RENAISSANCE PROJECT LIMASSOL

STORM DRAINAGE MANAGEMET REPORT.

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SUMMARY

The proposed development will cover 9350 out of the 12800 m^2 of the entire site. The remaining 3460 m^2, cover the area along the perimeter of plot 607 and plots, 637 and 454, which will be left uncovered.
The Amathus-Limassol Sewerage Board, (ALSB), the authority for stormwater collection and disposal, does not allow stormwater from the build-up areas of the site, to enter the storm drainage network.

It is therefore necessary to design a proper storm drainage management system for the development project.

Based on the drawing plans of the proposed development provided, the site was divided in seven (7) areas

The Rational equation /model/ is used to estimate the peak discharge.

All roofs have controlled stormwater disposal system consisting of downspouts. Stormwater from every downspout will be discharged into the ground water aquifer through specially constructed infiltration wells

All stormwater from the uncovered areas, will discharge on the roads

The roof runoff will be diverted and discharged into the ground through downspouts. It is recommended to use steel or plastic downspouts 125 mm in diameter. The capacity of such downspouts for the lengths and drops at the site is 125 lt/sec, adequate capacity for this site.

Drainage from roof areas 1 and 2 together with Roof 4 (Inner garden, green area) will be diverted to infiltration wells to be drilled and installed in the Public green area. The number of infiltration wells 16
Drainage from roof areas 3 and 5 will be diverted to infiltration wells to be drilled and installed below the basement foundation raft. The number of infiltration wells 6.

The total number of infiltration wells 22

INTRODUCTION

General

Rainfall is unevenly distributed over the island of Cyprus, Extreme dry conditions are very common. Flooding due to short duration high intensity rainfalls also often occur in several parts of the Island. Protection from flooding necessitates the construction of adequate storm drainage networks.
Storm water management, collection, and disposal of storm water is important factor to the successful function of a project site.

The amount of rain water to be collected and conserved depends upon the purpose of use, rainfall intensity at the locality and the available catchments from where rainwater shall be collected.

A general description of the project and dewatering method statement is given in the relevant report of November 2020. The report states that:

The proposed Development consists of a complex of buildings, with one underground basement for parking. The total depth of excavation will be approximately 5m - including 1.5 thick foundation rafts throughout. In addition, the lift wells will be founded below the general excavation level.

The building plot is situated between Androutsou, Karaiskaki, Poumpoulinas and Ayiou Andreou streets, about 600m west of Ayios Nikolaos round about and, covers an area of approximately 12,800 *m^2 which is generally flat, gently dipping towards the sea (south).*

The problem

Storm waters from the surrounding areas under present conditions, infiltrates to ground water. The proposed development will cover 9350 out of the 12800 m^2 of the entire site. The remaining 3460 m^2, cover the area along the perimeter of plot 607 and plots, 637 and 454, which will be left uncovered.

The Amathus-Limassol Sewerage Board, (ALSB), the authority for stormwater collection and disposal, does not allow stormwater from the build-up areas of the site, to enter the storm drainage network.

It is therefore necessary to design a proper storm drainage management system for the development project.

For this purpose, rainfall and runoff data are necessary to be provided to the designers to design rainwater drainage. It is within this framework that the present hydrological and hydraulic study is carried out

Purpose and objectives

Purpose

The purpose of the assignment is to evaluate the anticipated conditions and prepare a hydrological study for estimating the runoff from the project area having in mind that the results will be used for the hydraulic design and sizing of the necessary rainwater drainage network

Objectives

1. Collection and assessment of all relevant data.
2. Collection and appraisal of other relevant published reports for the area if any.
3. Reconnaissance survey to assess the existing conditions
4. Assessment of the hydrological information:
   - Delineation of catchment areas affecting the development project.
   - Study of the expected conditions of the basin(s) and the way of drainage.
   - Statistical analysis of precipitation maxima.
   - Statistical analysis of precipitation under various durations, intensities and return periods and prepare the IDF curves.
   - Division of the drainage basin into various smaller sub basins, ie, roofs, green areas etc.
   - Estimate of time of concentration for each sub basin
   - Selection of the most appropriate method for estimating the critical runoff in terms of volume and discharge.
   - Determine the return period or periods in order to estimate the respective runoff.
   - Documentation of the impact of ground water if any
   - .
5. Estimate of runoff, volume and discharge, for different rainfall intensities and return periods.
6. This will assist the planners and designers to select the most appropriate technically and economically viable solution with the aim to minimize undesirable consequences to the complex (buildings, machinery, services etc.) due to flooding.

