Evaluation of Wastewater Network of Al-Anwaar in Al-Kut City, Iraq by Using SWMM and GIS Techniques

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Abstract:-Sewerage network in urban areas, such most other infrastructure, buried underground, making access to data difficult and expensive. So, there are some Institutions that all or any data from their own sewage network is limited .The study provides an Various choice and appropriate modern technology in the design, development and expansion of sewerage networks instead of the usual ways to process a wide survey method, which requires a lot of time, effort and money with a high rate of errors. That the process of evaluation and expanding sewage adopted on parameters, they are provided by Remote Sensing and GIS .The study has addressed Al-Anwaar in Al-Kut city, is Iraqi city , as a study area that wastewater systems where needed analysis for manholes and pipes by using SWMM. Comparison between the slopes of the wastewater and surface slopes of the lines of the interview was conducted. Design of sanitation depends on two parameters, hydraulic engineering parameters and parameter which requires a substantial and broad sweep and accurate drawing. It was noted that the study of the pipeline is working adequately. Using GIS tools in the sewer pipes system is a suitable method in analysis sewer network and provides the data that used in SWMM program.

Keywords: (GIS), SWMM, Wastewater, Networks, pipe.

1 Introduction

Nowadays, GIS plays an important role in facilitating the representation and analysis of water-related phenomena. It is widely used in tracking wastewater contamination and management. It helps in mapping, modeling, facilities management, work-order management, and short- and long-term planning (Chandresh, 2014). Hydrological GIS models, were also developed for rainfall, runoff, stream flow, flooding and water quality (Hatzopoulos, 2002). About 90% of the water utilities in the U.S. were using GIS technology by the end of the year 2000 as reported by the American Water Works Association (AWWA). GIS softwares are developing on a daily bases to support the different applications in water and wastewater utilities (Mohsen, 2011 and Mohamed, 2012). GIS is also integrated with commonly used water utility systems such as work order, computerized maintenance, and enterprise asset management (Esri, 2010). Remote sensing (RS) data also provide an informative and visual analytical tools that have been widely applied in monitoring and conservation of water-resources and evaluating changes in environmental conditions (Ulugtekin et al., 2005, De Leeuw et al., 2010 and Umbarkar et al., 2014). RS and GIS can be integrated to provide thematic maps for spatial features and their attributes. RS data can also be used in the classification of clean water and wastewater reservoirs. However, these data are not likely be able to differentiate between different levels of pollutants in wastewaters (Gitelson, 1997). Therefore, these data have to be integrated with lab analysis of collected water samples from wastewaters.

Wastewater treatment and management are one of the most serious problems in Iraq. Most of wastewater drainage networks were combining both human wastes and rainfall. These waters were being discharged into the rivers without any treatment before 2003. Al-Kut city, which is the area of study in this work has three types of wastewater drainage networks. These networks are: a-sewage network, b- rainfall drains and c- combined drains (sewage and rainfall). Wastewater from the combined drains is being directly discharged into the river without any treatment, which cause a severe water pollution problem. The objective of this work to assess the velocities and the slopes of pipes in networks and evaluate the possibility to take advantage of the network combined sewer in the city of Kut.

2 MATERIAL AND METHODS

2.1 Description of study area

The study area is located in Al-Anwaar in Al-Kut city, which is the capital of Al-Kut district in Wassit Governorate, Iraq. It is bounded between these coordinates 45°46'00" to 45°53'20" E and 32°27'00" to 32°34'00" N as represented in Figure (1). It has an area of about 85 km2. Al-Kut city is located along the main highway connecting Baghdad with Amarah and Basrah in the south, about 150 km south-east of Baghdad and 150 km north-west of Amarah city. The population of Al-Kut city is about 390,000 people according to 1997 census data with an annual growth rate of about 3% (MMPW and COSIT, 2006). The topography of the city is mostly flat and the ground elevation ranges between 15 and 25 m above the sea level.

The studied region is represented by semi-arid climate, which is characterized by dry, hot and long summers and relatively wet, cold winters with short and mild springs. Large difference in temperature between day and night and between winter and summer were observed. The maximum temperature varies from 40^{o} to 45^{o} C, where July and august are the hotest months. The minimum tempertaure ranges between 6^{o} and 8^{o}, where December and January are the coldest months(COSIT, 2013). The prevailing winds for most parts of the year are from north to west direction and usually reach their maximum speed in June (about 5.5 m S-1).

Soil of Wasit were developed on the Tigris sedimentations (Powers, 1954). These soils close to the river banks are characterized by coarse grains mixed with silt and they have low salt content. They are considered as the most fertile soils for agricultural production. However, soils far away from the rivers banks have a high salt content and high clay content. They aslo have a high lime content (about 25%). Tigris River is the main source of water in Wasit in addition to Al-Garraf River that branching from Tigris at Al-Kut city. The Tigris River runs from the north to south and a number of dams were built on it to control the flow of water and irrigation of agriculture lands in the governorate.

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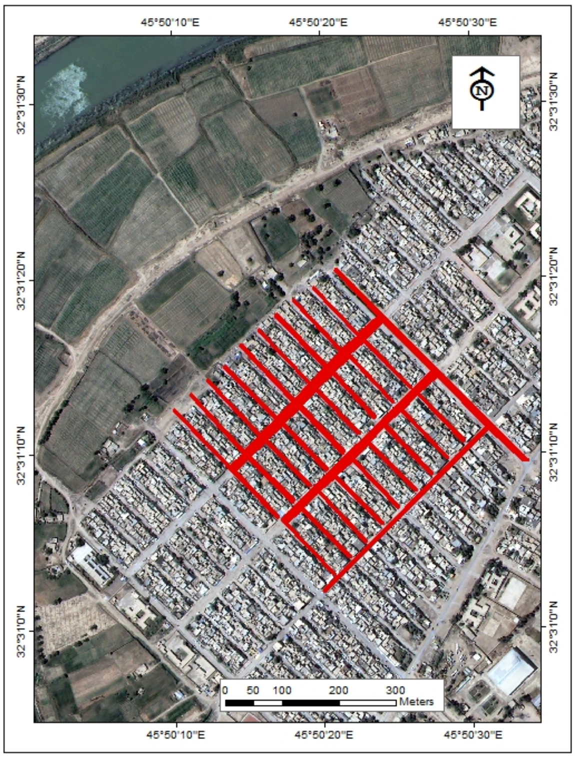

Figure (1) Location map of the study area.

Subtractions from the sewage of the city every day is mainly from domestic uses, its estimation is highly dependent on the population density in a given area and respective daily water consumption.

$$Q = q\,A\,J \qquad (1)$$

Where:
q: amount of daily disposal of sewerage per capita and equal to:
Daily disposal = 0.85 * consumption of supply water
A= Surface area
J=Population density.

TABLE1: Details of Al-Kut city

country	Iraq
state	kut
District	Al-Anwaar
coordinates	45°50'20.394"E 32°31'11.326"N
Area Al-Anwaar	4km^2
eleavation	23m
Population(2014)	40000
Mean of consumption	400L/Day
Density	42 person/hectare

3 Flow chart software SWMM.

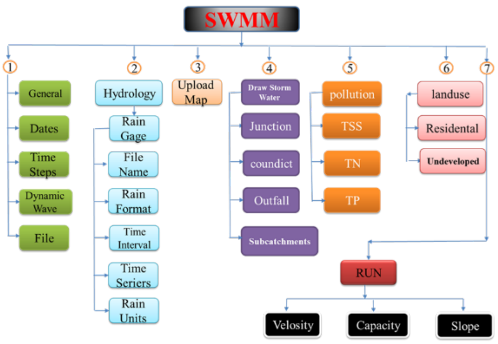

Figure (2.) Flowchart software SWMM.

