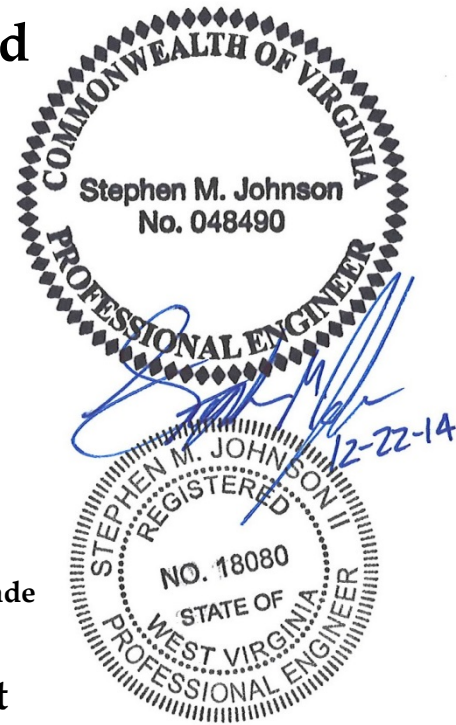




# Sanitary Board of Bluefield

Mercer County, West Virginia  
Tazewell County, Virginia



Wastewater Pump Station Evaluation and Upgrade

## Preliminary Engineering Report

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## **I. Introduction**

The Sanitary Board of Bluefield owns and operates a traditional sanitary sewer collection system. The system is composed of approximately 94,000 LF of gravity sewer pipe, several hundred manholes, nine (9) main wastewater pump stations, and multiple smaller grinder wastewater pump stations.

Two of the pump stations in particular, Midway and Thompson's, have been problematic and suffered from regular sanitary sewer overflows. These stations are part of the overall collection and conveyance system which convey sanitary sewer flow from the Bluewell and Brush Fork areas of West Virginia, to the collection system within the City of Bluefield, and ultimately to the Westside Wastewater Treatment Plant, located in Tazewell County, Virginia. A third pump station within the system, the Brush Fork Pump Station, has generally been reliable, but has recently suffered from force main breaks which have resulted in sanitary sewer spills.

The Deerfield pump station has generally, until recently, not been a problematic pump station. The station was designed to serve the nearly built-out Deerfield subdivision in Tazewell County, Virginia, near the western extents of the Sanitary Board's system. Recently however, the Deerfield pump station has also become problematic due to pump and electrical equipment failures.

Subsequently, due to these problems, the Sanitary Board retained Chapman Technical Group to perform a study and prepare a Preliminary Engineering Report to determine the appropriate course of action to prevent future overflows and maintain system reliability. An overall exhibit indicating pump station locations is contained in *Appendix A*.

Additionally, in June of 2014, shortly after commissioning the study, The Sanitary Board was issued an Administrative Order from the West Virginia Department of Environmental Protection (WV DEP). The Order noted between April 2009 and August 2013 there were forty-three (43) reported spills/upsets. The Sanitary Board was ordered to submit a timeline to complete necessary repairs/upgrades by December 31, 2014.

The recommendations contained herein should satisfy the requirements of the Order, as well as provide the Sanitary Board a planning document to complete the necessary improvements in order to maintain system reliability and prevent future spills under normal operating conditions.

## II. Data and Evaluation Factors

The information required to perform the analysis of the existing systems and produce report exhibits came from various sources including existing Sanitary Board topographical mapping, Town of Bluefield Lidar, and site specific survey performed by Chapman Technical Group.

### Reference Terminology:

*Wet Well* – the component, similar to a storage tank, of the pump station where flow from upstream sources enters until pumped downstream.

*Valve Vault* – the component of the pump station that houses check valves, manual shut-off valves, pressure gauges, and associated items. Each pump discharge pipe is connected in the valve vault prior to discharge into a single pipe, or force main.

*Force Main* – the pipeline where flow is conveyed from the pump station, under pressure, to a discharge location, typically a manhole or wet well.

*Air Release Valve* – an air release valve is required at high points of force mains to expel trapped air which accumulates. Trapped air which is not vented can create substantial restrictions and reduce pump/pipe capacity.

*Peak Factor* – a multiplier used to determine the peak instantaneous tributary flow and required pumping rate. Peak Factor's account for daily usage patterns. For example, typically residential areas experience very little flow at night, but high flows as people prepare for and return from work in the mornings and evenings.

*Pumping Capacity* – the total pump station discharge with all but one pump in operation. The remaining pump is installed for redundancy to maintain capacity in the event of normal pump or electrical component failures.

Flow per residence: 350 GPD (inc. I/I allowance)

Source: Virginia DEQ Sewage Collection and Treatment (SCAT) regulations.

Peak Factor:  $\frac{18+\sqrt{P}}{4+\sqrt{P}}$       Where P = population in thousands

Source: 10-States Standards.

Friction Loss in Pipes, Hazen Williams Equation:

$$H_{LF} = \frac{10.44 L Q^{1.85}}{C^{1.85} D^{4.8655}}$$

Q = Flow, gpm

L = Pipe Length, ft

C = Hazen-Williams Friction Coefficient

D = Pipe Diameter, in

H<sub>LF</sub> = Friction Loss, ft.

### III. Deerfield Pump Station System

#### A. Existing Conditions

The existing Deerfield wastewater pump station was originally constructed in 2000, by Keesling Construction Company, to serve the Deerfield Subdivision, in Tazewell County, Virginia. The subdivision currently contains 136 residences, with plans to add an additional 8 in the near future.

The station is located below the subdivision on Developer owned land, and pumps wastewater through approximately 2,285 linear feet of 4" PVC force main to an existing manhole located along Virginia Avenue (US Route 19), at the edge of the Town of Bluefield corporate limits. The flow is conveyed to the Westside Wastewater Treatment Plant through the Sanitary Board's gravity sewer collection system. The overall pump station location and service areas are shown in *Appendix B*, on sheet *DF-1*. Additional station specifics are listed in *Table 1*, below.

***Photo 1 – Existing Deerfield Wastewater Pump Station***



The current required station capacity was calculated based on previously referenced criteria. Calculations are provided below:

Total Daily Flow:

$$350 \text{ gallons per residence per day} \times 144 \text{ residences} = 50,400 \text{ GPD}$$

Peak Daily Flow:

$$144 \text{ residences} \times 3 \text{ persons per residence} = 432 \text{ people}$$

$$\text{Peak Hourly Flow Factor} = \frac{18 + \sqrt{(432/1000)}}{4 + \sqrt{(432/1000)}} = 4.1$$

$$4.1 \times 50,400 \text{ GPD} / 24 \text{ hrs} / 60 \text{ min} = \underline{143 \text{ GPM Req'd}}$$

A drawdown test was performed to determine the actual pumping capacity of the station. The results yielded 140 GPM and 115 GPM each for pumps 1 and 2, respectively. The difference in pumping rates is likely due to wear or a solids accumulation near the pump suction. As expected given the near built out condition of the development, the stronger pump is operating near the required design capacity of the station.

Additional deficiencies at this facility include lack of a standby generator and remote monitoring system as required by Virginia DEQ for Reliability Class 1 wastewater pump stations. The Deerfield pump station meets Reliability Class 1 criteria due to its proximity to Wrights Valley Creek, an immediate tributary of the Bluestone River which is listed as a 303d impaired water body.

Station access by vehicle is limited. Highway access is currently through an adjacent privately owned driveway, and through a Developer owned field.

The existing control panel does not contain intrinsic safe barriers for control circuits which enter the wet well, as required by the National Electric Code (NEC).

**Table 1 – Existing Deerfield Pump Station Summary**

<b>Component</b>	<b>Value</b>
Pumps	(2) 9.4 HP Flygt 3127.170 – 890
Current Pump Capacity	140 GPM / 115 GPM
Wet Well	6' Diameter, Fiberglass
Wet Well Top Elevation	2,427.20'
Wet Well SS In Elevation	2,423.26'
Wet Well Bottom Elevation	2,417.00'
Force Main Discharge Elevation	± 2,495'
Force Main	2,285 LF of 4" PVC
Static Head	± 78
Electrical Service	240 Volt, 1-Phase, 200 Amp
Station Piping	2" Threaded



### Summary of Identified Deficiencies:

- Station operating at or slightly below required capacity
- No standby generator
- No remote monitoring system
- Difficult access
- Non-code compliant control panel
- Aged and generally worn components

### **B. Future Requirements**

As previously noted, the Deerfield Pump Station serves the western limits of the Sanitary Board's system. Subsequently, it is reasonable to assume flow from future development would be conveyed through the pump station. Additionally, there is an existing, un-sewered, residential area immediately to the east, between the pump station and force main discharge location. The area currently contains approximately 45 residences and small business, plus some additional area for future development. The local topography would prevent service of the area by an extension from the existing downstream gravity sewer system; subsequently, future service would be provided through a gravity extension from the Deerfield pump station.

Ultimate station capacities for two alternatives were considered for the upgrade of the pump station. The first, *Flow Case 1*, includes capacity to provide service only to the existing Deerfield subdivision as well as the existing adjacent un-sewered area. The second, *Flow Case 2*, would also provide capacity to serve future development to the west, including some existing residences and businesses nearby along Wrights Valley Road. Ultimate tributary flow and pump hydraulic calculations are presented below.

#### ***Flow Case 1 – Capacity for Adjacent Service Areas Only***

##### Total Daily Flow:

*350 gallons per residence per day x 45 residences = 15,750 GPD*

*Add 20% for undeveloped area = 15,750 x 0.20 = 3,150 GPD*

*Add Existing Deerfield Subdivision: 50,400 GPD*

*15,750 + 3,150 + 50,400 = 69,300 Gallons Per Day*

### Peak Daily Flow:

$$69,300 \text{ GPD} / 350 \text{ gallons per residence per day} = 198 \text{ equivalent residential connections}$$

$$198 \text{ residences} \times 3 \text{ persons per residence} = 594 \text{ people}$$

$$\text{Peak Hourly Flow Factor} = \frac{18 + \sqrt{(594/1000)}}{4 + \sqrt{(594/1000)}} = 3.9$$

$$3.9 \times 69,300 \text{ GPD} / 24 \text{ hrs} / 60 \text{ min} = \underline{188 \text{ GPM Req'd} \rightarrow \text{Use 200 GPM}}$$

### Pump Station Hydraulic Calculations:

$$H_{LF} = \frac{10.44 (2285)(200)^{1.85}}{(120)^{1.85} (4)^{4.8655}} = 72.2' \quad H_{LF} = \frac{10.44 (2285)(200)^{1.85}}{(120)^{1.85} (6)^{4.8655}} = 10.0'$$

$$\text{Static Head} = 78'$$

$$\text{Total Dynamic Head (4" Force Main)} = 150'$$

$$\text{Total Dynamic Head (6" Force Main)} = 88'$$

$$\text{Required Pump Horsepower (4" Force Main)} = 23 \text{ HP}$$

$$\text{Required Pump Horsepower (6" Force Main)} = 11 \text{ HP}$$

### **Flow Case 2 – Capacity for Western Service Areas**

In order to estimate the possible tributary flow from undeveloped areas, the housing density of surrounding developed areas was applied to the undeveloped areas.

### Residential Density Calculations:

$$\text{Deerfield: } 144 \text{ houses} / 90 \text{ Acres} = 1.6 \text{ houses per acre}$$

$$\text{Undeveloped area} = 1,250 \text{ Acres}$$

$$\text{Assume 40\% developable} = 1,250 \times .40 = 500 \text{ developable acres}$$

$$\text{Probable future residences} = 500 \text{ Acres} \times 1.6 \text{ houses per acre} = 800 \text{ houses}$$

Total Daily Flow:

*350 gallons per residence per day x 800 residences = 280,000 GPD*

*Add existing Deerfield subdivision and adjacent areas: 69,300 GPD*

*280,000 + 69,300 = 349,300 Gallons Per Day*

Peak Daily Flow:

*349,300 / 350 = 998 equivalent residential connections*

*998 residences x 3 persons per residence = 2,994 people*

*Peak Hourly Flow Factor =  $\frac{18 + \sqrt{(2,994/1000)}}{4 + \sqrt{(2,994/1000)}} = 3.4$*

*3.4 x 349,300 GPD / 24 hrs / 60 min = 825 GPM Req'd*

An 825 GPM pump station would require at least an 8-inch force main. The downstream gravity sewer where the Deerfield force main discharges is only approximately 8-inch diameter. While a detailed downstream gravity sewer evaluation is beyond the scope of this report, it is reasonable to assume portions of the existing gravity sewer system would not have capacity to receive the total additional flow that would be generated from build-out conditions of the unserved western area. If development in this area is anticipated, preparation of a further detailed sanitary sewer master plan is recommended.

Without a master plan in place, a more reasonable allocation of additional capacity to allow future connections of the existing residences on Wrights Valley Road and new development in the near future would be to size a facility that would operate at the practical limit of a 6" force main. A practical maximum flow through a 6" force main is approximately 400 GPM, which yields 4.5 feet per second velocity. Pipes operating at greater than approximately 5.0 fps result in significantly increasing friction loss, which equates to larger, higher horsepower pumps, and corresponding operation and maintenance costs.

Total Additional Allowable Daily Flow:

*Assume 3.5 Peak Hour Flow Factor*

*400 GPM / 3.5 x 60 x 24 = 164,571 GPD*

*164,571 GPD – 69,300 GPD = 95,271 GPD*

*95,271 GPD / 350 gallons per residence per day = 272 Residences*

### Pump Station Hydraulic Calculations:

$$H_{LF} = \frac{10.44 (2285)(400)^{1.85}}{(120)^{1.85} (6)^{4.8655}} = 36'$$

*Static Head = 78'*

*Total Dynamic Head = 114'*

*Required Pump Horsepower = 23 HP*

### **C. Upgrade Options**

Three options to upgrade the Deerfield Pump Station are presented below. Each option includes construction of an access road, installation of a portable standby generator, and installation of a remote monitoring system similar to what was recently installed at the Sanitary Board's other large pump stations.

Due to the fiberglass construction of the existing wet well and valve vault, it is unlikely replacement of existing piping, valves, and guide rails to accommodate larger pumps will be possible without irreparable damage to the structure. Therefore, options for capacity upgrades are actual complete pump station replacements.

In recent years other sanitary board owned stations have suffered from accumulation of rags and similar solids. The existing Deerfield pumps are grinder type pumps which chop such solids into small, easily passed pieces. However, grinder pumps are typically not available in configurations larger than those currently installed. Larger pumps, typically referred to as "non-clog" pumps are better suited to pass larger solids; however excessive amounts of rags can still cause clogging of pumps, downstream force mains, and downstream gravity sewers. Therefore, options for capacity upgrades include upstream channel grinders.

The existing Deerfield pump station is fed by a 200 Amp, 120/240 volt, single phase electric service, similar to a residential service. Larger pumps, above approximately 10 horsepower, are typically not available in a single phase configuration. There is no three phase utility service available in the immediate vicinity of the existing pump station. Due to the cost associated with an extension of the electric utility's three phase distribution system, options for capacity upgrades include upgrading the existing electrical service to a 400 Amp, 120/240 volt, single phase service and utilizing Variable Frequency Drives (VFD's) to provide three phase service to the pumps.

Due to the location of the pump station, it was discussed that enclosing the generator, control panel, and as much ancillary equipment as possible within an aesthetically pleasing structure may be desirable. Enclosing the generator would also have the added benefit of deadening sound during weekly exercises. There would be little, if any, difference in such a structure between each option presented. The cost to construct a small, masonry, building housing the generator and control panels is included for consideration.

The property surrounding the Deerfield pump station is currently owned by Keesling Construction Company, the Developer. The owner has indicated he would be willing to convey the necessary additional property required to facilitate the upgrade to the Sanitary Board. It is recommended that immediately upon determination of the selected plan of action, the Sanitary Board procure the required property.

#### Option 1 – Rehabilitate Existing

This option would represent the minimum recommended upgrades to maintain the current level of service, and basically includes only replacement of pumps and control panel; installation of an access road; installation of an emergency generator; and installation of a remote monitoring system. This option would not allow any future customer connections beyond those already planned in the Deerfield subdivision.

#### Option 2 – Replacement & Upgrade

The second option would be to upgrade the pump station to allow additional capacity. Coincidentally, the same pumps can be used to convey the flow determined for *Flow Case 1* with the existing force main as *Flow Case 2* with a new 6" force main.

Generally speaking, lower horsepower, more efficient pumps are always desirable. However, practically, there is very little difference in initial capital or operational costs between an 11 HP and 23 HP pump. Although the larger pump yields more than twice the power output of the smaller pump, both are similar in size and weight, and generally considered "small" pumps. Similarly, the difference in required wet well sizes between the two flow scenarios (2 vertical feet), is nominal.

Therefore, it is recommended the second option consist of two phases: upgrade the station to the capacity identified in Flow Case 1 without replacing the existing force main, and install a larger, 6-inch force main as capacity is needed in the future.

#### **D. Opinion of Cost and Recommendations**

The opinion of probable construction cost for each option presented above, and parts thereof, are summarized below in *Table 2*. Itemized and detailed opinion of probable construction costs are contained as part of *Appendix B*.

