Jacobs

Memorandum

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Subject	Task 3 - Develop Understanding of Causes and Potential Solutions	**Project Name**	Republic Services Landfill Odor Study
Attention	Joseph E. Stroin Jr., Director-MTUD	**Project No.**	E6X98000
From	Bart Kraakman and John Tobia		
Date	January 19, 2021		
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1. Introduction

Jacobs Engineering Group Inc. (Jacobs) was engaged by the Monroe Township Utility Department (MTUD) to undertake an Odor Investigation Study (Study). The Study includes gathering data from focused field sampling, lab analyses, landfill cover inspection and sewage collection system analyses. The goal is to understand how odor nuisance occurred in the Monroe Township community north-east of the Monroe Township Landfill Superfund Site (Landfill) and help develop potential solutions.

1.1 Purpose and Objectives

The purpose of the Study was to define the odor sampling locations, sampling methodology, and associated analytical methods to enable the Study team to support the following objectives:

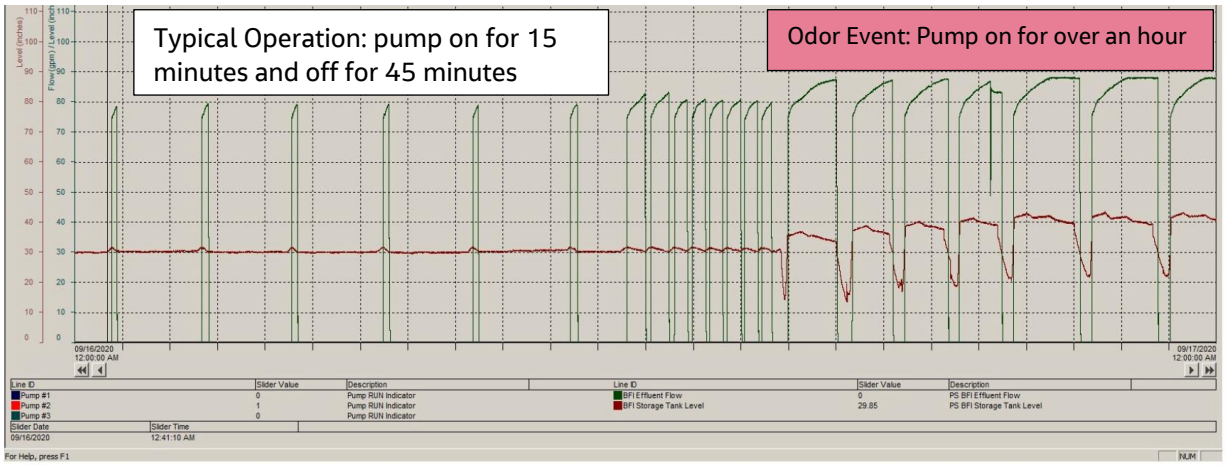
- Identification of critical odorant compounds and potential hazardous compounds;
- Develop an understanding of potential causes of the odors experienced in the community;
- Generate a list of potential solutions for eliminating odor nuisance generated; and
- Review Republic Services recommended corrective action(s).

The overall objective is to communicate to the responsible parties (EPA, Republic Services and the New Jersey Department of Environmental Protection) potential corrective actions needed to prevent certain chemical odors from being released into the residential neighborhood known as Inwood Estates, consisting of portions of Michelle St., Lori St., and Lani St., adjacent to the Landfill site.