3.1 network modeling using software SWMM.

EPA Storm Water Management Model (SWMM) is a dynamic process and torrents of rain simulation model using a single event or long-term (continuous) simulation to the quantity and quality of runoff from urban areas in the first place [19]. Modeling methodology follow the logical progression of events, including data acquisition, build a model to assess the capacity of the sewage system and evaluate the system using SWMM program.

3.2 Design Result for the Al-Anwaar network

After entering all the required data (pipe diameters, lengths, elevations of the pipeline inlet and outlet ....) as well as for Manholes (dimensional, level, ...) and the data on rain, and the highest intensity of rain during the previous 20 years it has been running the program for the purpose of evaluation of the network as Figure(3) and the network is working well, except for the ends of the network, which was suffering from a overflow because of rain depths few of these manholes as described Figure (3) to (30) and table(2)

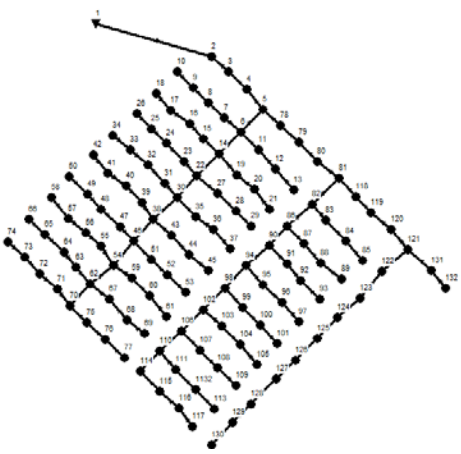

Fig. (3): Sewer Network in Al-Anwaar

In order to evaluation the network and find the suitable way to modify this network, it is necessary to make hydraulic analysis for the network depending on the software. After the data are fed into the program such as; the length of the pipes and their diameters in addition to rate of the infiltration and

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Manning coefficient, the results of analysis appear in line as shown in table (3) . From this table, it was found that these pipes have been designed on (315-400-600 mm) in diameters and the lateral pipes have been designed on a sufficient gradient to achieve a self-cleaning velocity at partial flow. In addition, the sewer network (Al-Anwaar) have 28 routes as shown in figure (2). All the paths had been analyzed and their profiles at the maximum flow are shown in figures (3) to (30). Table (3) show the paths of the sewer network for Al-Anwaar network in Al-Kut city.

Table (2): Characteristics of the sewer network**.**

Line No.	Manhole No.		Length(m)	Ground Elev.(m)	
	From	To		Upper End	Lower End
C1	M2	M1	10	23.93	24
C2	M3	M2	34.5	23.93	23.93
C3	M4	M3	34.45	23.95	23.93
C4	M5	M4	33.9	23.95	23.95
C5	M6	M5	50	23.95	23.95
C6	M7	M6	30	23.7	23.95
C7	M8	M7	32	23.65	23.7
C8	M9	M8	26	23.6	23.65
C9	M10	M9	32.75	23.55	23.6
C10	M11	M6	35	23.9	23.95
C11	M12	M11	32	23.97	23.9
C12	M13	M12	35	24	23.97
C13	M14	M6	43	23.96	23.9
C14	M15	M14	30	23.7	23.96
C15	M16	M15	29	23.65	23.7
C16	M17	M16	32	23.6	23.65
C17	M18	M17	30	23.55	23.6
C18	M19	M14	35	23.9	23.96
C19	M20	M19	30	23.95	23.9
C20	M21	M20	35	23.95	23.95
C21	M22	M14	38	24.01	23.96
C22	M23	M22	30	23.77	24.01
C23	M24	M23	29	23.7	23.77
C24	M25	M24	32	23.62	23.7
C25	M26	M25	30	23.55	23.62
C26	M27	M22	35	23.97	23.77
C27	M28	M27	30	24.03	23.97
C28	M29	M28	35	24.1	24.03

Table (3): Design result of the sewer network.

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Line No.	Manhole No.		Length (m)	Slope of sewer	Dia. mm	V m/sec	Qf m3/min	Sewer invert Elev.(m)	
	From	To						Up. End	Lr. End
C1	M2	M1	10	0.0016	600	3.01	2.36	20.56	20
C2	M3	M2	34.5	.0016	600	2.98	3.58	20.59	20.56
C3	M4	M3	34.45	0.0016	600	2.98	4.38	20.61	20.59
C4	M5	M4	33.9	0.0016	600	2.98	3.55	20.64	20.61
C5	M6	M5	50	0.003	400	2.76	0.91	21.63	20.64
C6	M7	M6	30	0.0025	315	0.77	0.28	22.28	21.63
C7	M8	M7	32	0.0025	315	1.26	0.79	22.37	22.28
C8	M9	M8	26	0.0025	315	0.98	0.71	22.46	22.37
C9	M10	M9	32.75	0.0025	315	0.99	0.80	22.55	22.46
C10	M11	M6	35	0.0025	315	0.80	0.23	22.8	22.55
C11	M12	M11	32	0.0025	315	1.50	0.75	22.9	22.8
C12	M13	M12	35	0.0025	315	1.06	0.78	23	22.9
C13	M14	M6	43	0.003	400	2.18	2.00	21.74	23
C14	M15	M14	30	0.0025	315	0.61	0.25	22.28	21.74
C15	M16	M15	29	0.0025	315	1.14	0.59	22.37	22.28
C16	M17	M16	32	0.0025	315	0.90	0.62	22.46	22.37
C17	M18	M17	30	0.0025	315	0.92	0.60	22.55	22.46
C18	M19	M14	35	0.0025	315	0.77	0.24	22.8	22.55
C19	M20	M19	30	0.0025	315	1.38	0.73	22.9	22.8
C20	M21	M20	35	0.0025	315	1.00	0.78	23	22.9
C21	M22	M14	38	0.003	400	1.83	1.66	21.84	23
C22	M23	M22	30	0.0025	315	0.62	0.27	22.28	21.84
C23	M24	M23	29	0.0025	315	1.06	0.50	22.37	22.28
C24	M25	M24	32	0.0025	315	0.84	0.53	22.46	22.37
C25	M26	M25	30	0.0025	315	0.89	0.51	22.55	22.46
C26	M27	M22	35	0.0025	315	0.77	0.24	22.9	22.55