Assignment

The hydrological study was assigned to Char. Kridiotis C Eng and Chr Ioannou Hydrogeologist.

GENERAL DESCRIPTION OF THE AREA-PRESENT CONDITIONS.

Location

The development project is to be built in Plot 607, in LRO plan 54/580303 (LTM) scale 1:1000, plots 637, and 474, in LRO plan 54/580602 (LTM), scale 1:1000. The area of the three plots as registered at the Department of Lands and Surveys is 12763 square meters (12763 m^2). It is located at an elevation of about 4 meters above sea level. Its coordinates in UTM, WGS84 projection system is N 3,837,694 E 504,618. Figure 1 depicts the site google earth satellite image.

Geology

The geology of the site is described by **'Geoinvest'** who performed the the site investigation.

Hydrology

The general hydrogeological conditions prevailing in the site area, and the Infiltration Tests carried out are well described by **Themeliotechniki,** in the relative report of October 2020,

Rainfall

The Average annual precipitation in the area amounts to about 450 mm (Source Hydrogeological map of Cyprus scale 1:250000 Geological Survey Department 1970). Isohyets for the years 1990-2000, show the same amount. The nearest Meteorological Station to site is the Limassol Municipal Garden Met Station No 394. To estimate peak discharge from an area rainfall intensities and intensity-duration-frequency (IDF) curves are required. Statistical Analysis and IDF curves ware obtained from Meteorological Note No. 15, November 2009, page 8. Statistical analysis and IDF curves are given in Appendix II. Table 1 summarize the rainfall statistics from Met Station No 394. Figure 3 depicts the IDF Curves.

Table 1. Rainfall Statistics

Maximum rainfall intensities I in mm/hr various durations and return periods									
Coastal Met Station									
Statistical Analysis									
Gumbel General extreme value distribution (GEV- Maximum κ =0.15 L moments)									
Meteorological Station			Limassol	Munic.Garden	Station Number		394		
	η=	0.77	θ=	0.060					
Statistical Analysis was obtained from Meteorological Note No. 15, November 2009, page 8									
Return		Estimated amount of rainfall in							
Period	Years	millimeters/hour for different time periods (minutes)							
		5 minutes	**10 minutes**	**20 minutes**	**30 minutes**	**1 hour**	**2 hours**	**6 hours**	**24 hours**

		5	10	20	30	60	120	360	1440
T2	2	81.7	57.4	37.5	28.6	17.5	10.5	4.6	1.6
T3	3	92.9	65.2	42.6	32.5	19.9	11.9	5.2	1.8
T5	5	115.2	80.9	52.9	40.3	24.7	14.8	6.5	2.2
T10	10	140.7	98.8	64.7	49.3	30.2	18.1	7.9	2.7
T20	20	168.0	118.0	77.2	58.8	36.0	21.6	9.4	3.3
T25	25	174.7	122.7	80.3	61.2	37.4	22.5	9.8	3.4
T50	50	208.1	146.2	95.6	72.9	44.6	26.7	11.7	4.0
T100	100	242.0	170.0	111.2	84.7	51.9	31.1	13.6	4.7
T200	200	279.5	196.4	128.5	97.9	59.9	35.9	15.7	5.4

