METROPOLITAN SEWER DISTRICT of greater CINCINNATI

Date: October 8, 2012

To: Commissioner Greg Hartmann
Commissioner Chris Monzel
Commissioner Todd Portune

Cc: Christian Sigman, County Administrator
Jeff Aluotto, Asst. County Administrator

From: James A. Parrott, Executive Director

Subject: LICK RUN FLOODING EVALUATIONS

The geography of the Lick Run watershed is such that it is shaped similar to a bathtub, with the center of the watershed being the lowest point, and the combined sewer currently as the drain. Flooding evaluations and analysis for this watershed were conducted in November 2009 and summarized in the Preliminary Engineering Analysis Report and incorporated into the planning and design of all proposed storm water improvements. Sizing and locations of new pipes and drainageways are designed to reduce CSOs with long term, sustainable techniques by implementing stormwater mitigation projects that improve existing conditions and reduce the risk of potential flooding. The design of the Sustainable Alternative utilized current and applicable stormwater design standards and best management practices so as to conform with relevant criteria; the valley conveyance system (VCS) was specifically designed for the 100 year storm condition.

In general, concerns regarding "flooding" and "water in basement" were identified in public comments as a potential risk with sewer separation projects of MSD's Sustainable Alternative. Specific concerns related to the South Fairmount Corridor were "Could localized flooding occur which could threaten real property and human life" if:

- The proposed design storm is exceeded

- The flow model projections are incorrect

- Other hydraulic issues, such as backwater caused by elevated stage levels at Mill Creek or Ohio River.

Below are the considerations that have been included in the Lick Run project to address these identified risks:

- Preliminary Engineering Analysis included stormwater modeling for sewer separation areas and drainageway evaluations. The HEC-HMS model was used which was developed by the United States Army Corps of Engineers to simulates the precipitation-runoff process; this developed output results for incorporation into routing models for further analysis. These models were used to design the storm sewer system and Valley Conveyance System (VCS) to convey the 25-yr and 100-year storm events, respectively.

- Preliminary designs of the open and closed storm sewer conveyance systems within the Tier 1 area are sized based on SMU design criteria which require the 10 year pipe full and the 25 year hydraulic grade line does not break the ground surface. For open conveyance system, this is dependent upon a major or minor drainage way. Roadway ditches are designed for a 10 year storm and all other channels (except major) are designed for a 25 year storm. For all major channels, 100 year storm is the SMU design standard. The proposed storm sewer alignment utilizes existing storm water entry points into the CSS. Those entry points are being sealed and disconnected so that the storm water and natural drainage can flow into the new conveyance system (for 25 year design). Additional conservancy is included in the pipe sizes which are sized for storm water volumes from the tributary areas, including rooftops which will still be connected to the CSS.

- Preliminary designs of the VCS have been completed, and need to be refined into final designs. The VCS preliminary design is a hybrid system that provides capacity for the 100 year storm event using a combination of a box conduit/storm sewer, underneath a naturalized conveyance channel. The combination VCS channel and box conduit, located within the South Fairmount neighborhood corridor, are currently sized to convey the stormwater runoff from the entire watershed, even though a percentage of the stormwater will continue to be conveyed by the existing combined sewer. This is one example of the conservative design approach being considered to provide additional protection from localized flooding. This approach also allows for additional separation overtime as the VCS is a central conveyance asset within this network of stormwater mitigation/CSO reduction project.

- The current land acquisition plan is intended to procure necessary parcels within the South Fairmount corridor for construction and operation of the VCS, including those parcels necessary for re-shaping existing grades to accommodate the 100 year storm condition. Availability of assembled property will be further evaluated as the design of the VCS advances.

CURRENT CONDITIONS FOR A 100 YEAR STORM EVENT

Stormwater and natural drainage from the Lick Run watershed currently flow into the combined sewer system. During 100-year flooding conditions, Mill Creek can and likely does back up at CSO 005 into the combined sewer system and exits into the neighborhood from upstream manholes, inlets and sewer laterals, causing flooding within the South Fairmount corridor.