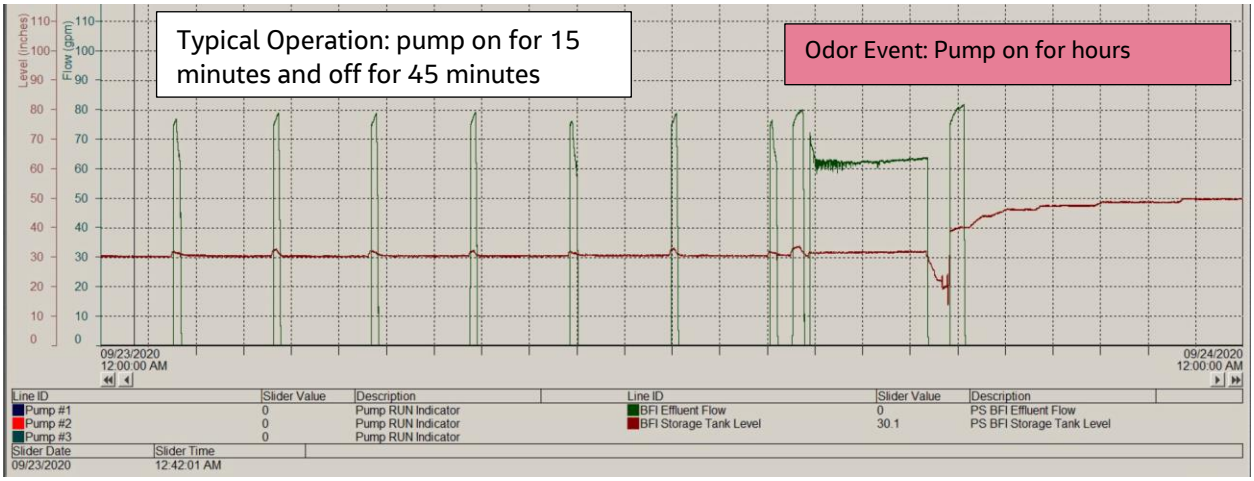
Jacobs scope of work consisted of field sampling, lab analyses and sewage collection system analyses to understand how odor impacts in the communities likely occur, data analysis for identification of critical odorant compounds and potential hazardous compounds, a cause analysis and reporting. Data analysis was presented in the Task 2 memo submitted on January 11, 2021. In addition, Jacobs reviewed Republic Services recommended corrective actions.

1.2 Problem Statement

Monroe Township residents complained during August and September 2020 of chemical odors in their homes and neighborhood from the municipal sewer system on different occasions. Monroe Township Utility Department (MTUD) in consultation with Republic Services (Republic) determined that the duration of flow from the untreated landfill leachate system, which discharges into the municipal sewer system that runs through the residential neighborhood, was longer than typical (hour plus on, 15 minutes off on 9/16, continuous for hours on 9/23 versus normal operation: 15 minutes on – 45 minutes off) during the subject period and was the likely cause of the odors. The SCADA screen shots below depict flow rate and duration for the leachate pump. Since the odor incidents, Republic has been hauling the leachate offsite from the leachate holding tank and no longer using the leachate force main that discharges to the residential sewer system.



September 16, 2020 – Leachate Pump SCADA data



September 23, 2020 – Leachate Pump SCADA data

Several residents who live on Michelle Street and Lori Street, just north east of the Landfill site notified the EPA and the Township about a chemical odor in August 2020. On September 16 and 17, 2020, those same residents, and several additional neighbors reported significant and constant odor both inside and outside their homes. Township officials investigated the situation on September 17 and confirmed the odors and determined that the sewer collection system was operating normally without malfunction.

The liquid flow from the Landfill site during the weeks leading up to September 16 demonstrated a relatively steady state operation. However, on September 16, the pumping pattern changed significantly with a total flow increase of ten times normal flow until late afternoon of September 17 when Republic was ordered by the mayor of Monroe Township to shut down all pumps. Republic stated that operational issues caused higher pumping but did not clarify exactly what happened. Republic responded by lowering the leachate pump rates, which seemed to help, but the odor and the complaints returned on September 23rd; Republic then decided to shut the pumps off. Republic is hauling the leachate offsite since and no longer using the leachate force main system that discharges to the municipal sewer. Temporary above ground storage tanks were brought on-site to provide additional leachate storage and to improve the Republic's ability to remove (haul away) leachate on a regular schedule.

