe to be replaced, rehabilitated and/or upgraded along with all 1965 service pipes.

WATER QUALITY

As a part of this study Hazen & Sawyer, Environmental Engineers and Scientists, Greensboro, NC were contracted to perform a water quality study. This consisted of taking the existing water system and mapping predicted water age within the system. Water age is a rather reliable predictor of overall water quality. The study revealed the water age in the Pinnacle Inn tank to be 32.6 days, 17.8 days in the Summit tank, 17.1 days in the Emerald Mountain tank, and 7.9 days in the Meadows II tank and 7.7 days in the Meadows I tank. The Parkway, Spruce Hollow, Mill Pond and Ashwood tanks were all under 2 days, while water quality is always dependant upon the specific water supply, it is desirable to keep water age everywhere within the system to under 5 days. The maximum acceptable age for the water would be about 10 days and could be less depending upon specific conditions. Parts of the distribution system also have water age over two weeks as well even though the storage tank might be OK. The excessive water age, in the distribution system, is caused by having so much pipe that has so few taps. As an on going study every line showing excessive age will be evaluated to determine if there is any reasonable way to get better circulation in that part of the system. Actually the vast amount of leakage does help with some of the water quality problems, but certainly is not an acceptable process for solving the problem.

In order to maintain residual chlorine, as well as other aspects of water quality it is at times necessary for water system personnel to manually flush parts of the system. This is true frequently in the area of Emerald Mountain tank. It has been shown by other systems with this problem that water quality can be better maintained, while at the same time wasting less water, by installing an automatic flushing unit. There will be at least one unit installed on a fire hydrant in the Emerald Mountain area. After evaluation of this unit, if things are going as expected, other units may be installed.

Storage tank age and therefore water quality has been addressed by water system personnel, the regulatory community, as well as the vendors supplying the industry. There are commercial units available to place into storage tanks to help improve water quality. These work by causing mixing and circulation within the tank. The commercially available units cost from about $30,000 to $35,000. Rothrock Engineering has designed a unit which can be built by town staff. It is estimated that the cost of this unit will cost about $2,000. In order to determine if the unit works, base data will be collected from a selected tank. After the base data is collected, the first unit will be installed into the selected tank and evaluated. If the evaluation is successful, as it is expected to be, additional units will be built and installed. After these are installed into the tanks with the longer storage times, they probably will be installed into all of the tanks to help improve overall water quality of the entire system.

In addition to water age in the storage tanks there is a serious problem with water age because of sections of the distribution system which have very low flows due to lack of taps. Many of the streets are dead end streets with dead end water lines. Most of these do not have any means of blow off at the end of the line. The regulatory requirement today requires that all dead end lines must terminate with a "blow off" of sufficient size to flush the line. The entire water distribution system will be reviewed to see where dead end lines can be eliminated and where that is not practical the installation of a properly sized blow off will be considered.

NEW TAPS AND SERVICE LINES

Originally when the system was first installed all taps were made using ¾", screwed, galvanized steel pipe with swing joints. A swing joint is built by the use of a series of elbows and nipples and is for the purpose of making the line "flexible." At that time the galvanized steel pipe was probably one of the best choices for the high pressure but I do not think the use of swing joints was ever a good idea. It was used to help with "making up" the line during installation so that the cutting of the pipe did not have to be as accurate. The swing joint would compensate by allowing the pipe to move laterally as it was connected. This movement can also break a seal previously obtained.

Because it is conceded that many, if not most, of the swing joint tap lines are leaking, a method was needed which would not have this problem. The first thought was to use copper tubing but it was reported that Beech Mountain has some "hot soils" which cause rapid corrosion of copper. The continued search revealed that a HDPE (High Density Poly Ethylene) pipe, which is NSF 14 approved and rated at 335 PSI working pressure, is now available. The technology is the same which the natural gas industry has been using for over 25-30 years and has now been developed for use with potable water. Even though it is believed that most of the existing swing joint taps have some leakage it is not practical to just go in and replace all of them. The estimated cost to replace a tap is about $800-$1000 each. With 1965 taps the total cost of replacement, in 2011 dollars, is between $1,572,000 and $1,965,000. Starting immediately, any time work is done on either a water tap or a water main which has a tap, the old swing joint tap will be replaced. This process will take some time but is the only method to be used which is practical. Eventually all of the old taps will be replaced.