The Federal Emergency Management Agency (FEMA), the agency that determines floodway and floodplain mapping has not defined or mapped floodplain boundary within the Lick Run watershed. To illustrate projected flood conditions in the South Fairmount corridor during existing conditions, the Design Team conducted a coarse modeling exercise to illustrate how the overland flow for the 100-year storm condition for Lick Run watershed comparatively impacts this corridor. The outcome of this

analysis, with an assumption that the CSS has capacity for the 25-year runoff flow and the remaining 100-year runoff flow account for flow that cannot enter the existing combined sewer system (CSS) or exit to the Mill Creek. In Figure 1 below is an illustration of the projected flooding for this condition. In comparison of this existing condition with the future VCS condition, as shown in Figure 2, flooding is anticipated to be significantly reduced.

FIGURE 1- Projected Existing Surface Flooding in the South Fairmount corridor for 100 year storm (25 year CSS capacity assumed)

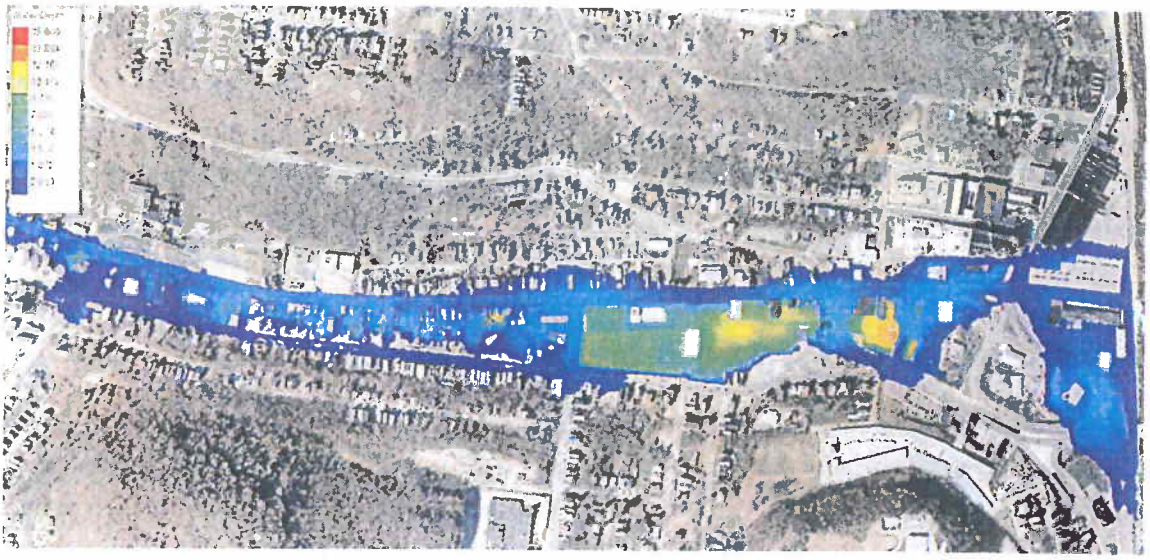


FIGURE 2- Projected Surface Flooding in the South Fairmount corridor during future conditions for 100 year storm event