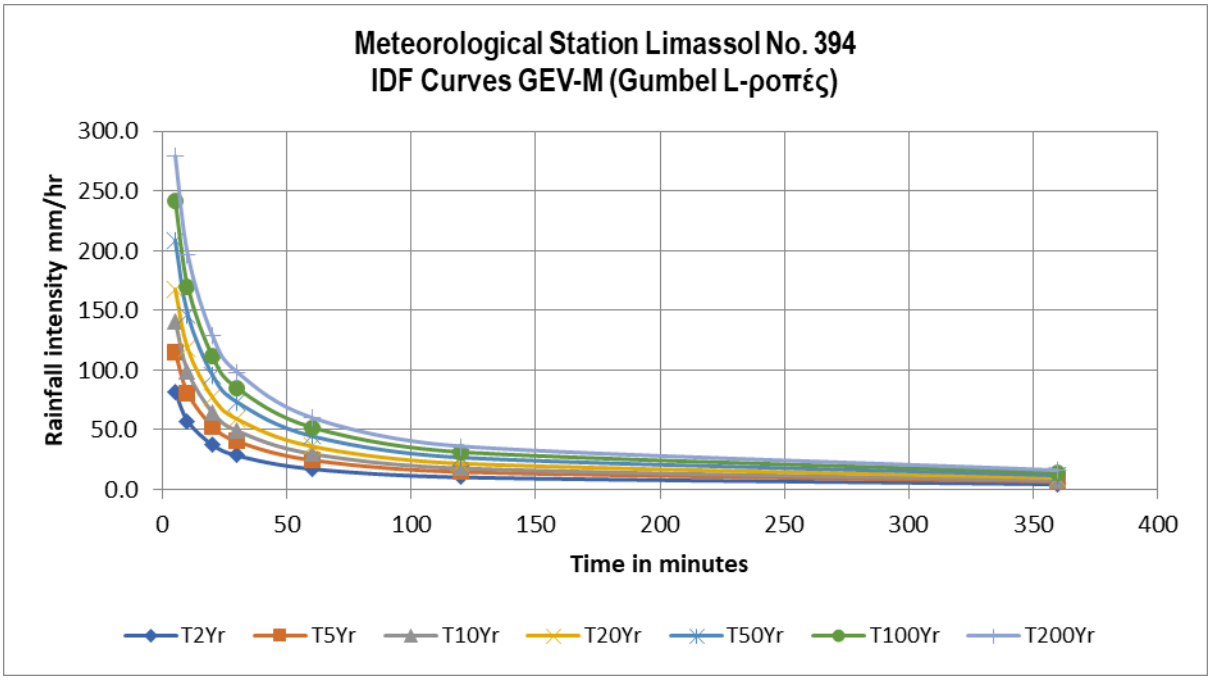

Figure 3. Limassol Municipal gardens Met Station No 394. IDF Curves

HYDROLOGY

Delineation of watersheds

Based on the drawing plans of the proposed development provided, the site was divided in seven (7) areas as shown in Figure 4.

Peak discharge estimate

In areas where no streamflow data are available, as in this case, hydrological models are used to estimate runoff depth from rainfall. The critical parameter in such cases is the time of concentration T_c. For this particular case, due to the small area of each sub-watershed the time of concentration is estimated to be is 0.083 hours or 5

minutes. The other important factor is the return period and the duration of rainfall to be selected. Peak discharge estimates and runoff volume were carried out for 5,10,20,30, minutes,1, 2, 3,6 and 24 hours with return period of 2, 3,5,10, 20,25, 50,100, and 200 years. To minimize the chances for flooding a return period of 1:50 and 1:100 year was selected (2 and 1% chance for an event to occur).

Intensive storm duration events in Cyprus last for about 30 minutes. Therefore for sizing drainage pipes, (downspouts), the 5 and 30-minute rainfall intensity for 1:50 and 1:100 year was selected.

Selection of model

The Rational Method model is appropriate to be used. The Rational equation /model/ is a simple method to determine peak discharge from drainage basin runoff given the rainfall intensity, the time of concentration and the catchment area.

Table 2. Rational Method (Equation/model)

RATIONAL METHOD	
Rational Formula Q = CIA	
Q =	Flow in cubic meters/second (m^3/sec)
C =	Runoff Coefficient (number)
I =	Rainfall intensity in millimeters/hour for different time periods (minutes)
A =	Area in square meters m^2
	Runoff Coefficients for use in the Rational method for this area
	was takem from V.T.Chow et al. p.498 ,και W.Viessman et al,p.508

Assumptions for peak discharge:

All roofs have controlled stormwater disposal system consisting of downspouts.
Stormwater from every downspout will be discharged into the ground water aquifer through specially constructed infiltration wells
All stormwater from the uncovered areas, will discharge on the roads
Peak discharge estimates from the site are given in Table 3.
The roof runoff will be diverted and discharged into the ground through downspouts. It is recommended to use steel or plastic downspouts 125 mm in diameter. The capacity of such downspouts for the lengths and drops at the site, (Hazen- Williams equation, L= 15 m, d=10m, n=120) is 125 lt/sec, adequate capacity for this site.
Based on the results of the infiltration test, the amount of water that can be recharged into the ground water, is 20 m^3/hour, or 5.55 lts/sec. Each downspout will be connected to an infiltration well.
Table 3, gives the recommended number of recharge, (infiltration), wells required to recharge peak flows of 1:50 and 1:100 Years return period.