2. Develop Understanding of the Odor Causes

2.1 Summary of the Analytical Odor Testing

Jacobs performed services related to the identification of critical odorant compounds and potential hazardous compounds. Task 2 (Conduct Data Acquisition and Analysis) was focused on obtaining the necessary data to allow identification of odor strength, odor compounds and potential hazardous compounds (see Task 2 Memo). This study shows that:

1. The odor character of the leachate is significantly more intense and less pleasant when compared to the odor character of the sewage. The odorous chemical compounds detected in the leachate by the laboratory explain the general odor description of the leachate ('*chemical', 'gasoline', 'solvent', 'diesel'*) at the time of the sampling.

2. The odor emission rate (OER) will be significantly higher from the leachate when compared to the sewage; and can be expected to be significantly more than one order magnitude higher when the leachate pumping rate is around 80 gpm and the daily average sewage flow is about 7.5 gpm. It is expected that sewage turbulence will increase during periods of higher residential water use (diurnal peaks) as compared with the average sewage flowrate of 7.5 gpm; this may also increase the odor emission rate of the liquids. Therefore, caution is recommended when considering the future leachate pumping rates into the sanitary sewer system.

3. Multiple hazardous compounds have been identified in the leachate which can be emitted from the leachate when discharged into the sewerage collection system. Based on the samples taken on December 2, 2020, it is expected that the exposure to compound concentrations in the residential neighborhood and homes along the sewer alignment that conveys leachate are most likely not exceeding the exposure limits as recommended by the National Institute for Occupational Safety and Health (NIOSH). Although the chemical compound concentrations appear to be below the NIOSH Recommended Emission Limits (REL), the compounds are toxic substances and should not be in people's homes. It also needs to be noted that the leachate sample taken on December 2

was relatively dilute when compared to what is typical for leachate; therefore, if the leachate were to become more concentrated with contaminants, it is expected that concentrations in air would be higher than noted in this memorandum and may exceed their REL.

4. The liquid quality of the leachate seems typical for leachate (although relatively dilute at the time of sampling). Based on the parameters measured of both the sewage and the leachate, it is not expected that the sewer water chemistry is making the leachate odors significantly worse. It may be that the pH of the leachate becomes slightly higher when blended with the sanitary flow, potentially promoting the emissions of ammonia from the leachate, while the pH of the sewage will become slightly lower, potentially promoting the emissions of odorous hydrogen sulfide and methyl mercaptan from the sewage.

2.2 Summary of the Landfill Cover Inspection

Jacobs review of the landfill, summarized in our November 12, 2020 memorandum, indicates that, in general, the well-established vegetative landfill cover is intact and there are limited signs of cover erosion. However, there are numerous areas of standing water primarily in the southern half of the landfill. The depressed areas are typical surface expressions for a landfill of this age and are likely caused by decomposition and subsequent subsidence of the landfill contents. These irregularities are typically repaired on an annual basis as part of routine post-closure care maintenance. Regulatory requirements for post-closure maintenance of municipal solid waste landfill cover systems are contained in 40 CFR §258.61 (a)(1):

> *"(a) Following closure of each MSWLF unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for 30 years, except as provided under paragraph (b) of this section, and consist of at least the following:*
>
> > *(1) Maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover."*

There are a number of routine activities that should be conducted as part of a long-term cover system maintenance program. These activities can generally be divided into the following major categories:

- vegetation-related activities
- erosion-related activities
- subsidence-related activities
- other surface layer performance related activities
- drainage layer related maintenance
- surface-water related activities
- monitoring system-related activities

An example of typical landfill post-closure care monitoring and maintenance schedule is presented in Table 1.

It is not clear if there is a landfill post-closure plan for this landfill. It should be used as a guide to maintain and track the integrity of the landfill closure.

We recommend the landfill cover be surveyed to identify depressions, areas of reverse sloping, and rutting and that in these areas the operator reestablish grades to promote stormwater runoff toward the perimeter and ensure vegetation is established to reduce the incidence of soil erosion. Reducing or eliminating depressions that retain rainwater should help reduce the quantity of landfill leachate generated.

