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THE EFFECT AND THE INFLUENCE OF CLIMATE CHANGES ON THE METEORIC WATER MANAGEMENT IN RESIDENTIAL AND INDUSTRIAL ZONES

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Abstract: The paper analyzes the management of meteoric water in residential and industrial areas under the influence of recent climate change.

These areas are frequently confronted with floods occurring in periods of heavy rainfall, leading to a centralized meteorological sewerage system.

These floods are mainly due to the inability to take the meteoric waters from the drainage channels and the unitary sewerage, which are undersized for the current urban development.

The proposed solutions for the management of meteoric waters from residential and industrial areas consist in the construction of sewerage networks in the separating system only for collecting meteoric waters and setting up retention basins for storage during abundant rainfalls.

Retention basins will store the amount of meteorological water collected from the areas of residential and industrial areas during precipitation, and after the rainfall will be pumped into the existing sewerage collector, in the nearest emissary or used to water the green areas or at watering the enclosure platforms.

Key words: climate change, meteorological water management, meteorological sewerage networks, hydrocarbon decanters - separators, retention basins.

1. INTRODUCTION

Urban development of residential and industrial areas has led to changes in meteorological water drainage coefficients (new constructions, road platforms, roads, sidewalks, industrial platforms, etc.), resulting in their floods during the heavy rainfall.

Also, the existing drainage channels were dimensioned to take only the meteoric waters from the grassy surfaces. These channels are generally clogged or dismantled on some portions due to total lack of maintenance and operation. During the heavy rainfall, drainage channels cannot take over the meteorological flows in their surrounding areas because they are under-dimensioned and clogged for current urban development.

In plain areas, sewage systems are in a unitary system, leading to poor operation in case of heavy rainfall. This leads to the entry of the under pressure drainage system with devastating effects on the flooded areas and the treatment plant.

Calculation and sizing of sewerage networks is done at $Q_{hourmax}$, and for meteoric sewerage the sizing is done according to the surface area, leakage coefficient and calculation rain intensity.

The influence of climate change on residential and industrial areas leads to the development of meteorological sewage systems designed to ensure good functioning of new climatic conditions.

In order to limit floods in periods of heavy rainfall, it is intended to set up retention basins equipped with pumping stations capable of accumulating precipitation volume during the rain and to be pumped into the existing sewerage network or in the nearest emissary from the vulnerable area.

Arrangement of retention basins should be correlated with the replacement of degraded sewerage channels, with the removal of sediment deposits and the maintenance of drainage channels, ensuring by these measures the elimination of the risk of floods in these areas during adverse periods.

2. DETERMINATION THE CALCULATION METHOD OF METEOROLOGICAL DEBITS

The maximum flow of meteorological waters flowing through a section of a channel (Qm), in l / s, is calculated with the relation:

$$Qm = i \cdot m \cdot \Sigma\, S \cdot \Phi \qquad (1)$$

where: i is the intensity of the rainfall in l/s ha;

m - non-dimensional reduction coefficient of the calculation flow, which takes into account the storage capacity of the channels and the duration of the calculated rainfall (t_p) that can be considered (m = 0,8

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for $t_p \leq 40$ min, m = 0,9 for $t_p \geq 40$ min and m = 1 for residential buildings, for t_p<15 min);

S - the area of the sewage basin of the computing section in ha;

Φ - the coefficient of leakage of the receiving surface, having values between 0.05 and 0.95 depending on the nature of the surface.

The leakage coefficient can be considered differentiated, by stages of development of the localities, in relation to the evolution over time of the solutions for the design of the meteorological waters collection areas. This fact led to the doubling of the drainage coefficient in many populated centers, the projected sewerage networks being unable to carry the flows even in normal rainfall rains.

The intensity of the rainfall (i) is set according to the standard frequency (f), the rain duration (t_p), in minutes and the intensity curves for an equal rain frequency.

Frequency of calculation rain (f), depending on the class of importance of use and the character of the unit: social (populated centers, housing districts, etc.) and economic (industrial and agricultural, etc.).

Rain duration (t_p) is the time from the start of rain to the end of rain, being determined from the pluviograms bands, respectively from pluviograms and highlights the amount of water that has fallen.