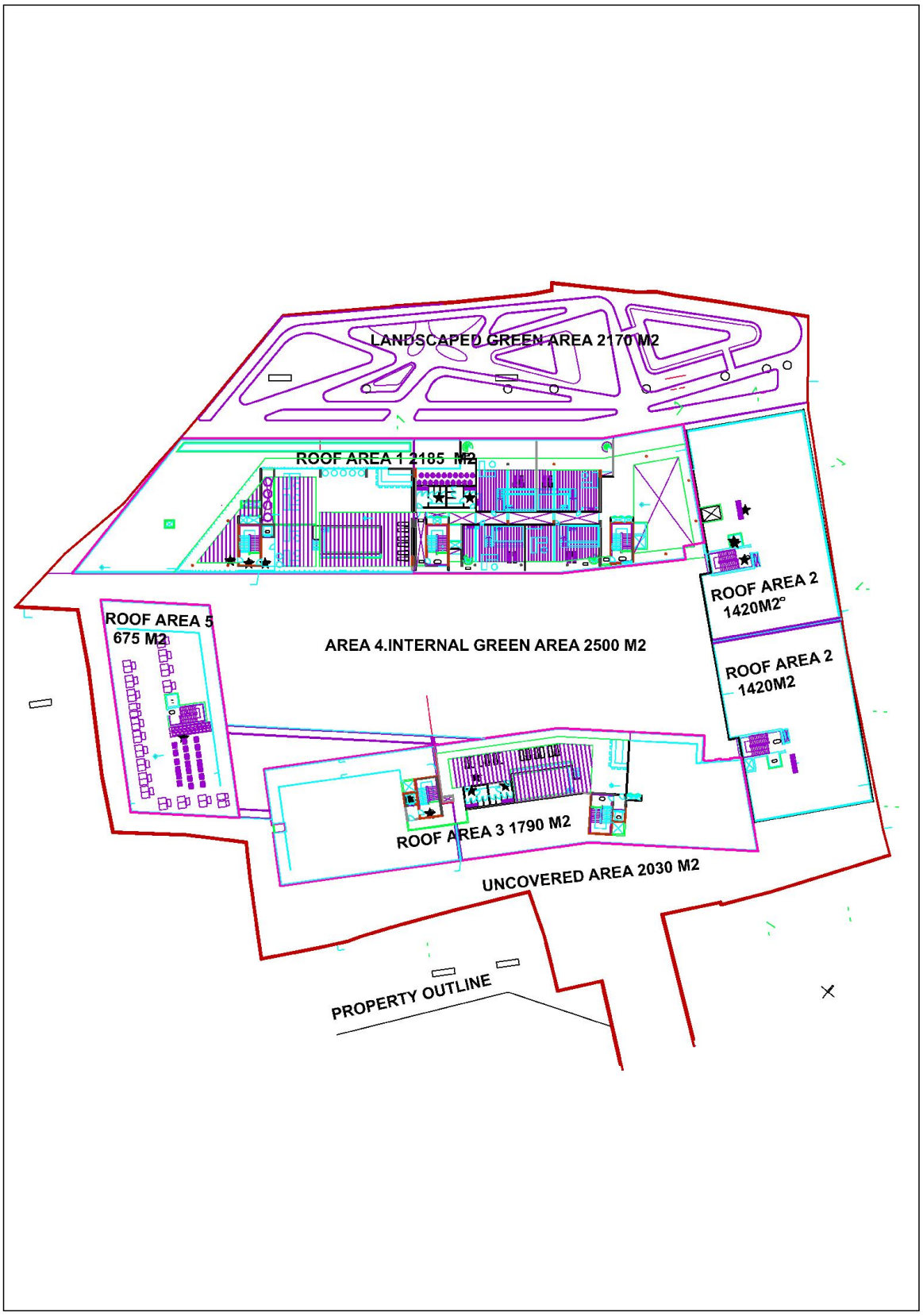

Figure 4. Sub areas of the proposed development

Table 3. Peak discharge estimates from the development site

Sub areas									
		5 min peak	Peak		30 Min m peak	Peak	Number		Comments
	Area m^2	discharge	discharge		discharge	discharge	of downspouts to carry the peak flow		
Sub Roof 1	2183	m^3/sec	m^3/sec		m^3/sec	m^3/sec			Drained to Groundwater
1:50 Yyrs		0.1009516	0.00841264		0.0353646	0.017682	**3.186**	4	**Recommended infiltration wells 6**
1:100 Yrs		0.1173969	0.00978307		0.04108891	0.020544	**3.701704**	4	**Recommended infiltration wells 6**
Sub Roof 2	1420								Drained to Groundwater
1:50 Yyrs		0.0656671	0.00547226		0.023004	0.011502	**2.072432**	3	**Recommended infiltration wells 4**
1:100 Yrs		0.0763644	0.0063637		0.02672756	0.013364	**2.407888**	3	**Recommended infiltration wells 4**
Sub Roof 3	1790								Drained to Groundwater
1:50 Yyrs		0.0827776	0.00689813		0.028998	0.014499	**2.612432**	3	**Recommended infiltration wells 4**
1:100 Yrs		**0.0962622**	0.00802185		0.03369178	0.016846	**3.035295**	4	**Recommended infiltration wells 4**
Sub Roof 5	675								Drained to Groundwater
1:50 Yyrs		0.031215	0.00260125		0.010935	0.005468	**0.985135**	1	**Recommended infiltration wells 2**
1:100 Yrs		0.0363	0.003025		0.012705	0.006353	**1.144595**	2	**Recommended infiltration wells 2**
