

## Appropriate technology for sewerage and drainage systems: A case study in Vietnam

*J. Corning, Denmark*

---

*The selection of appropriate technology is fundamental to the long-term success of any project. Project formulation in developing countries must carefully weigh the available fiscal, material and human resources to create a project well suited to the needs of the beneficiary. Simplicity in design and implementation will ultimately lead to increased understanding by the end user, thus increasing the opportunity for a reliable and sustainable solution. This paper shares the experiences of a Danida-funded sewerage and drainage infrastructure project in Vietnam, focusing on sustainable development through application of simplified solutions based upon the most appropriate technology.*

---

### Introduction

The Buon Ma Thuot Sanitation Sub-Component (hereinafter referred to as “the Project”) is a Danida-funded intervention for improving the sanitation, health and hygiene in the central highlands city of Buon Ma Thuot City, Vietnam. The DKK126.2 million (USD 21.7 million) infrastructure-based project focuses on the application of appropriate technology in the implementation of sewerage and drainage infrastructure in this Vietnamese provincial capital city of 250,000 people, located 380km north of Ho Chi Minh City.

The purpose of this paper is to provide a case study of the Project, so as to share the Project’s experiences in the use of appropriate sewerage and drainage technology with others who may be planning similar works elsewhere in developing countries around the world. The Project’s use of separate sewerage and drainage piping systems is unique in Vietnam, as compared to traditional combined sewer systems. However, separate sewerage collection offers significant benefit through reducing the quantity of sewage collected by excluding rainwater, fully containing the sewage flow (and odors) in an enclosed sewerage collection pipe, and effectively preventing the entry of solid waste into the sewerage collection system.

Wastewater treatment by the environmentally-friendly and low-cost stabilization pond wastewater treatment system, provides a financially sustainable and operationally reliable method of wastewater treatment, consistent with Danida’s

### Water supply and sanitation sector policies.

The design of the drainage system has departed from the use of traditional covered channel drains and instead focused on use of large drainage diversion pipelines, intended to avoid flooding by conveying large quantities of rainwater directly

to the nearest appropriate watercourse.

### Basis of design – sewerage system

Prior to this Project, only on-site sanitation systems were utilized in the city, even in the densely populated core city areas. The basis of design of the Project’s new piped sewerage collection system and wastewater treatment plant, as currently being implemented, is as follows:

#### Sewerage collection system

- The system utilizes a separate sewerage system. Rainwater entry shall be strictly prohibited.
- An estimated 5500 households shall be connected in the sewerage service area, with a 100% mandatory connection policy. Existing household septic tanks shall be bypassed. All sanitary fixtures from each household shall be discharged directly to the new separate sewerage system, by connecting the household’s sanitary piping to the junction box located in the sidewalk area in front of each household.
- The junction box is connected to the downstream tertiary sewer piping, which is constructed of DN150 uPVC material and shall collect sewage from up to 15 households. The tertiary sewer piping terminates at an inspection chamber, an off-road manhole, which is piped directly to the secondary sewer piping located in the roadway.
- The secondary sewer piping in the roadway shall be constructed with DN200 (minimum) to DN300 uPVC piping materials, with pre-cast concrete access manholes constructed at a maximum 60 meter spacing.
- The main pumping station utilizes six submersible type pumps, which discharge into a twin-barreled uPVC rising main. Approximately 30% of the City’s collected sewerage flow will pass through this pumping station.
- The primary (trunk) sewer piping, constructed of DN400 to DN700 HDPE piping materials and installed in

principal roadways, receives flow from the secondary sewer piping, as well as the pumped flow from the main pumping station. All sewerage flow is then conveyed to the wastewater treatment plant by gravity.

A schematic layout of the sewerage system piping, showing the relationship between the internal household sanitary piping, the tertiary sewer piping and the secondary sewer piping, is shown on Figure 1:

