Application of SWMM in the simulation of point source pollution in a macrodrainage system

Aplicação de SWMM na simulação de poluição de fontes pontuais em um sistema de macrodrenagem

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ABSTRACT

Many cities in Brazil still present, in some locations, flaws in the urban drainage system, mainly concerning water contamination by punctual and diffuse sources, with drainage channels visibly contaminated by domestic sewage and solid waste. Therefore, the present study aimed to perform the diagnosis of dry weather flows and evaluate the behavior of pollutant concentrations during the propagation of the flow and the response of mathematical modeling to an intervention proposal in case the punctual entries that present greater polluting potential to be removed, aiming at improving the quality channel waters. The identification of the sewage entry points in the Canal do Prado was based on field observations. The flow measurement was made at each selected point, to better understand the flow behavior and obtain a good average for the analyzed period. To perform the simulation, the concentrations of the variables BOD, COD and FT for the sewage inlets were raised. A diagnosis of dry weather flows was carried out, corresponding to the reality of the drainage system in the non-rainy periods of the city. The results indicate that SWMM responds well to the Dry Climate Flow (DWF) simulation. Furthermore, even small interventions done in the canal would not yield a significant improvement in the overall quality of the drainage system of the basin, the improvements would be only local.

Keywords: quality of drainage water, mathematical modeling, storm water management model.

RESUMO

Muitas cidades do Brasil ainda apresentam, em alguns locais, falhas no sistema de drenagem urbana, principalmente no que se refere à contaminação da água por fontes pontuais e difusas, com canais de drenagem visivelmente contaminados por esgoto doméstico e resíduos sólidos. Portanto, o presente estudo teve como objetivo realizar o diagnóstico de fluxos de tempo seco e avaliar o comportamento de concentrações de poluentes durante a propagação do fluxo e a resposta de modelagem matemática a uma proposta de intervenção no caso de entradas pontuais que apresentem maior potencial poluente a ser removido, visando melhorar a qualidade das águas do canal. A identificação dos pontos de entrada de esgoto no Canal do Prado foi feita com base em observações de campo. A medição do fluxo foi feita em cada ponto selecionado, para melhor compreender o comportamento do fluxo e obter uma boa média para o período analisado. Para realizar a simulação, as concentrações das variáveis BOD, COD e FT para as entradas de esgoto foram elevadas. Foi feito um diagnóstico de fluxo de tempo seco, correspondente à realidade do sistema de drenagem nos períodos não chuvosos da cidade. Os resultados indicam que o SWMM responde bem à simulação do DWF (Dry Climate Flow). Além disso,
mesmo pequenas intervenções feitas no canal não produziriam uma melhoria significativa na qualidade geral do sistema de drenagem da bacia, as melhorias seriam apenas locais.

**Palavras-chave:** qualidade da água de drenagem, modelagem matemática, modelo de gestão da água de tempestade.

### 1 INTRODUÇÃO

Over the past decades, high-speed urbanization has led to increasing waterproofing in urban-underlying surface around the world, modifying and impacting the drainage system (CHUNHUI LI et al; MIGUEZ et al, 2016). Since a large quantity of urban dust is transported into water bodies by rainfall-runoff processes, this might cause deterioration of urban water quality, risk to the health of the population and serious environmental impacts.

Another important source of deterioration in the quality of urban drainage water is nopoint source (NPS). In recent years, with the control of point sources pollution, NPS pollution has become a major contributor to the degradation of surface water quality in many urban areas (ELLER and KATZ, 2017; GHOZADEH et al. 2016; XU et al. 2017). Accordingly, research and management efforts have turned to this kind of pollution (DUPAS et al. 2015).

Compared with the point source pollution, NPS pollution has some distinguished features: random occurrence, complicated mechanisms and processes, and extensive pollution sources. Furthermore, its geographical boundaries and locations are also difficult to identify and determine (YANG et al, 2016).

Studies involving the temporal and spatial analysis of surface water quality are important tools to support decision-making and the establishment of goals and mitigation measures (ZAFFANI, 2012). However, the management of the quantity and quality of stormwater runoff from urban areas has become a complex task and an increasingly important environmental issue for urban communities. To deal with this issue, computer-aided models are extremely useful for simulating and predicting the quantity and quality of urban stormwater (CHUNHUI LI et al, 2016).
Among the computational hydrological models for the evaluation of drainage systems the Storm Water Management Model (SWMM), created by the American Agency Environment (US EPA) in 1971, enables the modeling of diffuse pollution and can assess the impacts of surface runoff pollution and evaluate the effectiveness of many mitigation strategies (SOUZA, 2014; CHUNHUI LI et. al, 2016).