Sub Roof 4	2495								Drained to Groundwater
1:50 Yyrs		0.1153799	0.00961499		0.040419	0.02021	**3.641351**	4	**Recommended infiltration wells 6**
1:100 Yrs		0.1341756	0.0111813		0.04696144	0.023481	**4.230761**	5	**Recommended infiltration wells 6**

Uncovered	2030								
Sub Roof 6									Drained to streets
1:50 Yyrs		0.0938762	0.00782302		0.032886	0.016443	**2.962703**	3	
1:100 Yrs		0.1091689	0.00909741		0.03820911	0.019105	**3.442262**	4	
Land scaped area	2170								
1:50 Yyrs		0.1166978	0.00972481		0.035154	0.017577	**3.167027**	4	
1:100 Yrs		0.1347811	0.01123176		0.04084422	0.020422	**3.67966**	4	
TOTAL	12763								

RECOMMENDATIONS

Drainage from roof areas 1 and 2, together with Roof 4 (Inner garden, green area) will be diverted to infiltration wells to be drilled and installed in the Public green area. The number of infiltration wells 16
Drainage from roof areas 3 and 5 will be diverted to infiltration wells to be drilled and installed below the basement foundation raft. The number of infiltration wells 6.
The total number of infiltration wells 22.

REFERENCES AND BIBLIOGRAPHY

Chin, David A. 2000. Water-Resources Engineering. Prentice-Hall

Chow, Ven Te, David R. Maidment, and Larry W. Mays. 1988. Applied Hydrology. McGraw-Hill.

McCuen, Richard H. 1998. Hydrology Analysis and Design. Prentice-Hall. 2ed.

Figure 1. Location Map Google earth sat image.

