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September 17, 2020

Matthew Fountain
Director, Department of Stormwater Management
City of Charleston
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Dear Matt,

Thank you very much for your offer to answer further engineering questions as they arise.

In this regard, I am writing to follow-up on an e-mail that you sent on April 28, 2020, to 30 residents, consultants, attorneys, and city, county and state staff and elected officials. I understand that the purpose of the e-mail was to explain why the City of Charleston does not wish to unseal the 42" stormwater outfall pipe at the EME Apartments.

This is the passage from your e-mail that is confusing to me:

"The EME Apartment access road cross pipe has been a major area of questions in this email thread. We did review the current condition of that system as part of our work. The drainage box in the location of number 4 (see photo below) does have 2 pipes (a 42" diameter pipe, and a 48" diameter pipe) that leave the box to go under EME's Access Driveway. On the outfall side at the location of number 5, only the 48" diameter pipe is currently present. It does look like the 42" pipe was actually sealed shut a number of years ago rather than it being clogged.

As a result we reviewed the stormwater models that have been run recently for this area including the work by AECOM for the City on evaluating drainage improvement projects. The models have been using the single 48" pipe for the existing drainage condition based on the currently present condition.

We did have AECOM evaluate upsizing or reconstructing this pipe in our current model to determine if it has any benefit on reducing flooding. The drainage model shows that there are a number of upstream constrictions that also need to be improved before upsizing this pipe would reduce flooding in the area. For example, the pipes under Central Park Road are a 42" pipe and a 36" pipe, and between Central Park and this drainage box are another pair of 42" pipes, all of which already have less capacity than this downstream 48" pipe."

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I am confused about your argument that two parallel 36" and 42" pipes, as well as two parallel 42" pipes, each have less flow capacity than a single 48" pipe.

Suppose that we start with the Chézy Equation for gravity-driven flow

$$U = \left(\frac{gRS}{K_T}\right)^{1/2}$$

where U is average velocity, g is acceleration due to gravity, R is hydraulic radius, S is slope and K_T is a dimensionless proportionality constant (S.L. Dingman, Fluvial Hydraulics, 2009, Equation 6.15a).

The hydraulic radius (ratio of cross-sectional area to wetted perimeter) for a circular pipe is $D/4$, where D is the pipe diameter.

Thus, the Chézy Equation for a circular pipe is

$$U = \left(\frac{gDS}{4K_T}\right)^{1/2}$$

so that Q, the flow rate through a circular pipe, is given by

$$Q = \frac{\pi D^2}{4}\left(\frac{gDS}{4K_T}\right)^{1/2} = \frac{\pi}{4}\left(\frac{gS}{4K_T}\right)^{1/2} D^{5/2}$$

Thus, we see that the flow rate is proportional to the diameter to the (5/2) power. On that basis, the diameter of a single circular pipe that would have the same flow rate as two smaller parallel circular pipes is given by

$$D = \left(D_1^{5/2} + D_2^{5/2}\right)^{2/5}$$

where D is the diameter of the larger pipe and D_1 and D_2 are the smaller pipe diameters.

The above equation can then be used to show that two parallel 36" and 42" pipes have the same flow capacity as a single pipe with diameter 51.7". Moreover, two parallel 42" pipes have the same flow capacity as a single pipe with diameter 55.4."

If the Manning Equation were used instead of the Chézy Equation, the flow rate would be proportional to the diameter to the (8/3) power. In that case, two parallel 36" and 42" pipes

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would have the same flow capacity as a single pipe with diameter 50.8" and two parallel 42" pipes would have the same flow capacity as a single pipe with diameter 54.5."

On the above basis, it seems that the constriction is not upstream. The constriction is at the drainage box at the EME Apartments.

If I have made some mistake, I would be grateful if you could let me know. Otherwise, I would be grateful if you could explain further why the City does not to wish to unseal the 42" stormwater outfall pipe at the EME Apartments.

I thank you very much for your attention to this matter and look forward to hearing from you.

Best wishes,

Steven H. Emerman