DISTRIBUTION LINES

As has been noted earlier, about 53 miles of the existing 66 miles of transmission lines was installed in the 1960's using galvanized steel pipe and Victaulic couplings. The issue with this older pipe actually is not with the pipe but with the couplings. The fact that the bolts used to put the couplings together were standard steel means they have not lasted since the 1960's until now. When these have been dug out many of them have been rusted completely through, and only the pressure of the earth is holding things in place to keep from having a total blow out. It might be possible to dig out some of the couplings and replace the bolts with stainless steel bolts but such a course of action is not practical. The only practical method of correcting the problem is either replacement or slip lining. At this time we have not found a slip lining system which can be used in potable water. Also the slip liners have not been tested for use under the pressure conditions existing at Beech Mountain.

When investigating the Victaulic couplings for this report it was decided that for the report presentation it would be helpful to the Beech Mountain Town Council to see a picture of a typical coupling and pipe. The director of utilities went to take a picture of a coupling and a pipe end. The pipe was plain and with no groove. When asked about this the engineer was told that, so far as the director of Utilities knew, everything in the Beech Mountain System is installed using plain end pipe. I have seen and worked with "victaulic" pipe since about 1960 and have never seen it used with plain end pipe. The pipe has always had a groove for the coupling to fit down into to hold the pipe so it can not pull out and to compress the gasket. I am totally surprised that any of the original pipe with plain ends, is still in service, especially with some of the extreme pressures existing on Beech Mountain. However investigation has revealed Victaulic couplings for plain end pipe are available.

It is estimated that in order to replace the remaining 53 miles of original pipe the cost in 2011 dollars, would be about $13,992,000. If the tap upgrades are added, the cost of repairing the entire distribution system would be an estimated $15,950,000 in 2011 dollars. This does NOT address the storage tanks, booster pumps, excessive pressures, treatment plant, new raw water, etc.

At the present time about 50% of the Town's water distribution system is served by a single 6" gravity line. The 12" transmission line from the Clearwell is reduced to 6" near the Spruce Hollow tank and the distribution system. The Parkway tank is gravity feed from this part of the distribution system. There is a pump station at the Parkway tank which supplies the two Meadows tanks, Pinnacle Inn, Summit and Emerald Mountain tanks. There are additional pump stations after Parkway but the Parkway Station actually supplies all of the water to them. Because the present system severely limits the availability of water in the event of a major fire at one of the condo or time share complexes creates problems for operating personnel as well as some water quality issues. The proposed solution is to install a pump station at the end of the 12" transmission line and run it to the Parkway tank. In addition to making adequate fire protection available, this will improve water quality as well and will make operations more versatile. The estimated distance is about 9000 L.F. at $55/L.F. ($495,000 including rock and pave & patch).

PUMP STATIONS

Several of the booster pump stations are in need of attention. Three of these are Parkway, Mill Pond and Ashwood. The electrical systems need to be updated. This will require rewiring the stations and replacing the controls. One of the problems with some of the pump stations is the lack of valving to allow for taking the tanks off line. This is definitely not a preferred situation. A major blow out in certain areas of town could result in draining two or more tanks and putting major sections of the Town out of water for an extended period of time. The proposal will be to revise the piping for all of the booster pump stations, as they are updated, to allow for maximum flexibility.

Some of the stations have the original pumps which have never been replaced nor rebuilt. Ashwood and Mill Pond were both installed in 1986. In order to have water for any part of Town above these two tanks these booster stations are required. With over 25 years of service all of these pumps need to be rebuilt or replaced, one at a time, until the project is complete. The results of the inspection of the first pump will let the Town know how urgent the remaining pumps are going to be.