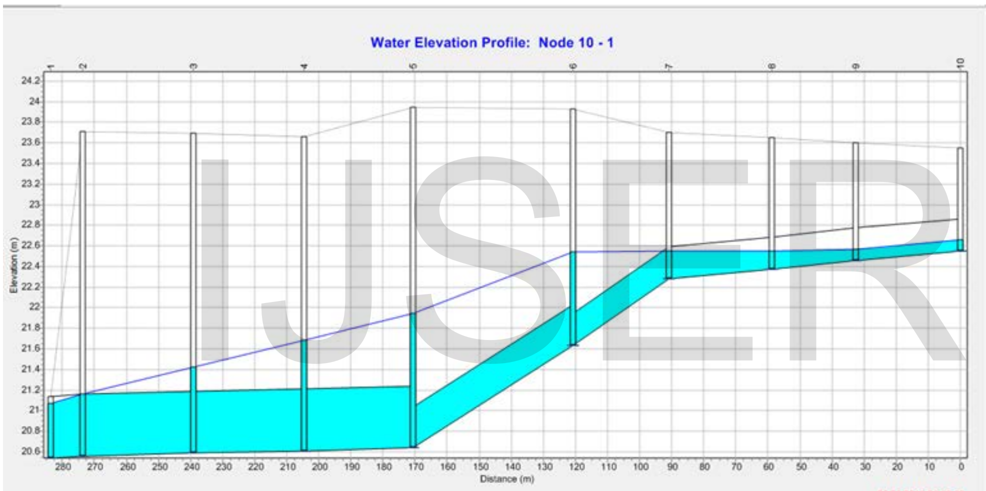

Figure (4): Sewer profile for Path 1

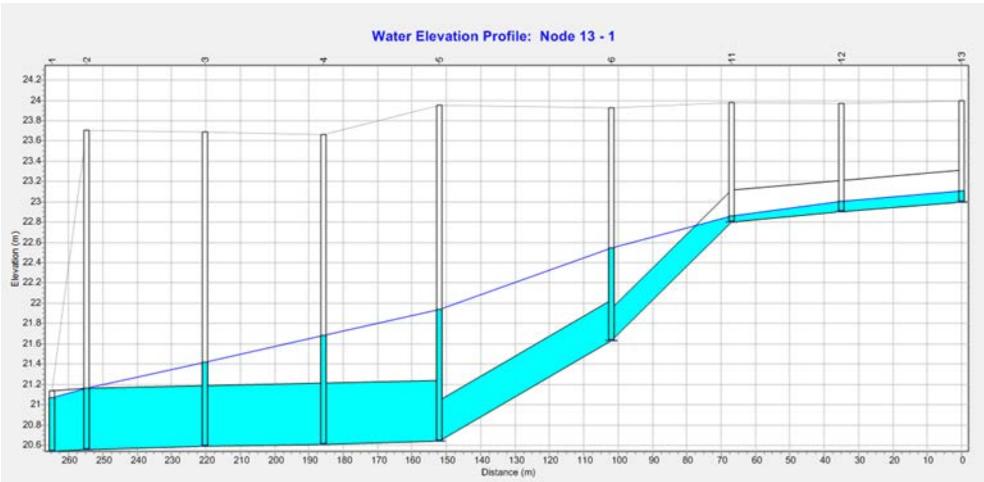

Figure (5): Sewer profile for Path 2

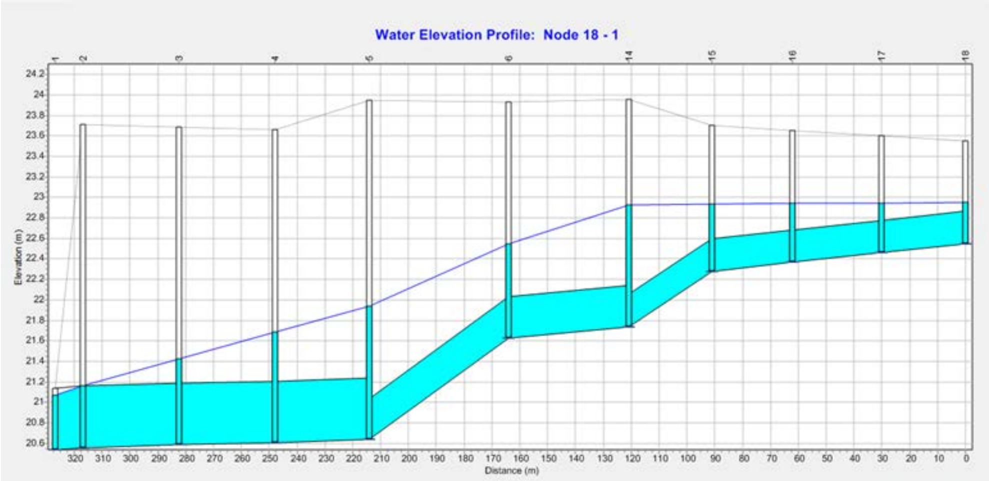

Figure (6): Sewer profile for Path 3

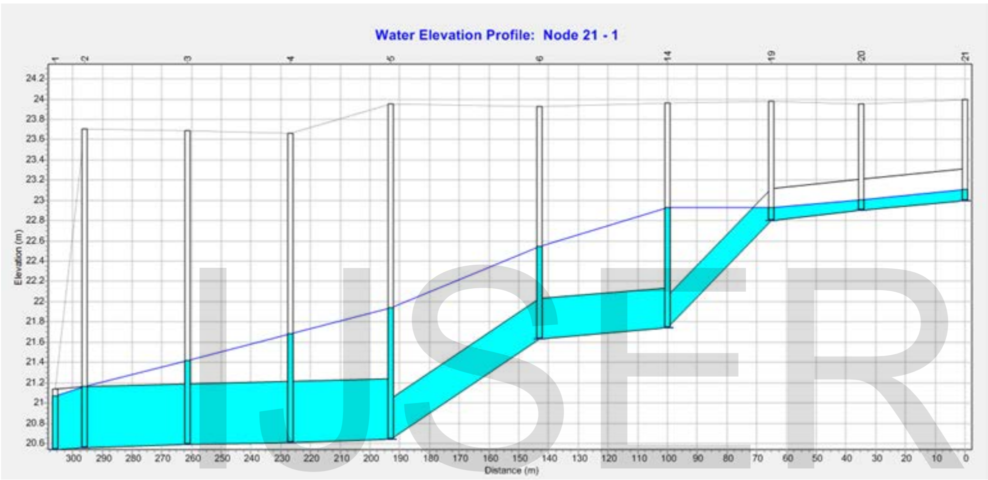

Figure (7): Sewer profile for Path 4

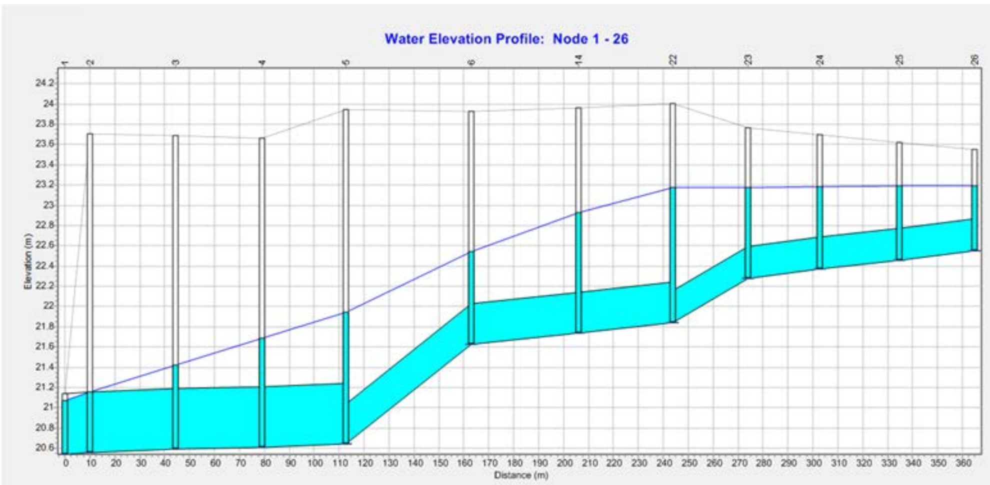

Figure (8): Sewer profile for Path 5