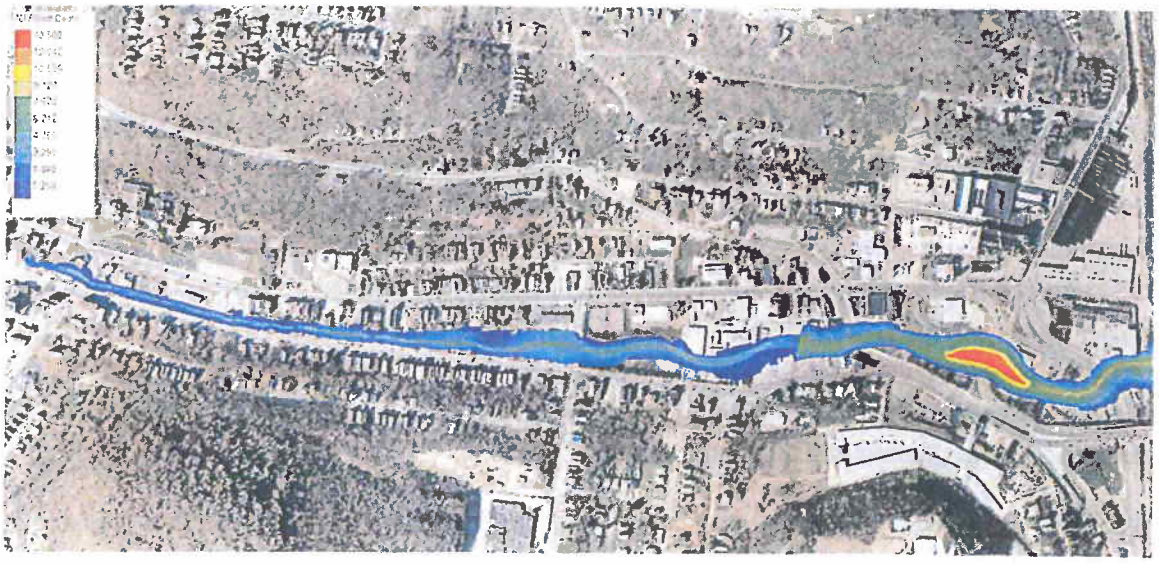


Figure 1 above illustrates existing conditions of surface flooding within the South Fairmount corridor. The darker blue suggests depths of water ranging from 0-1 foot of water during the 100 year storm, light blue being approximately 3 feet of water and green being between 5 – 7 feet of water. During events up to the 100 year storm condition, the CSS is the only conveyance system for such flood water to exit the South Fairmount corridor. Existing ground elevations at the railroad corridor and Beekman Street act as barriers, essentially damming up the flow so that it can not flow overland into Mill Creek from the South Fairmount corridor. Also, as previously noted, when Mill Creek is at flood stage, it is actually 5 feet above the catwalk of CSO 5 and has the ability to backflow up into the CSS and enter the South Fairmount corridor by manholes, inlets and sewer laterals.

Figure 2 above illustrates the anticipated future flooding conditions, with 1-foot of freeboard, once the VCS is constructed. The difference between the before and after conditions shown are significant, illustrating that flooding risks following the construction of the VCS will be significantly reduced.

VALLEY CONVEYANCE SYSTEM SIZING AND FLOOD ELEVATION CRITERIA

The development of engineering models to analyze and refine the preliminarily design for the proposed hybrid VCS has evolved through several phases. A hydrologic stormwater model has been created to develop runoff hydrographs entering the VCS, utilizing HEC-HMS. HEC-HMS is a computer program developed by the United States Army Corps of Engineers that simulates the precipitation-runoff process. HEC-HMS estimates peak stormwater discharges and volumes based on mathematical input parameters representing precipitation depth and time distribution, drainage area, land use, and time of concentration for each subbasin. Further discussion regarding hydrologic modeling methodologies, input parameters, and assumptions is included in the November 2009 Lick Run Preliminary Engineering Analysis report.

Sewer separation is proposed for approximately 1,800 of the 2,700 acre Lick Run watershed. This area has been termed Tier 1 area, with the remaining 900 unseparated acres being termed Tier 2 area. As previously noted, a percentage of the stormwater runoff will continue to be conveyed by the existing combined sewer. This consists of the Tier 2 stormwater flows that are currently intercepted by the CSS during storm events. Although strategic sewer separation is being proposed for the Tier 1 areas only, it was conservatively assumed that none of the runoff during the larger 100-year design storm event, was collected in the existing combined system and would ultimately need to be conveyed by the VCS. This assumption was made, due to SWM modeling indicating wide spread surcharging in combined sewers throughout the Tier 2 areas during frequent storm events.