RAW WATER SUPPLY

During the summer of 2010 the Town of Beech Mountain had a serious water shortage in their raw water reservoir on Buckeye Creek. The water level dropped to only about 18 inches above the lower intake (the lake has intakes at 3 levels * -6.5', -13.5' and -23.5'), the inflow into Buckeye Lake from Buckeye Creek dropped to only a trickle and the estimated raw water supply dropped to less than 20 days without a good rain. The possibility of adding an adapter to the lower intake when the water level is extremely low will be investigated. The amount of water available will be very limited but under these particular circumstances any addition would be very welcomed. One of the problem is the fact that the intakes are not isolated from each other and flow to the raw water pumps by gravity.

Buckeye Lake is not adequate to serve the long term needs of Beech Mountain. Additional raw water supply is needed. Preliminary evaluation indicates that any solution will be neither quick nor inexpensive. Some of the possible solutions are:

1. Raise the height of the existing dam in order to increase the size of the lake.

2. Pump water from Pond Creek.

3. Pump water from Watauga River.

Raising the height of the reservoir in order to increase the impoundment is a viable option but is not a permanent solution. The problem with this approach is that the actual water supply is totally dependent upon the sustainable flow of water in Buckeye Creek. Raising the dam 10' would result in and estimated 21,000,000 – 22,000,000 gallons of additional water or only some 21-22 days now and even less when the plant is expanded. The NCDENR, Division of Water Supply, uses the 7Q10 to determine the sustainable water flow available at any point on a given stream. The sustainable flow, which can normally be relied upon during drought conditions, is considered 20% of the 7Q10.. The 7Q10 for Buckeye Creek is roughly 0.5-0.9 CFS (0.32-0.5 MGD), for Pond Creek it is roughly 0.1-0.3 CFS (0.065-0.19 MGD) and for the Watauga River near the confluence with Beech Creek it is 25-38 CFS (16.2-24.6 MGD). The safe yield, what NCDENR is likely to approve for Beech Mountain to withdraw, would be 3.24-4.92 MGD. A more precise evaluation of both Buckeye Creek and the Watauga River has been requested from USGS.

During the summer of 2010 Buckeye Creek virtually went totally dry. It was only because of the occasional thunderstorms on the mountain that the lake did not go dry, putting the town out of water. The summer of 2010 was not as dry off of the mountain as some of the recent summers have been. Frequently thunderstorms would occur all around in the area except up on the mountain. This weather pattern was somewhat unusual and resulted in the severe water shortage for the Town of Beech Mountain. This same weather pattern has existed part of the time during the spring of 2011.

The second option is to put a pump station on Pond Creek. This either with or without raising the dam would provide for an additional supply of water. However this also would not be a permanent solution. Eventually as the Town grows the water requirement will exceed the capacity of both these small streams to provide adequate water. Their combined 7Q10 is only 0.6-1.2 CFS (0.3-0.77 MGD) while the present capacity needed is about 1.10 MGD and the future will grow to over 2.0 MGD.

The third option of drawing water from the Watauga River is the only long term permanent solution to the raw water problem. If a pump station were to be placed on the Watauga River it would not be necessary to raise the dam for Buckeye Lake. The pump station would be used to keep Buckeye near full pond. During periods when the lake was at full pond the pump station would not be used. Of the three possible alternatives, a pump station on the Watauga River is the preferred. This type of system is now being used and/or proposed for a number of systems in North Carolina, including neighboring Boone/Blowing Rock.

Obviously this solution will present several challenges. Some of those are:

1. Distance and therefore cost.

2. Elevation change.

3. Community resistance to stream reclassification.

4. Right of way.

The existing water treatment plant (WTP) was built in 1986. The plant is a modified conventional sand filter, package plant. The plant consists of two steel 500,000 GPD modules if operated at NCDENR maximum rate of 4 GPM/SF. In order to get the necessary settling in the basin, the basins have tube settlers installed. These are intended to increase detention time and settling.