The effectiveness of the cover stormwater management system should also be evaluated, and corrective measures should be implemented as deemed necessary. Consideration should be also given to evaluating the hydraulic performance of the cover system. Freeze–thaw, desiccation, settlement, and rotational movement can cause increases in hydraulic conductivity[1] in soil and clay covers. Benson et al. (1995) documents hydraulic conductivity increases of at least an order of magnitude and in some cases two to three.

Table 1 : Example of Landfill Site Monitoring and Maintenance Schedule

Component	Inspection and Monitoring Frequency	Methods[1]
Cover System Vegetation	Monthly	Visual
Cover System Erosion	Monthly and After Major Storms	Visual
Cover System Intrusion	Monthly	Visual
Cover System Subsidence	Quarterly	Visual
Cover System Slope Stability	Quarterly	Visual
Cover System Drainage Outlets	Quarterly	Visual
Cover System Grades (Survey)	Every 5-years	Survey/GPS
Gas Extraction System	Monthly	Visual
Surface-Water Management System	Quarterly and After Major Storms	System Check
Leachate Collection and Removal System	Monthly	System Check
Perimeter Security (fence, gate, locks)	Quarterly	Visual
Access Roads	Quarterly	Visual
Groundwater Monitoring System	Quarterly	System Check
Gas Monitoring System	Quarterly	System Check
Survey Monuments	Annually for First 5 Years, at 5 Year Intervals Thereafter	Survey
1. Frequency of inspection and monitoring may be reduced (or increased) based on observed conditions during the post-closure period.		

[1] Benson, C., T. Abichou, M. Olson, and P. Bossacher. 1995. "Winter Effects on the Hydraulic Conductivity of Compacted Clay." J. of Geotech. Eng. ASCE. Vol. 121, no. 1. pp. 69–79.

2.3 Summary of the Sanitary Sewer Geometry and Characteristics

The leachate is discharged from the landfill leachate storage tank into the Township's sanitary sewer system in Lani Street. This is an 8-inch pipe that gravity drains east along Lani Street, flows north along Michelle Street and discharges into a manhole located at the intersection of Michelle Street and Lori Street. Appendix A provides an overview of the sewer collection system. MTUD undertook a sewer camera inspection of the sewer system completed on October 13, 2020. The camera inspection videos show that the inspected pipes appear to be in working order as no damage or blockages were observed. Nevertheless, the following sewer characteristics should be taken into consideration while developing solutions to the odor problems.

1. The sewer pipe beneath Michelle Street has a steep slope of the pipes of nearly 4%. Steep slope sections of pipe create negative air pressure along that pipe run as the wastewater drags the headspace air with it as the sewage (and leachate) flow accelerates downwards. That vacuum may create a negative impact on the sanitary sewer and plumbing systems; if the vacuum is strong enough to drain the water out of the sanitary laterals and evacuate water from the house plumbing traps that are in place to keep sewer system gases out of houses.

2. The slope of the pipe flattens out at the end of Michelle Street, flatter to about 0.5%. This pipe connection of a steep slope with a flatter slope is known to create a hydraulic jump as the faster moving wastewater from the steeper slope tries to overrun the slower moving wastewater in the flatter pipe. Hydraulic jumps occur at the transition zone, which means an area of high turbulence in the sewage flow, which is directly related to stripping of odor causing compounds from wastewater and leachate flow into the sewer headspace. This intersection of fast-moving water meeting slow moving water also creates a positive air pressure shock wave that radiates out and away in all directions possible. Increased leachate flow rates for extended time periods may increase the water levels in the 8-inch pipe exacerbating the above phenomena and potentially creating a bottleneck for the headspace air causing a 'choking' effect. The choking effect traps and pressurizes odor-laden air in the sewer headspace, which can back-up into homes with compromised plumbing traps or through sanitary sewer manhole cover and frame gaps.