The calculation rain intensity (i) is a function dependent ofrain duration(tp) and rain frequency (f) expressed as:

$$I = F(t_p, f) \qquad (2)$$

The intensity of the calculation rain can be determined by diagrams or empirical or semi-empirical relations.

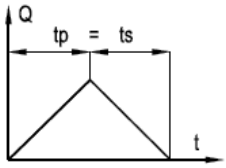
In Romania, the intensity of the calculation rain for the 19 characteristic areas is determined in relation to the frequency (f) and the duration of the calculation rain, using the diagrams from STAS 9470-73.

Due to the recent climate changes, these charts no longer reflect the actual rainfall situation, and for calculating the rainfall intensities, Reinhold's relationship can be used:

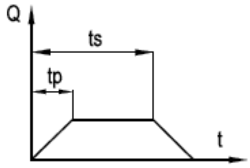
$$i_f = 38\cdot(t_p + 9)\cdot(f^{-1/4} - 0,369)\cdot i_{15(1/1)} \qquad (3)$$

where: i_f is the intensity of the rainfall in l/s·ha; t_p - duration of rainfall in minutes; f - frequency of calculation; $i_{15\ (1/1)}$ - the rainfall intensity for t_p = 15 min and f = 1/1, which can be considered as 120 l/s·ha for the plain and hilly areas, of 150 l/s·ha for the mountain / alpine areas.

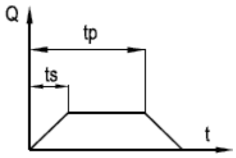
The maximum flow rate of meteoric waters on a channel section by the limit intensity method is obtained when $t_p = t_s$. In this case, the flow chart is of triangular shape (Figure 1.a), and the calculation surface is fully embedded.



a) Triangular hydrograph ($t_p = t_s$)



b) Straight hydrograph ($t_p < t_s$)



c) Straight hydrograph ($t_p > t_s$)

Figure 1. Leakage hydrograph

If $t_p < t_s$ it results that the total area is not incorporated in the calculation until the rain stops, but at lower t_p values results higher rain intensities.

If the collection area decreases, the flow rate may be lower than the one obtained when $t_p = t_s$, although the intensity of the rain increases. In this situation, the flow chart, shown in Figure 1.b, is trapezoidal.

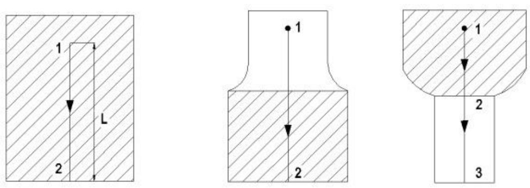
If tp> ts results in a lower flow than if tp = ts, since the collection surface remains constant from ts time to tp time, and the rain intensity decreases. In this case, the flow hydrograph, shown in Figure 1.c, is also trapezoidal.

The meteoric flow is also dependent on the shape of the drainage surfaces (Fig. 2. a, b, c).

If the drainage surface is rectangular (Fig.2.a), the maximum meteorological flow is reached in section 2, when $t_p = t_s$ and the flow area is fully embedded.

In the case of the drainage surface, shown in figure 2.b, at a constant slope and a constant drain coefficient, the maximum flow is obtained in section 2, when only the hatched surface is taken into account, because compared to the case of the total surface, the intensity increases much and the surface decreases less.

In the case of the drainage surface shown in (Fig. 2.c), a higher flow rate is obtained in section 2 and not in section 3. In this case, the channel section 2-3 will be dimensioned for the flow rate in section 2 because the flow rate in an upstream section cannot be reduced during the downstream sections.



a) Rectangular surface b) Elongated downstream area c) Elongated upstream area

Figure 2. Leakage surface

2. MANAGEMENT OF METEORIC WATERS FROM RESIDENTIAL AND INDUSTRIAL ZONES

Due to the urban development of residential and industrial areas with changes in meteorological water leakage coefficients (new constructions, road platforms, roads, sidewalks, industrial platforms, etc.), good meteorological water management is required to eliminate the risk of flooding in periods of heavy rainfall.