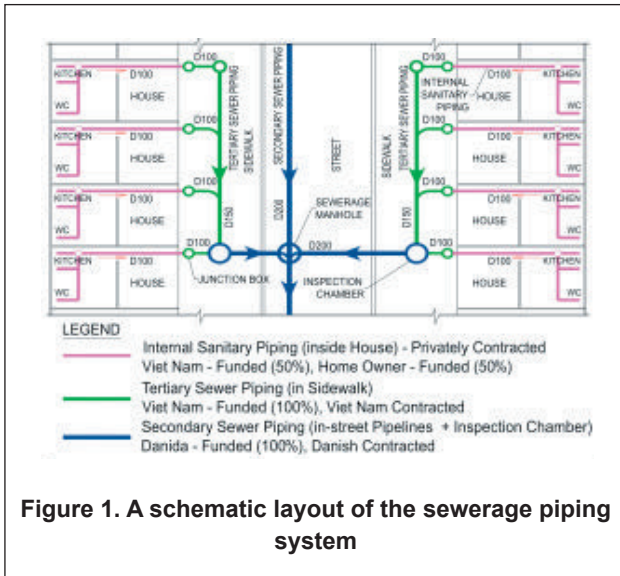


Figure 1. A schematic layout of the sewerage piping system

## Wastewater treatment plant

- The wastewater treatment plant (WWTP) is designed for 8125m<sup>3</sup>/day capacity, equivalent to the sewerage flow generated by 65,000 people. The WWTP site is planned for future expansion, which will allow ultimate treatment capacity of 13,000 m<sup>3</sup>/day (103,000 population equivalent).
- The WWTP, which utilizes a dual-train, three-stage stabilization pond treatment technology, is shown schematically in Figure 2. The six meter deep first stage anaerobic pond provides both sedimentation and anaerobic decomposition functions. The two meter deep second stage facultative pond provides biological oxidation and the shallower third stage maturation pond will provide disinfection (by sunlight) and clarification of the final effluent. Each pond is lined with a 1.5 mil HDPE liner to prevent degradation of the groundwater. The final effluent shall achieve Vietnamese Class B discharge standards, namely 50mg/l BOD<sub>5</sub>, 100mg/l TSS and 10,000 fecal coliform/100ml.
- Cascade aerators utilize the relative elevation differences between the three treatment pond stages, thus converting that energy into a useful means to transfer oxygen to the wastewater without the use of electrical power. Each of the two cascade aerator structures consists of 16 - six meter wide stair steps (cascades), designed to optimize surface to air transfer of oxygen to the wastewater, thus ensuring higher performance of the downstream stabi-

lization ponds.

- Anaerobically digested sludge settled in the bottom of the two anaerobic ponds will be periodically removed by taking one pond out of service during the dry season, decanting the clear water portion and allowing the remaining sludge residuals to dry in-situ in the concrete pond bottom. This hardened-bottom design allows the use of a tractor-driven plow for mixing of the sludge to maximise drying efficiency and the use of loaders and trucks for removal of the dried sludge. The harvested dried sludge will then be distributed to local area farmers for agricultural reuse. No external sludge drying beds will be required. Windrow composting techniques are envisioned in the future for increasing the sanitary condition and quality of the dried sludge.
- The WWTP does not require highly technical staff for

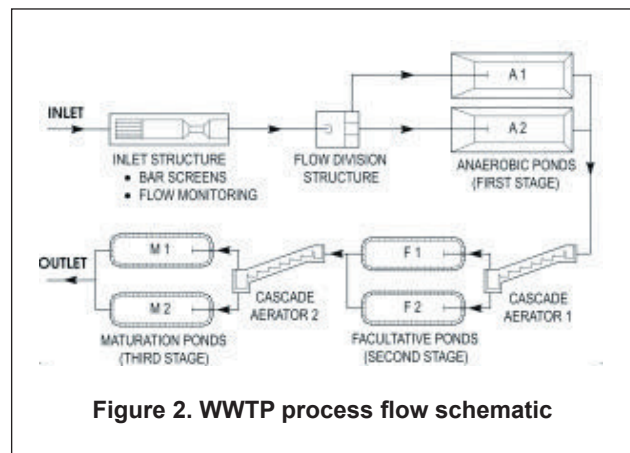


Figure 2. WWTP process flow schematic

operation, nor does it require the use of electrical power or chemicals. The basic simplicity of operation and maintenance of the stabilization ponds will ensure a high degree of reliability in attaining Vietnamese discharge standards, while keeping costs low.

