9 Impact Assessment of Water and Soil Erosion

9.1 Introduction

This chapter is compiled based on the nation's regulations on water and soil conservation. There is no relevant regulations in Hong Kong on the topic.

According to the regulations issued by the Ministry of Water Resources, a special scheme of water and soil conservation should be made for Stage III of the Shenzhen River Regulation Project. This chapter is not intended to replace the scheme of water and soil conservation of the Project that must be compiled according to the regulations concerned.

Construction activities, such as construction material excavation, waste spoil disposal, dyke building, material pile-up, etc., will change the configuration of ground surface and land utilization pattern, and destroy vegetation and damage the facilities for water and soil conservation, causing water and soil erosion in the Project Area. This chapter describes the status quo of the water and soil erosion, the scope and extent of the water and soil erosion might be caused by the Project, and put forward the countermeasures to prevent and mitigate the potential water and soil erosion.

9.2 Regulations and Criteria

The legal basis for assessing water and soil erosion:

(1) *Water and Soil Conservation Law of the People's Republic of China*

(2) *Regulations on Implementing the Water and Soil Conservation Law of the People's Republic of China*

(3) *Management Procedures of Water and Soil Conservation Scheme for Construction Items*

(4) *Methods for Implementing "Water and Soil Conservation Law of the People's Republic of China" in Guangdong Province*

(5) *Regulations on Water and Soil Conservation in Shenzhen Special Economic Zone*

(6) *Planning for Urban Water and Soil Conservation in Shenzhen City* (1995)

(7) *Planning for Flood (tide) Control in Shenzhen City* (1994)

The technical criterion and standards adopted:

(1) *Technical Criterion for Water and Soil Conservation Scheme in Construction Projects* (*SL*204-98)

(2) *Technical Criterion for Integrated Regulation of Water and Soil Conservation* (*GB/T* 16453.1-16453.6-1996)

(3) *General Rule for Water and Soil Conservation Integrated Improvement Planning* (*GB/T* 15372-1995)

(4) *Manual for Water and Soil Conservation in Shenzhen City*

9.3 Existing Condition of Water and Soil Erosion

The Shenzhen River basin is located in the south of the tropic zone with abundant and concentrated precipitation. The multi-year average rainfall in the region is about 1,900 mm, which mainly concentrates in the rainy season (from April to August), accounting for 90% of the annual total. The precipitation quantity of the heaviest rainstorm within 24 hours reached about 363 mm (observed at the Shenzhen Meteorologic Station in June 1996). In addition, as tributaries on both sides of the river and the upper reach of the River flow through low hill area with uneven earth's surface and thick uncompacted deposit. It offers condition and material sources for water and soil erosion to occur.

In recent years, due to rapid urban development, earth borrowing, quarry, road construction, house building and other construction activities have been widely conducted in this region. As a result, the vegetation, which used to be in good condition, has been destroyed in the upper reach area, and the natural topography and structure of land are violently disturbed. These factors, combined with the natural factors, have caused and further aggravated the water and soil erosion in this region.

Because of rather short flow path and large drop ratio, floods often rise and fall rapidly in tributaries of the Shenzhen River and in its upper reaches. In the rainy and flood season, the roaring flood flow peak, carrying sediment scoured from the river course,

often reached the urban area of Shenzhen City in just a few hours. In the downstream reaches, however, the River is very narrow with zigzag course. The low slope and the low dykes make it to resist floods. Besides, there is back water effect of the sea tides. Therefore, the flood peaks of the River often cannot discharge into the sea freely, and the tyranny floods always overtop the dikes, leading the deposition of sediment in the river and lowland. Flood damage often occurred in this area.

According to the field measured data (by the South-Central Survey & Design Institute during November 1995-October 1996), the highest daily average sediment concentration of the Shenzhen River is 1.02 kg/m^3 in Sha Wan, (15 August, 1996), 0.12 kg/m^3 in Ng Tung (16 June, 1996), 4.63 kg/m^3 in Buji, (3 September, 1996), and 0.99 kg/m^3 in the river mouth, (23 June, 1996). From the result calculated by models, in the case of a 50- year return period flood and a 10-year return period tide, the average annual siltation in the reaches of the Shenzhen iver is: 0.08 m for the section from the San Pan River mouth to Man Kam To, 0.023 m from Yumin Village to the Buji River, 0.095 m from the Buji River to the Futian River, 0.070 m from the Futian River to the Yunong Village, and 0.088 m from the Yunong Village to the Shenzhen River mouth. The gross amount of siltation is estimated to be 48,500 m^3. (Ref. Table 6-8, Chapter 6)

During the construction of Stage III Project, it is estimated that about 18,000 m^3 of soil will be leaked and deposits in the River Ganges mouth and the 6 km river course from it if no appropriate mitigation measures are adopted (Ref. Chapter 6). By adding the impact of the construction activities to the results above, the extent of siltation of the Shenzhen River will be aggravated greatly. Therefore, water and soil erosion should not be ignored in the construction period.