SWMM can also be used to simulate sanitary sewers and systems with cross connections. Dry weather flow (DWF) might also be applied to simulations of those systems. DWF is the continuous discharge of sanitary or industrial wastewater directly into the conveyance portion of a SWMM model, typically at junction nodes of a sanitary sewer network (ROSSMAN; HUBER, 2016).

Campina Grande, a city located in the Northeast of Brazil, has numbers above the national average concerning basic sanitation, although it still presents, in some locations, flaws in the urban drainage system, mainly about water contamination by punctual and diffuse sources, with drainage channels visibly contaminated by domestic sewage and solid waste. Among these locations, the Riacho do Prado Hydrographic Basin is presented in this document as an object of analysis. In the non-rainy periods of the city, only the continuous flows that correspond to the wastewater entering the system are observed in the drainage system, that is, the flows of the sewers that are connected to the channel.

Based on the above consideration, the present study aimed to perform the diagnosis of dry weather flows and evaluate the behavior of pollutant concentrations during the propagation of the flow and the response of mathematical modeling to an intervention proposal in case the punctual entries that present greater polluting potential were removed, aiming at improving the quality channel waters.

1.1 SWMM MODEL

According to Rossman & Huber (2016), SWMM is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. SWMM conceptualizes urban drainage system as a series of water and material flows between several
major environmental compartments. These compartments include: the Atmosphere, the Land Surface, the Sub-Surface, and the Conveyance.

The Conveyance compartment contains a network of elements (channels, pipes, pumps, and regulators) and storage/treatment units that convey water to outfalls or to treatment facilities. Inflows to this compartment can come from surface runoff, groundwater flow, sanitary dry weather flow, or from user-defined time series (Figure 1). depicts the processes that SWMM models and how they are tied to one another.

![Diagram of processes modeled by SWMM](image)

Source: (ROSSMAN; HUBER, 2016).

Regarding water quality, the processes of entry of dry weather sanitary flows and user-specified external inflows at any point in the drainage system and routing of water quality constituents through the drainage system, can be modeled for any number of user-defined water quality constituents. DWF usually follows some repeating pattern on both a diurnal, daily, and monthly basis. SWMM allows one to define how both the flow rate and concentration of water quality constituents vary periodically with time at any specific node of the drainage network.
Water quality constituents in surface runoff and from other external sources will typically be transported through a conveyance system until they are discharged into a receiving water body, a treatment facility, or some other type of destination.

Pollutants can be removed by natural decay processes as they flow through conduits and storage nodes, and they can also be reduced by treatment processes applied at both non-storage nodes (e.g., high-rate solids separators) and storage nodes (e.g., physical sedimentation).

SWMM computes pollutant concentrations within all conduits and nodes of the conveyance network at each computational time step using an approach where the conduits are represented as completely mixed reactors connected at junctions or at completely mixed storage nodes. This approach eliminating the need to compute the spatial variation of concentration along the length of a conduit. Equation 1 represent the conservation of mass equation for a completely mixed reactor.

\[
\frac{d (Vc)}{dt} = c_{in} Q_{in} - c Q_{out} - Vr (c)
\]  

(1)

Where

\( V \) is the volume within the reactor, \( c \) is the concentration within the reactor, \( c_{in} \) is the concentration of any inflow to the reactor, \( Q_{in} \) is the volumetric flow rate of this inflow, \( Q_{out} \) is the volumetric flow rate leaving the reactor, and \( r(c) \) is a function that determines the rate of loss due to reaction.

2 METHODS
2.1 STUDY AREA

The municipality of Campina Grande, located in the Northeast of Brazil, has 594,182 km² of territorial area and an estimated population of 411,807 inhabitants (IBGE, 2021). The city is in an accelerated transformation process driven by real estate dynamics, which has been altering the urban landscape through the intensification of the verticalization process and the implementation of new horizontal condominiums (SILVA & BARROS FILHO, 2014).
Regarding sanitary sewage, even with the absolute separator system, it is possible to observe problems related to discharge of sewage into water cups and the presence of clandestine connections in the rainwater drainage network. In addition, floods and problems related to the drainage system are usual, which proves inefficient.