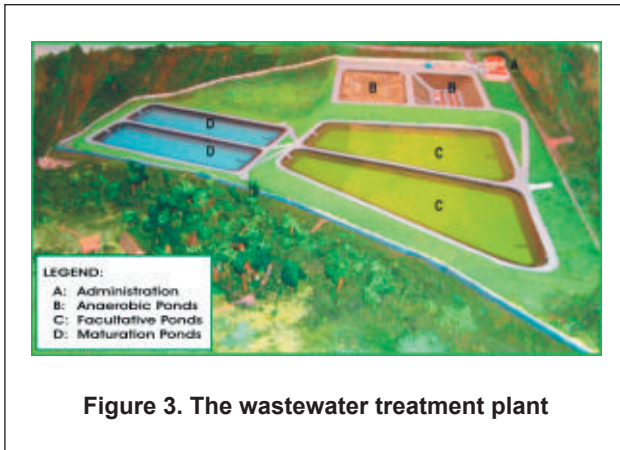
A photograph of the model of the planned wastewater treatment plant, featuring the dual train, three-stage stabilization pond treatment concept, is shown in Figure 3:

## Basis of design – drainage system

### Drainage collection system

The existing drainage system in Buon Ma Thuot City was in poor condition and only served a portion of the intended drainage area. During heavy rainfall, the channels and pipes of the drainage system became overloaded and the streets became flooded. Much of the flow generated in the newer expanding northeast area of the city was being conveyed by surface flow in the streets and in the drains directly to the core city areas, resulting in severe flooding and human hardship to the lower-lying areas. The basis of final design of the drainage system for the Project, as currently being implemented, is as follows:

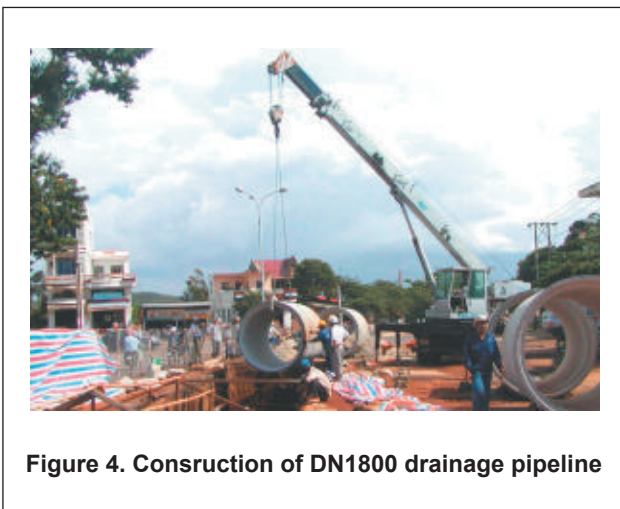
- Large diameter drainage diversion pipelines were planned to effectively contain and collect the northeast



**Figure 3. The wastewater treatment plant**

area drainage for diversion to an appropriate receiving stream, thus removing this flow from the core city areas. The first such drainage diversion, a DN1800 pipeline, is now completed and is designed to divert nine m<sup>3</sup>/second of collected rainwater to a large receiving stream, south of the core city area. A second DN2000 drainage diversion pipeline, designed to divert over 13 m<sup>3</sup>/second of collected rainwater to an upper reach of the same large receiving stream, is now under construction. By diverting these large quantities of rainwater away from the core city area, the resulting rainwater loading on the existing drainage system in the core city area will be greatly reduced, thus significantly reducing local flooding.

- With the introduction of the concept of large drainage diversion pipelines, the rehabilitation and expansion of the existing drainage system was consequently reduced accordingly in scope. The new focus for drainage was to provide new drainage piping only for major streets, allowing the minor streets to utilize surface drainage flow for a limited one or two block distance, until that surface flow could reach a major street drain. This concept eliminated the need for numerous small diameter drainage pipes, thus minimizing cleaning and maintenance requirements.