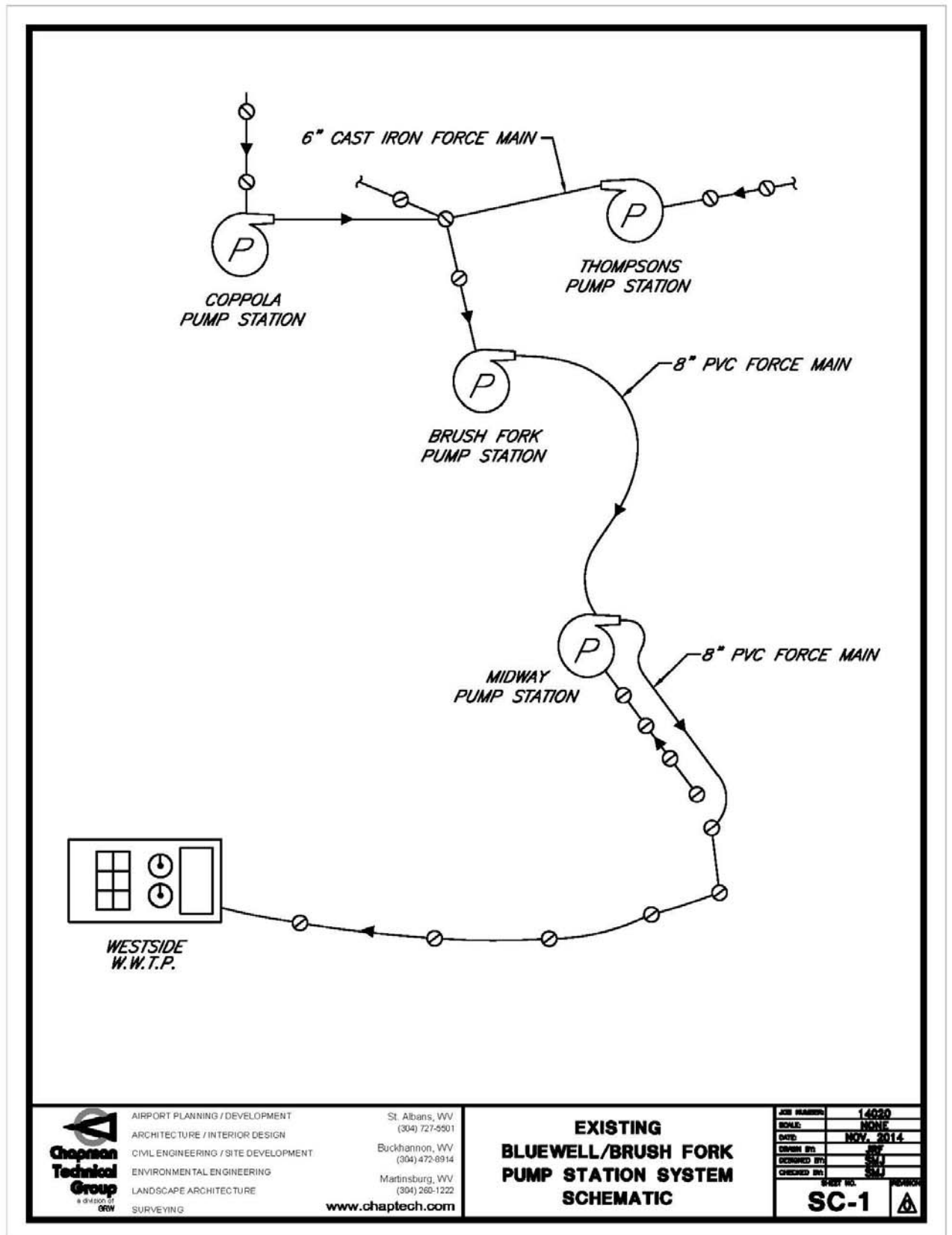
***Table 2 – Opinion of Probable Construction Costs***

<b>Item</b>	<b>Cost</b>
Option 1 – Rehabilitate Existing	\$207,562
Option 2 – PS Upgrade (Phase I)	\$403,340
Option 2 – Force Main Upgrade (Phase II)	\$140,647
Option 2 –Electrical Building	\$70,028

#### **IV. Bluewell/Brush Fork Pump Station System**

The overall system begins with the Thompson’s pump station which receives flow through a gravity collection system that serves the Bluewell area. The Thompson’s pump station conveys flow through a 6” force main to the Brush Fork pump station, which also receives flow from the Coppola mobile home park. The park is served by its own small grinder pump station and 2” force main. Brush Fork pumps wastewater to the Midway pump station, which also receives flow from its own tributary gravity collection system. Midway then transports the wastewater to the gravity collection system which flows through the City of Bluefield and ultimately to the Westside Wastewater Treatment Plant. The overall system schematic is shown below as *Schematic 1*.

**Schematic 1 – Bluewell / Brush Fork Pump Station System**



## **IV-1. Thompson's Pump Station**

### **A. Existing Conditions**

Thompson's pump station was originally constructed in 1970 as part of the Bluewell Public Service District's collection system; the pump station was conveyed to the Sanitary Board of Bluefield in 1998. The station is located at the intersection of Brush Fork Road (WV State Route 123) and Packing Plant Road. The station is situated behind a private garage and at the toe of the slopes for the adjacent roads. Access is via a gated entrance from Brush Fork Road, through a private driveway.

The pump station site is located several feet below the 100-year flood elevation. There is no on-site standby generator. West Virginia DEP determines where generators are required on a case-by-case basis; however typically for a facility this size a generator is required.

The station is a dry-pit type, where piping extends from the wet well to a steel below grade chamber where the pumps are located. Access to the dry pit is via 24" diameter manway and ladder. The limited access dry pit environment is classified as confined space and inherently hazardous to maintenance personnel.

The pump station discharges through 2,900 linear feet of 6" force main to a manhole immediately upstream of the Brush Fork pump station. The overall pump station location is shown in *Appendix C*, on sheet *BF-1*. Additional station specifics are listed in *Table 2*, below.

Thompson's pump station has been an extremely problematic station due to excessive rags which clog pumps, ultimately resulting in sanitary sewer overflows. Recently, Sanitary Board staff fabricated a wet well basket which captures most of the rags entering the station. Although the basket fills and requires emptying each 2-3 days, since its installation there have been no reported overflows. Although no overflows have been reported, during rain events the wet well level rises and the pumps run continuously.

Due to the frequently high and unchanging wet well levels a field draw down was not performed. The station throughput was calculated using manufacturer's curves. The calculated station throughput, during a high wet well condition, and assuming a new unworn pump, is approximately 350 GPM. The actual throughput is likely slightly lower given the downstream Brush Fork pump station capacity is approximately 380 GPM and does not suffer from overflows.

A review of run time data obtained from the recently installed remote monitoring system reveals that the station will run continuously for several consecutive days during wet weather events. However, during lower flows, the station operates between 4 – 9 hours per day. Therefore it is believed the station is adequately sized to convey the normal sanitary flow but is marginally sized to convey extraneous water from infiltration and inflow (I/I). A sample of run time data from October of 2014 is contained as part of *Appendix C* for reference.



***Photo 2 – Existing Thompson's  
Wastewater Pump Station Dry Pit Access***



***Photo 3 – Existing Thompson's  
Wastewater Pump Station Dry Pit Access***



**Table 2 – Existing Thompson’s Pump Station Summary**

<b>Component</b>	<b>Value</b>
Pumps	(2) 7.5 HP Smith & Loveless, 4B2, 7” Imp.
Current Pump Capacity	± 350 GPM
Wet Well	6’ Diameter, Concrete
Wet Well Top Elevation	2,351.05’
Wet Well SS In Elevation	2,339.74’
Wet Well Bottom Elevation	± 2,334.74’
Force Main High Point	± 2,361’
Force Main Discharge Elevation	± 2,340’
Force Main	± 2,900 LF of 6” Cast Iron
Electrical Service	230 Volt, 3-Phase, 200 Amp

Summary of Identified Deficiencies:

- Difficult access
- Aged and generally worn components
- Hazardous personal access
- Pumps subject to ragging and clogging
- Within 100-year flood zone
- No standby generator

**B. Future Requirements**

At this time no significant development in the Thompson’s Pump Station service area is anticipated. Moreover, since Thompson’s is upstream of miles of existing gravity collection system and two major pump stations, capacity upgrades could require significant and costly downstream infrastructure upgrades

Should development be anticipated, a sewer shed master plan should be prepared to determine the probable extent of development, corresponding flows, and best method of providing sanitary sewer for such.

As previously noted, the station suffers from a substantial amount of I/I. Similarly, increasing capacity to ensure conveyance of the substantial amount of extraneous I/I is not recommended, as such would also likely require significant and costly downstream infrastructure upgrades. Dollars would be better spent by the Sanitary Board to continue to locate and disconnect sources of I/I in the upstream collection system. Therefore, the evaluations presented below are based on a design pump rate of 350 GPM.

### Option 1 – Complete Replacement

This option would be for construction of a brand new pump station adjacent to the existing station. Due to age and original materials of construction, replacement of the existing force main is also recommended. In order to maintain functionality and minimize temporary piping, excessive road restoration costs, and provide for better maintenance conditions for Sanitary Board staff, the proposed replacement force main would not be installed in the same location as the existing. The probable location would be similar to the gravity sewer alignment presented in *Option 2*. Due to the site constraints and elevation in the flood plain, complete replacement will be difficult and leave the facility subject to substantial damage.

While the existing 230V, 200 Amp, 3-phase electrical service is adequate for the existing and proposed equipment, a new service entrance is recommended due the age and condition of the existing main disconnect breaker and enclosure. Additionally, Variable Frequency Drives are recommended due to the substantial amount of I/I. Variable frequency drives can be used to reduce the pumping rate if necessary to prevent downstream capacity problems should they occur due slight increases in pump station discharge due to new, more efficient pumping equipment. Variable Frequency Drives can also substantially reduce the size of standby generators as they eliminate the initial starting load on the electrical system.

### Option 2 – Eliminate Pump Station

A somewhat odd feature of the Thompson's pump station is that it pumps down-hill. Further investigation determined that the station can be eliminated by installation of traditional gravity sewer. The station and force main was likely originally constructed in lieu of gravity sewer due to a lower initial installation cost.

Option 2 would completely eliminate the Thompson's pump station. Installation of gravity sewer between Thompson's and the existing Brush Fork pump station would also allow additional customers to be served.

## **D. Opinion of Cost and Recommendations**

The opinion of probable construction costs for each option presented above, as well as the anticipated operation and maintenance costs are summarized below in *Table 3*. Itemized and detailed opinion of probable construction and life cycle costs are contained as part of *Appendix C*.

**Table 3 – Opinion of Probable Construction and Life Cycle Costs**

<b>Item</b>	<b>Cost</b>
Option 1 – Complete Replacement	\$355,566
Option 1 – Replace Force Main	\$196,164
<b>Option 1 – Total Initial Construction:</b>	<b>\$551,730</b>
Option 1 – 20 Year O&M Costs	\$233,304
<b>Option 1 – Total 20 Year Cost</b>	<b>\$775,034</b>
<b>Option 2 – Eliminate Pump Station</b>	<b>\$759,034</b>

While the initial capital cost of eliminating Thompson's pump station is greater than replacement and upgrade, strong consideration should be given to complete elimination. Once normal, long term, Operation and Maintenance expenses are considered, the difference in anticipated overall life cycle costs are nearly identical.

Additionally, elimination of a wastewater pump station eliminates the possibility of spills due to mechanical or electrical equipment failures. Installation of gravity sewer would allow immediate connections of 8 new customers, and additional line extensions to serve approximately 17 additional customers. Costs for line extensions are discussed in greater detail in *Section V* of this report.

## **IV-2. Midway Pump Station**

### **A. Existing Conditions**

The Sanitary Board's Midway pump station was originally constructed in 1999 as part of the Brush Fork Sewer System Improvements project. The project also consisted of construction of the upstream Brush Fork pump station which served to eliminate an existing wastewater treatment lagoon, originally constructed and operated Bluewell Public Service District, but conveyed to the Sanitary Board of Bluefield. In 2014, the pump station control panel was upgraded and a remote monitoring system was installed.

The station is located on an easement adjacent to Ball Dairy Road. Midway receives flow from surrounding gravity sewer as well as the Brush Fork force main, which discharges directly to the station. The station location is shown on *Sheet M-1* of *Appendix D*.

The station is a triplex (three pump), submersible type station constructed of pre-cast concrete components and discharges through approximately 5,750 linear feet of 8" PVC force main. The Midway facility incorporates two inflow surge / equalization tanks; an on-site chemical feed tank and pump for odor control; and emergency standby generator.

The pump station and force main were originally constructed by Sanitary Board staff. According to current staff, the actual force main contains portions of 6" PVC pipe. The force main was also installed at less than minimum required depth (36-inches req'd). Additionally, no air release valves were installed during the original construction. At some point after the original construction, the force main was extended with 6" PVC to a manhole further downstream in order to resolve odor complaints from residents in the area of the original force main discharge location.

The station has suffered from overflows since its original construction. In 2010, Sanitary Board staff re-laid a portion of the force main and installed an air release valve in an attempt to increase station capacity and minimize overflows. After installation of the air release valve, Chapman Technical Group verified the pump and force main system was operating near its original design capacity.



Actual calculations and field testing revealed the pumps showed some normal wear, but there were no apparent restrictions in the force main. Sanitary Board staff indicates that after installation of the air release valve the frequency of overflows was reduced; however, overflows still regularly occur.

The overall pump station location is shown in *Appendix A*, on *Sheet A-1*, and *Appendix D*, on *Sheet M-1*. Additional station specifics are listed in *Table 4*, below.

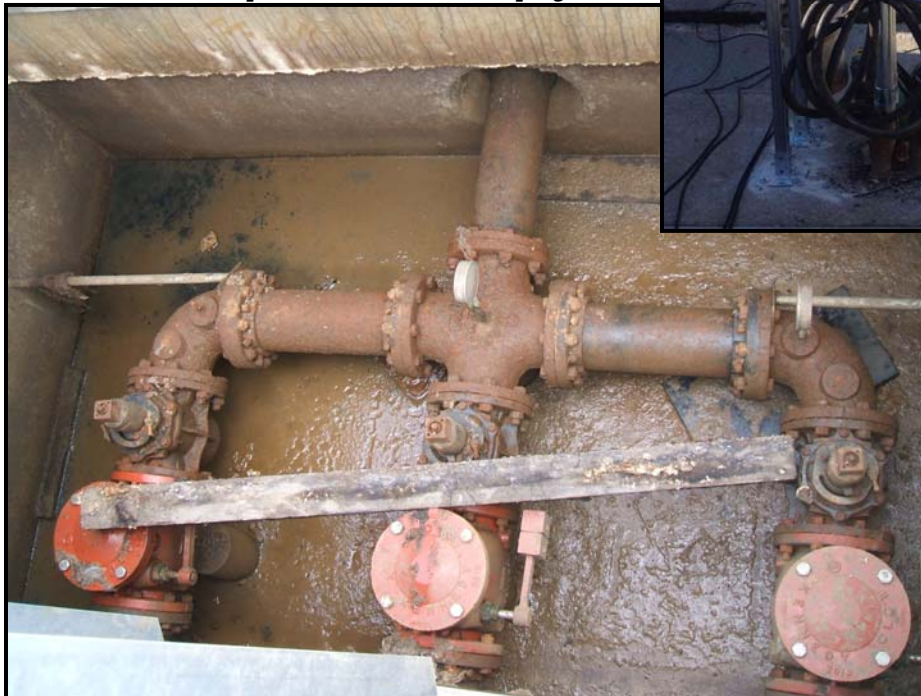
**Photo 4 – Existing Midway  
Wastewater Pump Station Generator & Control Panel**



**Photo 5 – Existing Midway  
Wastewater Pump Station  
Chemical Tank & Surge Tank Tops**



**Photo 6 – Existing Midway  
Wastewater Pump Station Valve Vault Piping**



**Table 4 – Existing Midway Pump Station Summary**

<b>Component</b>	<b>Value</b>
Pumps	(3) 25 HP Flygt C-3152.452
Current Pumping Capacity	510 GPM
Wet Well	18' x 8', Pre-Cast Concrete
Wet Well Top Elevation	2,446.20'
Wet Well SS In Elevation	2,441.89'
Wet Well Bottom Elevation	± 2,431.80'
Force Main High Point	± 2,522'
Force Main	± 5,750 LF of 6" & 8" PVC
Electrical Service	480 Volt, 3-Phase, 200 Amp
Standby Generator	Olympian 125 KVA

Flow meters were installed in the upstream gravity sewer system by the Sanitary Board staff. Results were provided in excel format. A summary of such data is contained in *Table 5*, below.

**Table 5 – Midway Pump Station Gravity Inflow Summary, GPM**

<b>Function</b>	<b>May – July, 2014</b>	<b>Aug – Sept, 2014</b>
Average	80	122
Min.	31	26
Max.	733	979
Standard Deviation	60	100
High Range <sup>1</sup>	139	223
Low Range <sup>1</sup>	21	23

*1 – Ranges calculated with one Standard Deviation from Average*

The flow meter data above represents only inflow from Midway's upstream gravity sewer. It does not include flow pumped directly to the station wet well by the Brush Fork pump station. The Brush Fork station adds an additional 380 GPM when pumping. Brush Fork run times indicate the station does not run continuously during large rain events.

During the longest high flow period in the data set, the Brush Fork pump station operated 18.5 hours per day.

$$380 \text{ GPM} \times 18.5 \text{ hours per day} / 24 \text{ hours per day} = 293 \text{ GPM Average Inflow}$$

It is reasonable to assume the Brush Fork pump station was designed with no less than a minimum peak flow factor of 2.5.

$$380 \text{ GPM} / 2.5 = 152 \text{ GPM Average Design Flow}$$

**Table 6– Midway Pump Station Total Inflow Summary, GPM**

<b>Function</b>	<b>Gravity Inflow</b>	<b>Brush Fork Inflow</b>	<b>Total Inflow</b>
Average	122	152	274
Min.	31	152	183
Max.	979	293	1,272
Std. Dev.	100	N/A	N/A
High Range <sup>1</sup>	223	293	516
Low Range <sup>1</sup>	21	152	173

*1 – Ranges calculated with one Standard Deviation from Average*

At average and high range flows the Midway Pump Station has adequate pumping capacity to reliably convey flows without overflow, even when Brush Fork is operating. However, the station is overwhelmed during max flow, undoubtedly due to extraneous water from infiltration and inflow (I/I). Moreover, removing inflow from the Brush Fork pump station will not remedy the overall lack of station capacity.

A major renovation of the Midway pump station would be required in order to reliably convey the total flow entering the station. The upgrade would include complete replacement of all pumps, piping, valves, generator, control panel, force main, and incoming electrical service upgrade.

Moreover, since Midway is upstream of miles of existing gravity collection system increasing capacity to ensure conveyance of the substantial amount of extraneous I/I is not recommended, as such could require significant and costly downstream infrastructure upgrades. Dollars would be better spent by the Sanitary Board to continue to locate and disconnect sources of I/I in the upstream collection system. Therefore, the evaluations presented below are NOT based on a capacity upgrade.

## **B. Future Requirements**

At this time no significant development in the Midway Pump Station service area is anticipated. Moreover, since Midway is upstream of miles of existing gravity collection system, capacity upgrades could require significant and costly downstream infrastructure upgrades.

Should development be anticipated, a sewer shed master plan should be prepared to determine the probable extent of development, corresponding flows, and best method of providing sanitary sewer for such.