In these areas it is necessary to have a centralized sewerage system consisting of sewerage networks, pumping stations, hydrocarbon decanters and separators, retention basins and discharge pipes of conventionally clean water in the emissary (drainage channels, sewerage) or used in dry periods on watering green areas, platforms associated with areas and combating possible fires.

The calculation of retention basins should take into account the local conditions within the studied areas, the possibilities of conventionally clean water evacuation.

The existing drainage channels were dimensioned to take only the meteoric waters from the grassy surfaces. These channels are generally clogged or dismantled on some portions due to a total lack of maintenance and exploitation. During the heavy rainfall, drainage channels cannot take over the meteorological flows in their surrounding areas because they are under-dimensioned and clogged for current urban development.

The capacity to transport of the sewerage networks in a unitary system from floodplains is far exceeded, especially in the torrential rain, due to the fact that, through climate change, the rainfall intensity has increased well above the values considered when estimating the initial flows for sizing the sewerage networks .

The studies analyzed in this paper for these areas were aimed at ensuring good functioning of the sewerage system for meteoric waters during the torrential / abundant rains, without these areas being flooded.

3. TECHNICAL SOLUTIONS FOR THE ASSURANCE OF METERIC SEWERAGESYSTEM OF A PRODUCTION AREA, STORAGE, SERVICES AND RESIDENTIAL ZONE IN THE GIARMATA VILLAGE

The meteoric sewerage system has been sized, depending on the meteoric flows and all the sewerage sections within the objective (diameter, hydraulic slope, flow to full and speed at full). Figure 3 shows the placement and the technical solution adopted for this objective.

Each service housing parcel will be provided with a rainfall collection basin of approx. 3 mc. Stored water will be used to water the green spaces.

The rainwater from the industrial hall platforms will be treated and evacuated independently with the investment.

The rainwater collected from the roads of the studied object will be collected through a pluvial sewerage networks made of drains, sewerage network from PVC-KG tubes, SN 4, De 250 mm, De 315 mm, De 400 mm and De 500 mm and passed through hydrocarbon decanters - separators and stored in the proposed retention basin via a pumping station.

The pumping station is provided with:3 submersible electropumps 2 + 1R with the characteristics: Q = 792 mc / h, H = 15 mCA, P = 42 kW;1 vertical axial ventilator type VVAT400 / 12 with Q = 1800 mc/h, H = 13 mmCA, electric motor; 1 centrifugal ventilator type V491/6 with Q = 500 mc / h, H = 353 mmCA, electric motor 1.1 kw, 3000 rpm (the ventilator is part of the mobile ventilation system); hydraulic and ventilation facilities.

In case the electric current supply is interrupted, the pumping station is equipped with a diesel generator.

The discharge pipe will be made of PE-HD, PE80, PN6, De 450x25.5 mm in length of 7 m, to the retention basin.

The retention basin will have a volume of 1500 m^3. Conventionally clean rainwater will be used to water the green spaces and wash the road.

The flow of meteoric water dropped onto road surfaces is: $Q_P = m \times S \times \varphi \times I = 440$ l / s

In this case, three hydrocarbon decanters - separators are needed, which have been dimensioned at a total flow rate of 440 l/s and will collect sand and oils accidentally produced from motor vehicles from the streets of this area.

The retention basin provides water storage during the rain of a volume of 1500 cubic meters.

$$V = Q \times tp = 440 \text{ l/s} \times 47{,}71 \text{ min} = 440 \times 10^{-3} \times 60 \times 47{,}71 = 1.259{,}54 \text{ mc}$$