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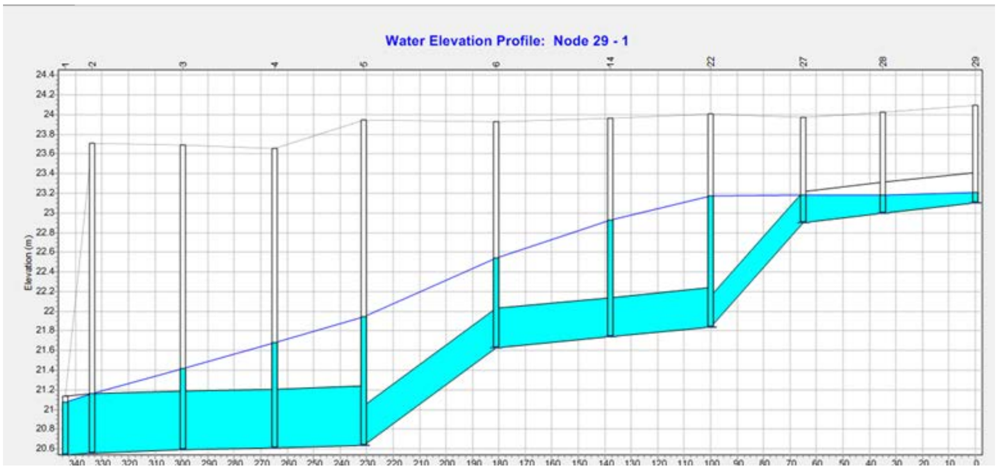

Figure (9): Sewer profile for Path 6

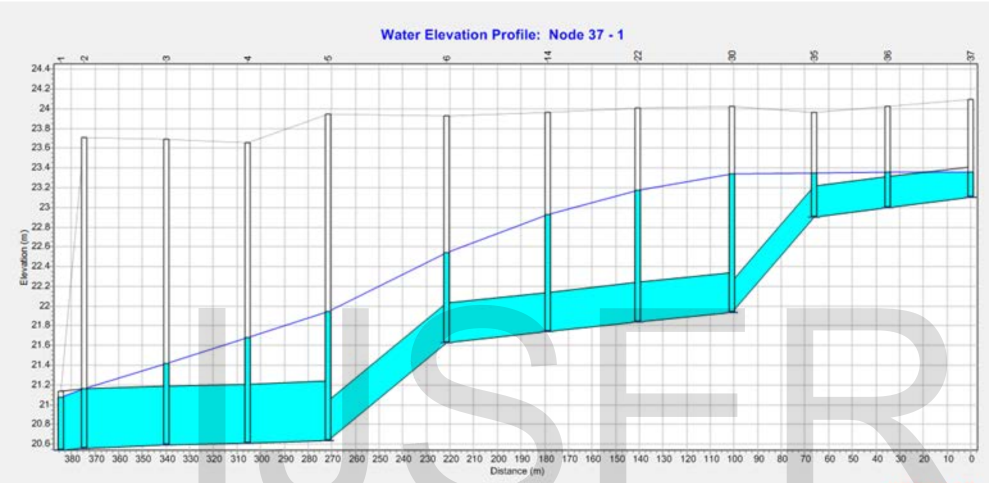

Figure (10): Sewer profile for Path 8

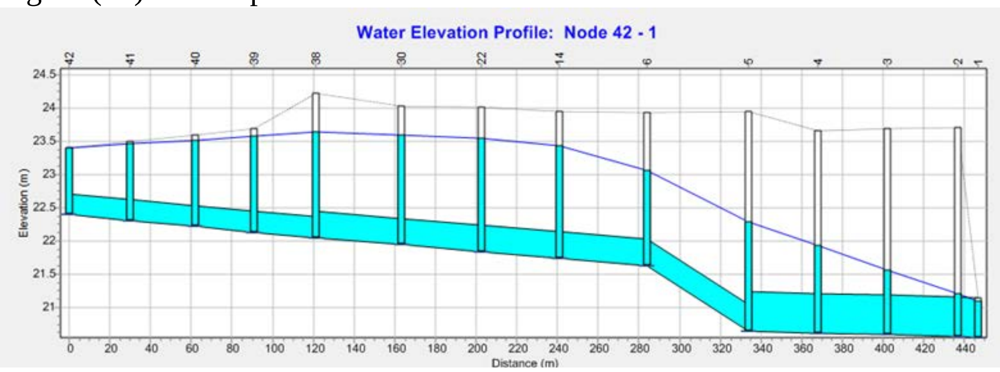

Figure (11): Sewer profile for Path 9

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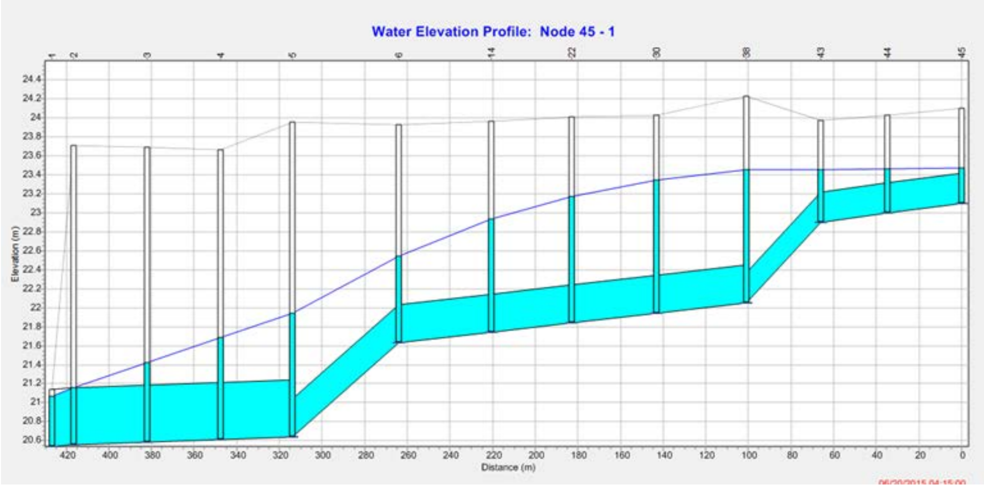