Runoff hydrographs for various storm events were developed, for both the entire watershed and the Tier 1 areas, and imported into the XPSWMM computer program to develop a hydraulic stormwater model for the VCS. Because of the unique character of the VCS and the hydraulic interconnection of the channel and box conduit, the Extended Transport (EXTRAN) module of XPSWMM was used to calculate the hydraulic capacity of this system working together. EXTRAN is a dynamic flow routing model that

routes runoff hydrographs through an open channel and/or closed conduit system computing the time history of peak runoff flows, hydraulic grade line elevations, and velocities throughout the system. Inputs to EXTRAN included the following:

- The physical geometry and dimensions of the box conduit conveyance system including invert elevations, roughness coefficients, and special hydraulic structures such as grates that provide interconnectivity to the open channel system.
- The physical geometry and dimensions of the open channel conveyance system including invert elevations, storage volume, roughness coefficients, and proposed bridge opening configurations.
- Starting tailwater elevations at Mill Creek. Flood elevations from the Hamilton County Flood Insurance Study (FIS) were used for starting conditions for each corresponding return interval storm event analyzed [i.e., the Mill Creek 100-year FIS flood elevation 484.0 (NGVD)].

Using this information, the proposed VCS was preliminarily designed to protect the South Fairmount corridor from flooding up to a 100-year storm event, with a factor of safety. Several points are critical factors in understanding how this flood protection is provided, and the conservancy that has been included in the design.

1. As mentioned above, the VCS is sized to convey up to a 100-year storm event from the entire Lick Run watershed, with a minimum of 1-ft freeboard to adjacent roadway and bridge infrastructure, as well as developed areas within South Fairmount remaining after project construction. This sizing criteria is conservative in that there are portions of the upper areas of the watershed (Tier 2 areas), where a percentage of the stormwater will continue to flow into the CSS, and will not make it to the VCS.
2. The tailwater elevation used for the VCS the 100-year storm event is assumed to be 484.0, which is the 100-year flood elevation for Mill Creek. However, according to American Association of State Highway and Transportation Officials (AASHTO), the joint probabilities of design coincident flows at tributary and mainstream confluences should be considered when designing for the probability of flooding at a confluence. In order to do this, selection of the proper combination of design storms depends on the watershed area ratio of the mainstream and tributary waterways.

The Mill Creek and Lick Run watershed areas (at their confluence) are approximately 150 and 4.3 square miles, respectively. This equates to a watershed area ratio of 35 to 1. Review of AASHTO Table 3.02-1, shown on the following page, indicates that in order to attain a 100-year design frequency for the confluence, the hydraulic analysis shall consider the simultaneous occurrence of a 100 -year event for Lick Run (the tributary) and between a 25- and 50-year event for Mill Creek. Review of Mill Creek flood profiles provided within the Flood Insurance Study (FIS) report for Hamilton County, Ohio, and Incorporated Areas (May 17, 2004) published by the FEMA indicates the 50-year base flood elevation of Mill Creek at the confluence of Lick Run is 482 (NGVD). This would suggest then that a tailwater

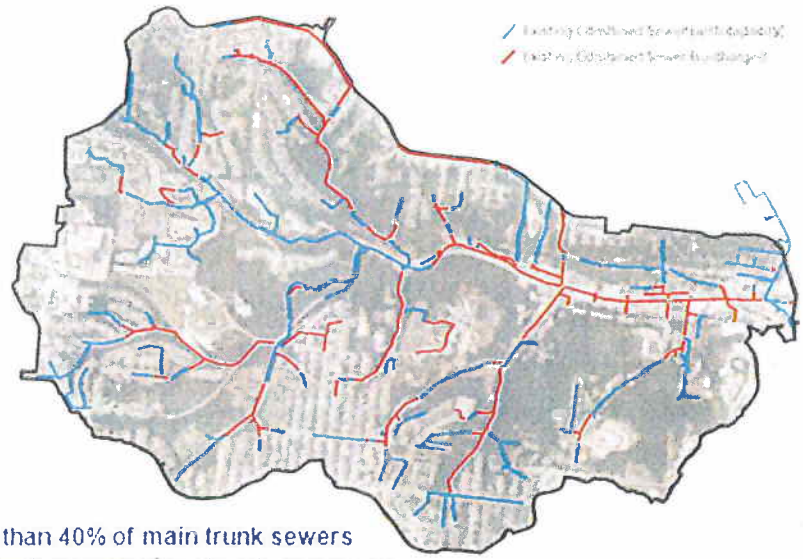
LICK RUN FLOODING EVALUATIONS

A comparison was performed evaluating surcharged conditions of the combined sewer system pre- and post- sewer separation in the Lick Run watershed, utilizing the Lick Run subbasin/system wide model (SWM). A summary of these results is presented in the table below and accompanying maps.