In terms of the drainage system, according to the Municipal Basic Sanitation Plan (CAMPINA GRANDE, 2015), the city is inserted in an area that covers three basins, called basins B, C and D – Riacho do Bodocongó Basin, Riacho das Piabas Basin and Riacho do Prado Basin, respectively. For this study the main focus is the Riacho do Prado Basin (Figure 2) which has an area of 24.7 km² and a perimeter of 40.2 km and is divided into 13 sub-basins (D1 to D13), comprising totally or partially 22 neighborhoods in the city (TSUYUGUCHI, 2015).

The channel under study starts at the overflow of surplus water from an urban reservoir (7°13′35.8″ S; 35° 52′47.7″ W) and has two tributaries that contribute to the main channel. After a certain point (7°14′47.6″ S; 35° 53′22.1″ W) the channel no longer has its artificial coating, following its route through a natural bed until it flows into the Bodocongó Stream, which is a tributary of the Paraíba River, the main river of the state (HENRIQUES, 2014).

Figure 2 – Location of the Riacho do Prado River Basin

Subtitle:
- Brazil
- Paraíba
- Campina Grande
- Campina Grande urban perimeter
- Riacho do Prado Basin
- Sub-basins

Source: Camelo et al. (2020).
2.2 MONITORING AND DATA COLLECTION

Quality predictions by SWMM or almost any other surface runoff model is mostly hypothetical unless local data for the catchment being simulated are available for calibration and validation. there is no substitute for local data (rain, flow, and concentration measurements) with which to calibrate and verify the quality predictions (ROSSMAN; HUBER, 2016).

The identification of the sewage entry points in the Canal do Prado was based on field observations. The entire channel was covered, on foot, to detect all possible inlets. It was found the existence of pipes that flow into the channel, however, several of them did not show any flow contribution throughout the analysis period, thus, they were disregarded in this study. In contrast, some pipes presented intermittently flow.

Ten sewage entry points were selected along the entire channel. Its characteristics in the hydrographic basin area are identified in Figure 3 and its geographical coordinates are in Table 1. The points are illustrated in Figure 3 and Figure 4.

<table>
<thead>
<tr>
<th>Point</th>
<th>Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7°13'48.68&quot;S e 35°52'51.52&quot;O</td>
</tr>
<tr>
<td>B</td>
<td>7°13'49.03&quot;S e 35°52'52.15&quot;O</td>
</tr>
<tr>
<td>C</td>
<td>7°13'54.30&quot;S e 35°53'4.22&quot;O</td>
</tr>
<tr>
<td>D</td>
<td>7°14'10.14&quot;S e 35°53'2.53&quot;O</td>
</tr>
<tr>
<td>E</td>
<td>7°14'34.85&quot;S e 35°52'46.98&quot;O</td>
</tr>
<tr>
<td>F</td>
<td>7°14'35.18&quot;S e 35°52'49.92&quot;O</td>
</tr>
<tr>
<td>G</td>
<td>7°14'35.91&quot;S e 35°52'56.46&quot;O</td>
</tr>
<tr>
<td>H</td>
<td>7°14'41.89&quot;S e 35°53'16.01&quot;O</td>
</tr>
<tr>
<td>I</td>
<td>7°13'42.22&quot;S e 35°53'10.24&quot;O</td>
</tr>
<tr>
<td>J</td>
<td>7°13'52.05&quot;S e 35°53'5.99&quot;O</td>
</tr>
</tbody>
</table>

The entry I correspond to the sum of several sewage contributions from households that were built on the banks of the channel I and that discharge their effluents directly into the macro-drainage system. As it is a domestic effluent, its flow varies with time, depending on the use of water. For the quantification of this effluent, an estimate of the flow was made based on the population residing on
the banks of the channel (number of households) and the average sewage production per inhabitant. Entry J corresponds to a flow contribution upstream of that point, representing the inflow of the tributary where it is located. Entries I and J are shown in Figure 5.

The flow measurement was made at each selected point on four different days, to better understand the flow behavior and obtain a good average for the analyzed period. At points A, B, C, D, F, G and H the volumetric method was used (Figure 5), determining the time needed to fill a given container of known volume. As they are very close to each other and to facilitate the insertion of the points in the SWMM model, the flow rates of the two pipes referring to point D were added.