However, there are approximately 30 unserved residences located nearby to the pump station, along Old Bramwell Road, that could easily be served by a gravity sewer extension from the existing collection system, and is shown on *Sheet M-1* in *Appendix D*.

*350 gallons per residence per day x 30 residences = 10,500 GPD*

*30 residences x 3 persons per residence = 90 people*

*Peak Hourly Flow Factor =  $\frac{18+\sqrt{(90/1000)}}{4+\sqrt{(90/1000)}} = 4.3$*

*4.3 x 10,500 GPD / 24 hrs / 60 min = 31.4 GPM Req'd*

Currently the Midway pump station does not have capacity to add additional customers; subsequently, it is recommended the additional line extension should *NOT* be completed until enough upstream I/I has been removed from the system to eliminate regular overflows.

### **C. Upgrade Options**

As previously mentioned, a capacity upgrade is not recommended for the Midway pump station. Although the force main has been installed with less than required minimum cover and contains portions of 6" pipe rather than 8" as designed, it has not been particularly problematic. The pump station also has recently had two pumps and the control panel rebuilt.

Remaining items that could require attention are minor and well within the capabilities of Sanitary Board staff. Recommended items include:

- Clean and repaint valve vault piping.
- Install dog house manhole on force main and relocate flow meter.
- Install pressure gauge taps on each pump discharge pipe, upstream of check valves.

The Midway pump station is located on a Sanitary Board obtained easement. The conditions of the easement state the facility was to be constructed with a brick masonry building with a shingled roof, and maintain such in a manner fit for a residential neighborhood. The underlying property owner has frequently complained to the Sanitary Board that the building was never constructed. As such, an opinion of probable cost to enclose the generator, electrical equipment, chemical feed tank, and other above grade ancillary components within a brick masonry structure is provided below. Such building will offer little operation or maintenance advantages. It is also assumed the wet well, valve vault, and other precast structures will remain as-is. In order to safely construct a building where these features are enclosed will require replacement of the structures, or essentially a complete pump station replacement. The proposed electrical building would be similar to the one shown on *Sheet EB1*, in *Appendix B*.

### **D. Opinion of Cost and Recommendations**

The opinion of probable construction cost presented below is for construction of an electrical building and removal of the existing fence at the station. Other recommended items that were identified are minor in capital cost and would likely be completed by in-house sanitary board staff. Costs for aforementioned line extensions are discussed in greater detail in *Section V* of this report.

**Table 7 – Opinion of Probable Construction Cost**

<b>Item</b>	<b>Cost</b>
Construct Building & Remove Fence	\$141,114

Itemized and detailed opinion of probable construction costs are contained as part of *Appendix D*.



### **IV-3. Brush Fork Pump Station**

#### **A. Existing Conditions**

The Sanitary Board's Brush Fork pump station and force main was originally constructed by Sanitary Board staff in 1999 as part of the Brush Fork Sewer System Improvements project. The project eliminated an existing wastewater treatment lagoon, originally constructed and operated Bluewell Public Service District, but conveyed to the Sanitary Board of Bluefield. The station is located on an easement adjacent to Brush Fork Road. Brush Fork receives flow from the Thompsons and Coppola Pump Stations. The station's location is shown on *Sheet BF-1*, in *Appendix C*.

The station is a series-duplex (four pump) station where two submersible pumps discharge to two dry pit pumps. Each pair of series pumps operates independently of the other pair in a typical alternation/lead-lag scenario. All four pumps are identical 60 Horsepower Flygts, and are the largest in the Sanitary Board's system. The station pumps through approximately 6,732 linear feet of 8" PVC force main which ultimately discharges directly to the Midway pump station.

The station is constructed of pre-cast concrete components and incorporates an on-site chemical feed tank and pump for odor control, and emergency standby generator. In 2014, the pump station control panel was upgraded and a remote monitoring system was installed.

Brush Fork does not normally suffer from overflows, even with the excessive amount of upstream I/I noted in the collection system upstream of Thompson's pump station. A review of pump run time data gathered from the recently installed remote monitoring system indicates that even during high flows the station cycles normally. Subsequently, it is believed the station has ample capacity.

Although recent pump failures have occurred, such were attributed to poor workmanship on the part of the repair facility which previously rebuilt the pumps; no failures have resulted in overflows. Recent rebuilds have been performed by manufacturer authorized service facilities; it is therefore believed pumps are currently in good condition.

The force main however has suffered from repeated failures. According to sanitary board staff, in many places the force main is laid on top of rock, shallow, or even exposed. Original design drawings indicate the force main was constructed with differing pipe pressure classes where heavier walled pipe was used leaving the pump station and in low areas where operating pressures were greater. This practice is generally not recommended as accidental placement of inadequate pressure class pipe is not uncommon and could be a contributing factor in force main failures.

Brush Fork also suffers from a substantial amount of rags which are passed through the Thompson's pump station. Although Brush Fork normally passes rags without clogging, such rags and solids can cause problems with level controls which could ultimately lead to premature pump failures.

Both options presented for the Thompson's pump station include installation of grinders which should substantially reduce the amount of rags and other debris entering the Brush Fork pump station.

**Photo 7 – Brush Fork Wastewater Pump Station  
Hung Float**



**Photo 8 – Brush Fork Wastewater  
Pump Station - 60 HP Pump**



**Photo 9 – Brush Fork Wastewater Pump Station  
Rag Bound Float**



The pump station was originally constructed with an inadequately sized electrical service. The incoming electrical service, nor emergency generator, is capable of operating all four pumps concurrently. To prevent the second pair of pumps from starting upon a high water level and completely shutting down the station, the “lag pump run” feature has been disabled. While the station has not suffered overflows from such, a lead pump pair failure could result in an overflow condition if Sanitary Board staff were not in a position to immediately respond to alarm conditions. Additionally, redundancy is a requirement of the WV DEP NPDES permit.

The existing electric service entrance also contains no over-current protection. Previously when, without knowledge of the inadequately sized electric service, operators tried to operate more than two pumps, the main utility-line fuses blew.

Station specifics are presented in *Table 8* below.

**Table 8 – Existing Brush Fork Pump Station Summary**

<b>Component</b>	<b>Value</b>
Pumps	(4) 60 HP Flygt CP(T)-3300.465
Current Pump Capacity	380 GPM
Wet Well	12’ Dia., Pre-Cast Concrete
Wet Well Top Elevation*	2,345.5’
Wet Well SS In Elevation*	2,340.0’
Wet Well Bottom Elevation*	2,330.67’
Force Main High Point*	± 2,662’
Force Main Discharge Elevation*	± 2,438’
Force Main	6,732 LF of 8” PVC
Electrical Service	480 Volt, 3-Phase, 200 Amp
Standby Generator	Olympian 225 KVA

\* – Elevations obtained from Record Drawings

## **B. Future Requirements**

As previously noted, as with surrounding station service areas, at this time no significant development in the Brush Fork pump station service area is anticipated. Moreover, since Brush Fork is upstream of miles of existing gravity collection system and the Midway pump station, capacity upgrades could require significant and costly downstream infrastructure upgrades.

Should development be anticipated, a sewer shed master plan should be prepared to determine the probable extent of development, corresponding flows, and best method of providing sanitary sewer for such.

## **C. Upgrade Options**

As previously noted, the Brush Fork pump station currently has adequate capacity to convey current flows, including excessive upstream I/I. While excessive rag buildup is a problem, the installation of a grinder which has been presented for upgrade and elimination options at the Thompson’s pump station should substantially alleviate the ragging problems at the Brush Fork station.

Although the existing generator is not adequately sized to operate all four wastewater pumps, it is currently in good condition and replacement is not recommended. In lieu of a new and larger generator, it is recommended the pump control panel should be interlocked with the generator to limit station operation to only one pair of pumps while operating on generator power.

Since the Brush Fork station has not historically suffered overflows with only one pair of pumps operable, utilization of the second and redundant pair would be required only during unusual high flow conditions; operating all four pumps during a utility power outage would represent an extremely rare occurrence. It is believed the cost to install a new and larger generator to protect against such extremely rare occurrences would outweigh the potential benefit which may never be utilized.

#### **D. Opinion of Cost and Recommendations**

The opinion of probable construction costs for each option presented above are summarized below in *Table 3*. Itemized and detailed opinion of probable construction costs are contained as part of *Appendix E*.

**Table 9 – Opinion of Probable Construction Costs**

<b>Item</b>	<b>Cost</b>
Replace Force Main	\$303,002
Upgrade Electrical Service (AEP)	\$9,500
Pump Station Electrical Components	\$30,733
<b>Total</b>	<b>\$343,235</b>

At this point, it is recommended replacement of the entire length of force main should be planned and budgeted. The last approximately 3,300 linear feet of force main generally flows downhill, and by gravity. Therefore, this portion of the pipeline is not subject to significant operating pressures and regular surges and may be able to be reliably re-used. Such determination should be made during detailed design and construction document preparation however.



## IV-4. Copolla Pump Station

### A. Existing Conditions

The Copolla pump station is located within eyesight of the Brush Fork pump station, to the west, in the Copolla Mobile Home Park. The Copolla station is a small grinder which serves the immediate surrounding mobile homes and a single, single family residence. The station's location is shown on *Sheet BF-1* in *Appendix C*.

The Copolla pump station was originally constructed as a private pump station to serve the mobile home park, but was conveyed to the Sanitary Board in 2011. As such little specific information, beyond field observations, is available. The pump station is constructed of a 6'-10" deep steel wet well with an integral valve vault. The pumps are single phase grinder type pumps believed to be manufactured by Goulds. At the time of field visit there was not adequate liquid in the wet well or inflow to perform a drawdown test. However, due to the limited area of the collection system, reasonable tributary flow volumes can accurately be calculated.

There was no evidence in the station or surrounding areas of high wet well levels or sewer overflows. The Sanitary Board staff has reported the station has generally not been problematic.

As expected, corrosion was noted on the steel components, but no deep pitting or complete loss of material was evident. A complete examination of the bottom or exterior of the wet well was not possible however.

The existing control panel was generally in acceptable condition from a functionality standpoint; however it does not contain intrinsic safe barriers for control circuits which enter the wet well, as required by the National Electric Code (NEC).

**Photo 10 – Copolla Wastewater Pump Station Control Panel**

**Photo 11 – Copolla Wastewater Pump Station**



**Photo 12 – Copolla Wastewater Pump Station Wet Well**



## **B. Future Requirements**

Due to the location of the pump station, the possibility of its utilization to receive additional wastewater flows are limited. There are currently approximately 12 additional un-sewered customers which could be served by the pump station.

### Current Estimated Flow:

*Assume 2 persons per residence for mobile homes, or 2/3 of normal residential values:*

$$350 \times 2/3 = 233 \text{ Gallons per residence per day}$$

$$233 \text{ gallons per residence per day} \times 69 \text{ residences} = 16,077 \text{ GPD}$$

$$69 \text{ residences} \times 2 \text{ persons per residence} = 138 \text{ people}$$

$$\text{Peak Hourly Flow Factor} = \frac{18 + \sqrt{(138/1000)}}{4 + \sqrt{(138/1000)}} = 4.2$$

$$4.2 \times 16,077 \text{ GPD} / 24 \text{ hrs} / 60 \text{ min} = \underline{47 \text{ GPM}}$$

### Additional Estimated Flow:

$$350 \text{ gallons per residence per day} \times 12 \text{ residences} = 4,200 \text{ GPD}$$

$$4.2 \times 4,200 \text{ GPD} / 24 \text{ hrs} / 60 \text{ min} = \underline{12 \text{ GPM Req'd}}$$

### Total Estimated Flow:

$$47 \text{ GPM} + 12 \text{ GPM} = \underline{59 \text{ GPM Req'd}}$$

## **C. Upgrade Options**

Although the station is not currently suffering from capacity or reliability issues, due to its age and steel construction, ultimate replacement should be considered and budgeted for in the foreseeable future. Fortunately, due to the station's small size, such is within the capabilities of the Sanitary Board staff. Although the exact capacity of the station is unknown at this time, similarly due to its small size, there would be negligible cost difference between replacement components sized to convey current tributary flows as possible future flows.

The primary consideration with respect to upgrade of the Copolla pump station is, due to its location relative to Brush Fork, would be to eliminate the pump station completely. Since the Copolla pump station is constructed at a lower elevation than the Brush Fork pump station, it is not possible to construct gravity sewer to convey flow to the existing Brush Fork pump station; however, it is possible to construct a single station to eliminate both existing stations.

Constructing a new station utilizing all new components would similarly be cost prohibitive; however, as previously noted, the existing Brush Fork pump station contains recently rebuilt pumps, a rebuilt control panel, and a generator in good condition. Such components could be moved and installed in a new wet well and valve vault.

#### **D. Opinion of Cost and Recommendations**

Opinions of probable construction cost for complete replacement of the Copolla pump station as well as the necessary work to relocate Brush Fork and eliminate the Copolla pump station are contained below in *Table 10*. Detailed opinion of probable construction costs are contained in *Appendix F*.

Due to the small size of the Copolla pump station, it is anticipated replacement would be completed utilizing in-house staff; costs shown are shown for parts and equipment only.

**Table 10 – Opinion of Probable Construction Costs**

<b>Item</b>	<b>Cost</b>
Option 1 – Replace Copolla Pump Station	\$35,000
Option 1 – 20 Year O&M Costs	\$74,700
<b>Option 1 – Total 20 Year Cost</b>	<b>\$109,700</b>
Option 2 – Relocate Brush Fork Pump Station	\$489,927

Relocation of the Brush Fork facility has the added benefit of utilizing all new piping and concrete which, although currently in good condition at Brush Fork, do have a finite life and will at some point beyond a reasonable planning period require replacement or rehabilitation.

However, even when the long term cost of ownership associated with the Copolla pump station is considered, it is still more economical to replace it in at its current location. Although there also many intrinsic benefits in elimination of any pump station, it is not believed the cost to do so is worth the benefit.

## V. Line Extensions and Additional Customers

As previously referenced, there are two opportunities to relatively easily add several additional customers while contractors are mobilized in the area and the Sanitary Board is seeking capital for system improvements. Opinions of probable construction cost and a description of each are presented below.

### A. Thompson's Gravity Extensions

The first opportunity to add additional customers would be a separate line extension along Nichols Road from the proposed gravity sewer main which eliminates the Thompson's pump station. Such extensions are shown on *Sheet TG-2*, contained in *Appendix C*, and are identified as *Thompson Gravity Extension Line B* and *Thompson Gravity Extension Line C*. These costs are for only customers who would be added due to additional line extensions; customers added to as a result of the main line installation required to eliminate the pump station are not considered in the analysis presented below. A detailed opinion of probable construction cost and basic financial analysis is provided in *Appendix G*.

**Table 11 – Opinion of Probable Construction Costs & Analysis**

Item	Cost
Thompson's Gravity Extensions	\$448,823
Annualized Debt Service (4% Interest)	\$25,713
Anticipated Revenue (Average Bill, Current Tariff)	\$7,980
<b>Net</b>	<b>\$-17,733</b>

### B. Midway Gravity Extension

The second opportunity to add additional customers is a new line extension from the existing gravity collection system upstream of the Midway pump station, along Old Bramwell Road. The extensions are shown on *Sheets M-2 and M-3*, contained in *Appendix D*, and are identified as *Thompson Gravity Extension Line B* and *Thompson Gravity Extension Line C*. A detailed opinion of probable construction cost and basic financial analysis is provided in *Appendix G*.

**Table 12 – Opinion of Probable Construction Costs & Analysis**

Item	Cost
Midway Gravity Extensions	\$654,282
Annualized Debt Service (4% Interest)	\$37,484
Anticipated Revenue (Average Bill, Current Tariff)	\$11,760
<b>Net</b>	<b>\$-25,724</b>



## C. Results

As indicated above, based solely on projected additional revenue, it is not financially feasible to extend service to the areas in question by conventional gravity sewer. If connecting the additional customers is desired, alternative technologies such as Septic Tank Effluent Pump / Gravity (STEP or STEG) or low pressure grinder pump systems may provide a more economically viable option. However, such systems do require regular maintenance thus a complete life cycle analysis should be taken into consideration.

## VI. Summary, Recommendations, and Implementation

### A. Summary

Various alternatives have been presented with their associated opinion of probable construction costs. *Table 13* below summarizes the various options and their associated anticipated capital costs. Items labeled as *Options* are just that – various ways to provide the necessary level of continued service. The *Optional* items are not required to provide continued, reliable sewer service; however such additional items may be determined as appropriate for the specific installations.

**Table 13 – Opinion of Probable Construction Costs**

Item	Cost
<b>Deerfield Wastewater Pump Station Options</b>	
Option 1 – Rehabilitate Existing	\$207,562
Option 2 – PS Upgrade (Phase I)	\$403,340
Option 2 – Force Main Upgrade (Phase II)	\$140,647
<i>Optional</i> Electrical Building (Inc. deducts for site-items not required)	\$70,028
<b>Thompson's Wastewater Pump Station Options</b>	
Option 1 – Complete Station & Force Main Replacement	\$551,730
Option 2 - Elimination / Gravity Sewer Installation	\$759,034
<b>Midway Wastewater Pump Station</b>	
<i>Optional</i> Electrical Building & Site Rehabilitation	\$141,114
<b>Brush Fork Wastewater Pump Station</b>	
Brush Fork Force Main & Electrical Upgrade	\$343,235
<b>Copolla Wastewater Pump Station</b>	
Option 1 – Replace Pump Station	\$35,000
Option 2 – Eliminate Pump Station (Replace Brush Fork)	\$489,927

While the ultimate decision as to which combination of options best suits the Sanitary Board's long term goals rests with the Board Members, a probable proposed project scenario is detailed below.

## **B. Probable Project Scenario**

The Deerfield wastewater pump station will be replaced with a new station which would allow extensions of service to nearby residences. It is anticipated the larger force main will be constructed at a later date if local growth necessitates. At this time it is anticipated the optional electrical building will not be constructed.

Thompson's pump station will be eliminated by the installation of new gravity sewer. While installation of new sewer does carry a higher initial capital cost, it is the less expensive alternative when basic operation and maintenance expenses are considered. Additionally the gravity sewer extension will reduce the chance of spills as a result of equipment failures and generate revenue from additional customers, which was not accounted for in life cycle analysis.