Figure (12): Sewer profile for Path 10

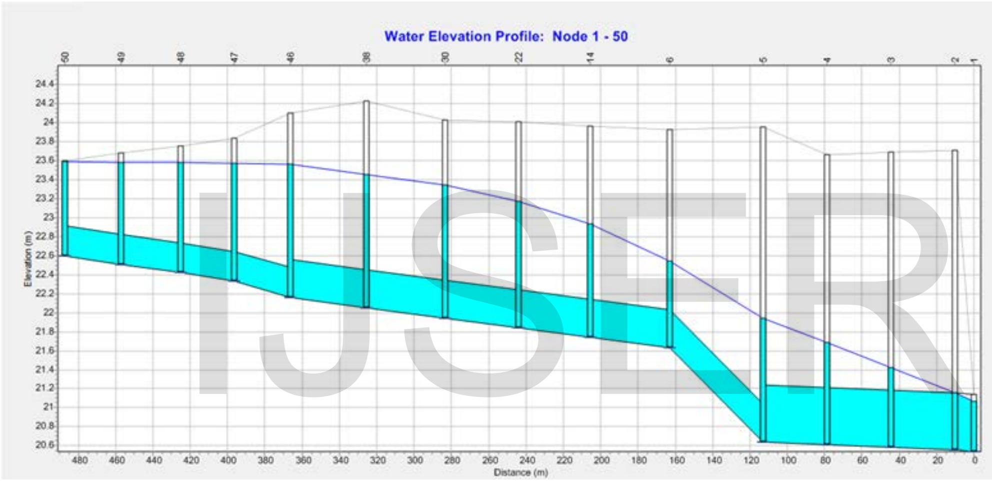

Figure (13): Sewer profile for Path 11

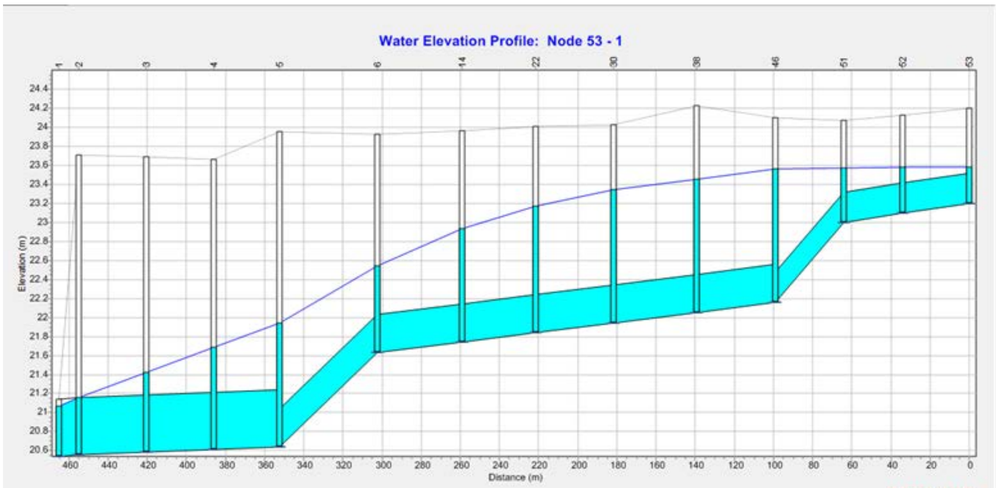

Figure (14): Sewer profile for Path 12

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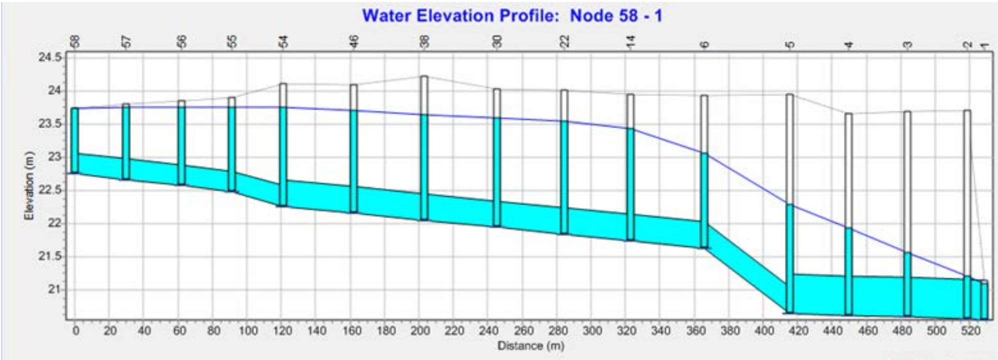

Figure (15): Sewer profile for Path 13

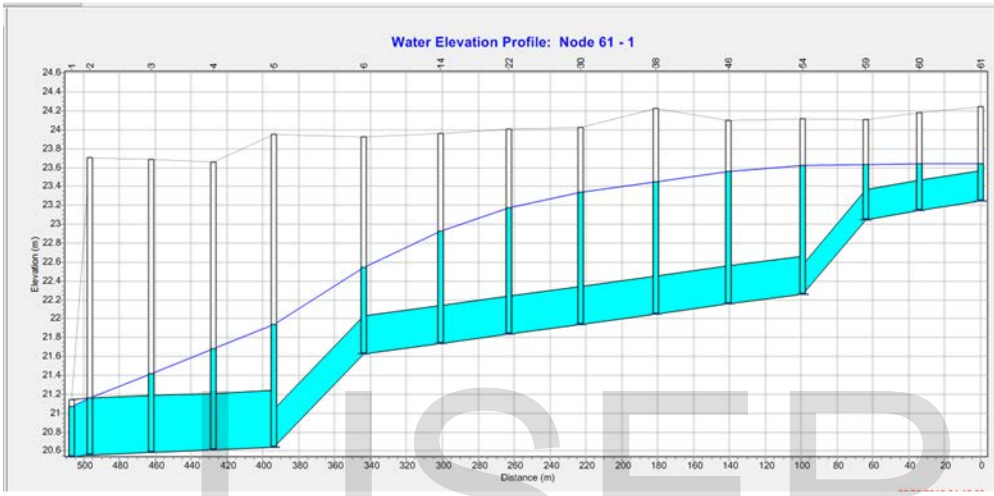

Figure (16): Sewer profile for Path 14

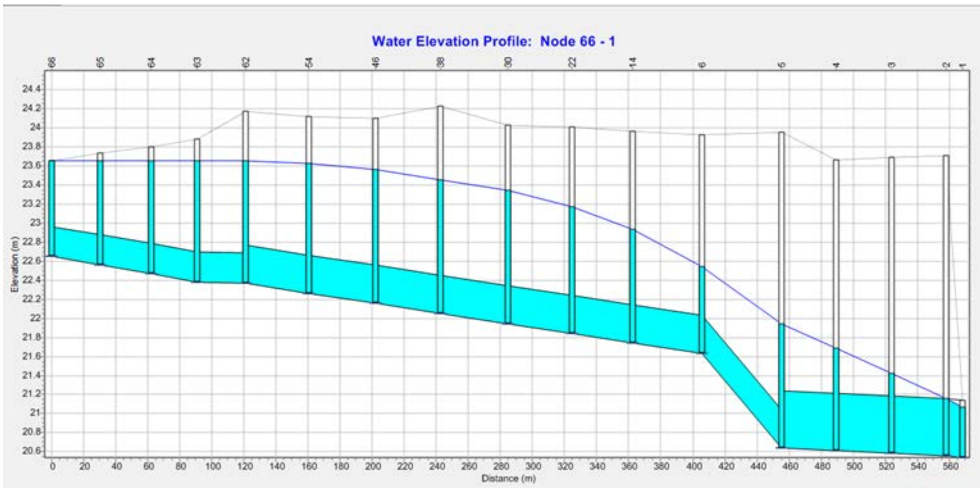

Figure (17): Sewer profile for Path 15

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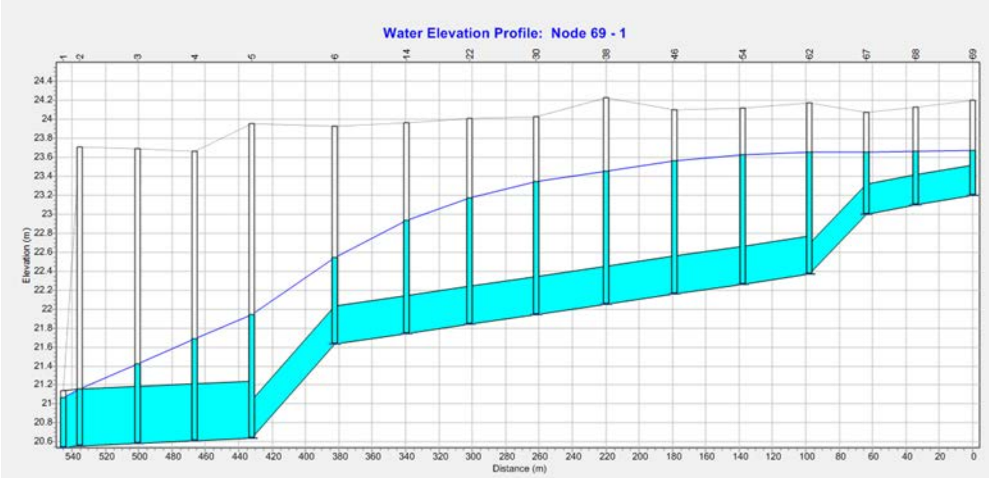