The float method was used to measure the three pipes at point E and point J. This method was chosen because the pipelines are located at the beginning of the channel and are responsible for all the inlet flow in the same channel. At point E, the measurement was made in the section immediately downstream of the entry of the last contribution.

To perform the simulation, the concentrations of the variables BOD, COD and FT for the sewage inlets were raised. Sample collections were made at points within the Canal do Prado that were located remarkably close to the sewage entry
points, during the dry period (CAMELO et al., 2020), when there is no precipitation and within the channel there are only contributions from clandestine domestic sewage connections.

2.3 MODELING

In the SWMM model, the drainage system is represented by the elements sub-basins, ducts, and nodes, which are interconnected according to the level of the represented area. The parameters of these elements were defined based on the data collection carried out through on-site visits, by consulting the projects with SEPLAN – Secretariat of Planning, Management and Transparency of Campina Grande, and aerial images made available by the Google Earth. The parameters necessary for the characterization of the study area will be covered in more detail below.

2.4 CHANNEL DATA

According to Rossman (2015) the conduits in the SWMM can be natural channels, such as rivers or rainwater pipes, or artificial channels, which can be characterized according to the shape of the cross-section and to whether they are open or closed. In this work, only the artificial and natural channels corresponding to the macrodrainage system will be considered in the modeling. The characterization of the channels in the model is made from the input channels in Table 2.

The length of the conduits was automatically measured by the SWMM, from the insertion of the geographic coordinates in the drawing. The mean values of Manning roughness for each section of the ducts were taken from Tsuyuguchi (2015) apud Methods and Dietrich (2007) and are shown in Table 3.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Abbreviation</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>L</td>
<td>m</td>
</tr>
<tr>
<td>Roughness coefficient</td>
<td>n</td>
<td>-</td>
</tr>
<tr>
<td>Transversal section</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3 – Values of the Manning coefficient for the channels

<table>
<thead>
<tr>
<th>Section</th>
<th>Manning coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canal do Prado</td>
<td>0.016</td>
</tr>
<tr>
<td>Calha do Riacho</td>
<td>0.045</td>
</tr>
</tbody>
</table>


2.5 QUALITY DATA

For this analysis, variables such as BOD5, COD, and FT were used as source indicators in the modeling process. The information required for each of these polluting agents is shown in Table 4.

Table 4 – Characterization of pollutants in SWMM

<table>
<thead>
<tr>
<th>Property</th>
<th>Abbreviation</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant concentration</td>
<td>Rconc</td>
<td>mg/L</td>
</tr>
<tr>
<td>Pollutant concentration in groundwater</td>
<td>GWconc</td>
<td>mg/L</td>
</tr>
<tr>
<td>Pollutant concentration in direct entry or infiltration processes</td>
<td>I e Iconc</td>
<td>mg/L</td>
</tr>
</tbody>
</table>


As the approached system does not receive direct priority from groundwater or infiltration, such as procedures for pollutants in groundwater (GW\text{conc}) and pollutants from direct entry or infiltration (I and I\text{conc}) will be disregarded.

2.6 CALIBRATION AND VALIDATION MODEL

The calibration of the model was performed through an iterative process. The results of the values obtained for the model parameters were reached manually through a trial-and-error process until simulated values were obtained compatible with those observed by measurement. The BOD, COD, and FT concentration values of the sewage entry points in the system were changed until the results obtained with the simulation were as close as possible to the concentrations obtained at the sample collection points. When the values generated by the SWMM reached close conformations with the observed data, the calibration step was completed.

The validation of the method aims to legitimize the results obtained during the simulations through the interpretation and analysis of these results. For this step, the simulation report and the summary of continuity errors presented by the
SWMM program were considered for each simulation. According to what is established by the model, such errors cannot exceed the value of 10% (ROSSMAN, 2015).

2.7 SIMULATED SCENARIO

A diagnosis of dry weather flows was carried out, corresponding to the reality of the drainage system in the non-rainy periods of the city. In this case, only the continuous flows that correspond to the wastewater entering the drainage system are considered, that is, the flows of the sewage that are connected to the channel.

