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STUDY OF PROBLEMS AND CORRECTIVE ACTIONS OFURBAN DRAINAGE NETWORK

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ABSTRACT

The concentration of the inlet wastewater of urban sewage treatment plants is much lower than the expected level in the design stage, mainly because of the problems of construction, management and maintenance of the drainage systems. Through investigation of the urban drainage pipelines, primary problems of drainage network damage, local unreasonable elevation design, pipe blockage and drainage system confusion, etc. were found. Combining the local actual situation, some corresponding engineering and management measures and some feasible suggestions for drainage pipe construction, management and maintenance are put forward.

I. INTRODUCTION

1.1 Purpose Providing adequate drainage in urban areas has been proven as a necessary component in maintaining the overall health, welfare, and economic well-being of a region. Drainage is a regional feature that affects multiple jurisdictions and all parcels of land. It is important to develop drainage policy that balances both public and private considerations. Certain underlying principles should be applied when planning drainage facilities. These principles apply to both water quantity and water quality management. Policy statements and technical criteria serve as the implementation tools for the underlying drainage principles.

II. OBJECTIVES

Drainage, flood control, and water quality protection. Drainage represents only one component of a larger urban system. The objectives are with respect to drainage, flood control, and water quality protection is to:

a) To protect the general health, safety, and welfare of the residents of the region.

b) To minimize property damage from flooding, including minimization of localized neighbourhood flooding.

c) To ensure that new buildings and facilities are free of flood hazard from major and smaller storm runoff events.

d) To minimize water quality degradation by limiting the amount of sediment generation and erosion of channels.

e) To encourage the retention of open space, particularly along natural drainage ways.

f) To plan for large and small flooding events by providing both major and minor drainage systems

III. PLANNING CONCEPTS

The following general principles apply when planning for and designing urban storm drainage systems (ASCE, 1992).

IV.DRAINAGE REQUIRES A REGIONAL SOLUTION

Drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between public and private properties. Therefore, a successful plan must integrate regional jurisdictional cooperation, where applicable, to accomplish established goals.

V. STORM DRAINAGE IS A SUB-SYSTEM OF THE TOTAL URBAN SYSTEM

Drainage is a sub-system of all urbanization. The planning of drainage facilities must be included in the urbanization process. The first step is to include drainage planning with all regional and local urban master plans. Storm water management facilities, such as open channels and storm drains, serve both conveyance and storage functions. When a channel is planned as a conveyance feature, it requires an outlet as well as downstream space to safely convey and mitigate adverse impacts from the design flows. The space requirements for adequate drainage may become a competing use for space with other land uses. If adequate provision is not made in the land use plan for the drainage requirements, storm water runoff will conflict with other land uses, will result in water damages, and will impair or even disrupt the functioning of other urban systems (Tulsa, 1993).

VI. URBAN AREAS HAVE TWO DRAINAGE SYSTEMS

Urban areas are comprised of two drainage systems. The first is the minor or primary system, which is designed to provide public convenience and to accommodate relatively moderate frequent flows. The other is the major system, which carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system.

VII. RUNOFF ROUTING IS A SPACE ALLOCATION PROBLEM

Analysis and design of drainage systems generally should not be based on the premise that problems can be transferred from one location to another.

VIII. STORM WATER RUNOFF AS A RESOURCE

Storm water runoff and the facilities to accommodate the runoff can be an urban resource when properly included in the urban system. Drainage ways can provide environments for various life forms such as aquatic life, mammals, birds, and vegetation. In many cases the drainage facilities can provide areas for active and passive recreation for citizens to enjoy. Although sometimes a liability to urbanization, storm water runoff can be beneficial as an urban resource. When storm water runoff is treated as a resource, water quality aspects become important. As such, it is important to implement best management practices (both structural and non structural) for water quality and effective erosion and sediment control.

IX. PREVENTIVE AND CORRECTIVE ACTIONS

In existing urban settings, it may be necessary to develop a storm water management strategy based upon both preventive and corrective measures. For example, structural corrective measures such as inlets, storm drains, interceptor lines, channelized stream sections and reservoirs affect and control storm runoff and floodwaters directly. Non structural corrective measures, such as flood-proofing and land use adjustments, help limit activities in the path of neighbourhood storm runoff or in river floodplains. Preventive actions available for reducing storm runoff and flood losses include: flood-prone land acquisition, floodplain regulations, and control of land uses within flood-prone areas.