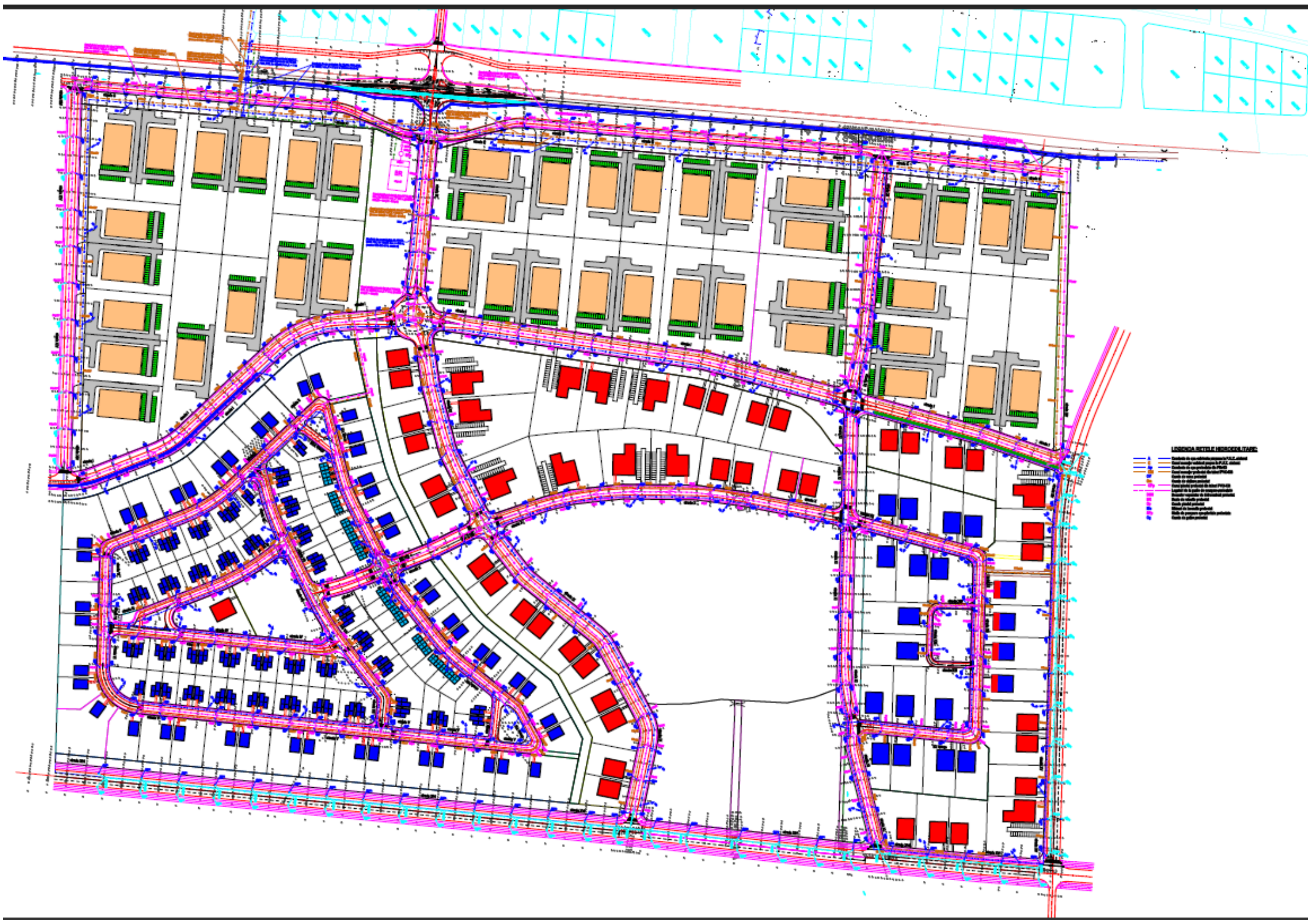


Figure 3. Situation plan - residential and industrial area

4. TECHNICAL SOLUTIONS FOR THE ASSURANCE OF A METEORIC SEWERAGE SYSTEM OF AN INDUSTRIAL ZONE IN THE TIMIŞOARA MUNICIPALITY

The meteoric sewerage system has been sized, depending on the meteoric flows and all the sewerage sections within the objective (diameter, hydraulic slope, flow to full and speed at full). Figure 8 shows the placement and the technical solution adopted for this objective.

The proposed channel will be made of PVC tubes, SN4, with De 250 mm, De 315 mm; De 400 mm and De 500 mm.

On this channel there are 33 walkways and 43 drains with storage and without siphon. The connection of the drainage ducts to the drainage channel will be made by PVC pipes, SN 4, De 160 mm.