It is recommended in lieu of constructing a new building and performing site modifications to comply with the original conditions of the easement, an alternative agreement should be negotiated with the underlying property owner. Such would likely be substantially less costly.

The Brush Fork pump station will remain in its current location and configuration but will be connected to a new, properly constructed, downstream force main.

At this time no action is recommended at the Copolla pump station. Ultimately a complete replacement of the station will be required; however "package" type complete pump stations are available and well suited for this installation. Similarly, due to the small size and relatively simple installation requirements, such replacement can be performed by Sanitary Board staff as part of normal R & R operations. As such, the associated costs are not included in the probable project costs presented below.

**Table 14 – Opinion of Probable Construction Costs – Minimum Recommended**

<b>Item</b>	<b>Cost</b>
Deerfield Upgrade (Phase I)	\$403,340
Thompson's Elimination / Gravity Sewer Installation	\$759,034
Brush Fork Force Main & Electrical Upgrade	\$343,235
<b>Total Opinion of Probable Construction Cost</b>	<b>\$1,505,609</b>

## **C. Recommendations**

The opinion of probable construction cost presented above represents only the necessary improvements to the pump stations and associated force mains. As noted previously, additional repairs to the collection system are warranted to economically resolve capacity issues at Thompson's and Midway pump stations. The Sanitary Board has retained *The Thrasher Group* to provide SSES services to determine specific areas of the collection system which require rehabilitation or replacement to reduce the extraneous I/I which is directly responsible for capacity issues at these two facilities.

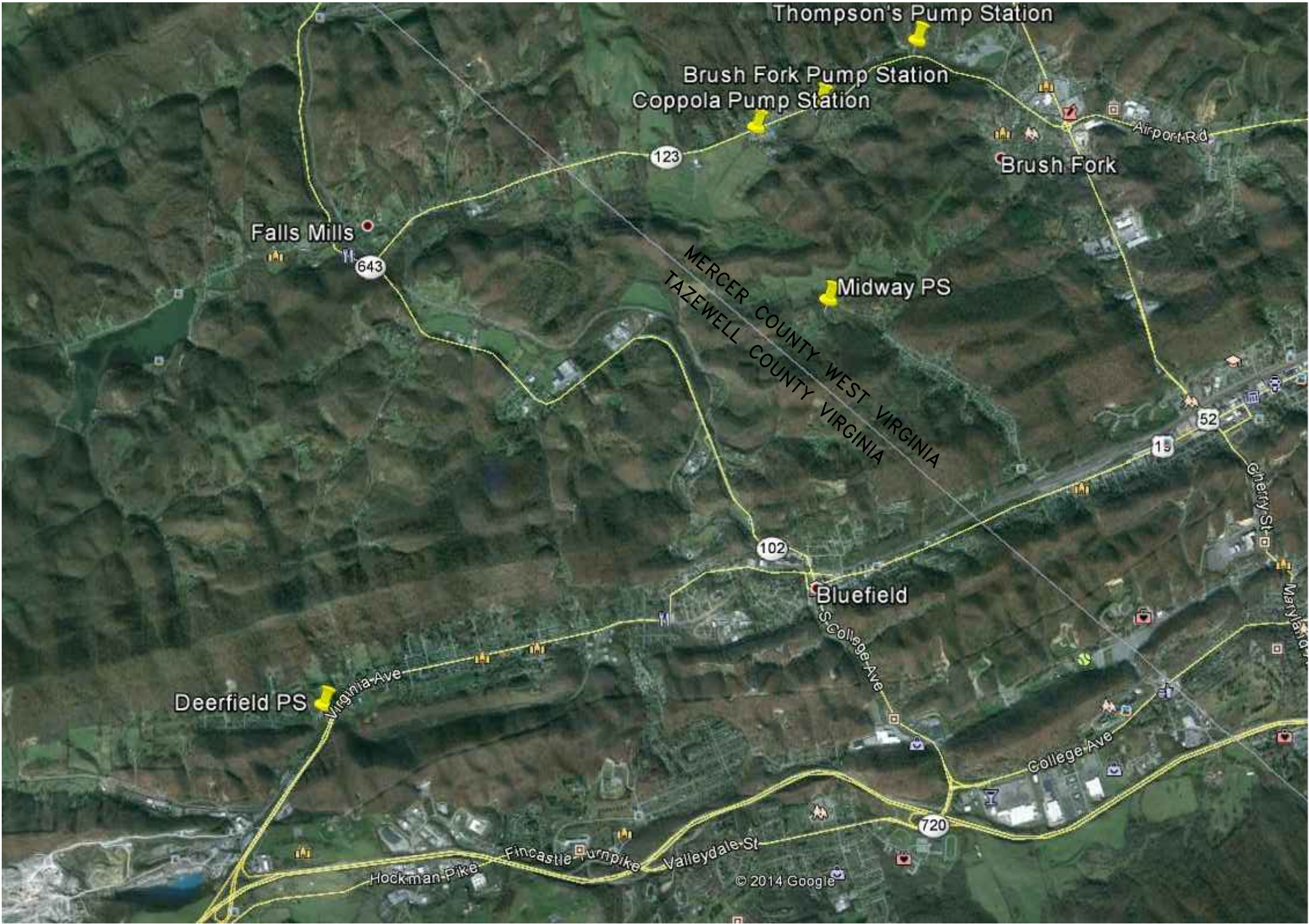
It is anticipated and recommended that if financing is sought from state agencies, such as West Virginia Department of Environmental Protection, a single application and bond issue for both collection system and pump station facilities should be made as many soft costs are fixed; and multiple applications and bond issues would result in unnecessary expenses.

Since at this time the SSES study is not yet completed, the total required project budget and time frame to obtain funding, design improvements, and complete construction is unknown. Given the aforementioned DEP Administrative Order, it is recommended that while the SSES is being completed, the Sanitary Board proceed with necessary property acquisition at Deerfield, and preparation of construction documents for the selected alternatives presented herein. Once recommendations from the SSES have been received, construction document preparation for collection system rehabilitation and overall project funding applications can be begin.

# **Appendix A**

## ***Overall Pump Station Location Map***





REVISION NUMBER	REVISIONS	DATE	BY



**Chapman  
Technical  
Group**  
a division of  
GRW

AIRPORT PLANNING / DEVELOPMENT  
ARCHITECTURE / INTERIOR DESIGN  
CIVIL ENGINEERING / SITE DEVELOPMENT  
ENVIRONMENTAL ENGINEERING  
LANDSCAPE ARCHITECTURE  
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PROJECT INFORMATION

**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

Overall Pump Station  
Location Map

SEAL

**- PRELIMINARY -  
NOT FOR  
CONSTRUCTION**

JOB NUMBER:	14020
SCALE:	NTS
DATE:	MARCH 2014
DRAWN BY:	FLB
DESIGNED BY:	SMJ
CHECKED BY:	RGB
SHEET NO.	REVISION
<b>A1</b>	

# **Appendix B**

## ***Deerfield Pump Station Exhibits***

***DF-1: Overall Service Areas***

***DF-2: Possible Future Service Areas***

***DF-3: Proposed Site Plan***

***DF-4: Force Main Profile***

***EB1: Electrical Building Details***

***11 HP Pump Data Sheet***

***23 HP Pump Data Sheet***

***Flow Case 1 – Wet Well Calculations***

***Flow Case 2 – Wet Well Calculations***

***Opinion of Probable Construction Costs***





REVISION NUMBER	REVISIONS	DATE	BY



AIRPORT PLANNING / DEVELOPMENT  
ARCHITECTURE / INTERIOR DESIGN  
CIVIL ENGINEERING / SITE DEVELOPMENT  
ENVIRONMENTAL ENGINEERING  
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PROJECT INFORMATION

**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

**Deerfield Pump Station  
Overall Service Areas**

SEAL

**- PRELIMINARY -  
NOT FOR  
CONSTRUCTION**

JOB NUMBER:	14020
SCALE:	NTS
DATE:	DECEMBER 2014
DRAWN BY:	FLB
DESIGNED BY:	SMJ
CHECKED BY:	RGB
SHEET NO.	DF-1
REVISION	





Opinion of Probable Construction Cost  
Deerfield Pump Station  
Option 1 - Rehabilitate Existing



Description	Quan.	Unit		
			Unit Price	Total Price
Submersible Grinder Pumps	2	EA	\$16,564.50	\$33,129.00
Pump Control Panel	1	EA	\$32,210.75	\$32,210.75
Remote Monitoring System	1	LS	\$6,201.00	\$6,201.00
Replace Threaded Valves & Check Valves	1	LS	\$2,207.00	\$2,207.00
Control Panel Backboard	1	LS	\$3,357.00	\$3,357.00
Flow Meter	1	EA	\$5,113.00	\$5,113.00
Flow Meter Manhole	1	EA	\$2,500.00	\$2,500.00
125 kW 1-Phase Generator w/ Tank & ATS	1	LS	\$61,910.00	\$61,910.00
Lighting - Site	1	LS	\$2,558.00	\$2,558.00
Electrical Misc. Materials & Installation	1	LS	\$14,330.00	\$14,330.00
Fencing	1	LS	\$8,000.00	\$8,000.00
Access Road Construction - Earthwork	300	CY	\$30.00	\$9,000.00
Access Road & Site Stone	80	CY	\$40.00	\$3,200.00
Bypass Connection Standpipe	1	LS	\$6,082.00	\$6,082.00
Bypass Pumping (2 pumps plus fuel)	14	Day	\$600.00	\$8,400.00
Yard Hydrant & Water Service	1	LS	\$3,852.50	\$3,852.50
Mobilization/Insurance/Gen. Conditions (3%)	1	LS	\$5,511.47	\$5,511.47
<b>Total Opinion of Probable Construction Cost</b>				<b>\$207,562</b>





Opinion of Probable Construction Cost  
Deerfield Pump Station  
Option 2 - Replace & Upgrade



Description	Quan.	Unit		
			Unit Price	Total Price
Submersible Pumps w/ Bases & Guide Rails - 23 HP	2	EA	\$26,512.00	\$53,024.00
Pump Control Panel	1	EA	\$33,562.00	\$33,562.00
Variable Frequency Drives	2	EA	\$7,351.00	\$14,702.00
Remote Monitoring System	1	LS	\$6,201.00	\$6,201.00
Chanel Grinder	1	EA	\$50,264.00	\$50,264.00
Grinder Control Panel	1	EA	\$10,102.00	\$10,102.00
Grinder Vault	1	EA	\$6,000.00	\$6,000.00
8' Diameter Wet Well	1	EA	\$16,764.00	\$16,764.00
Valve Vault	1	EA	\$2,500.00	\$2,500.00
FL DI Valves & Piping	1	LS	\$14,910.00	\$14,910.00
Ballast Concrete	10	CY	\$1,500.00	\$15,000.00
Flow Meter	1	EA	\$5,113.00	\$5,113.00
Flow Meter Manhole	1	EA	\$2,500.00	\$2,500.00
125 kW 1-Phase Generator w/ Tank & ATS	1	LS	\$61,910.00	\$61,910.00
Control Panel Backboard	1	LS	\$3,357.00	\$3,357.00
Lighting - Site	1	LS	\$2,558.00	\$2,558.00
Electrical Misc Materials & Installation	1	LS	\$14,330.00	\$14,330.00
Fencing	1	LS	\$8,000.00	\$8,000.00
Access Hatches	3	EA	\$4,674.00	\$14,022.00
Painting & Coatings	1	LS	\$9,830.00	\$9,830.00
Site Excavation & Material Waste	225	CY	\$25.00	\$5,625.00
Site Final Grading	1	LS	\$5,264.00	\$5,264.00
Access Road Construction - Earthwork	300	CY	\$30.00	\$9,000.00
Access Road & Site Stone	80	CY	\$40.00	\$3,200.00
Doghouse Manhole	1	EA	\$4,500.00	\$4,500.00
8" Gravity Sewer Piping	50	LF	\$75.00	\$3,750.00
Air Release Valve & Vault	1	LS	\$6,000.00	\$6,000.00
AEP Electric Service Upgrade	1	LS	\$4,000.00	\$4,000.00
Startup / Reliability Testing	1	LS	\$2,040.00	\$2,040.00
Yard Hydrant & Water Service	1	LS	\$3,852.50	\$3,852.50
Mobilization/Insurance/Gen. Conditions (3%)	1	LS	\$11,459.64	\$11,459.64
<b>Total Opinion of Probable Construction Cost</b>				<b>\$403,340</b>



**Opinion of Probable Construction Cost  
Deerfield Pump Station  
Force Main Replacement**



Description	Quan.	Unit		
			Unit Price	Total Price
6" C-900 PVC Force Main	2,285	L.F.	\$30.00	\$68,550.00
Asphalt Restoration	1,300	L.F.	\$40.00	\$52,000.00
12" Steel Casing Pipe - Bore & Jack Installation	50	L.F.	\$250.00	\$12,500.00
Connect to Existing MH	1	L.S.	\$3,500.00	\$3,500.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$4,096.50	\$4,096.50
<b>Total Opinion of Probable Construction Cost</b>				<b>\$140,647</b>



Opinion of Probable Construction Cost  
Deerfield Pump Station  
Electrical Building



Description	Quan.	Unit		
			Unit Price	Total Price
Brick Masonry Building, 20' x 14'	280	SF	\$200.00	\$56,000.00
Louvers/Dampers - Large (Generator)	2	EA	\$2,000.00	\$4,000.00
Louvers - Small	1	EA	\$1,000.00	\$1,000.00
Exhaust Fan	1	EA	\$1,500.00	\$1,500.00
Lighting - Interior & Exterior	1	LS	\$8,147.00	\$8,147.00
Electric Unit Heater	1	EA	\$1,678.50	\$1,678.50
Exterior Generator Fueling Connection	1	EA	\$4,507.00	\$4,507.00
Generator Piping & Duct Work	1	LS	\$10,071.00	\$10,071.00
Less Exterior Generator Enclosure	(1)	LS	\$5,000.00	(\$5,000.00)
Less Site Fence	(1)	LS	\$8,000.00	(\$8,000.00)
Less Control Panel Backboard	(1)	LS	\$3,357.00	(\$3,357.00)
Less Lighting - Site	(1)	LS	\$2,558.00	(\$2,558.00)
Mobilization/Insurance/Gen. Conditions (3%)	1	LS	\$2,039.66	\$2,039.66
<b>Total Opinion of Probable Construction Cost</b>				<b>\$70,028</b>





REVISION NUMBER	REVISIONS	DATE	BY



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(304) 472-8914  
Martinsburg, WV  
(304) 260-1222

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PROJECT INFORMATION

**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

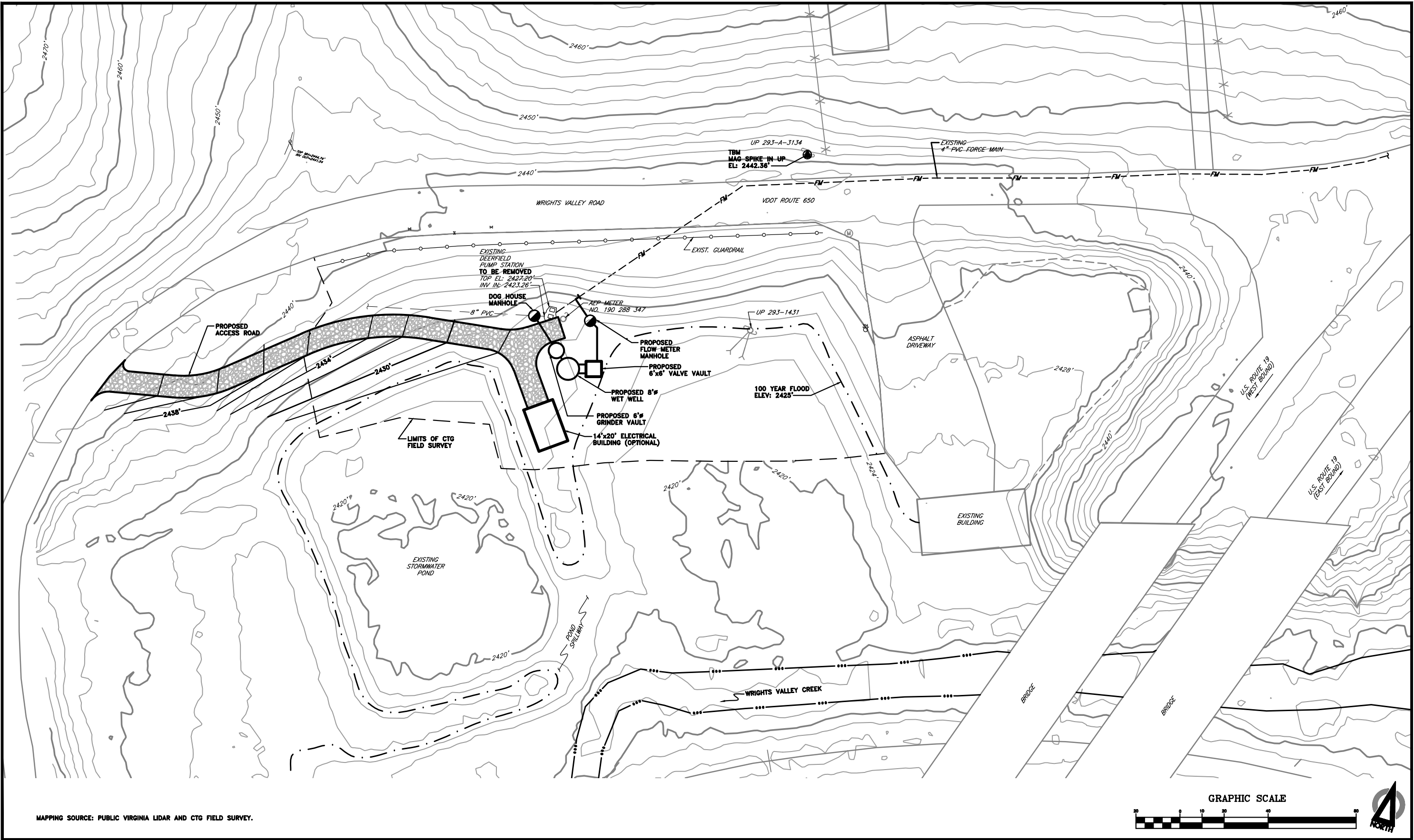
**Deerfield Pump Station  
Possible Future Service Area**