This scenario aims to assess the behavior of pollutant concentrations during the propagation of the flow and the response of mathematical modeling to an intervention proposal, if the entries that present the greatest polluting potential (E, F and G) were removed, aiming at improving the quality of channel water.

To facilitate the discussion, the channel was divided into sections whose results show the same behavior (Figure 6). The results are presented in SWMM in the form of tables, graphs, or maps. The maps indicate the simulated values through a color scale, where red indicates the most critical situation dark blue, which indicates the best situation or, in the case of this work, the lowest concentrations of pollutants.

Figure 6 – Division of the channel into sections

3 RESULTS AND DISCUSSIONS

3.1 SEWAGE INLETS FLOW

The values obtained from the four flow measurements referring to the sewage inlets in the channel are shown in Figure 7. According to the figure, it is possible to verify that the major sewage contributions are at points E, G and H. All are located in a predominantly residential area, which may justify this large contribution of domestic sewage. In these three points, in all measurements performed, flow values greater than 0.01 m³/s (864,000 l/day) were obtained, reaching more than 0.02 m³/s at the H input.

After analysis, there was a relatively stable behavior at all points monitored at the same time, thus, the value adopted as the sewage flow at each point was the average of the four measurements performed. Table 5 shows the average values obtained.

![Figure 7 – Measured values of sewage flow dumped into the channel](chart)


For the estimation of the sewage contributions of the residences that are on the banks of the channel corresponding to INLET I, a survey was carried out through satellite images, available on Google Earth, in which several 154 houses contributed to this flow. Then, adopting the per capita water consumption of 150L/inhab.day, recommended by Von Sperling (1996) for cities with a population
greater than 250,000 inhabitants, considering an average of 3.58
inhab/household (PMSB-CG, 2015) and a return coefficient of 0.8 (SABESP,
2006) obtained a contribution flow equivalent to 0.000788 m³/s.

### Table 5 – Average sewage flows measured in Canal do Prado

<table>
<thead>
<tr>
<th>Sewage inlets</th>
<th>Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INLET A</td>
<td>0.0007</td>
</tr>
<tr>
<td>INLET B</td>
<td>0.0004</td>
</tr>
<tr>
<td>INLET C</td>
<td>0.0002</td>
</tr>
<tr>
<td>INLET D</td>
<td>0.0019</td>
</tr>
<tr>
<td>INLET E</td>
<td>0.0154</td>
</tr>
<tr>
<td>INLET F</td>
<td>0.0005</td>
</tr>
<tr>
<td>INLET G</td>
<td>0.0133</td>
</tr>
<tr>
<td>INLET H</td>
<td>0.0242</td>
</tr>
<tr>
<td>INLET I</td>
<td>0.0008</td>
</tr>
<tr>
<td>INLET J</td>
<td>0.0831</td>
</tr>
</tbody>
</table>


### 3.2 RESULTS OF THE PROPOSED SCENARIO

To carry out the DWF simulation, the concentrations of BOD, COD and FT of the collection points that were located closest to each sewage entry point were adopted for the sewage inlets. The calibration was done by the trial-and-error method, adjusting the concentration and flow values so that the results of the simulation approached the values measured in the field in the dry period. The results of the calibrations for BOD, COD and FT are shown in Figures 8, 9 and 10.

Figure 8 – Comparison between BOD concentration (observed and simulated) after calibration

Figure 9 – Comparison between COD concentration (Observed and simulated) after calibration


Figure 10 – Comparison between FT concentration (Observed and simulated) after calibration


Figure 11 shows the behavior of the BOD concentration in mg/L 15 minutes after the start of the simulation and after 12 hours of simulation. Through the maps, it is observed that in the stretches just after the sewage inlets there is a greater concentration of BOD at the beginning of the simulation. After noon, there is a change in the behavior of BOD along the channel due to the
propagation of flows and the mixing of effluents, resulting in increased concentration in sections 1, 3, 5, 6, 7 and 8.

Figure 11 – Map of the behavior of the BOD concentration (current situation)
A) Start of the simulation (15min). B) End of the simulation


Section 1 corresponds to the part of the channel with the lowest concentration of BOD, with values from 44 to 93 mg/L. This low concentration is explained because the flow, originating from the overflow of the reservoir, does not present typical sewage characteristics. The points with the greatest polluting potential are found in section 4, which has a red color in the first 15 minutes simulated, with values varying between 353 and 576 mg / L, and an average of 469 mg / L, a value associated with average sewage, according to Pessoa and Jordão (2011).