CRITICAL DURATION STORM EVENTS (PERCENT MODELED CSS SURCHARGED)					
	6 Month	2 Year	5 Year	10 Year	25 Year
Pre-Sewer Separation CSS Surcharging	8%	28%	36%	42%	46%
Post-Sewer Separation CSS Surcharging	5%	9%	14%	19%	21%
Percent Reduction in CSS Surcharging	**35%**	**67%**	**60%**	**55%**	**54%**

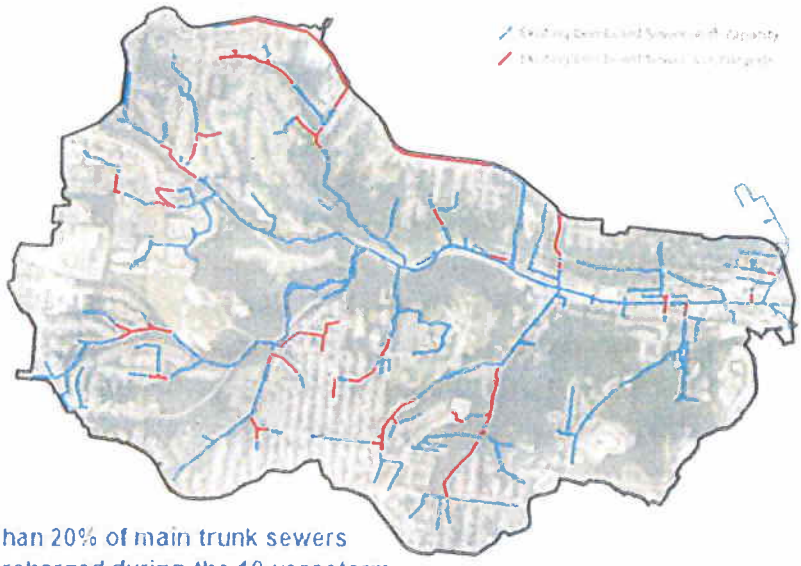
The indication from the results shown in the table above and maps below is that greater than a 50 percent increase in combined sewer system level of service can be expected in all modeled storm events greater than a six-month return interval. This further translates to an anticipated decrease of localized flooding.

Existing Conditions



More than 40% of main trunk sewers are surcharged during the 10-year storm

Proposed Separate Stormwater Conveyance



Less than 20% of main trunk sewers
are surcharged during the 10-year storm

The location of the VCS is at the lowest point in the watershed, where all wet weather flows that are not currently able to get into the surcharged combined sewer system currently travel overland from the remainder of the Lick Run watershed. Theses flows currently have no established overland route to Mill Creek once they reach the South Fairmount corridor and result in localized flooding of stormwater likely mixed with sewage until they are eventually drained through the existing CSS. The projected levels of flooding during these existing conditions are as shown previously in Figure 1.

As such, with construction of the proposed VCS, localized flooding and (lack of) overland flow routes currently existing in this area will be controlled to a much higher level. Further, the 100-year capacity of the VCS will provide increased reliability in the performance of the tributary storm sewer connections up to their design limitations.

IMPACT OF PEAK FLOWS

It is anticipated that impacts to Mill Creek associated with peak flows from the proposed SI projects would be relatively minor impacts in comparison to existing conditions. System-wide modeling efforts have indicated, a significant portion of the combined sewer system is inundated during storm events in excess of a 6-month return interval, and existing CSOs provide discharges to Mill Creek for storm events on a similarly frequent basis. So, in actuality the majority of the volume of flow is already getting into channels but it is mixed with sewage as a CSO. In Lick Run specifically, the CSO volume discharged to Mill Creek in the Typical Year is estimated to be approximately 1,000 million gallons (system-wide model version 4.2). After implementation of the Lick Run SI projects, the CSO volume discharged to Mill Creek