Figure (18): Sewer profile for Path 16

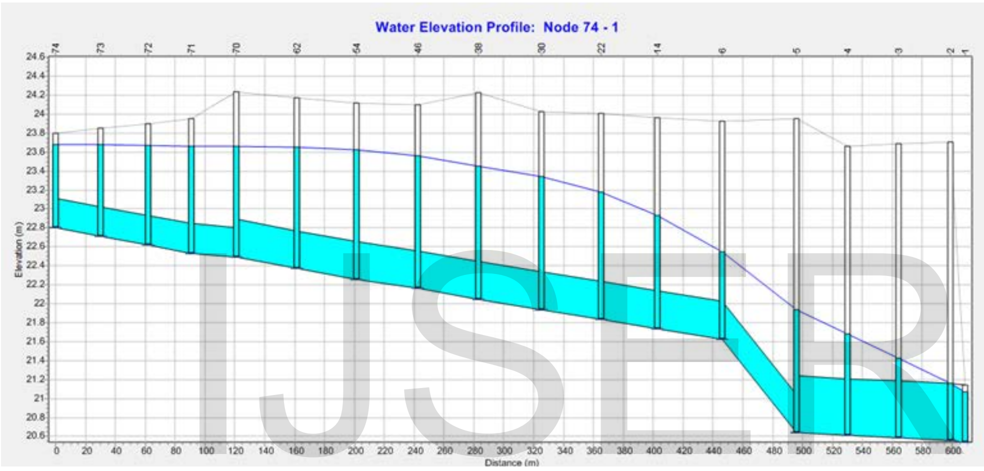

Figure (19): Sewer profile for Path 17

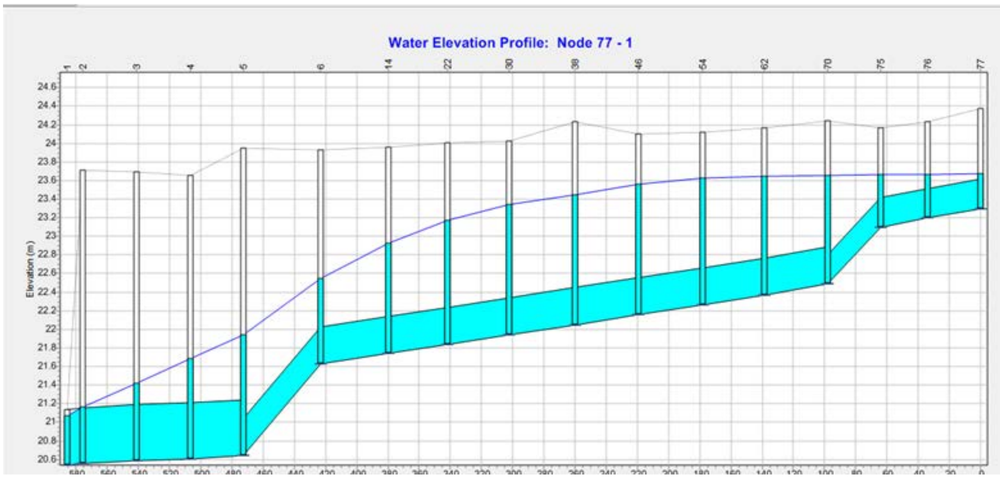

Figure (20): Sewer profile for Path 18

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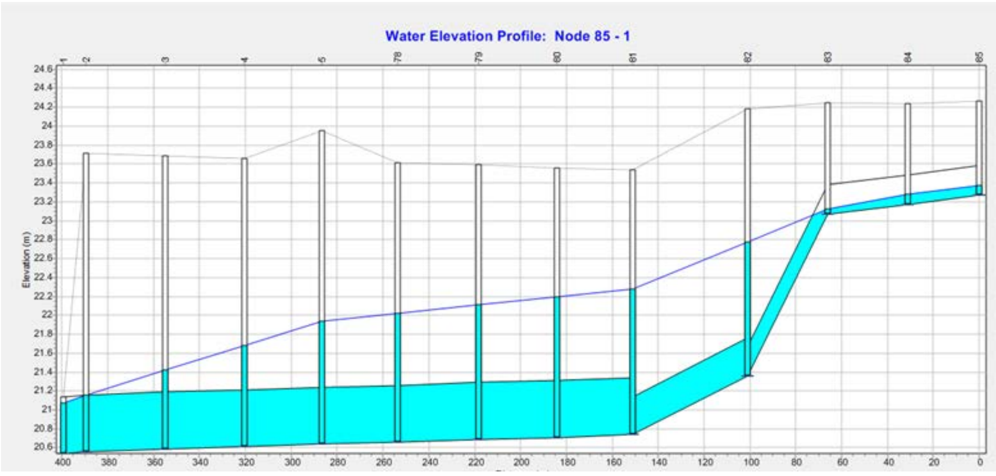