The meteoric waters in the enclosure will be passed through a hydrocarbon decanter - separator type ACO NG15/150 - OLEOPASS, and from there clean conventional waters are stored in two circular retention basins of armed polyesters, each having D = 2.5 m and L = 14 m. These basins communicate with each other and are equipped with access baskets and caps.

Due to the fact that there is no drainage channel in the area, overflow of the retention basin will be discharged into the canalization of Timişoara through a PE-HD, PN 4, PE 80, De 125 mm discharge pipe. In the retention basin a submersible electro pump is provided having: Q = 10 l/s, H = 8 mCA and P = 2 kW. On the discharge pipe was provided a Cref vane fireside equipped with a closing valve and a check valve with clapper with a clamp and quench chamber.

The constant evacuated flow rate will be 8.24 l/s calculated for the case where the surface of the objective would be grassy.

From the quench chamber, conventional clean water is discharged to the CR connection duct through a PVC tube channel, SN4, De 250 mm.

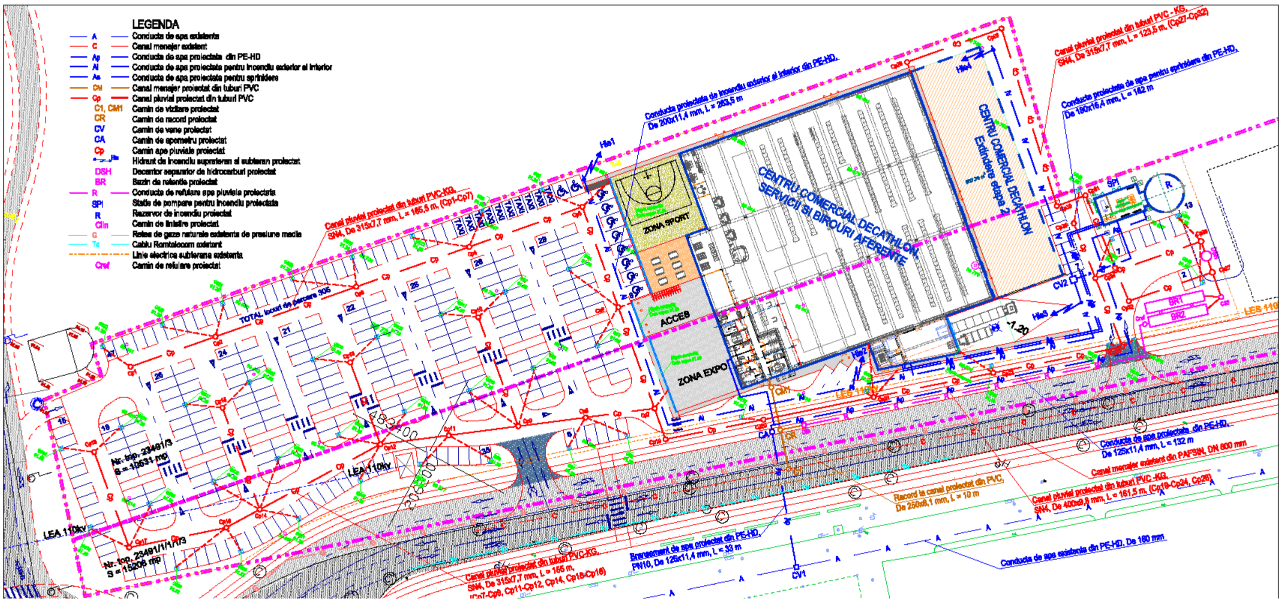


Figure 4. Situation plan - industrial area

5. CONCLUSIONS AND RECOMMENDATIONS

The researches and studies carried out in the paper on the effect and climate change on the management of meteoric waters in the residential and industrial areas collected at the hearth of urban populated centers located in the plain area have resulted in: the hydraulic sizing of the sewerage networks for the case their operation under pressure; hydraulic dimensioning of retention basinswith a relationship in dimensionless quantities; the technical and economical calculation of the hydraulic system consisting of sewerage networks and pumping stations in order to reduce the risk of floods in some areas; the applicability of the theoretical studies to reduce the risk of flooding through retention basins coupled to pumping stations equipped with submersible electro pump.

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