**Figure 4. Construction of DN1800 drainage pipeline**

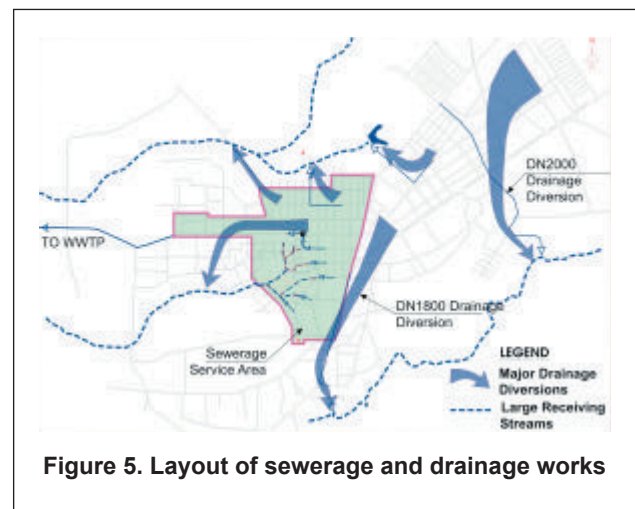
- The road inlet design was greatly improved. The existing traditional system of road inlets in the curb “face” restricted the amount of rainwater entering the drainage system. The new standard road inlet design, featuring a 1000x1000 size, removable entry grating in the roadway, significantly improved the conditions for entry of rainwater into the drainage system, while offering improved maintenance and servicing of the road inlets.
- All new drainage piping is locally produced, centrifugally spun reinforced concrete pipes with interlocking joints, sealed with a bitumen joint sealant. Sulfate resisting cement is used in the concrete mix to provide resistance to hydrogen sulfide attack in those drains still receiving combined sewerage and drainage flows from the areas outside of the core city sewerage service area.

The layout of the expanded drainage system, showing the location of large drainage diversion pipelines as well as the sewerage service area, is shown on Figure 5:

### Conclusions and lessons learned

Thus far, over the past 42 months of project implementation, the following conclusions and lessons learned can be presented:

- As in every overseas development assistance (ODA) project, a good working relationship between the Project and the local relevant authorities is essential. Keeping these authorities fully informed from the earliest stages of the project is fundamental to this good working relationship. Forming a “partnership” with the local relevant authorities facilitates approvals and will serve to build local ownership and support of the Project.
- Appropriate technical solutions, which reflect the technical capabilities of the recipient, the available capital budget and the annual operating budgets, will offer superior long-term advantages in terms of reliability, lowered operation and maintenance costs and financial sustainability.
- Appropriate technical solutions for the collection and conveyance of sewage can greatly impact the perception



**Figure 5. Layout of sewerage and drainage works**

of value of the project to the recipients. For example, the use of separate sewerage piping system will greatly reduce the odors long associated with traditional “covered channel” combined sewer systems, thus creating an easily recognized environmental improvement. Furthermore, there is no longer the need for the recipient to operate on-site septic tank sanitation systems, as this function will now be performed by a centralized wastewater treatment plant.

- Appropriate simplified technical solutions for wastewater treatment will generally require less power and chemicals to operate, will have less mechanical and electrical equipment to repair and maintain and will require less sophisticated staff to carry out the operation and maintenance. The Project selected the stabilization pond treatment system for exactly these reasons. Treatment technology need not be complex to achieve results, and in many cases, a more complex technology may be poorly understood and thus inherently less reliable.
- Appropriate technical solutions for drainage should focus on mitigating flooding by employing the use of rapid flow conveyance methods. Promulgation of antiquated flat channel design will place added stress on limited maintenance budgets and thus should be avoided. The implementation of large drainage diversions to appropriate receiving streams will reduce the hydraulic load on the network, while providing an easily serviceable infrastructure. Evident reduction in the flooding in the streets will be a very good indicator to the general public for measuring the benefits gained by the Project.
- Emphasis should be placed on the specifying of materials for construction, which can be locally procured for improved cost economy. However, these materials should be of a quality, which reflects the long-term nature of the investment. For example, the use of locally produced uPVC and HDPE pipes for all sewerage piping is an important consideration for a long-term solution. The use of pre-cast concrete manholes and drainage pipes, constructed of locally produced sulfate-resisting cement, is



**Figure 7. HDPE lining of stabilization pond**

another consideration. The Project must think long-term, 50 to 100 years, and specify materials accordingly

- Appropriate technology must focus on the simplest and most reliable solutions for use in developing countries. In doing so, the success of these works will serve as examples to encourage others to join in the development of improved sewerage and drainage infrastructure, providing long-term sustainable improvement to the environment.

#### **Contact address**

James Corning  
Project Manager  
Carl Bro a/s Consultant, Denmark  
01 Dao Duy Tu Street, Buon Ma Thuot City  
Daklak Province, Vietnam  
Email: [jrc-cbibmt@dng.vnn.vn](mailto:jrc-cbibmt@dng.vnn.vn)  
Tel: (84) 50 856 281



**Figure 6. Installation of HDPE sewerage piping**