SEAL

**- PRELIMINARY -  
NOT FOR  
CONSTRUCTION**

JOB NUMBER:	14020
SCALE:	NTS
DATE:	NOVEMBER 2014
DRAWN BY:	FLB
DESIGNED BY:	SMJ
CHECKED BY:	ROB
SHEET NO.	DF-2
REVISION	





REVISION NUMBER	REVISIONS	DATE	BY



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PROJECT INFORMATION

**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

Deerfield Pump Station  
Proposed Site Plan

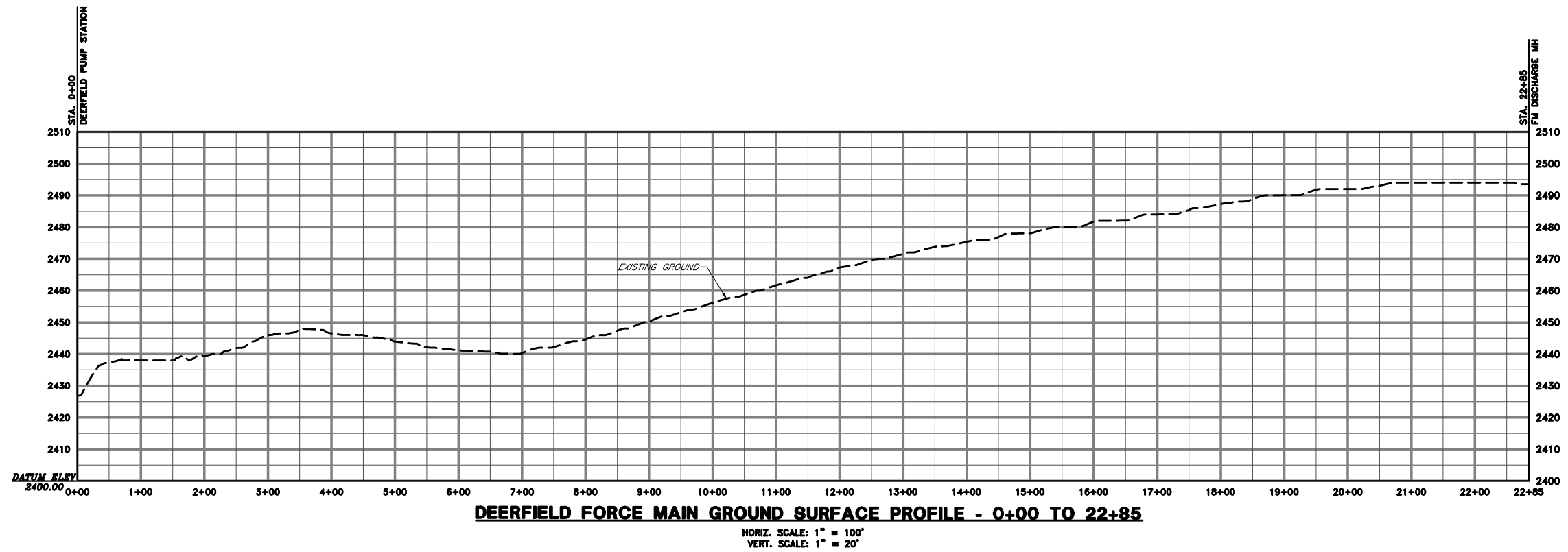
SEAL

**- PRELIMINARY -  
NOT FOR  
CONSTRUCTION**

JOB NUMBER: 14020  
SCALE: 1" = 20'  
DATE: MAY 2014  
DRAWN BY: FLB  
DESIGNED BY: SMJ  
CHECKED BY: RGB

SHEET NO. **DF-3**

REVISION  
△



MAPPING SOURCE: PUBLIC VIRGINIA LIDAR AND CTG FIELD SURVEY.

REVISION NUMBER	REVISIONS	DATE	BY



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PROJECT INFORMATION

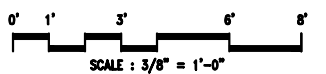
**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

Deerfield Pump Station  
Force Main Profile

SEAL

**- PRELIMINARY -  
NOT FOR  
CONSTRUCTION**

JOB NUMBER:	14020
SCALE:	AS SHOWN
DATE:	DECEMBER 2014
DRAWN BY:	FLB
DESIGNED BY:	SMJ
CHECKED BY:	RGB
SHEET NO.	DF-4
REVISION	



The logo for Chapman Technical Group features a stylized 'C' and 'T' in a grey circle. To the right of the logo, a list of services is provided: AIRPORT PLANNING / DEVELOPMENT, ARCHITECTURE / INTERIOR DESIGN, CIVIL ENGINEERING / SITE DEVELOPMENT, ENVIRONMENTAL ENGINEERING, LANDSCAPE ARCHITECTURE, and SURVEYING. Further to the right, two office locations are listed: St. Albans, WV (304) 472-5501 and Buckhannon, WV (304) 472-8914. At the bottom right, the Martinsburg, WV office is listed with phone number (304) 260-1222. The company's website, www.chaptechn.com, is displayed in a bold, black font at the bottom right of the advertisement.

# Electrical Building Details

SEAL

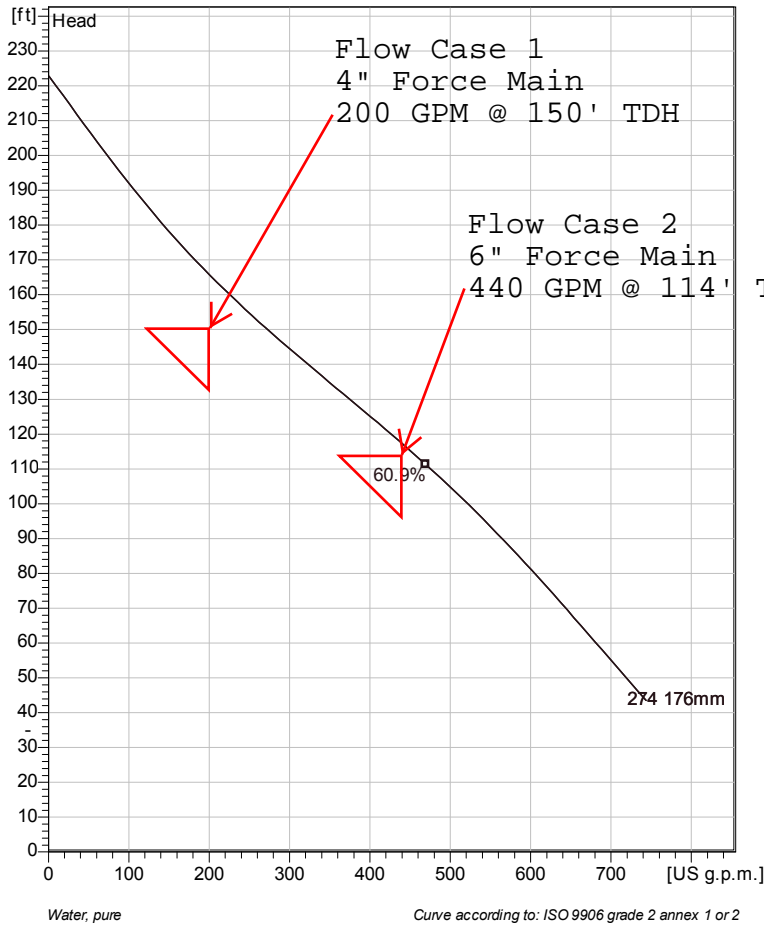
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<b>SCALE:</b>	<b>AS NOTED</b>	
<b>DATE:</b>	<b>DECEMBER 2014</b>	
<b>DRAWN BY:</b>	<b>JRF</b>	
<b>DESIGNED BY:</b>	<b>SMJ</b>	
<b>CHECKED BY:</b>	<b>JDE</b>	
<b>SHEET NO.</b> <div style="font-size: 48px; font-weight: bold; margin: 5px 0;">EB1</div>		<b>REVISION</b> <div style="border: 1px solid black; width: 40px; height: 40px; margin: 0 auto; display: flex; align-items: center; justify-content: center;"><div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto; display: flex; align-items: center; justify-content: center;">0</div></div>





## NP 3153 SH 3~ 274

### Technical specification



Note: Picture might not correspond to the current configuration.

#### General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

#### Impeller

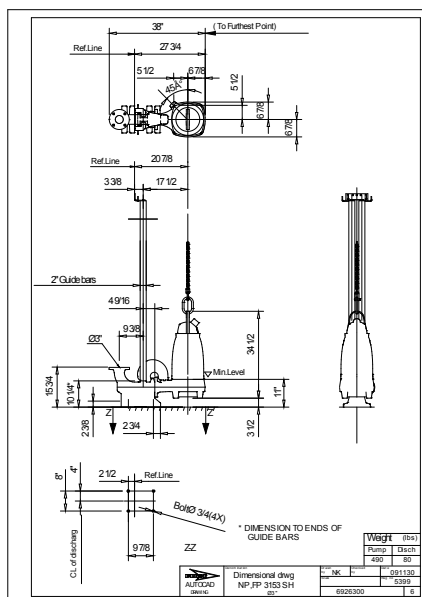
Impeller material	Grey cast iron
Discharge Flange Diameter	3 1/8 inch
Suction Flange Diameter	80 mm
Impeller diameter	176 mm
Number of blades	2

#### Motor

Motor #	N3153.181 21-18-2BB-W 23hp
Stator variant	8
Frequency	60 Hz
Rated voltage	200 V
Number of poles	2
Phases	3~
Rated power	23 hp
Rated current	59 A
Starting current	460 A
Rated speed	3505 1/min
Power factor	
1/1 Load	0.92
3/4 Load	0.89
1/2 Load	0.82
Efficiency	
1/1 Load	90.5 %
3/4 Load	91.5 %
1/2 Load	91.5 %

#### Configuration

Installation: P - Semi permanent, Wet



Project	Project ID	Created by	Created on 2014-11-22	Last update
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Bluefield Sanitary Board  
Deerfield Pump Station  
Wet Well Calculations - Flow Case 1

	Ave. Day Flow	
	(gpd)	
	69,300	
	-	
	-	
	-	
Total ADF	<u>69,300</u>	GPD
Initial Average Daily Flow =	69,300	GPD
	48.13	GPM
Peaking Factor =	3.9	
Peak Flow =	270,270	GPD
Peak Flow =	187.69	GPM

Design Peak Flow =	200	GPM
Force Main Diameter =	4.0	Inches
4" Velocity =	5.1	FPS

---

Bluefield Sanitary Board  
Deerfield Pump Station  
Wet Well Calculations - Flow Case 1

Determine Active Storage Volume in Pump Station

$$\begin{aligned} Q_{ddf} &= 48 \text{ gpm} \\ Q &= 200 \text{ gpm} \end{aligned}$$

Size Wetwell

Wetwell Diameter (feet)	Wetwell Area (gal / VF)	Wetwell Cycle (ft)	Wetwell Volume (gal)
8	376	2.0	752

Check Wetwell Cycles

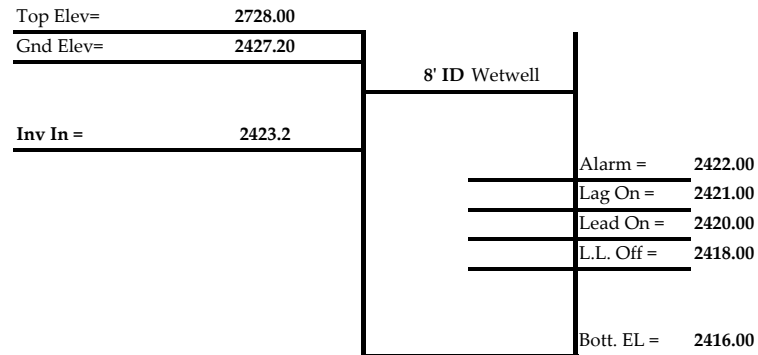
$$\text{Fill} = \frac{\text{Wetwell Volume}}{Q_{ddf}} = 15.6 \text{ minutes}$$

$$\text{Run} = \frac{\text{Wetwell Volume}}{Q - Q_{ddf}} = 4.9 \text{ minutes}$$

---


$$\text{Total} = 20.6 \text{ minutes}$$

$$\text{Cycle Time} = 2.9 \text{ Cycles / Hour}$$



Bluefield Sanitary Board  
Deerfield Pump Station  
Wet Well Calculations - Flow Case 2

Ave. Day Flow  
(gpd)

164,571

-

-

-

Total ADF 164,571 GPD

Initial Average Daily Flow = 164,571 GPD  
114.29 GPM

Peaking Factor = 3.5

Peak Flow = 575,999 GPD  
Peak Flow = 400.00 GPM

Design Peak Flow =	400	GPM
Force Main Diameter =	6.0	Inches
6" Velocity =	<u>4.5</u>	FPS

Bluefield Sanitary Board  
Deerfield Pump Station  
Wet Well Calculations - Flow Case 2

Determine Active Storage Volume in Pump Station

$$Q_{ddf} = 114 \text{ gpm}$$

$$Q = 400 \text{ gpm}$$

Size Wetwell

Wetwell Diameter (feet)	Wetwell Area (gal / VF)	Wetwell Cycle (ft)	Wetwell Volume (gal)
8	376	4.0	1503

Check Wetwell Cycles

$$\text{Fill} = \frac{\text{Wetwell Volume}}{Q_{ddf}} = 13.2 \text{ minutes}$$

$$\text{Run} = \frac{\text{Wetwell Volume}}{Q - Q_{ddf}} = 5.3 \text{ minutes}$$

---


$$\text{Total} = 18.4 \text{ minutes}$$

$$\text{Cycle Time} = 3.3 \text{ Cycles / Hour}$$

Top Elev=	2728.00	8' ID Wetwell	
Gnd Elev=	2427.20		
Inv In =	2423.2		
			Alarm = 2422.00
			Lag On = 2421.00
			Lead On = 2420.00
			L.L. Off = 2416.00
			Bott. EL = 2414.00

# **Appendix C**

## ***Thompson's Pump Station Exhibits***

***BF-1: Overall Service Areas***

***Existing Pump Curve***

***Calculated Pump & System Curve***

***Proposed 7.5 HP Pump Data Sheet***

***Station Run Times – October 2014***

***T-1: Proposed Site Plan***

***TG-1: Proposed Gravity Alignment***

***TG-2: Proposed Gravity Alignment***

***TG-P: Gravity Sewer Ground Profiles***

***Opinion of Probable Construction Costs***





REVISION NUMBER	REVISIONS	DATE	BY



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PROJECT INFORMATION

Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report

Thompson's, Brush Fork, and Coppola  
Overall Service Areas

SEAL

- PRELIMINARY -  
NOT FOR  
CONSTRUCTION

JOB NUMBER:	14020
SCALE:	NTS
DATE:	MAY 2014
DRAWN BY:	FLB
DESIGNED BY:	SMJ
CHECKED BY:	RGB
SHEET NO.	BF-1
REVISION	





Opinion of Probable Construction Cost  
Thompson's Pump Station  
Option 1 - Complete Replacement



Description	Quan.	Unit		
			Unit Price	Total Price
Submersible Pumps w/ Bases & Guide Rails - 7.5 HP	2	EA	\$16,564.50	\$33,129.00
Pump Control Panel	1	EA	\$32,210.75	\$32,210.75
Variable Frequency Drives	2	EA	\$5,051.00	\$10,102.00
Salvage & Reinstall Remote Monitoring System	1	LS	\$2,176.00	\$2,176.00
Chanel Grinder	1	EA	\$50,264.00	\$50,264.00
Grinder Control Panel	1	EA	\$10,102.00	\$10,102.00
Grinder Vault	1	EA	\$6,000.00	\$6,000.00
8' Diameter Wet Well	1	EA	\$16,764.00	\$16,764.00
Valve Vault	1	EA	\$2,500.00	\$2,500.00
FL DI Valves & Piping	1	LS	\$14,910.00	\$14,910.00
Ballast Concrete	10	CY	\$1,500.00	\$15,000.00
Flow Meter	1	EA	\$5,113.00	\$5,113.00
Flow Meter Manhole	1	EA	\$2,500.00	\$2,500.00
35 kW 3-Phase Generator w/ Tank & ATS	1	LS	\$38,910.00	\$38,910.00
Control Panel Backboard	1	LS	\$3,357.00	\$3,357.00
Lighting - Site	1	LS	\$2,558.00	\$2,558.00
Electrical Misc Materials & Installation	1	LS	\$14,330.00	\$14,330.00
Fencing	1	LS	\$8,000.00	\$8,000.00
Access Hatches	3	EA	\$4,674.00	\$14,022.00
Painting & Coatings	1	LS	\$9,830.00	\$9,830.00
Site Excavation & Material Waste	225	CY	\$25.00	\$5,625.00
Site Final Grading	1	LS	\$5,264.00	\$5,264.00
Sheeting & Trench Support	1	LS	\$10,000.00	\$10,000.00
Site Stone	30	CY	\$40.00	\$1,200.00
Doghouse Manhole	1	EA	\$4,500.00	\$4,500.00
8" Gravity Sewer Piping	50	LF	\$75.00	\$3,750.00
Bypass Pumping	21	Day	\$700.00	\$14,700.00
AEP Electric Service Upgrade	1	LS	\$2,500.00	\$2,500.00
Startup / Reliability Testing	1	LS	\$2,040.00	\$2,040.00
Yard Hydrant & Water Service	1	LS	\$3,852.50	\$3,852.50
Mobilization/Insurance/Gen. Conditions (3%)	1	LS	\$10,356.28	\$10,356.28
<b>Total Opinion of Probable Construction Cost</b>				<b>\$355,566</b>





Opinion of Probable Construction Cost  
Thompson's Pump Station  
Option 1 - Force Main Replacement



Description	Quan.	Unit		
			Unit Price	Total Price
6" C-900 PVC Force Main	3,095	L.F.	\$30.00	\$92,850.00
Asphalt Restoration	150	L.F.	\$40.00	\$6,000.00
Stone Surface Restoration	650	L.F.	\$5.00	\$3,250.00
12" Steel Casing - Bore & Jack	130	L.F.	\$250.00	\$32,500.00
12" Steel Casing - Bore & Jack Stream Crossing	100	L.F.	\$300.00	\$30,000.00
Air Release Valve & Vault	3	EA	\$6,000.00	\$18,000.00
Abandon-in-place existing FM	2,900	L.F.	\$1.50	\$4,350.00
Connect to Existing MH	1	L.S.	\$3,500.00	\$3,500.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$5,713.50	\$5,713.50
<b>Total Opinion of Probable Construction Cost</b>				<b>\$196,164</b>