One of the problems with the existing plant operations is the fact that it now requires the filters to be backwashed every 4 hours. This results in 12-15% of all finished water being used for filter backwashing. In addition, this also results in the loss of this raw water since the backwash water is discharged below the reservoir. The total volume of water lost during each cycle is estimated at approximately 20,000 gallons. This is about 15% of the total needed each day. The total estimated useable volume of water in the reservoir is about 14,600,000 gallons. The average daily finished water delivered to the system in 2010 was 362,000 gallons with the average raw water withdrawn being 403,000. Peak flow days were about 2.5-2.8 times the average.

The frequent backwash is caused, in part, by the fact that it has been thought by the operators that the tube filters could not be removed and properly cleaned because the ceiling of the existing building is so low that there is not the necessary head room to remove the tubes. It is suspected that the tube settlers may only be operating at an effectiveness of 50% or less, causing a lot of the material which should be settled out to be carried onto the filters. Investigation during this study has revealed that there is sufficient head room to remove the tube units because each 8' unit is in four 2' high modules. In all probability the tube condition will be such when they are removed that they will require replacement. A quote for replacement is being sought but has not yet been received.

There was a preliminary engineering report prepared by AECOM, Spartanburg SC and dated July 2009. The basic conclusion of that report was that the Town of Beech Mountain's WTP needed to be expanded to meet both the present and future potable water demand. The present system reached 882,000 GPD in December 2007. The report stated the plant capacity was anticipated to exceed present capacity by 2012.

The report performed 3 alternatives. A very brief summary of each is as follows:

> Alternative No. 1- Refurbish the two existing treatment modules, add one unit to increase the capacity to 1.5 MGD plus construct 3 pressurized carbon filters. This alternative will require that the existing building be widened. Estimated cost was $2,756,604.
>
> Alternative No. 2- "Construct a new water treatment process utilizing conventional pre-treatment and a submerged membrane filtration system. The new process will replace the two (2) existing conventional water treatment units and will be installed inside of the existing building." Each unit would be to process 0.750 GPD for a total of 1.5 MGD. It did not discuss how the existing building was going to be used and at the same time keep the existing plant operating. The estimated cost was $ 3,843,841.
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> Alternative No. 3- "Construct a new water treatment process utilizing two (2) helical up flow clarifiers and conventional sand filters. The new process will replace the two (2) existing conventional water treatment units." The estimated cost of this alternative was $3,512,213.

The prior report is attached at the end of this report in the appendix.

In addition to some of the operation problems listed earlier the existing WTP has several physical problems. Some of these are:

1. Severe rust on the filter end of the tanks between the wall and bottom.

2. The concrete base of the two units has settled.

3. HVAC for the existing building needs to be reworked.

Potentially the most severe problem with the existing plant is the physical conditions of the steel tanks. These tanks must be evaluated ASAP to determine, as much as possible, their actual condition. Once this evaluation is complete it should determine if an emergency condition exists. With this information the proper course of action can be planned. The goal will be to try and extend the life of the existing facility for a period of at least 5-7 years and if expansion of capacity can be delayed for 10 years.

In order to continue to operate the existing WTP for more than a year or so, will require that the tube filters be properly serviced. This will require the filters to be removed and properly replaced.

There are a few things which need to be done which will help with the operation of the existing WTP, might help to extend its life, and can be used with a new plant.

The raw water intake structure needs to be properly inspected. This will need the lake level down to near the lower intake, therefore unless there is a drought this summer, the inspection will be planned for next spring during the lowest usage period and historically heaviest period of rainfall in order to reduce the potential for a water shortage problem to a minimum. In addition to the intake structure the raw water pump station needs a complete rebuild. This would include the ability to select the level from which water is drawn from the lake, new raw water pumps, new controls, reworking of the station, the addition of the injection of potassium permanganate, and a possible system for oxidation of iron and manganese. All of this would continue to be used with any new facility.

At times there are problems with chlorine contact time in the clearwell prior to pumping to the system. The state asked in about 1995 or 1996 that a curtain wall to be installed in the existing clearwell. This work has not yet been done but needs to be completed ASAP. The clearwell will continue to be used with a new facility and with a larger WTP the curtain wall will become an absolute necessity.