X. CRITERIA SUMMARY

1- Drainage design and technical criteria The design criteria are based on national engineering state-of-the-practice for storm water management, modified to suit the specific needs. The criteria are intended to establish guidelines, standards, and methods for effective planning and design. The criteria should be revised and updated as necessary to reflect advances in the field of urban drainage engineering and urban water resources management.

2- Minor and major drainage systems Every urban area has two separate and distinct drainage systems, whether or not they are actually planned for and designed. One is the minor system and the other is the major system. To provide for orderly urban growth, reduce costs to taxpayers, and avoid loss of life and property damage, both systems must be planned and properly engineered and maintained.

XI. STORM RUNOFF COMPUTATION

The calculation of the storm runoff peaks and volumes is important to the proper planning and design of drainage facilities. Potential methods for calculation of runoff shall require advance approval from the City Department of Public Works.

XII. DETENTION

Detention facilities shall have release rates that do not increase the potential for downstream flooding and are consistent with the policies of the Watershed Master Plan. Submittal of hydraulic design calculations is required to document that major and minor design storm peak flows are adequately attenuated.

Streets-

The primary drainage functions of streets are to convey nuisance flows quickly and efficiently to the storm drain or open channel drainage with minimal interference to traffic movement and to provide an emergency passageway for the major flood flows with minimal damage to adjoining properties, while allowing for safe movement of emergency vehicles. The allowable use of streets for new land development in metropolitan Omaha for minor and major storms runoff in terms of pavement encroachment .

Water quality-

Both structural and non structural best management practices are recommended that address long-term Storm water quality enhancement. Effective, reasonable, and cost-effective should be selected for implementation on a site-specific basis and in a manner that is consistent with the Watershed Master Plan.

Methodology -

Data collection methodology-

a) Collecting information, including pipe network built drawings, meteorological data, hydrological data, etc., and conduct research and analysis.

b) Making a further research on the map of pipe network system, combined with in-situ field investigation to determine the location of all sewage wells and the sewage flow direction, understanding the scope of the pipe network collection. Numbering the sewage wells is well included.

c) Sampling for the main pipes and branch pipes to determine sewage pipes that are low in Chemical Oxygen Demand (COD) concentration and recording weather condition, as well as the water level of the adjacent rivers.

d) Making a detailed investigation on the main pipes and branch pipes of sewage where COD concentration is low or appear mutations to address the network problems. Corrective advices should be proposed for further improvement.

e) Areas that are of the most concern include: pipes, flap valve, inverted siphon pipes, culvert, and pump station, sewage interception wells which are close to rivers or ponds.

f) Employ robots, sight glasses, closed-circuit television (CCTV) in assisting the investigation.

The problems of drainage network-

The following problems were recognized through four months deep investigation into the drainage network.

a) Sewer damage Sewer was damaged by transformation of roads and bridges, construction of water pipes and gas pipes, crossover operation of sewer pipes. Sewage pipes experienced deforming, disjoint, sink, water leakage and some other relevant issues, hence finally result in collapse of surrounding roads.

b) Unreasonable local elevation design Sewage only piled up in the pipes and even refluxed because the elevation design is unreasonable in the sewage pipe junctions.

c) Severe blockage of pipe networks the blockage in the sewer pipes which are not conducive to sewage collection was generally made of construction waste (such as stone, cement), mud, plastic, foam, etc. The scour capability of low-speed flow is not high enough to rush the blockages into downstream pipe network thus garbage was easily stored in the slow flow pipe which forms a vicious cycle and results in more serious siltation .The silting of the inverted siphon pipe across the river is the most serious part. To illustrate, a section of DN600 inverted siphon which was jammed by a large number of sand bags and garbage led to cross section reduction around 20cm2 and cut down the transmission capacity of the sewage.

d) Improper flap valve installation

e) The installation of flap valve is rigorous. It must be tilted installed at a bias angle between 8°–15° to make it function well under stress. The flap valve does not open freely for its aging. And it is opened by the bricks in order to drain the flood during the monsoon, so that the river water flows into the pipe network through the flap valve.

f) Manholes and manhole covers Manholes are always covered by construction site. As to the manhole covers, some problems do exist: firstly, the manhole covers are easily breaking for their using low-quality material manufacturing; secondly, some manhole covers experienced difficulty in opening after a long time enclose; thirdly, it is hard to distinguish sewage wells from rainwater wells and water supply wells due to irregular management.

g) Wasted rivers the functions of a river are mainly described as landscape in town. However, they are usually formed to receive the domestic sewage and waste water due to a series of difficulties such as lack of capital, planning and poor construction conditions. It attributes to the damage of the original functions and the ecological environment of river. Meanwhile, rainwater and river water are likely to enter drainage networks through wasted rivers.

h) Incomplete drainage network construction the dirt holding rate is approximately 40% at present, which is way to reach the standard of 70%, indicating that the drainage network construction is incomplete. It is still commonly seen that sewage was discharged directly to the rivers in some places, especially in the country side, further enhancing the pollution of rivers. 2.3 Corrective measures In view of the above issues proposed and by combining with the local actual situation, effective, rational, economic and feasible corrective measures are to be developed to tackle the problems.