Figure (21): Sewer profile for Path 19

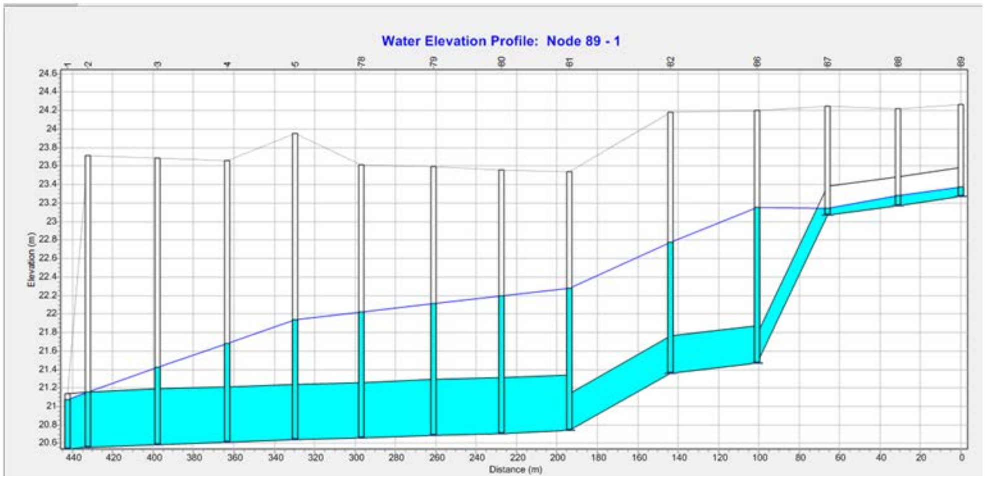

Figure (22): Sewer profile for Path 20

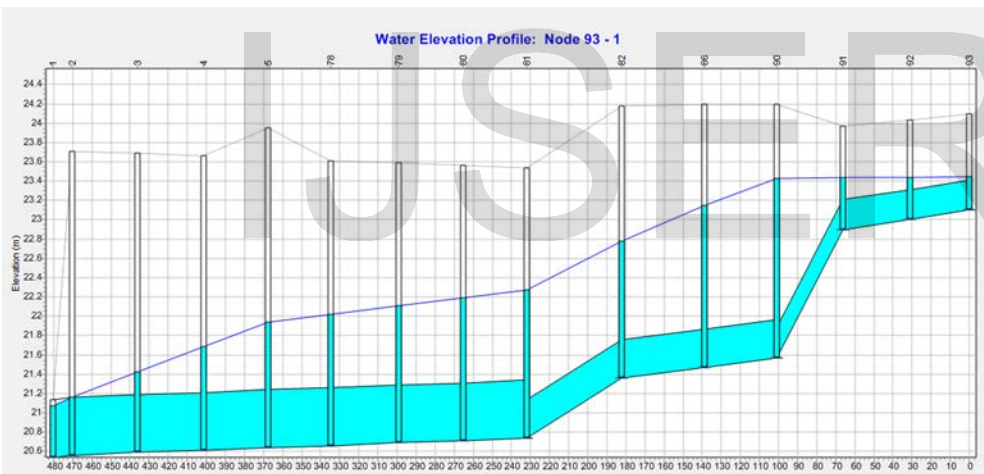

Figure (23): Sewer profile for Path 21

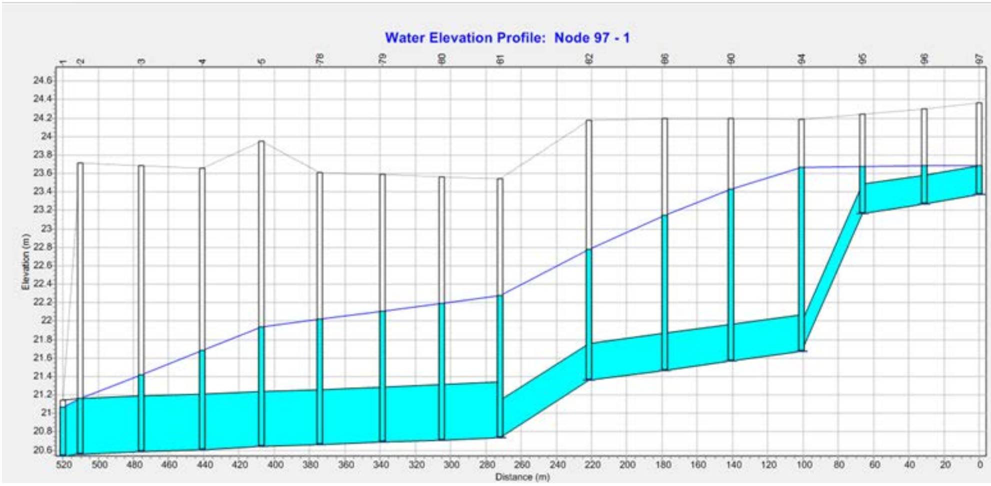

Figure (24): Sewer profile for Path 22

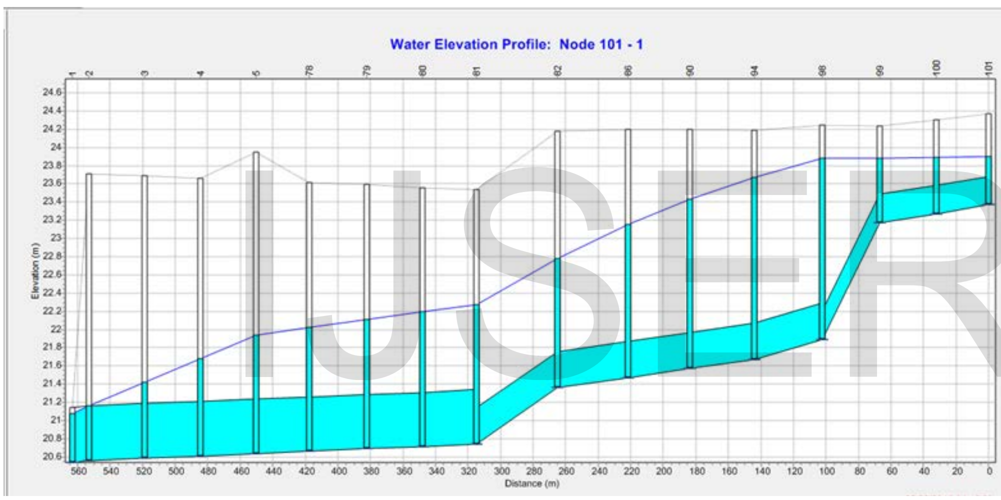

Figure (25): Sewer profile for Path 23

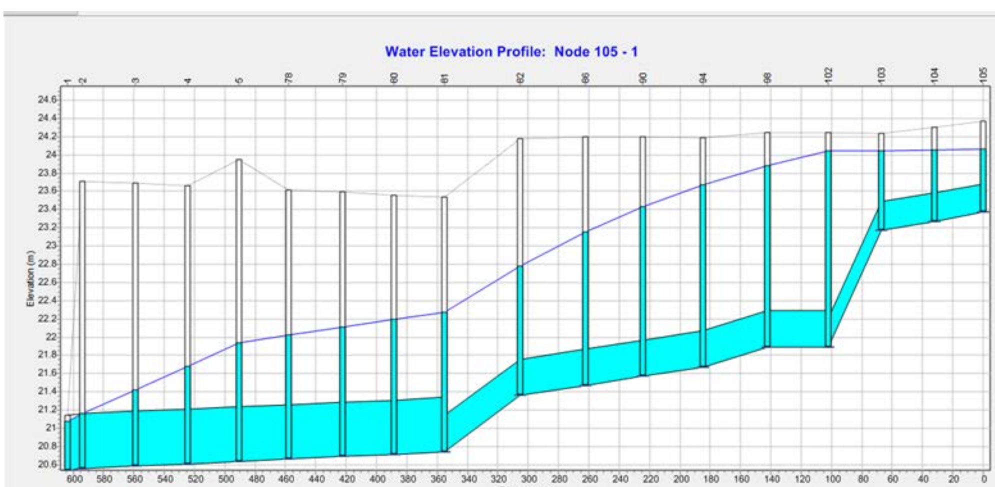

Figure (26): Sewer profile for Path 24

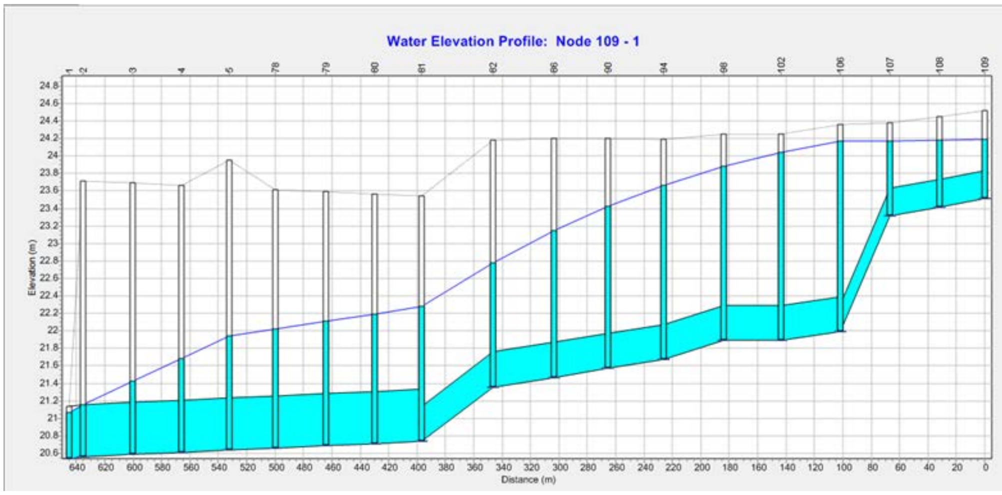

Figure (27): Sewer profile for Path 25

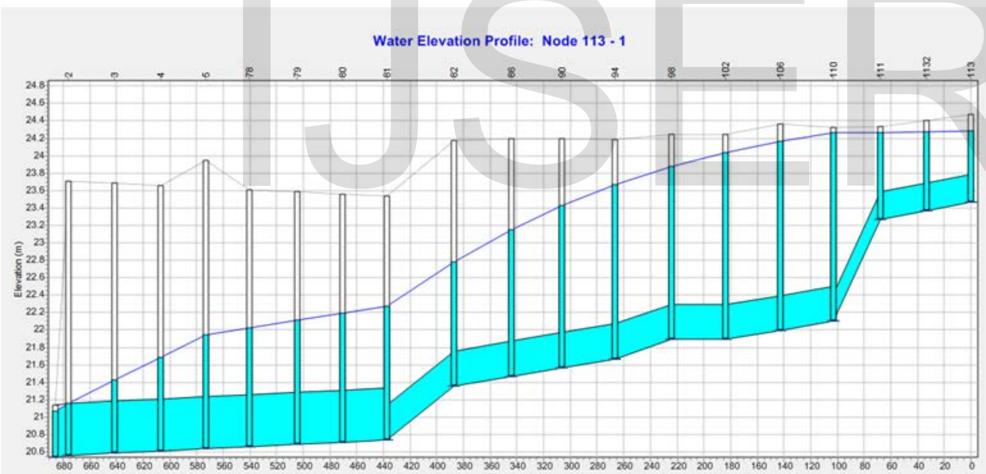

Figure (28): Sewer profile for Path 26

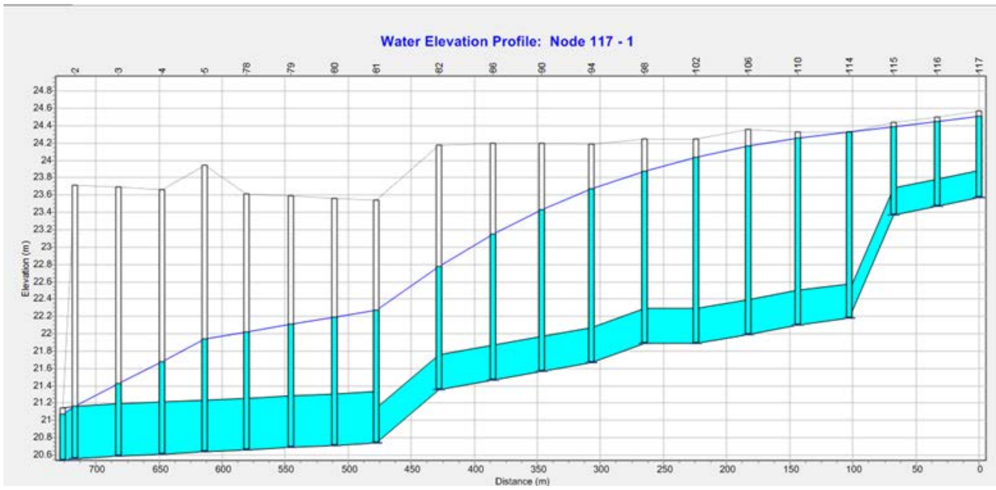

Figure (29): Sewer profile for Path 27

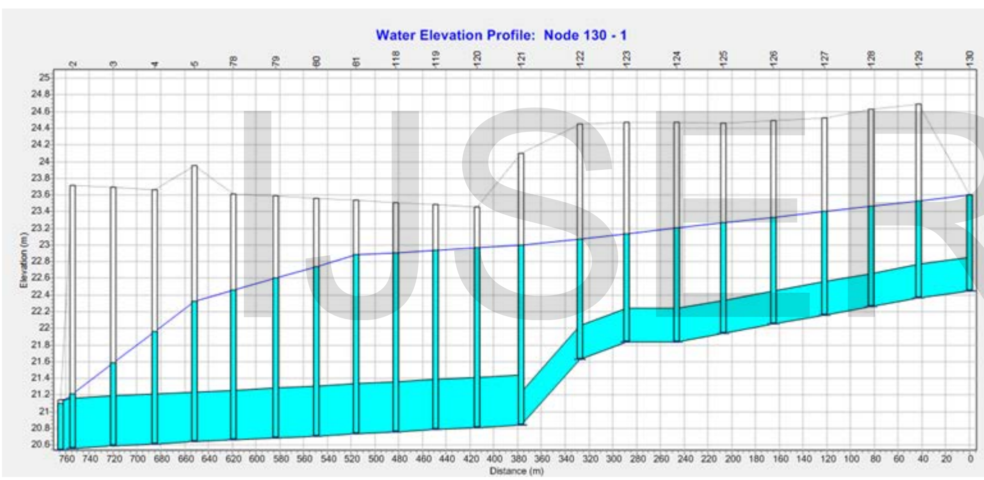

Figure (30): Sewer profile for Path 28

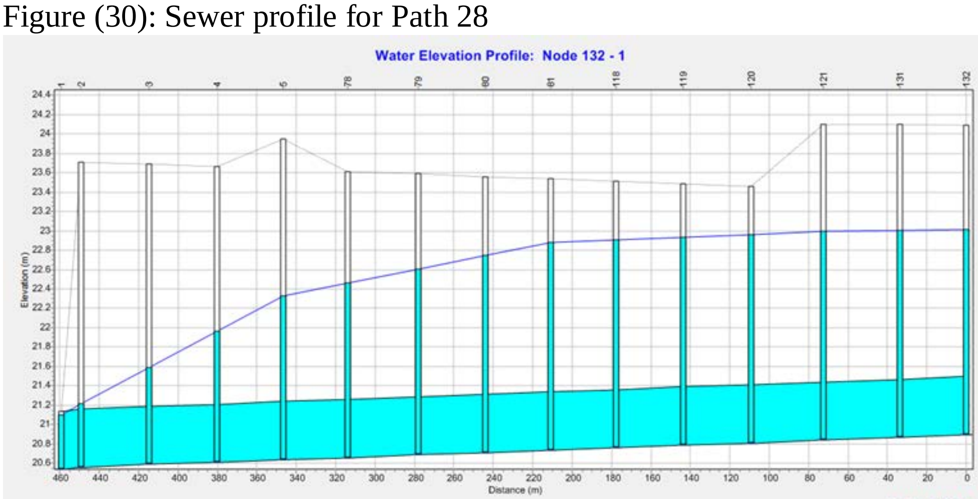

Figure (31): Sewer profile for Path 29

Conclusion

It was found that all sewer pipes were designed with equal diameter of 315 mm.This diameter was found to be larger than needed at this time. From the study, the minimum flow velocity is equal to (0.77) m/s, it will maintain the self-cleaning velocity to ensure the removal of sewer solids. The maximum flow velocity is equal to (3.01) m/s, and this velocity can be tolerated by the interior face of the pipes and save the pipes from scouring and tearing. Create thematic maps using geographic information systems (GIS) had been very useful in the design process and analysis. It is enhanced the analysis of sewerage network capacity with respect to the query, display and mapping results. Using the program (SWMM), in the analysis helped to find out the appropriate pipe diameters of the study area as well as flow velocity and the relationship between time and the amount of water through the illustrative charts for each pipe, joints and every part of the network with each other.

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