In order to continue to operate in the existing building, add some forced ventilation to remove some of the corrosive air. Also add some additional HVAC to the control room, lab and office area to help with temperatures.

The previous study suggested an expanded facility would be required by 2012. It is our opinion that work to reduce the loss of water can delay that until about 2017-2020. Continued study and evaluation must be performed in order to determine the extent to which the goals for reducing water loss are being reached.

At this time it would be recommended that a conventional plant with concrete, not steel, tanks/basins be designed to replace the existing WTP. The plant should NOT be designed to initially operate above 2 gpm per sq. ft. across the filters. In addition, all other parts of the plant should be designed for the maximum settling time etc. By following this procedure the plant can be expanded by 100%, or any part there off, without any change other than finished water pumps. Probably this will mean a new WTP with a capacity of from 1.25-1.50 MGD and minimum of 2 filters at about 250-260 SF. This would then allow the plant to operate up to 3.0 MGD which is beyond the estimated needs of Beech Mountain in 2110 (100 years).

The water plant is in rather poor condition. The steel tanks are corroded pretty badly but visually one cannot determine their true condition. Initial evaluation indicates that these units are going to require attention very soon. Also the plant is experiencing severe operations problems. The filters need backwashing every 4 hours. This means that about 12-15% of the water produced is used in plant operations. Also this raw water loss does not go back to the reservoir.

The high service pumps have never been rebuilt nor replaced. Initially the capacity of one was about 1000 GPM but now is down to only about 700-750 GPM. The second was 750 and is down to about 600-650. This indicates a lot of wear so they must be addressed in the short term.

SEWER

The Beech Mountain Sewer System is divided into two parts with a WWTP serving each. The Grassy Gap WWTP is an 0.080 MGD plant with an average daily flow in 2010 of 0.0383 MGD, a minimum daily flow in 2010 of 0.003 MGD, and a maximum daily flow in 2010 of 0.369 MGD. The Pond Creek WWTP is a 0.400 MGD plant with an average daily flow in 2010 of 0.135 MGD, a minimum daily flow in 2010 of 0.040 MGD, and a maximum daily flow in 2010 of 1.093 MGD.

An overview of both the Grassy Gap and the Pond Creek Collection systems show that, except for a small amount of line replaced in 2003/2004, the entire system has a systemic 1 & 1 problem. When reviewing the pictures contained in the GIS data, as well as physical inspection, it is very obvious that when the original sewer lines were installed, and in some cases later work, the workmanship was terrible. The MH's often do not have any inverts, the block used to build the MH's only has cement in some 40-50% of the joints, where precast units were used the holes look as if they may be as much as 18" diameter and no real effort was made to seal around the pipe, etc. In summary for that part of the system which one can see, which is the MH's, all of the MH's are leaking if any surface water can get to the outside wall of the MH or anywhere near the pipes either going in or out. Since this is the situation with the sewer collection system and since the entire system cannot be replaced in the short term, this study will try and identify some of the more pressing and most cost effective rehabilitation.

The Grassy Gap lift station must be replaced. It would be good if it could be moved away from the lake, but the collection system will not permit moving the LS so an overflow would not go into Buckeye Lake.

The waste water treatment plant at Pond Creek is almost new (2008) and in good shape except for the clarifier which is presently being addressed. The Grassy Gap waste water treatment plant is a package plant that is about 15 years old (1996). It is in pretty good shape and seems to only need routine maintenance at this time.

The problem with the sewer system is mostly from I & I in the collection system. Much of the system is the original pipe and it appears it was not properly installed. Flow studies have shown that the I & I in the system is a systemic problem over the entire system rather than a few point sources.

Presently slip lining, using a cured in place liner, is being considered. The cured in place liner being considered is cured using ultraviolet light. At this time it appears this technology can be used resulting in a savings over dig and replace by as much as 40-50% with the average savings of 30-35%. A good reliable long term method of rehabilitation for man holes has not been found and therefore it is proposed that where a man hole must be rehabilitated that it be replaced with a precast unit.