After the 12 hours of simulation, the concentration of BOD in the basin's outflow point is 89 mg / L, because the 12 hours were not enough for the entire pollutant load to be propagated up to that point. Analyzing this same situation after 15 hours, this value rises to 138.5 mg / L. And after 17 hours of simulation, it reached a maximum value of 154 mg / L. The graphic in Figure 12 shows the concentration of the pollutant analyzed in all stretches over the 12 simulated hours.

It is noticed that there is no change in the concentration in sections 2 and 4 because they are tributaries of the main channel, thus presenting only the point sources of sewage. Sections 3, 5, 6, 7 and 8 have their values increasing as they
receive contributions from other sections, causing mixing and increased concentration. Section 1 is the beginning of the drainage channel, thus also showing an initial increase due to the contribution of the surplus water from the Açude Velho.

Figure 12 – Behavior of BOD concentration throughout the simulation

![BOD Concentration Graph](image)


The behaviors of the COD and FT concentrations occur in a similar way to that observed for BOD. Figure 13 and Figure 14 shows the graphs of the COD and FT propagation in mg/L throughout the simulation performed.

Figure 13 – Concentration behavior throughout the simulation: COD

![COD Concentration Graph](image)

After 12 hours simulation, the COD concentration in the outflow point is 279.6 mg / L. Analyzing the same situation after 15 hours, this value rises to 358.7 mg / L. And after 17 hours of simulation, it reached a maximum value of 381.7 mg / L. According to Jordão and Pessoa (2011), these values are typical of average sewage.

For FT, after 12 hours of simulation, the concentration in the basin outflow point was 2.85 mgP/L. After 15 hours, this value rises to 4.3 mgP/L. And after 17 hours of simulation, it reaches a maximum value of 4.7 mgP/L.

A proposal for intervention in the system was also simulated, if the most critical sewage intakes were removed, that is, with the greatest polluting potential, presenting the highest flow and concentration of pollutants. The E, F and G inlets fit this requirement, together they represent 20% of the total flow drained by the channel during the dry period.

Figure 15 compares the results obtained with the SWMM for the BOD at the end of the simulation of the current scenario and the scenario with the intervention proposal, in case entries E, F and G were removed.

The withdrawal of sewage contributions results in changes in the downstream stretches. Figure 16 shows the variation of the BOD concentration along the simulation in sections 6, 7 and 8 before and after the E, F and G
withdrawals. Regarding the BOD concentration, there was a 10% reduction in section 6, 15% in section 7 and 25% in section 8. However, in the COD and FT concentrations there was no significant reduction in the analyzed sections.

Figure 15 – BOD concentration map. A) Current situation B) Withdrawal of entries E, F and G

![BOD concentration map](image-url)


Figure 16– Comparison between the BOD before and after the withdrawal of entries E, F and G

![BOD comparison graph](image-url)

From these results, it can be concluded that small interventions that would be made in the canal would not present a significant improvement in the quality of the drainage system of the basin, the improvements would be only local. However, an improvement, even if local, is already a major step forward in combating illegal practices of draining sewers into the channel. On the other hand, this type of intervention requires the implementation of structural measures to reallocate clandestine sewage inlets and their connection to the collection network. Often, interventions of this nature are more difficult to perform by managers because they require large investments and have greater constructive complexity, especially for already urbanized environments.

4 CONCLUSIONS

The investigation of the occurrence of clandestine sewage intrusion points in the drainage channel identified and mapped ten entry points that continuously discharge effluents into the channel. This made it possible to carry out a diagnosis of what happens in the study area during dry periods, where there is no precipitation, and the channel works only for the propagation and mixing of these effluents, presenting a small layer of water. In addition to the contribution of sewage, the system presents an accumulation of solid residues that, in addition to being carried by surface runoff, are also deposited by the surrounding population. It was found that the model responds well to the Dry Climate Flow (DWF) simulation, which is the continuous discharge of sanitary or industrial wastewater directly into the transport portion of a SWMM model, usually at the nodes, simulating the scenario in which the channel works most of the year, and it was concluded that small interventions that would be made in the canal would not present a significant improvement in the quality of the drainage system as a whole, the improvements would be only local.

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