## Thompson's Pump Station Option 1 – Replacement

### Probable Operation & Maintenance Costs



#### Assumptions:

- 20-year planning period
- Current electrical power rate of \$0.07/kW-hr remains constant
- Pump operation of 8-hours per day (assumes reduction in upstream I/I)
- 10-year pump and control panel life
- 20-year generator life

*8hrs x 365 days = 2,920 hours per year*

Pump HP: 7.5      Pump Motor FLA: 22 Amps @ 230 VAC

Actual Pumping HP Req'd (Reference Pump Curve): 7.06 HP

Actual Electrical Power Approximation:

*22 Amps x 7.06/7.5 = 20.7 Amps*

*20.7 Amps x 230 Volts x  $\sqrt{3}$  / 1000 = 8.2 kW*

*8.2 kW x 2,920 hours/year x \$0.07/kW-hr = \$1,676 / year*

*\$1,676/year x 20-years = \$33,520*

Replacement Pumps: 2 x \$33,129 = \$66,258

Replacement Control Panel & VFD's: 2 x (\$32,211 + \$10,102) = \$84,626

Replacement Generator & ATS: \$38,900

**Total 20 year life cycle cost:    \$223,304**



**Opinion of Probable Construction Cost  
Thompson's Pump Station  
Option 2 - Elimination**



Description	Quan.	Unit		
			Unit Price	Total Price
10" Gravity Sewer Pipe (< 6' Deep)	1,397	L.F.	\$130.00	\$181,610.00
10" Gravity Sewer Pipe (6' to 10' Deep)	955	L.F.	\$150.00	\$143,250.00
10" Gravity Sewer Pipe (> 10' Deep)	650	L.F.	\$175.00	\$113,750.00
20" Steel Casing - Bore & Jack	130	L.F.	\$250.00	\$32,500.00
20" Steel Casing - Bore & Jack Stream Crossing	100	L.F.	\$300.00	\$30,000.00
Precast MH (< 6' Deep)	8	EA	\$3,000.00	\$24,000.00
Precast MH ( 6' to 10' Deep)	6	EA	\$4,000.00	\$24,000.00
Precast MH ( > 10' Deep)	4	EA	\$4,500.00	\$18,000.00
Doghouse Manhole	1	EA	\$5,000.00	\$5,000.00
Cleanout - House Service	8	EA	\$600.00	\$4,800.00
Service Wye	8	EA	\$600.00	\$4,800.00
4" PVC Service Pipe	800	L.F.	\$60.00	\$48,000.00
Chanel Grinder @ Brush Fork PS	1	EA	\$50,264.00	\$50,264.00
Grinder Control Panel @ Brush Fork PS	1	EA	\$10,102.00	\$10,102.00
Grinder Vault @ Brush Fork PS	1	EA	\$6,000.00	\$6,000.00
Asphalt Restoration	150	L.F.	\$55.00	\$8,250.00
Stone Surface Restoration	650	L.F.	\$15.00	\$9,750.00
Abandon Existing PS	1	LS	\$15,000.00	\$15,000.00
Abandon-in-place existing FM	2,900	L.F.	\$1.50	\$4,350.00
Connect to Existing MH	1	L.S.	\$3,500.00	\$3,500.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$22,107.78	\$22,107.78
<b>Total Opinion of Probable Construction Cost</b>				<b>\$759,034</b>



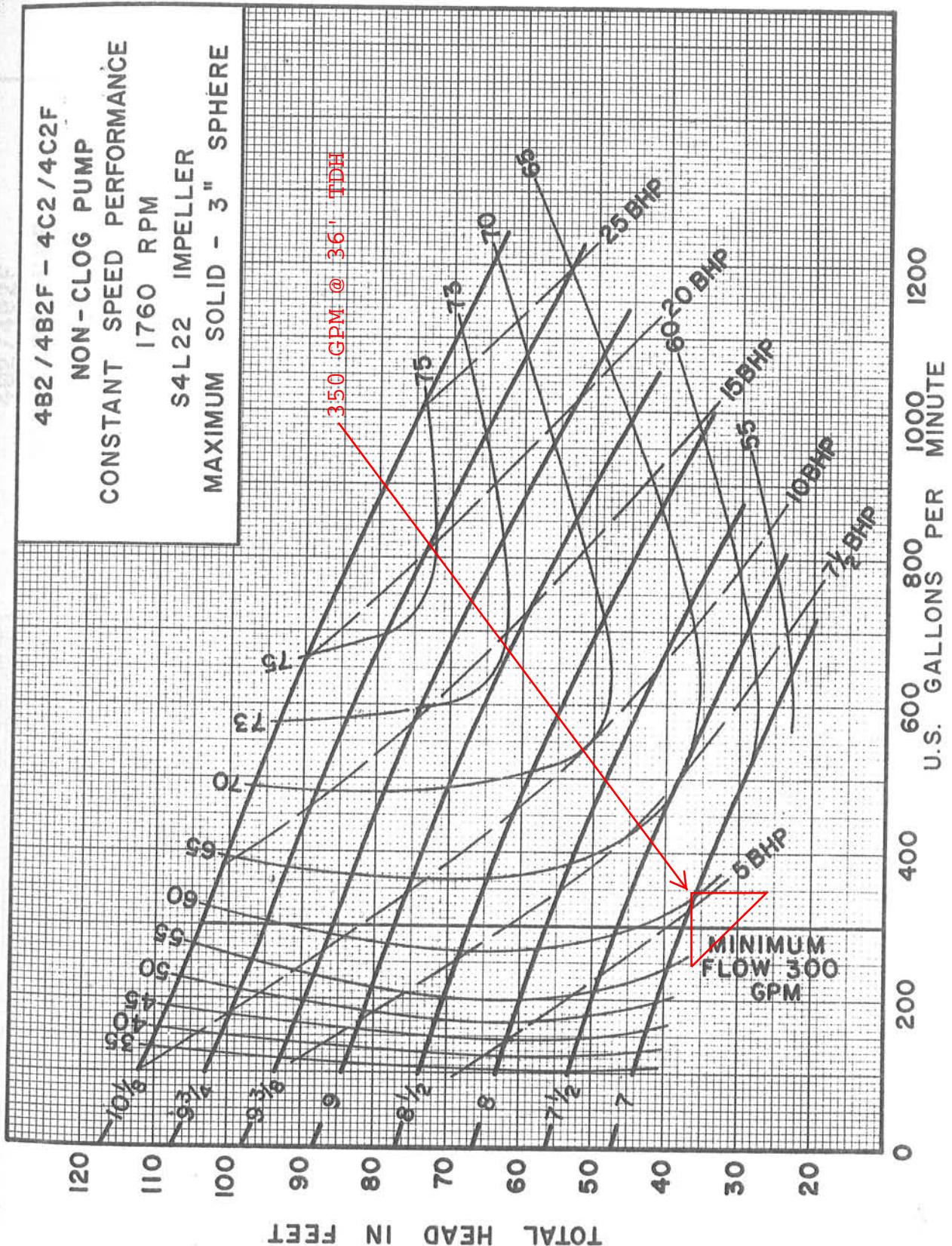
# ENGINEERING DATA



Smith &  
Loveless, Inc.

14040 W. Santa Fe Trail Dr.  
Lenexa, Kansas 66215

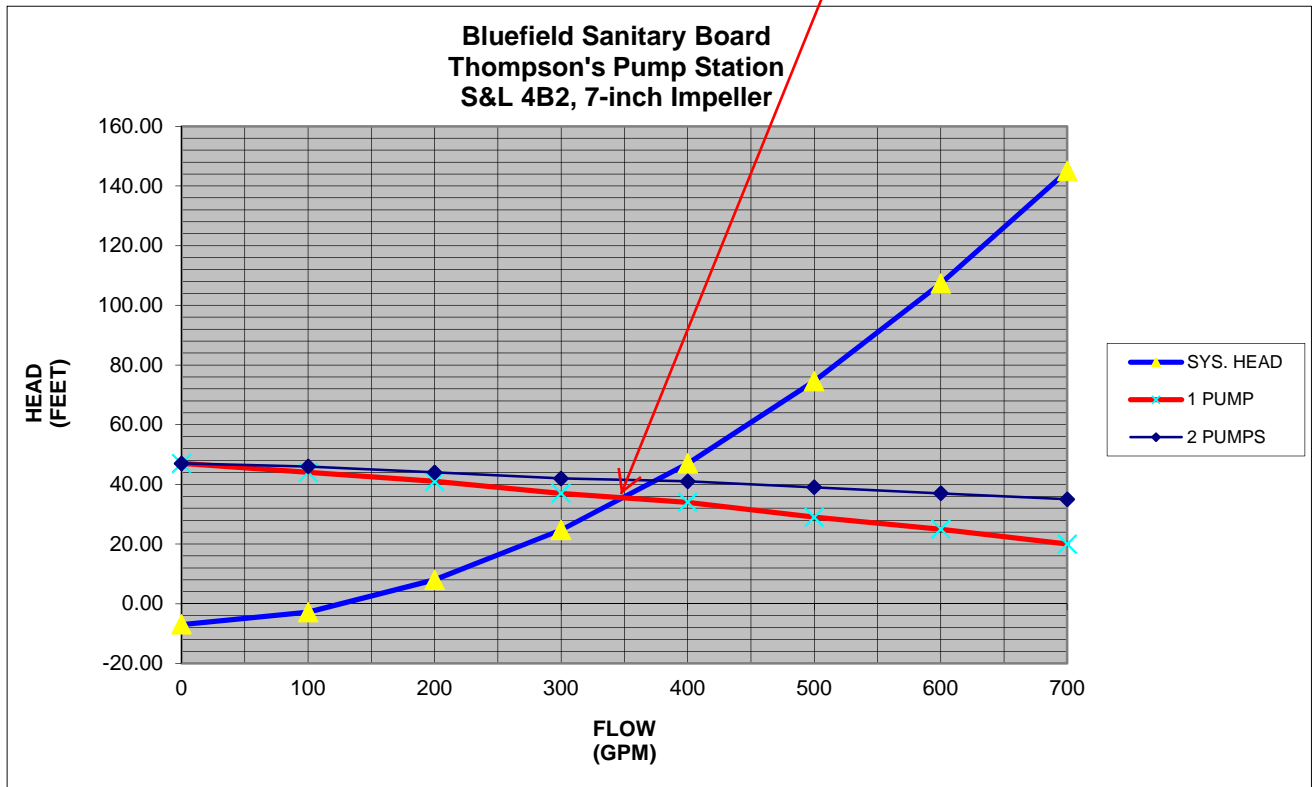
Pump Performance Curves  
Constant Speed  
4B2/4B2F - 4C2/4C2F  
1760 RPM  
March, 1989



# **Bluefield Sanitary Board Thompson's Pump Station**

WET WELL LIQUID LEVEL	2348	High Water Level
FM HIGH POINT	2340	
STATIC HEAD	-8	
STATION LOSS	1	
ENTER PIPE LENGTH	2900	
ENTER "C" VALUE	110	
ENTER PIPE DIA.	6	

FLOW	SYS. HEAD	1 PUMP	2 PUMPS	VELOCITY, fps
0	-7.00	47	47	0.0
100	-2.85	44	46	1.1
200	7.97	41	44	2.3
300	24.70	37	42	3.4
400	46.98	34	41	4.5
500	74.57	29	39	5.7
600	107.29	25	37	6.8
700	145.01	20	35	7.9



Project	Project ID	Created by	Created on 2014-12-04	Last update
---------	------------	------------	--------------------------	-------------



- Pump Calculations for The Sanitary Board of Bluefield -  
Thompsons  
Wednesday, October 01, 2014 to Friday, October 31, 2014

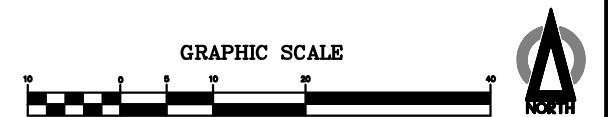
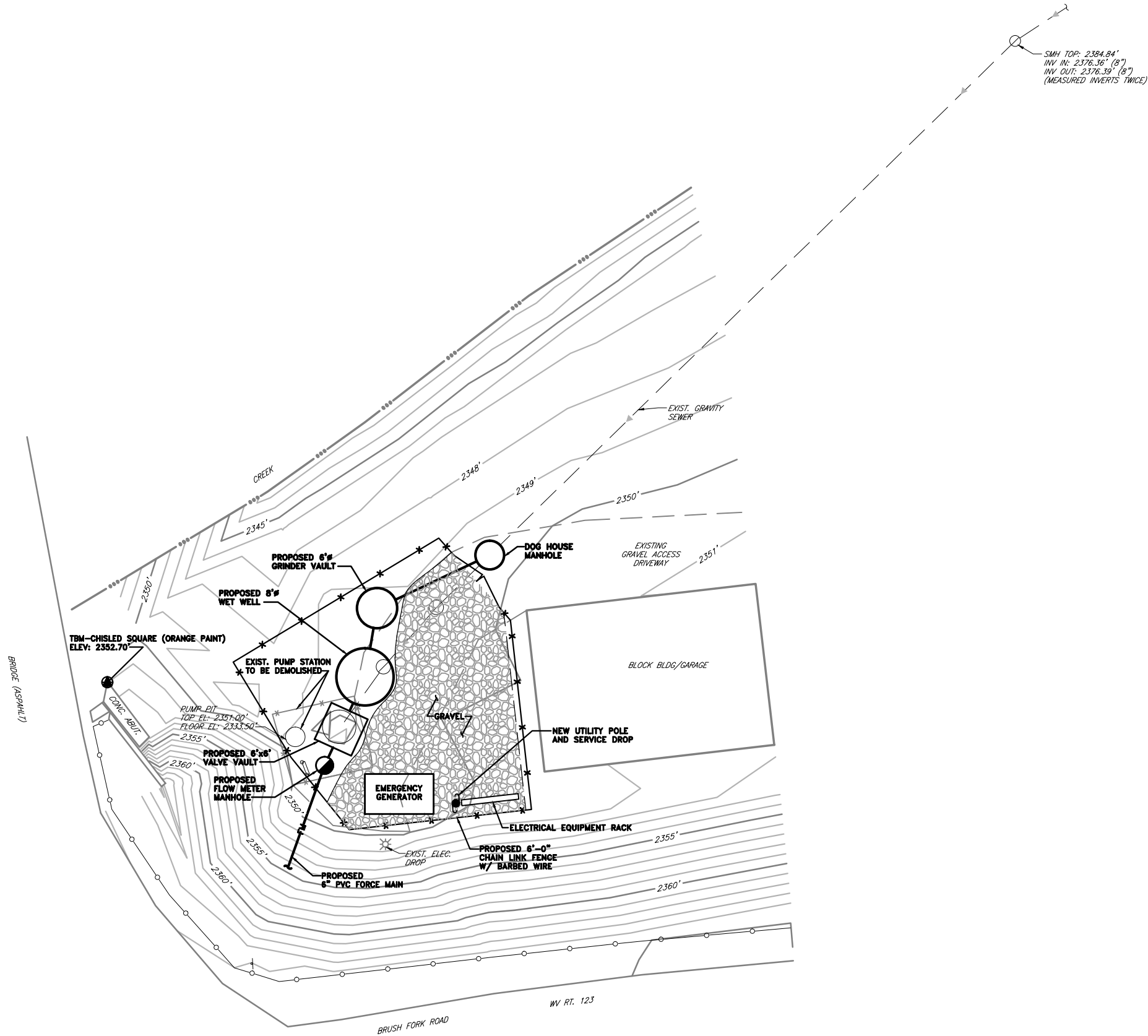
[illegible]

[illegible]



[illegible]

Date: 10/9/2014								
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26971		Thompsons	2	6	03:08:22	18:50:14	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/8/2014								
26971		Thompsons	1	2	11:58:23	23:56:46	0	0
26971		Thompsons	2	14	01:10:52	16:32:18	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/7/2014								
26971		Thompsons	1	1	23:18:22	23:18:22	0	0
26971		Thompsons	2	5	02:46:04	13:50:23	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/6/2014								
26971		Thompsons	1	156	00:03:41	09:36:10	0	0
26971		Thompsons	2	155	00:03:37	09:21:05	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/5/2014								
26971		Thompsons	1	243	00:01:02	04:11:47	0	0
26971		Thompsons	2	241	00:01:24	05:41:10	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/4/2014								
26971		Thompsons	1	255	00:01:13	05:13:14	0	0
26971		Thompsons	2	254	00:01:48	07:37:38	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/3/2014								
26971		Thompsons	1	258	00:00:51	03:41:30	0	0
26971		Thompsons	2	259	00:01:14	05:19:45	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/2/2014								
26971		Thompsons	1	262	00:00:45	03:19:20	0	0
26971		Thompsons	2	262	00:01:03	04:37:42	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0
							Station:	0
Date: 10/1/2014								
26971		Thompsons	1	267	00:00:47	03:29:49	0	0
26971		Thompsons	2	268	00:01:04	04:48:54	0	0
26971		Thompsons	3	0	00:00:00	00:00:00	0	0