Both the Grassy Gap and Pond Creek collection systems have high I & I. The I & I in Grassy Gap is much more severe and therefore it will be proposed for work first. Because of the magnitude of the problem with both water and sewer it will not be financially possible for the Town to do all the work at one time. The upgrading will most likely take several years. The initial work will be that required to try and "put out the fires". Once that is completed, the balance of the cost effective work can be done until both systems are at optimal performance. Regular maintenance will continue be required while these various upgrades and repairs are performed.

GRASSY GAP WWTP & SYSTEM

The Grassy Gap Basin collection system consists of about 116,322 L.F. 8" pipe, 4,176 L.F. 10", and 2,745 L.F. of 12" for a total of 124,127 L.F. There are approximately 742 M.H. and 2 pump stations in this basin along with some 3020 L.F. of 4" force main.

The Lift Station (L.S.) on Winter Crest Road serves approximately 36 customers and has a design pumping capacity of 100 GPM. This station is in pretty good condition and only requires routine maintenance at this time. The Grassy Gap L.S. (at Buckeye Lake) receives the flow from the Winter Crest L.S., serves a total of approximately 144 customers and has a design pumping capacity of 80 GPM. (Note this is less than the design capacity of the Winter Crest Road Station which pumps to the Grassy Gap LS.) The Grassy Gap LS is not in good condition and requires a lot of maintenance as well as requiring the pumps to be replaced every 3-4 months.

The Grassy Gap L.S. should be replaced. The existing L.S. will be stripped of all equipment and used as a sand/debris trap ahead of the new L.S. This existing wet well will then be routinely cleaned by town personnel with the Vac Truck. The new L.S. will have the pumping capacity increased from the present 80 GPM to 130-150 GPM. This may not be sufficient to eliminate 100% of the overflows caused by I & I but will help until part of the I & I can be eliminated. In order to eliminate any possibility that an overflow might occur would require a new force main and provisions at the WWTP to somehow handle the huge surge flows that would occur. The proper approach is to address the root cause of the problem which is wet weather induced I & I.

The collection system in the Grassy Gap basin routinely shows high levels of I & I. This Grassy Gap Collection System consists of 190.4 in. mi of line. Present NCDENR standards for a new system are 100 GPD/ in. mi. This would result in the 19,040 GPD of I & I for the over 23 miles in this parts of the system. Records indicate that during wet weather and highest 1 & 1 that 1 & 1 flow may be over 350,000 GPD. This is by no means normal, but was encountered during January 2010.

During the fall of 2010 a part of the system was smoke tested as well as inspected internally with a camera. Several areas showed smoke escaping from the line which indicates direct avenues from the sewer line to the surface and in turn potential for the introduction of surface water. No actual points of 1 & 1 were found with the camera. Smoke testing will not give a specific point needing repair, only the general area of concern.

The latest NOV (Notice of Violation) from NCDENR was for the Grassy Gap WWTP and for the month of March 2011. These NOV will continue to be received until the 1 & 1 is reduced.

Over time the entire collection system will require replacement of all old MH and slip lining of all original sewer line. This study is going to try to estimate the amount of work needing immediate attention in each basin and assign a priority to each. This is not an exact science, without spending more than can be justified and therefore must be a continuous process.

The breakdown of basins used in the 2001 study will be used for identification purposes.

The basins for the Grassy Gap WWTP were as follows:

| | Total L.F. | No. M.H. |
|---|---|---|
| T0225 | 2,891 | 19 |
| T0147 | 32,020 | 175 |
| T0337 | 13,706 | 70 |
| Grassy Gap WWTP | 9,735 | 50 |
| T0338 | 21,948 | 130 |
| T0339 | 23,541 | 149 |
| T0340 | 21,968 | 100 |
| | 125,812 | 693 |

According to data available, 100% of basin T0225 was replaced. However no data was obtained and turned over to the town for updating the GIS system so no one is actually sure this occurred. For this study it will be assumed that this work was properly done and does not need any reevaluation at this time.