2.4 Review of the Revised Republic Leachate Reintroduction Plan (1/6/21)

Jacobs reviewed Republic's initial leachate reintroduction plan, dated 12/2/20 and provided comments in a December 8, 2020 memorandum. An updated leachate reintroduction plan was submitted by Republic on 1/6/21; Jacobs reviewed this memo. The updated leachate reintroduction plan considers many of the recommendations identified in the Jacobs 12/8/2020 memo and should be an acceptable approach to establishing a baseline for the leachate flowrate the existing sanitary sewer can handle without triggering excessive sewer air (de)pressurization causing odor nuisance in the residential neighborhood and homes along the sewer alignment that conveys leachate.

The updated reintroduction plan involves an incremental increase of clear water flow into the sanitary sewer (simulating leachate flow) with a fixed flow rate for a duration of at least 60 minutes. However, rather than increasing the flow rate in incremental steps, a pump stop in between each flow rate change should be considered to not only establish base-lines for the maximum leachate flow rates, but also to help establish the baseline for sudden changes of the leachate flow rates in the sanitary sewer.

3. Solution Developments and Recommendations

Based on the information collected both by Jacobs and other stakeholders, we've identified the following recommendations to help eliminate the incidences of leachate-generated odor events:

- Determine the current and future minimum/maximum/average leachate production rates at the landfill. Develop a sound basis for leachate storage and pumping requirements based on historical records, and on future projections of climate change predictions; including, rainfall intensity and duration. Compare actual leachate production to calculated leachate production; determine if the landfill cover is compromised and is allowing excess surface water infiltration into the landfill.

- Make improvements to the landfill to reduce the amount of leachate generated, including filling low spots and regrading. These landfill cover improvements should ensure that excess rainwater is conveyed to the site storm drainage system and does not have the opportunity to percolate through the landfill cover and generate excess leachate.

- Effectively operate the landfill dewatering system to achieve the operational objectives; maintaining a lower groundwater elevation within the landfill as compared with external to the landfill and avoiding long leachate detention times ('cooking' times) in contact with the landfill contents which can increase the "strength" of the leachate making it more odorous.

- Ensure the leachate collection tank has adequate buffer capacity for now and in the future to level out the amount of leachate that needs to be removed from the landfill during any time of the year and pumped to the sanitary sewer system.

- Upgrade the existing SCADA system to monitor all leachate pump operations, leachate storage tank levels, and integrate pump and level control schemes and set points for pumping rates and durations so they never exceed the thresholds determined from any modeling or field studies of the sewer system. This should include remote access to allow for data viewing and intervening to instantly reduce or temporarily cease leachate flows when required.

- Determine the maximum flowrate capacity of the existing sanitary sewer (both in maximum flow rate and duration) to prevent sewer capacity problems from generating odors in the sewerage collection system downstream of the leachate discharge point near the impacted homes. Considerations should be given to the following when further developing a detailed plan for reintroducing leachate flow into the municipal sewer system:

    - The local air pressurization of the sewer as a result of relatively large volumes of leachate (compare to sewage flows) when leachate discharges take place over an extended period. This should include considerations of the existing sewer infrastructure, including transition zones between sections of sewer mains with steep pipe slopes and flatter pipe slopes.

    - Preparation and analysis of sewer pipe models and sewer gas models to determine acceptable flow rates, flow durations and acceptable sudden flow increases.

- The installation of in-situ sewer flow, level and air pressure instrumentation to generate data that captures "baseline" sanitary flow, level and headspace pressure conditions without leachate present, and to generate data during leachate flow simulation activities (i.e., introduction of potable water into the sewer system under controlled conditions) and potentially "return-to-service" conditions when leachate is reintroduced to the sewer system. The intent is to create the opportunity to determine the optimal leachate discharge flow and time of day considerations under all future scenarios (including unusual conditions such as extended periods of heavy rain and operational upsets in managing the collection of the leachate at the landfill). This data should be generated by introduction of clean water (fire hydrant with backflow preventer) into the sewer system, simulating leachate flow from the landfill.

- The installation of local odor control measures along the sewer alignment that conveys leachate flow could be considered. Examples are the installation of an "air jumper" at potential bottleneck sewer locations, elevated sewer stack vents, or an odor control unit.

