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## Some thoughts on "The Pointe" and the sewer capacity

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To: Matthew Sarcione &lt;msarcione@shrewsburyma.gov&gt;, dmorgado@shrewsburyma.gov

This is intended for the ZBA - I'm not sure how to email them. Can you let me know if this is not an effective way to contact them, and/or if there is a better way?

In Monday 3/21's ZBA meeting where sewer concerns were being addressed by the proponent of the 40B project called "the Pointe", I found the assertions about using a 95% maximum capacity to be concerning. The amount of flow through a pipe is proportional to its cross section, and it goes down exponentially with a reduction in the radius. This means that to decrease the capacity of a 10" pipe requires a very small reduction in radius. Any buildup inside of a sewer pipe reduces its radius and therefore exponentially its capacity. This may explain why the peer review firm uses an 80% guideline instead of 95%.

In their slides they showed a fair number of existing pipes that would be at 94% capacity after this project was constructed. (They pointed out that this is worst case; of course, worst case is what is important when it comes to planning and engineering. You don't want sewage backing up just because of a record rainfall.) As expected, they glossed over the fact that this would limit any future projects the town would like to consider. I also am concerned that any build up in the pipes would render their calculations meaningless, since the pipes in question would not be acting as 10" pipes. Please see the attached explanation of what I mean. Feel free to share it with anyone you deem appropriate to share it with.

Disclaimer: I am not a civil engineer nor a sewer expert. I do have a background in electrical engineering so have studied topics tangentially related. You should confirm my assertions with your experts in these topics.

Thanks,  
Dale Martin

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 **pipe\_calculations.pdf**  
301K

The capacity of a pipe is proportional to the cross section, or area, of the pipe.

$$\begin{aligned} & \text{Area} = \text{PI} * R^2 \\ & \text{Area} = \pi R^2 \end{aligned}$$

The sewer lines in question are 10 and 12 inches in diameter. We'll use 10 inch to keep things simple. 10 inches in diameter is 5 inches in radius.

$$\begin{aligned} & \text{PI} * (5 * \text{unit}::\text{inch})^2 \\ & 25 \pi \text{ inch}^2 \end{aligned}$$

Expressed numerically

$$\begin{aligned} & \text{float}(\%) \\ & 78.53981634 \text{ inch}^2 \end{aligned}$$

The cross section of a 10 inch pipe is approx. 78.54 sq inches. Now we'll compute that area reduced by 5%

$$\begin{aligned} & (\% - (\% * .05)) \\ & 74.61282552 \text{ inch}^2 \end{aligned}$$

What is the radius of a circle with that area?

$$\begin{aligned} & R = \text{sqrt}(\text{Area}/\text{PI}) \\ & R = \frac{\sqrt{\text{Area}}}{\sqrt{\pi}} \end{aligned}$$

$$\begin{aligned} & \text{sqrt}(74.613/\text{PI}) \\ & \frac{8.637881685}{\sqrt{\pi}} \end{aligned}$$

Expressed numerically

$$\begin{aligned} & \text{float}(\%) \\ & 4.87340287 \end{aligned}$$

Times 2 for diameter

$$\begin{aligned} & 2 * \% \\ & 9.746805741 \end{aligned}$$

So a 10 inch pipe with a coating just over 1/8th inch (1/4 inch reduction in diameter) has its capacity reduced by 5%.

The peer review uses a standard of requiring a maximum of 80% capacity. What is the equivalent pipe diameter?

$$\begin{aligned} & \text{PI} * (5 * \text{unit}::\text{inch})^2 \\ & 25 \pi \text{ inch}^2 \end{aligned}$$

$$\begin{aligned} & \% - (\% * .20) \\ & 20.0 \pi \text{ inch}^2 \end{aligned}$$

Expressed numerically

$$\begin{aligned} & \text{float}(\%) \\ & 62.83185307 \text{ inch}^2 \end{aligned}$$

So a 20% reduction in area of a 10" pipe takes it from 78.5 square inches down to 62.8 square inches.

Solve for radius of such a pipe with an area of 62.8 inches.

$$\begin{aligned} & \text{sqrt}(62.832/\text{PI}) \\ & \end{aligned}$$

$$\frac{7.926663863}{\sqrt{\pi}}$$

Expressed numerically

```
float (%)
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4.472141184

Times two for diameter

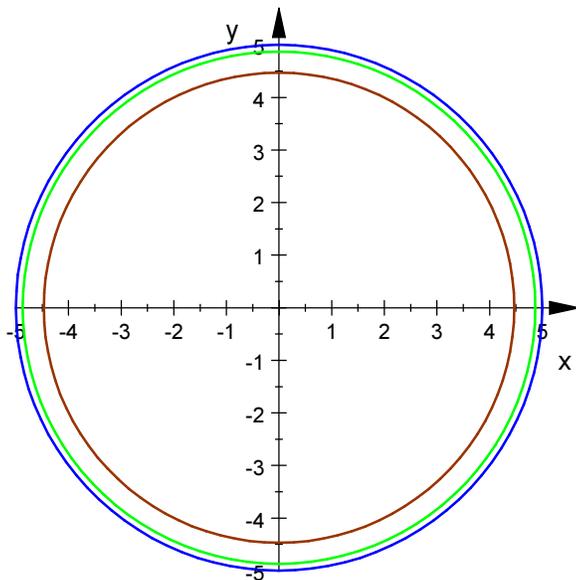
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2 * 4.472
```

8.944

A 8.9 inch pipe has 80% of the capacity of a 10 inch pipe. So a coating of a bit more than 1/2 inch (reducing diameter by a bit over an inch) will reduce its capacity by 20%

Looking at this graphically:

```
plot(plot::Circle2d(5, LineColor=RGB::Blue),  
      plot::Circle2d(4.87, LineColor=RGB::Green),  
      plot::Circle2d(4.47, LineColor=RGB::Brown))
```



The proponent's margin where we can run the pipes at 95% capacity gives a margin signified by the the area between the green and blue circles. The peer review's margin where we can run the pipes at 80% capacity is signified by the area between the brown and blue circles. The proponent's own projections start many of the pipes at 94% capacity (worst case, which is what you must plan for) but they somehow conclude that this is enough.