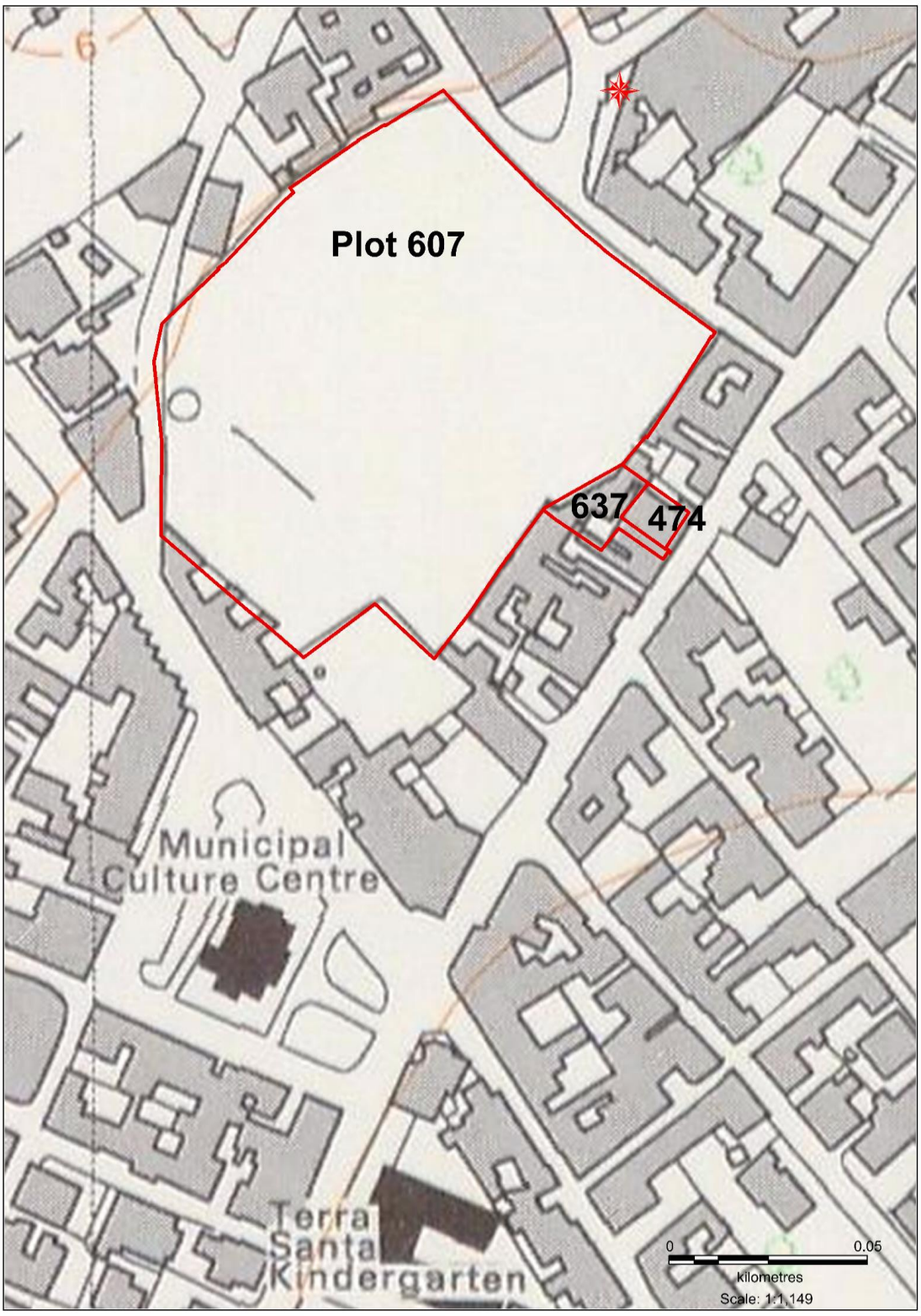

Figure 2. Plot 607,637 and 474 on Topographical map 1:50000

APPENDIX I

Meteorological Data

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T200	200	279.5	196.4	128.5	97.9	59.9	35.9	15.7	5.4
T500	500	335.4	235.6	154.1	117.4	71.9	43.1	18.8	6.5

Return	Runoff	Estimated amount of maximum expected runoff in							
period	Coefficient	cubic meters/ second/m² for different time periods							
Years	C	**5 minutes**	**10 minutes**	**20 minutes**	**30 minutes**	**1 hour**	**2 hours**	**6 hours**	**24 hours**
2	0.33	0.000007	0.000005	0.000003	0.000003	0.000002	0.000001	0.000000	0.000000
3	0.33	0.000009	0.000006	0.000004	0.000003	0.000002	0.000001	0.000000	0.000000
5	0.36	0.000012	0.000008	0.000005	0.000004	0.000002	0.000001	0.000001	0.000000
10	0.38	0.000015	0.000010	0.000007	0.000005	0.000003	0.000002	0.000001	0.000000
20	0.42	0.000020	0.000014	0.000009	0.000007	0.000004	0.000003	0.000001	0.000000
25	0.42	0.000020	0.000014	0.000009	0.000007	0.000004	0.000003	0.000001	0.000000
50	0.80	0.000046	0.000032	0.000021	0.000016	0.000010	0.000006	0.000003	0.000001
100	0.80	0.000054	0.000038	0.000025	0.000019	0.000012	0.000007	0.000003	0.000001
200	0.80	0.000062	0.000044	0.000029	0.000022	0.000013	0.000008	0.000003	0.000001

Locality	Renaisance Lsol								
Extent	2170	square meters							
Return	Runoff	Estimated amount of maximum expected runoff in							
period	Coefficient	cubic meters/ second for different time periods							
Years	C	**5 minutes**	**10 minutes**	**20 minutes**	**30 minutes**	**1 hour**	**2 hours**	**6 hours**	**24 hours**
2	0.33	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
3	0.33	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
5	0.36	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00
10	0.38	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
20	0.42	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00
25	0.42	0.04	0.03	0.02	0.02	0.01	0.01	0.00	0.00
50	0.50	0.10	0.07	0.05	0.04	0.02	0.01	0.01	0.00
100	0.50	0.12	0.08	0.05	0.04	0.03	0.01	0.01	0.00
200	0.80	0.13	0.09	0.06	0.05	0.03	0.02	0.01	0.00

Sub areas									
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