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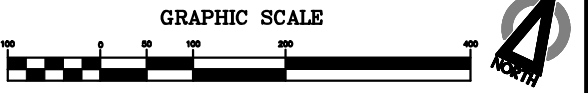
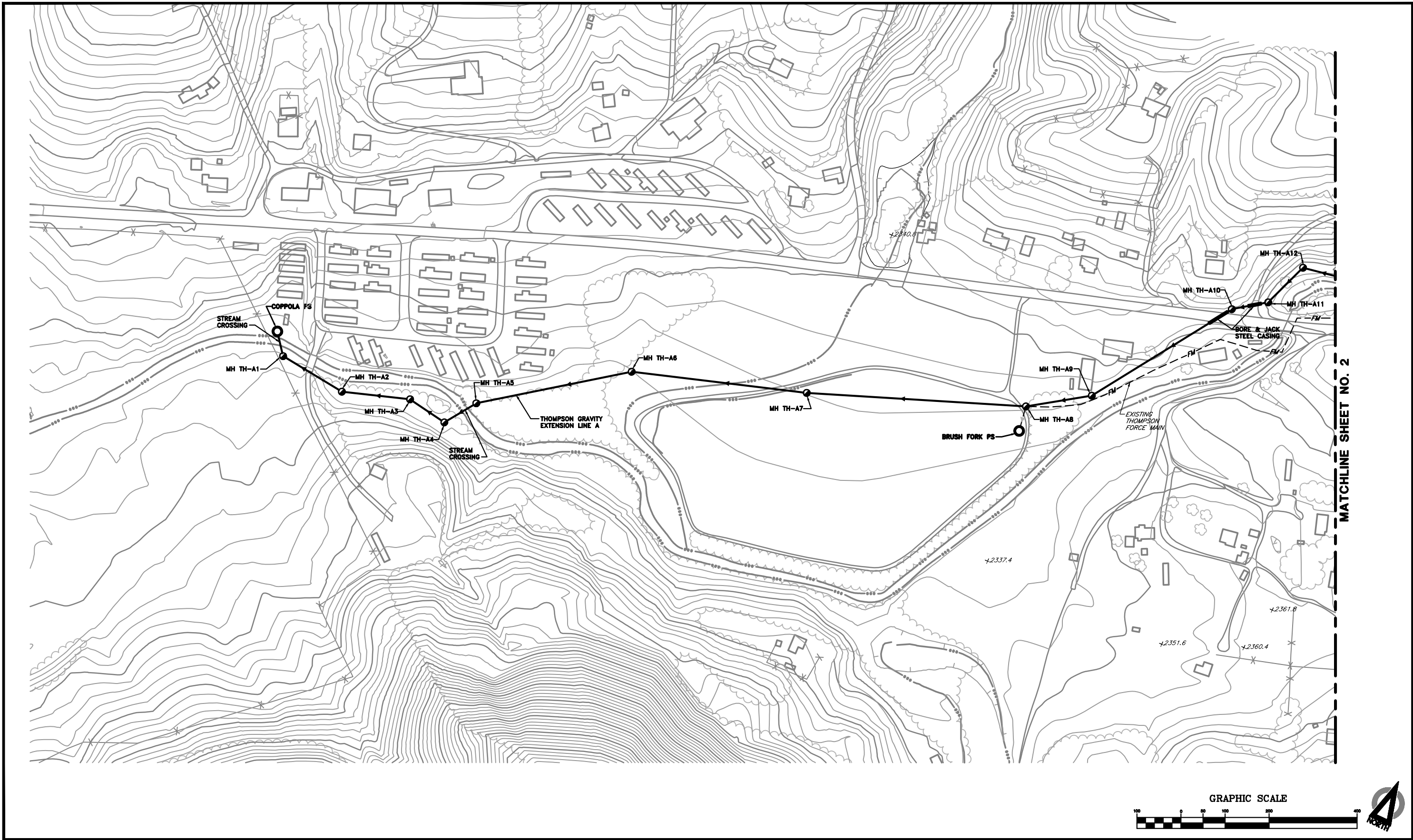
Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report

Thompson's Pump Station  
Replacement  
Proposed Site Plan

SEAL

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**Thompson's Pump Station Elimination  
Preliminary Gravity Sewer Alignment**

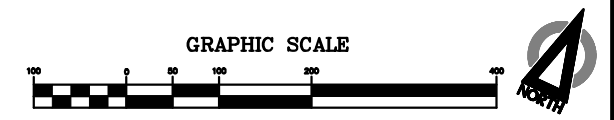
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MATCHLINE SHEET NO. 1



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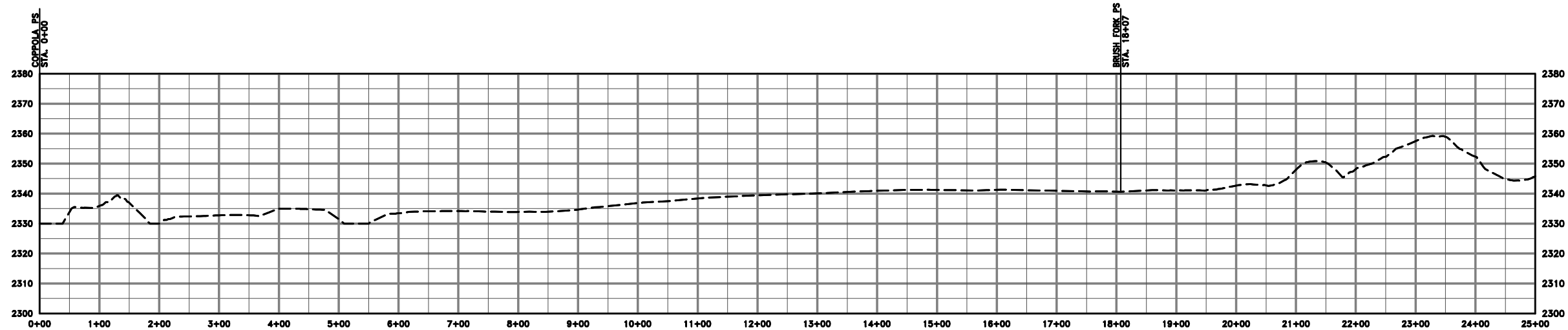
**Sanitary Board of Bluefield  
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Evaluation & Upgrade  
Preliminary Engineering Report**

**Thompson's Pump Station Elimination  
Preliminary Gravity Sewer Alignment**

SEAL

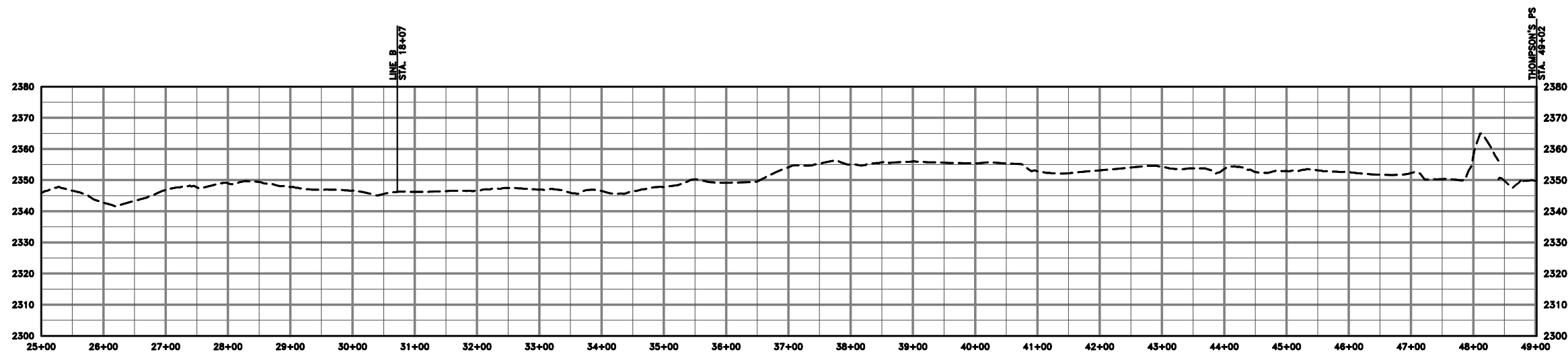
**- PRELIMINARY -  
NOT FOR  
CONSTRUCTION**

JOB NUMBER:	14020
SCALE:	1" = 100'
DATE:	DECEMBER 2014
DRAWN BY:	FLB
DESIGNED BY:	SMJ
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REVISION	



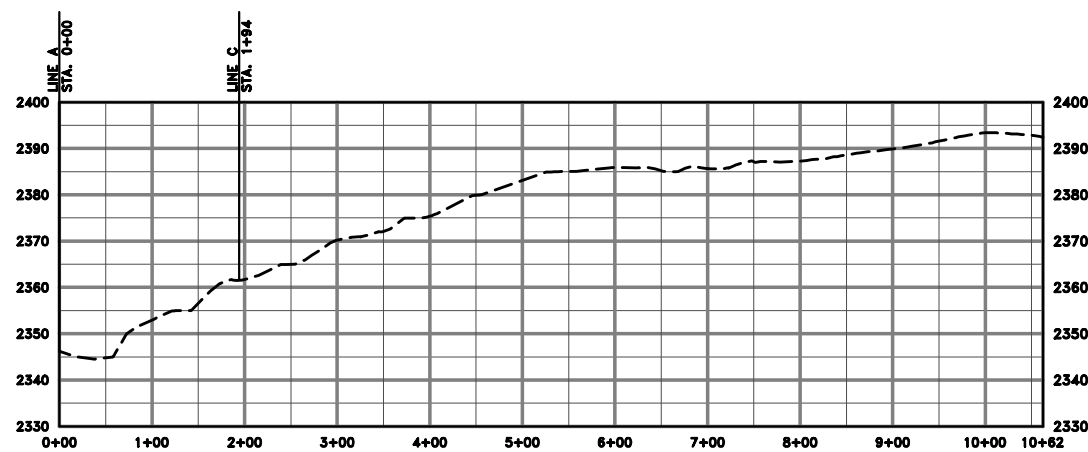
**THOMPSON GRAVITY LINE A - 0+00 TO 25+00**

HORIZ. SCALE: 1" = 100'  
VERT. SCALE: 1" = 20'



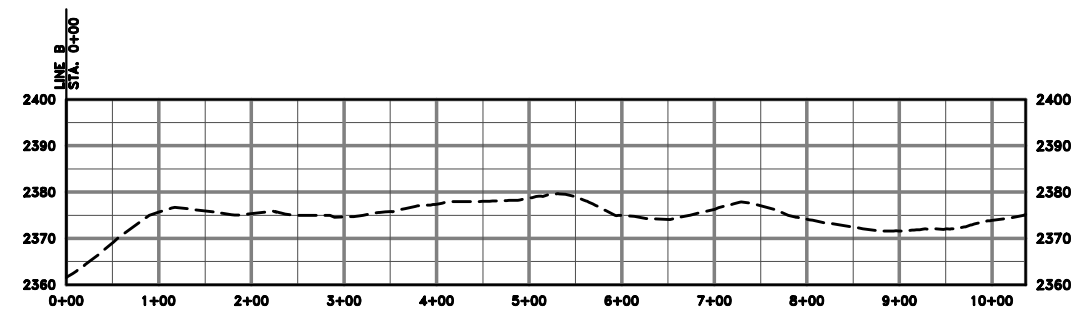
**THOMPSON GRAVITY LINE A - 25+00 TO 49+02**

HORIZ. SCALE: 1" = 100'  
VERT. SCALE: 1" = 20'



**THOMPSON GRAVITY LINE B - 0+00 TO 10+62**

HORIZ. SCALE: 1" = 100'  
VERT. SCALE: 1" = 20'



**THOMPSON GRAVITY LINE C - 0+00 TO 10+36**

HORIZ. SCALE: 1" = 100'  
VERT. SCALE: 1" = 20'

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PROJECT INFORMATION

**Sanitary Board of Bluefield  
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Evaluation & Upgrade  
Preliminary Engineering Report**

Thompson's Pump Station Elimination  
Preliminary Gravity Sewer  
Ground Profiles

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# **Appendix D**

## ***Midway Pump Station Exhibits***

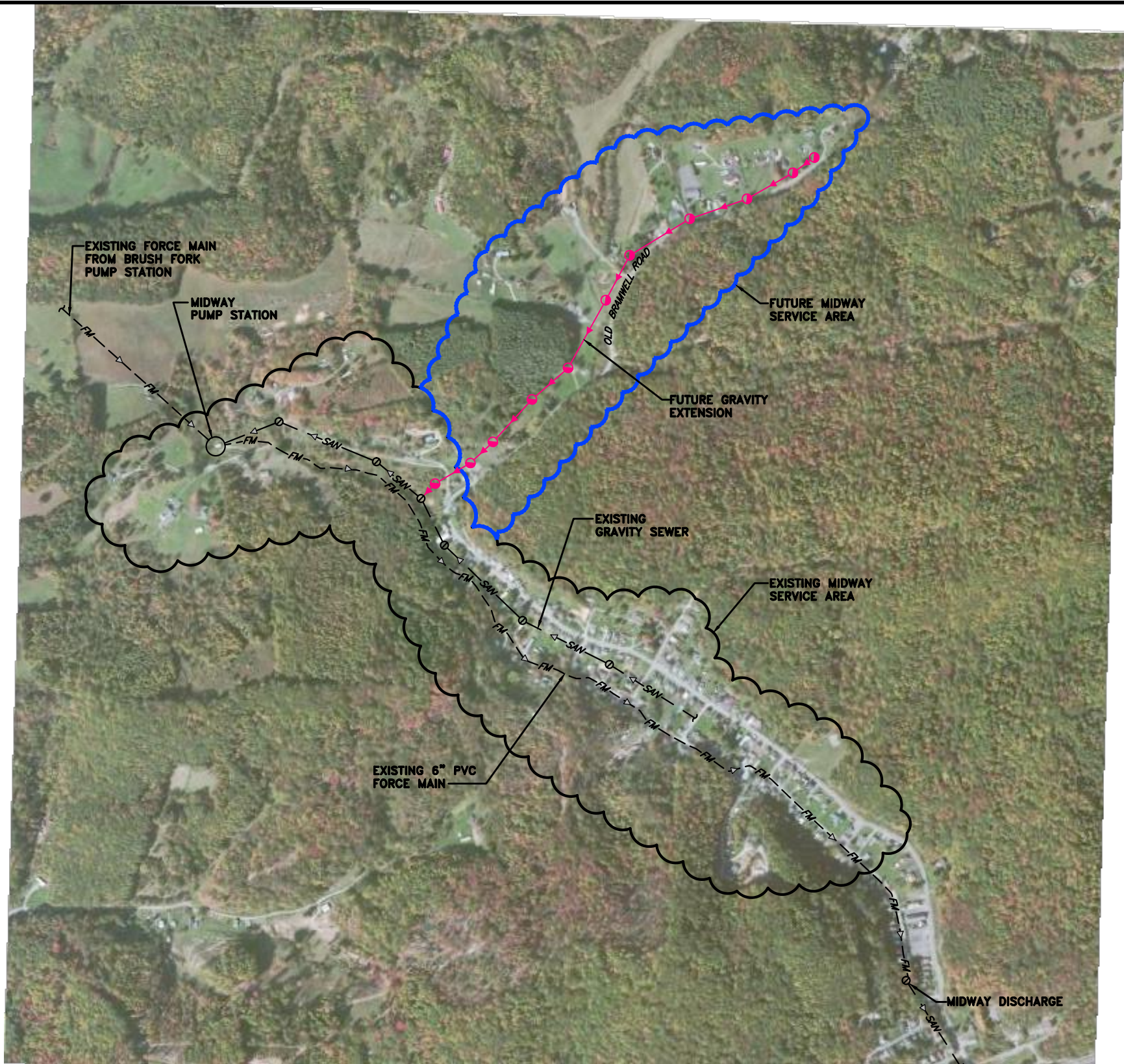
***Sheet M-1: Midway Service Areas***

***Sheet M-2: Proposed Electrical Building Site Plan***

***Sheet M-3: Midway Gravity Extension***

***Sheet M-4: Midway Gravity Extension***

***Opinion of Probable Construction Costs***



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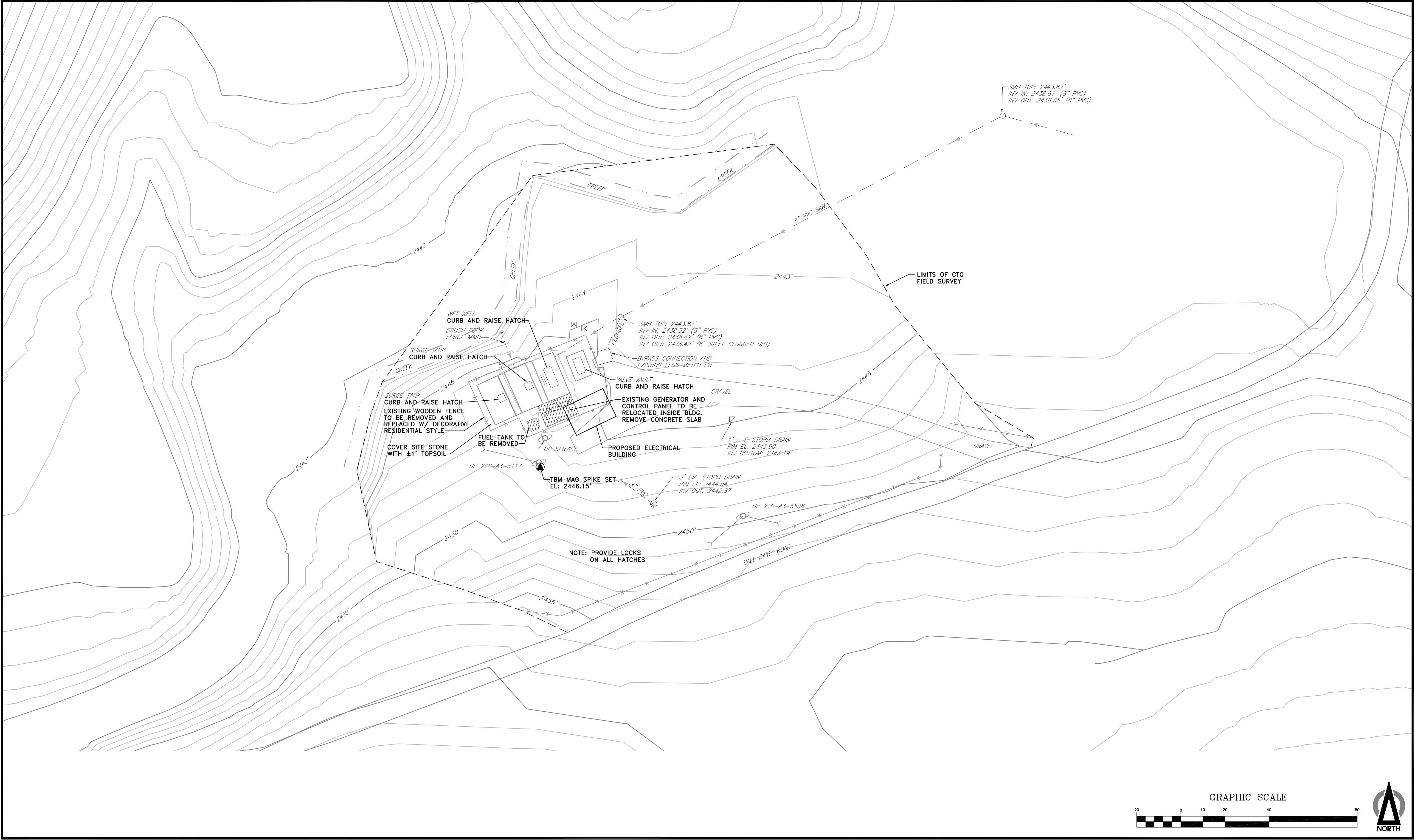
Midway Pump Station  
Overall Service Area