Even though other areas have been looked at and addressed, more emphasis has been placed on basin T0147 and basin T0337 because these drain to the Grassy Gap L.S. Part of the lines in basin T0337 were smoke tested and inspected with a camera in 2010 for help in the analysis of the Grassy Gap Lift Station problem. It is estimated that, of the approximately 45,726 L.F. and 245 M.H. in these two drainage basins, some 12,400 L.F. of sewer line and 82 M.H. need immediate attention in Phase I. Much of this has already been identified. The balance of the areas already identified must be evaluated and these repairs completed. For the collection system this is top priority.

Priority No. 2 for the collection system is the basin labeled Grassy Gap WWTP. This has a total of 9,735 L.F. and 50 M.H. Estimates are that about 5500 L.F. and 30 M.H. will be included in Phase I. The balance will be addressed in the future.

No. 3 is the basin labeled T0338 containing 21947 L.F. and 130 M.H. Estimates are that 3600 L.F. and 35 M.H. need immediate attention in Phase I.

No. 4 is basin T0339 with 23540 L.F. line and 149 M.H. Estimated Phase I repair needs are 3000 L.F. and 25 M.H.

No. 5 is basin T0340. This basin consists of 21968 L.F. sewer line and 100 M.H. Estimated amount in need for Phase I is 2800 L.F. sewer line and 22 M.H.

The entire collection system draining to the Grassy Gap WWTP consists of almost 126,000 L.F. of sewer line and 693 M.H. of this total only 19400 L.F. of line and 154 M.H is proposed in Phase I. This is 15.4% of the line and 22.2% of the M.H.

POND CREEK WWTP

The Pond Creek plant also has a 1 & 1 problem as can be seen by the fact that a daily flow of 1,093 MGD, 2.73 times permitted and over 8 times annual average, was measured at the plant in 2010.

The basin designation for the pond creek WWTP are:

| | Total L.F. | Total M.H. |
|---|---|---|
| Pond Creek WWTP | 21,378 | 133 |
| T0336 | 10,308 | 34 |
| T0344 12" pipe | 33,095 | 160 |
| T0344 8" pipe | 27,438 | 130 |
| T0335 | 20,556 | 94 |
| T0578 | 12,473 | 66 |
| T0343 | 40,785 | 160 |
| Total | 166,036 | 857 |

Priority No. 1 for the Pond Creek plant is the basin designated as WWTP. This basin has 21,378 L.F. and 133 M.H. The estimated amount to be addressed initially is 10700 L.F. and 70 M.H.

Priority No. 2 is basin T0336 consisting of 10,308 L.F. and 34 M.H. Estimated amount to be addressed in Phase I is 4500 L.F. and 18 M.H.

No. 3 priority is basin T0344 - 8" pipe consisting of 27,438 L.F. and 130 M.H. Estimated Phase I rehab is 4800 L.F. and 25 M.H.

No. 4 priority for the Pond Creek Plant is basin T0343 containing 40,785 L.F. and 160 M.H. Estimated present need for Phase I is 3000 L.F. line and 30 M.H.

Priority No. 5 for Pond Creek is basin T0334 - 12". This basin has 33,095 L.F. of line and 160 M.H. Phase I need is estimated to be 10500 L.F. line and 60 M.H.

Priority No. 6 for Pond Creek is basin T0335 consisting of 20,556 L.F. and 94 M.H. with an estimated 2600 L.F. and 20 M.H. in Phase I.

Priority No. 7 in Pond Creek is basin T0578. This has 12,473 L.F. and 66 M.H. and contains an estimated 3000 L.F. line and 30 M.H. included in Phase I.

PRIORITY

Establishing an overall priority for all of the water and sewer needs is very difficult and can also be subjective.

Because of the visual condition of the WTP this will be the No. 1 priority. Once the condition is known, and, if required, a fix planned, then the balance of the needs can be addressed. The total need identified for the town of Beech Mountain water and sewer systems is over $6,200,000 for Phase I. Obviously the town cannot do all of the work as "a project" but should plan to work on this task for the next several years.

The loss from the water system should be evaluated at least once every year. With the new radio read water meter this will not be a major project. Also I & I must be continuously looked at so that going forward the work that is done will be the most effective work first. The priorities will be constantly changing with time.