- If expected future leachate discharge flows and durations are higher than the determined maximum capacity of the sanitary sewer allows, consider installation of a new dedicated leachate force main from the landfill site to a discharge point in the larger downstream sewer along Spotswood Englishtown Road.

Appendix A Sanitary Sewer Characteristics

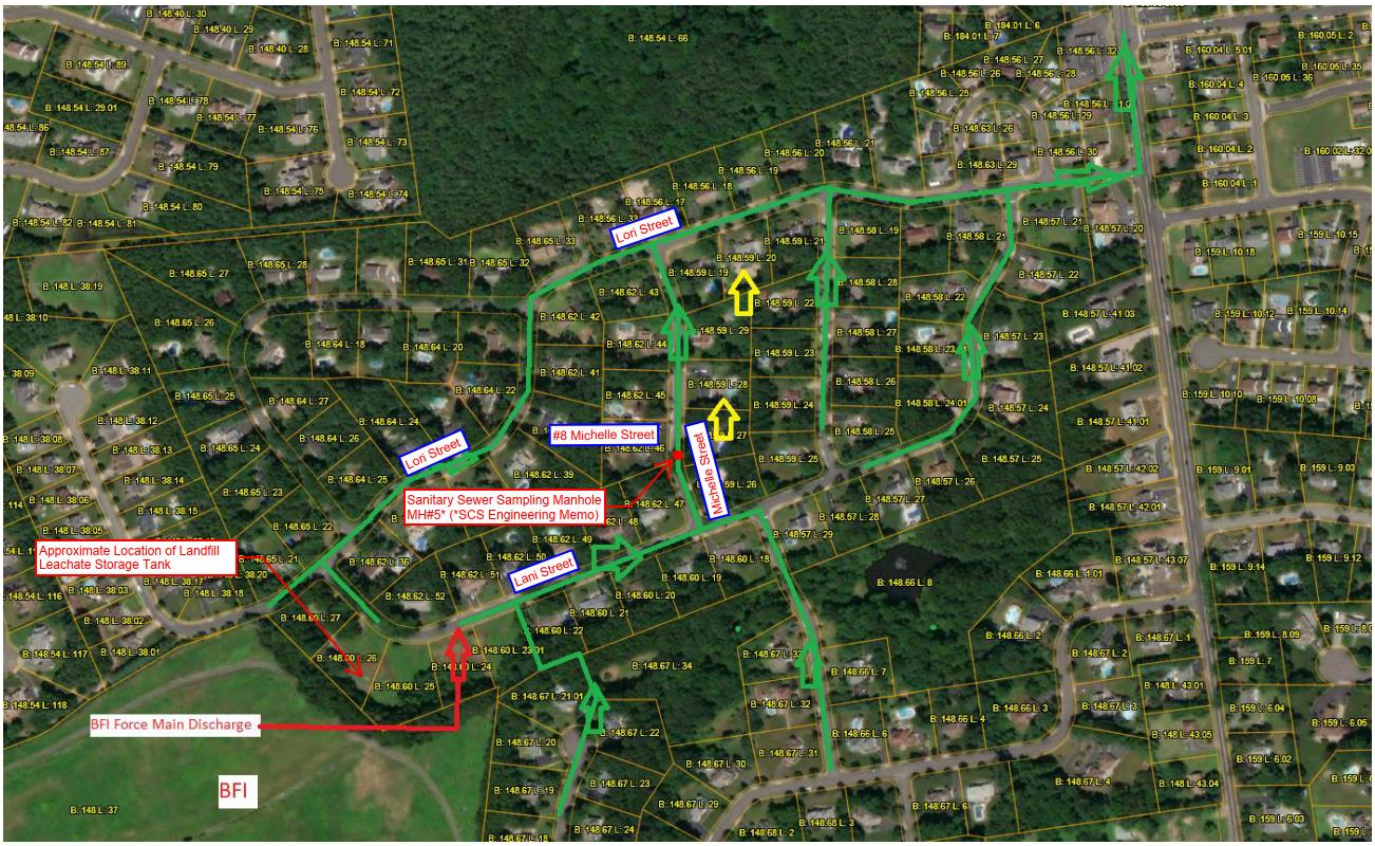


Exhibit A: Sanitary Sewer System Map Adjacent to Landfill Site

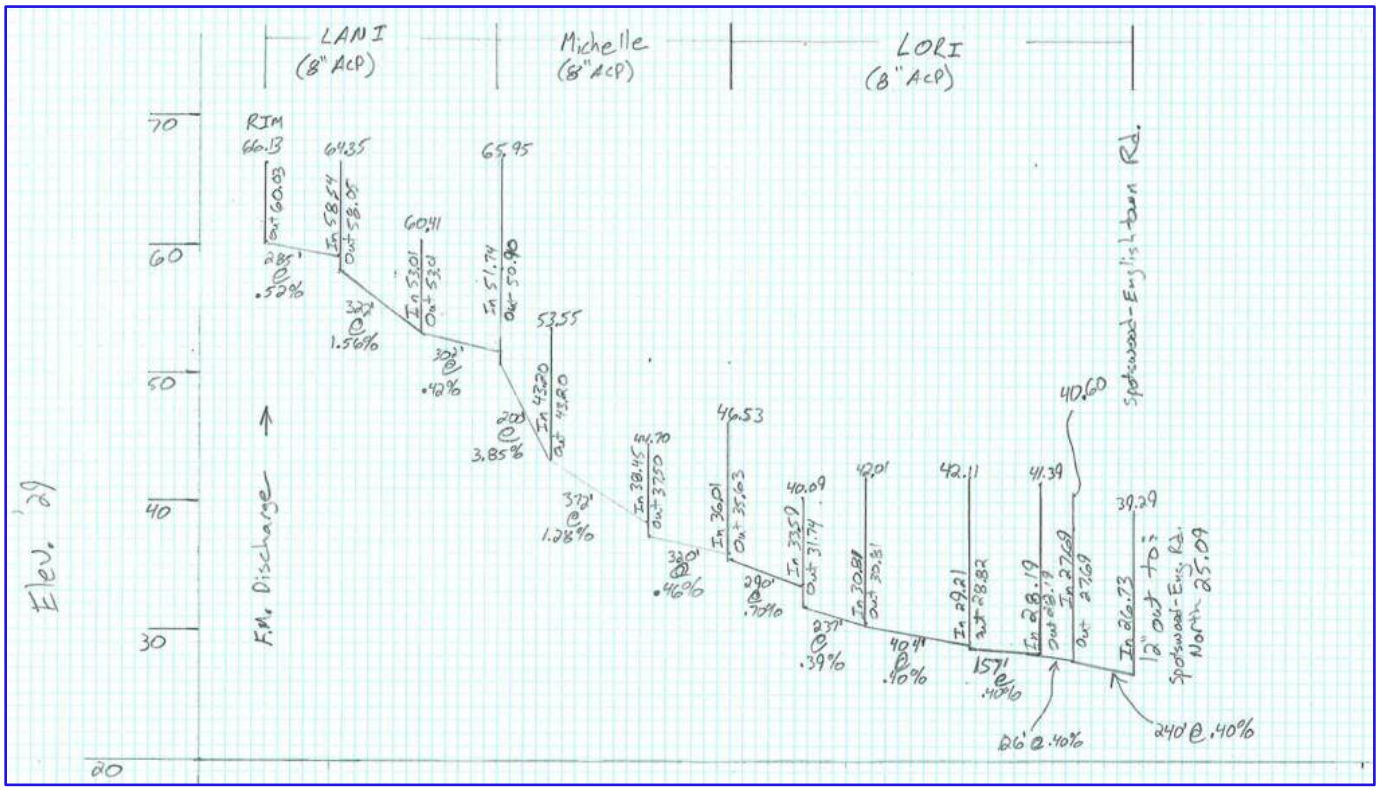


Exhibit B: Sanitary Sewer System Profile, Courtesy of MTUD