SEAL

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JOB NUMBER:	14020
SCALE:	NTS
DATE:	MAY 2014
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Evaluation & Upgrade  
Preliminary Engineering Report

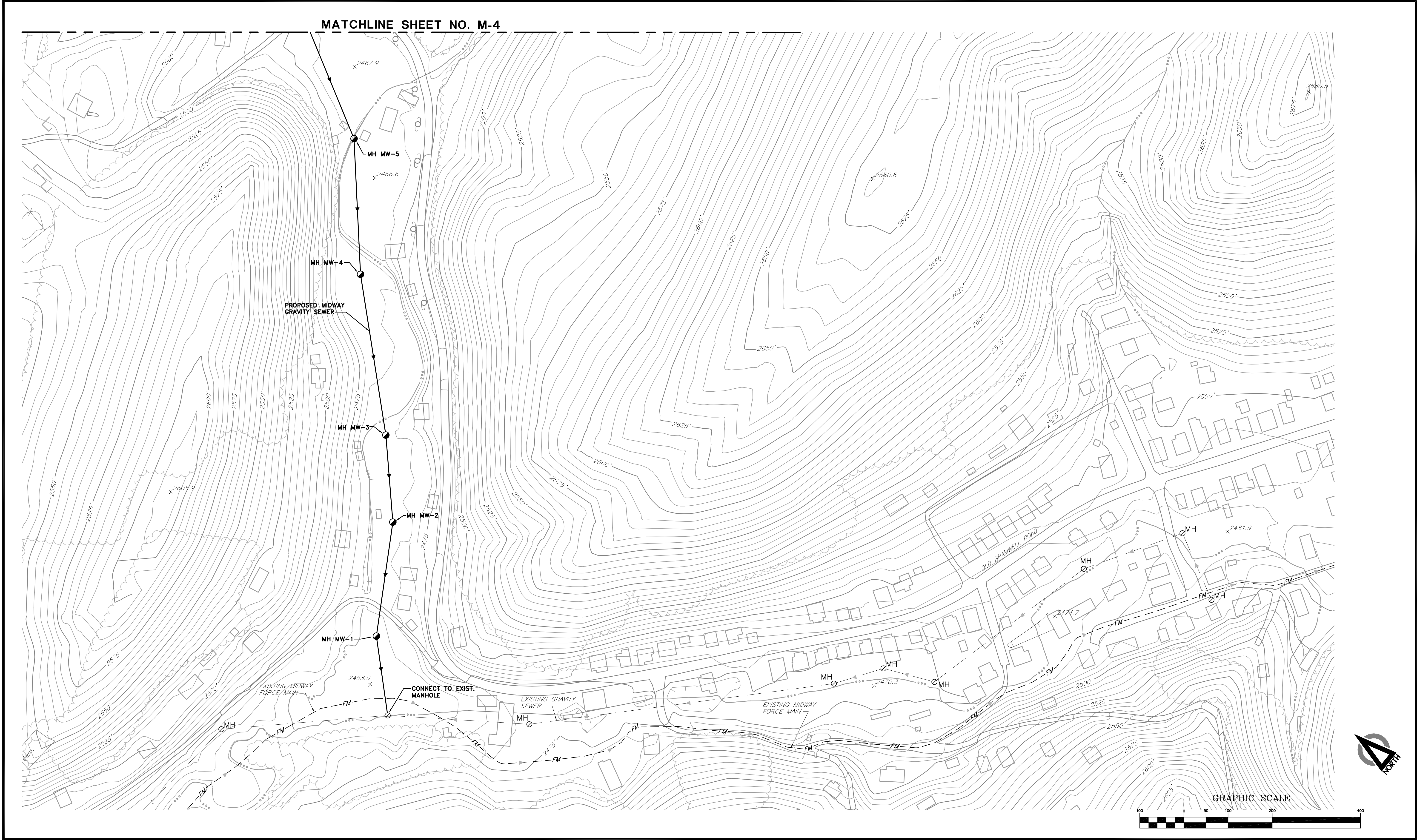
Proposed Midway Pump Station  
Site Plan  
Electrical Building Addition

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**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

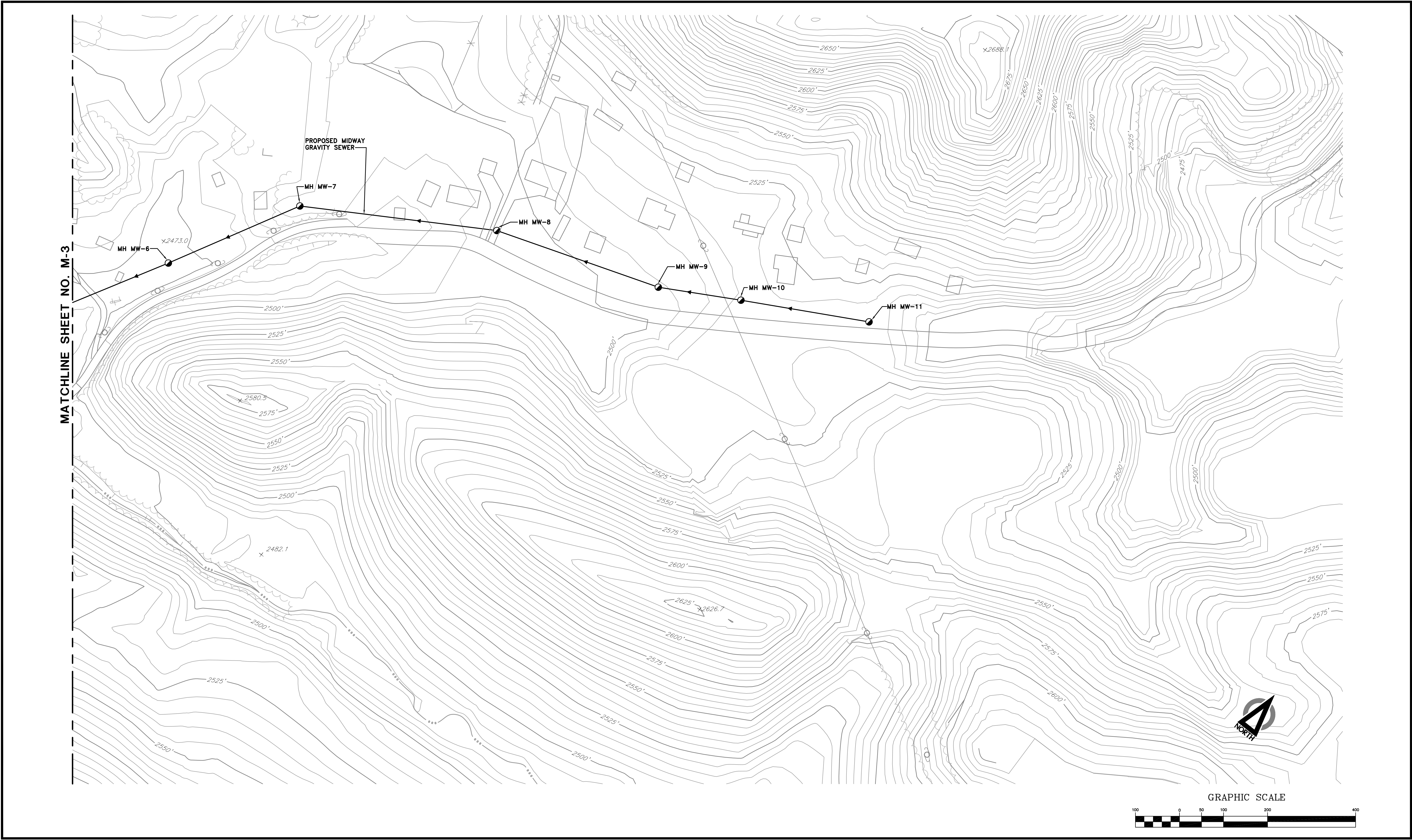
**Proposed Midway Gravity  
Sewer Extension**

SEAL

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CONSTRUCTION**

JOB NUMBER:	14020
SCALE:	1" = 100'
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**Sanitary Board of Bluefield  
Wastewater Pump Station  
Evaluation & Upgrade  
Preliminary Engineering Report**

**Proposed Midway Gravity  
Sewer Extension**

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DATE:	DECEMBER 2014
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<b>M-4</b>	





Opinion of Probable Construction Cost  
Midway Pump Station  
Electrical Building



Description	Quan.	Unit		
			Unit Price	Total Price
Brick Masonry Building, 20' x 14'	280	SF	\$200.00	\$56,000.00
Louvers/Dampers - Large (Generator)	2	EA	\$2,000.00	\$4,000.00
Louvers - Small	1	EA	\$1,000.00	\$1,000.00
Exhaust Fan	1	EA	\$1,500.00	\$1,500.00
Lighting - Interior & Exterior	1	LS	\$8,147.00	\$8,147.00
Electric Unit Heater	1	EA	\$1,678.50	\$1,678.50
Exterior Generator Fueling Connection	1	EA	\$4,507.00	\$4,507.00
Generator Piping & Duct Work	1	LS	\$10,071.00	\$10,071.00
Relocate Generator & ATS	1	LS	\$9,616.00	\$9,616.00
Remove Fence	1	LS	\$2,966.00	\$2,966.00
Relocate Control Panel	1	LS	\$13,154.00	\$13,154.00
Bypass Pumping	14	Day	\$700.00	\$9,800.00
Curb & Raise Hatches	4	EA	\$1,391.00	\$5,564.00
Topsoil & Fine Grading	1	LS	\$5,000.00	\$5,000.00
Fence - Decorative	1	LS	\$4,000.00	\$4,000.00
Mobilization/Insurance/Gen. Conditions (3%)	1	LS	\$4,110.11	\$4,110.11
<b>Total Opinion of Probable Construction Cost</b>				<b>\$141,114</b>

# **Appendix E**

***Brush Fork Pump Station Exhibits***

***Opinion of Probable Construction Costs***



**Opinion of Probable Construction Cost  
Brush Fork Pump Station  
Force Main Replacement**



Description	Quan.	Unit		
			Unit Price	Total Price
8" C-900 PVC Force Main	6,732	L.F.	\$38.00	\$255,816.00
Creek Crossing Pipe & Rip Rap	45	L.F.	\$49.00	\$2,205.00
Air Release Valve & Vault	2	LS	\$6,000.00	\$12,000.00
Connect to Midway Pump Station	1	L.S.	\$1,000.00	\$1,000.00
Temporary Piping & Flow Control	1	L.S.	\$23,850.00	\$23,850.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$8,130.63	\$8,130.63
<b>Total Opinion of Probable Construction Cost</b>				<b>\$303,002</b>



Opinion of Probable Construction Cost  
Brush Fork Pump Station  
Electrical Service Upgrades



Description	Quan.	Unit		
			Unit Price	Total Price
400 Amp Automatic Transfer Switch	1	L.S.	\$7,988.00	\$7,988.00
400 Amp Fused Disconnect	1	L.S.	\$3,388.00	\$3,388.00
4" PVC Conduit	50	LF	\$7.50	\$375.00
Conductors, 2 - 3/0 per Phase	150	LF	\$20.00	\$3,000.00
Generator / Control Panel Interlock	1	L.S.	\$6,652.00	\$6,652.00
Temporary Generator to Control Panel Wiring	1	L.S.	\$2,238.00	\$2,238.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$7,092.30	\$7,092.30
<b>Total Opinion of Probable Construction Cost</b>				<b>\$30,733</b>

# **Appendix F**

## ***Coppola Pump Station Exhibits***

***Opinion of Probable Construction Costs***  
***Opinion of Probable Construction Costs***





**Opinion of Probable Construction Cost  
Brush Fork Pump Station  
Relocate**



Description	Quan.	Unit		
			Unit Price	Total Price
12' Diameter Concrete Wet Well	1	LS	\$28,264.00	\$28,264.00
Precast Concrete Dry-Pump Pit	1	LS	\$14,464.00	\$14,464.00
Guide Rails, Base Elbow, and Piping	1	LS	\$13,130.00	\$13,130.00
Relocate Generator	1	LS	\$11,737.00	\$11,737.00
Relocate Pumps	4	EA	\$2,391.00	\$9,564.00
Relocate Control Panel	1	LS	\$7,077.00	\$7,077.00
Flow Meter	1	EA	\$5,113.00	\$5,113.00
Flow Meter Manhole	1	EA	\$2,500.00	\$2,500.00
8" PVC Force Main	1,900	LF	\$38.00	\$72,200.00
10" Gravity Sewer Pipe (< 6' Deep)	1,900	LF	\$130.00	\$247,000.00
Precast MH (< 6' Deep)	7	EA	\$3,000.00	\$21,000.00
Lighting - Site	1	LS	\$2,558.00	\$2,558.00
Electrical Misc. Materials & Installation	1	LS	\$14,330.00	\$14,330.00
Fencing	1	LS	\$8,000.00	\$8,000.00
Access Road Construction - Earthwork	100	CY	\$30.00	\$3,000.00
Access Road & Site Stone	80	CY	\$40.00	\$3,200.00
Bypass Connection Standpipe	1	LS	\$7,232.00	\$7,232.00
Bypass Pumping (2 pumps plus fuel)	21	Day	\$700.00	\$14,700.00
Yard Hydrant & Water Service	1	LS	\$3,852.50	\$3,852.50
Abandon Existing Pump Station	1	LS	\$15,000.00	\$15,000.00
Mobilization/Insurance/Gen. Conditions (3%)	1	LS	\$14,269.73	\$14,269.73
<b>Total Opinion of Probable Construction Cost</b>				<b>\$489,927</b>



## Copolla Pump Station

### Probable Operation & Maintenance Costs



#### Assumptions:

- 20-year planning period
- Current electrical power rate of \$0.07/kW-hr remains constant
- Pump operation of 8-hours per day
- 10-year complete pump station life

*8hrs x 365 days = 2,920 hours per year*

Pump HP: 5 Pump Motor FLA: 15 Amps @ 230 VAC (1-Phase)

*15 Amps x 230 Volts / 1000 = 1.15 kW*

*1.15 kW x 2,920 hours/year x \$0.07/kW-hr = \$235 / year*

*\$235/year x 20-years = \$4,700*

Replacement Pump, Panel, & Wet Well: 2 x \$35,000 = \$70,000

**Total 20 year life cycle cost:    \$74,700**

# **Appendix G**

***Additional Gravity Sewer Extension Exhibits***

***Opinion of Probable Construction Costs  
Financial Analysis***



**Opinion of Probable Construction Cost  
Midway Pump Station  
Additional Gravity Sewer Extensions**



Description	Quan.	Unit		
			Unit Price	Total Price
8" Gravity Sewer Pipe (< 6' Deep)	3,095	L.F.	\$100.00	\$309,500.00
8" Gravity Sewer Pipe (6' to 10' Deep)	180	L.F.	\$120.00	\$21,600.00
8" Gravity Sewer Pipe (> 10' Deep)	245	L.F.	\$145.00	\$35,525.00
8" Gravity Sewer Pipe - Stream Crossing	100	L.F.	\$200.00	\$20,000.00
Precast MH (< 6' Deep)	8	EA	\$3,000.00	\$24,000.00
Precast MH ( 6' to 10' Deep)	2	EA	\$4,000.00	\$8,000.00
Precast MH ( > 10' Deep)	1	EA	\$4,500.00	\$4,500.00
Cleanout - House Service	28	EA	\$600.00	\$16,800.00
Service Wye	28	EA	\$600.00	\$16,800.00
4" PVC Service Pipe	2,800	L.F.	\$60.00	\$168,000.00
Asphalt Restoration	100	L.F.	\$55.00	\$5,500.00
Stone Surface Restoration	100	L.F.	\$15.00	\$1,500.00
Connect to Existing MH	1	L.S.	\$3,500.00	\$3,500.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$19,056.75	\$19,056.75
<b>Total Opinion of Probable Construction Cost</b>				<b>\$654,282</b>



Opinion of Probable Construction Cost  
Thompson's Pump Station  
Additional Gravity Sewer Extension



Description	Quan.	Unit		
			Unit Price	Total Price
8" Gravity Sewer Pipe (< 6' Deep)	1,097	L.F.	\$100.00	\$109,700.00
8" Gravity Sewer Pipe (6' to 10' Deep)	955	L.F.	\$120.00	\$114,600.00
16" Steel Casing - Bore & Jack	60	L.F.	\$240.00	\$14,400.00
8" Gravity Sewer Pipe - Stream Crossing	75	L.F.	\$200.00	\$15,000.00
Precast MH (< 6' Deep)	4	EA	\$3,000.00	\$12,000.00
Precast MH ( 6' to 10' Deep)	3	EA	\$4,000.00	\$12,000.00
Cleanout - House Service	19	EA	\$600.00	\$11,400.00
Service Wye	19	EA	\$600.00	\$11,400.00
4" PVC Service Pipe	1,900	L.F.	\$60.00	\$114,000.00
Asphalt Restoration	50	L.F.	\$55.00	\$2,750.00
Stone Surface Restoration	1,000	L.F.	\$15.00	\$15,000.00
Connect to Existing MH	1	L.S.	\$3,500.00	\$3,500.00
Mobilization/Insurance/Gen. Conditions (3%)	1	L.S.	\$13,072.50	\$13,072.50
<b>Total Opinion of Probable Construction Cost</b>				<b>\$448,823</b>





## Gravity Sewer Extension Financial Feasibility



### Assumptions:

- 30-year, 4% interest loan
- Current average sewer bill of \$35 remains unchanged

### Thompson's Line Extensions

*Opinion of Probable Construction Cost = \$448,823*

*Additional Customers = 19*

Additional Annual Revenue =  $12 \times 19 \times \$35 =$  \$7,980

Annual Debt Service = \$25,713

**Net = \$-17,733**

### Midway Line Extension

*Opinion of Probable Construction Cost = \$654,282*

*Additional Customers = 28*

Additional Annual Revenue =  $12 \times 28 \times \$35 =$  \$11,760

Annual Debt Service = \$37,484

**Net = \$-25,724**