Some of the projects do not lend themselves to be broken into phases, therefore planning must be started for their financing well in advance of construction. They are:

(Note – Estimates are in 2011 dollars with an escalation of 4%/yr.)

New WTP – Schedule for 2020 → $4,982,000

New WWTP to Replace Grassy Gap – Schedule for 2024 → $900,000

New Intake on Watauga River ASAP 2011 Dollars → $2,250,000

Grassy Gap L.S. (2011 Dollars) → $185,000

All other projects are either less than $100,000 or can be phased.

1 – Water Treatment Plant → Cost unknown

2 – Reclassification of Watauga River → $25,000 (This will take from 1-3 years)

3 – Grassy Gap Lift Station → $185,000

4 – Tube filters for WTP → $25,000

5 – Replace finished water pumps → $80,000

6 – Basin T0147 and T0337 Draining to Grassy Gap L.S. Phase I 6700 L.F. Sewer line and 75 M.H. → $367,500

7 – Build and install first tank mixer → $3,000

8 – Build and install auto flush unit on water system → $3,000

9 – Replace first 5000 L.F water line → $250,000

10 – Install Curtin Wall in the clearwell in order to get needed chlorine contact line → $25,000

11 – Basin Grassy Gap WWTP 5500 L.F. sewer and 30 M.H. → $240,000

12 – Rebuild booster pump stations ad piping for tanks
7 tanks at $25,000 each → $175,000

13 – Pond Creek Plant Basin WWTP 10,700 L.F. sewer and 70 M.H. → $487,750

14 – Grassy Gap basin T0338 → $187,000

15 – Replace 5000 L.F. water line → $250,000

16 – Rework Raw Water Pump Station → $80,000

17 – Replace 5000 L.F. water line → $250,000

18 – Install blow off units on dead end lines → $1,500 ea.

19 – Pump station and 12" transmission line from Spruce Hollow to Parkway → $

20 – Install potassium permanganate feed in raw water → $1,500

21 – System on raw water for oxidation of iron and magnesium → $25,000

22 – Pond Creek Plant Basin T0336 4500 L.F. sewer and 18 M.H. → $182,250

23 – Replace 5000 L.F. water line → $250,000

24 – Pond Creek Plant Basin T0344 – 8" pipe 4800 L.F. sewer and 25 M.H. → $206,000

25 – Replace 5000 L.F. water line → $250,000

26 – Grassy Gap WWTP Basin T0339 3000 L.F. sewer line and 30 M.H. → $157,500

27 – Replace 5000 L.F. water line → $250,000

28 – Pond Creek WWTP Basin T0443 3000 L.F. and 30 M.H. → $157,500

29 – Replace 5000 L.F. water line → $250,000

30 – Pond Creek WWTP Basin T0344 – 12" pipe 10500 L.F. and 60 M.H. → $461,250

31 – Replace 5000 L.F. water line → $250,000

32 – Grassy Gap WWTP Basin T0340 2800 L.F. and 22 M.H. → $135,000

33 – Replace 5000 L.F. water line → $250,000

34 – Pond Creek WWTP Basin T0335 2600 L.F. and 20 M.H. → $124,500

35 – Replace 5000 L.F. water line → $250,000

36 – Pond Creek WWTP Basin T0578 3000 L.F. sewer and 30 M.H. → $157,500

37 – Replace 5000 L.F. water line → $250,000

38 – Continue to replace water lines, sewer lines, and M.H. until all cost effective repairs have been completed → $6,430,750 for Phase I.

TOTAL IDENTIFIED NEED SUMMARY

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The following is the total estimated need for the Town of Beech Mountain for the forseable future.

Water lines – 53 miles -------------------------------------------------- $15,990,000

Sewer Lines – Rehabilitate Estimated 80% --------------------------- $ 7,588,000

Man Holes – Replace 90% of Original -------------------------------- $ 2,790,000

Other Water and Waste Water Needs Identified ---------------------- $ 8,132,000

Total Identified Need Summary ---------------------------------------- $ 34,500,000