Engineering measures-

a) Making a scientific and reasonable plan as soon as possible and integrate the pipe network construction, in order to improve the dirt holding rate. Transform both sides of the creek, and built sewage pipe network on the shores to collect domestic sewage from the direct discharge port to prevent the pollution. Speed up the construction of primary pipes as well as branch pipes construction. Collect all sewage coming from institutions, enterprises, factories and residents to the greatest extent to accomplish zero discharge of sewage.

b) Improve drainage systems towards better separation between rainwater and sewage collection to avoid illicit connections in some residential districts. The rainwater pipes must be separated from the sewage pipes. When the pipes are connected by the inhabitants, it should be done under the guidance that is right to the separate system. The existing illicit connections should be notified for correction under improved policy.

c) Maintain the destructed pipes. Such problems subsidence, collapsing and breakdown of the pipes led by the alternate construction should be worked out as soon as possible to avoid the infiltration of groundwater.

d) Opening channels should be reformed and wasted rivers should be conducted to intercept the sewage from both sides of them by laying sewage pipes.

e) Reforming flap valves and inverted siphons. Replace the old or malfunctioned flap valves with energy–saving flap valves which are strongly recommended. What is more, replace inverted siphons made of reinforced concrete with seamless steel pipes, which can work under high pressure and hold better properties such as seismic resistance, relatively light dead weight and long pipe section.

XIII. CONCLUSIONS

a) A detailed survey of sewage collected area must be done before drainage network construction the consideration of the original pipeline flow trend and polluted inflows of the sewage collected area has usually been neglected before setting the sewage designed quantity of the sewage treatment plant. In addition, the hardhats builds the drainage pipes only according to drawing paper mechanically, problems whether sufficient sewage quantity can be collected by the building sewage pipes and even whether river water can flow backward the sewage pipe network have not been taken into account in construction. Hence, the outfalls in the built drainage network leading to water flowing backward or discharging directly into the river.

b) Separate system must be set in the future Despite such disadvantages as illicit connections, high investment and the pollution of initial rainwater, separate system has the advantages of easy pollution control, rain water collecting and recycling. The sewage treatment plant under such a system is able to treat the sewage effectively and being managed easily.

c) Integrate checking system of drainage network construction Pipe leakage, closed water test fail, location deviation of the pipes; deformation and subsidence of inspection well, great foundation deformation of the pipes are problems commonly to occur in the drainage network, whose main courses are quality of construction and materials. Discharge characteristics and watertight test must be done seriously when checking, and subsidiary facilities of the drainage network as materials of flap valves and inspection well, construction quality should also be double checked.

d) Enhance archives management of the drainage network Archives management of the drainage network must be carried out under the filing-up system of completion drawing. Outlets, temporary plugs, survey coordinate and diameter of the future pipes connection points must be marked on the completion drawing clearly for checking. The misunderstandings of only focusing on original record maintenance and putting such modification of filing works into subordinate position must be replaced, and set up the archives management system of the drainage network for modification and supplementation, which can file in denomination of every street and function as an index for information and data inquiry.

e) Establish GIS system for drainage network management Geographic Information System (GIS) system for drainage network management has four functions: information access and input, data storage and management, data conversion and analysis, results generation and output. GIS management system is widely used in the drainage network. The system, which is made of computer graphics and database, is a high technology for data processing and storage. Correlation attributes and geographical location are organically combined in such a system, and can be displayed to the users with picture-illustrated composing and accuracy style. Users can make decisions by its spatial analysis function and visualization. The needs for design, management and running of the drainage network inquiry can also be satisfied from it. The relevance municipal departments should carry out investigation of drainage network as soon as possible and set up the GIS system for drainage network management.

f) Strengthen the environmental protection education and encourage public participation Questionnaires must be done before the construction or reform of drainage network and encourage public participation to supervise the construction and maintenance of the drainage network, and to enhance the environmental protection.

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