9.4 Prediction and Assessment for Water and Soil Loss

Land acquistion is needed in Stage III Project. It is mainly used for construction facilities and construction yard, spoil disposal ground and construction material pile-up yard and so on. If no proper water and soil conservation measure is adopted, new water and soil erosion might be caused in these areas.

Among 323.7 hm^2 of the Project Area and its adjacent area, 14.6% is woodland (including shrub woodland), 28.5% is lawn (including fallow), 7.8% is swamp and

pond, while farmland accounts for 6.2%, river surface for 2.8%, bare land for 1.0% and city for 39.1%.

The present configuration of the ground surface and land utilization pattern in these areas will be changed to certain extent. The original vegetation and water and soil conservation facilities will be destroyed. In addition, the original function of water and soil conservation of land will be lost due to river dredging, spoil disposal, and dyke construction, material pile-up and other construction activities. As a result, it will lead about 80% of the land (about 260 hm^2 or 2.6 km^2) in Project Area and the affected area to become the new erosion area.

In the preliminary design report, 1,603,600 m^3 of waste material will be produced in excavation in addition to a large amount of construction spoil. If no measures for water and soil conservation are adopted in the construction period, spoil, waste solids and rubbish scoured by water will result in new water and soil erosion.

From past experience, the intensity of water and soil erosion will be increased by 3-5 times than the original intensity in the area where the topographic unevenness is great, while 1-3 times in the area with flat topographic condition. As the water surface slope is low in the downstream of the river, the topography is low-lying on both sides. While the quantity and intensity of the rainfall are high, it is estimated that the intensity of water and soil erosion might become tripled as compared with the original intensity. From the planning of water and soil conservation in Shenzhen, the annual soil erosion modulus is 500 $t/km^2 \cdot a$, if measures for water and soil conservation are not adopted in the construction period, the gross water and soil erosion might be caused by project is:

Gross water and soil erosion $= 500\ t/km^2 \cdot a \times 3 \times 2.6\ km^2 = 3900\ t$

9.5 Damage from Water and Soil Erosion

The following water and soil erosion damage might be resulted from the Project construction:

(1) Aggravation of flood flooding

As most of the construction activities will be conducted in river channel and adjacent

area, bed sediments might suspend again during dredging. In addition, certain losses will also be induced during spoil disposal and material pile-up. In the event of heavy storm, large amount of sediment will be brought into the river, which will result in river channel deposition, aggravating the flood disaster.

(2) Water quality pollution of the River

Along with the sediments entering the River, the harmful material carried by sediments will aggravate water pollution of the River.

(3) Destruct vision and landscape

Visual sight will become worse, and landscape seriously destroyed when the soil carried by rainfall entering the water body and construction site.

(4) Affect the progress of the Project construction

Due to water and soil erosion as well as flooding, some construction facilities might be damaged. It will affect the progress of construction activities and cause certain economic losses.

9.6 Measures for Afforestation and Water and Soil Conservation

Afforestation and other measures for water and soil conservation should be adopted during construction in order to avoid or minimize water and soil erosion rising from construction activities.

The measures are divided into two types, namely temporary measures and permanent measures. The temporary measures include the requirements for construction equipment, construction method, construction schedule, construction management, and short-term measures adopted to prevent water and soil erosion. The permanent measures include waste blocking, slope protection, drainage improvement, afforestation, restoration of construction site, etc.

9.6.1 *Preventive Measures in Stocking Yard*

For the borrow area outside the Project Area, the following measures for water and soil conservation should be adopted during excavation.

(1) Excavating in step of divided sub-areas, which should be restored timely after construction is completed. Wide excavation of bare land should be prevented to avoid serious water and soil erosion.

(2) The water-retaining facilities are needed in the edge area of upper side of the excavation site to hold up the run-off from upper-stream. Drainage ditches are needed in the other marginal part for rainwater discharge in the surrounding area, to prevent the erosion around.

(3) In the light of the requirement, settling tanks should be set up in the construction site. In addition, water drainage system should be improved.

(4) The slope of the excavated cross-section should be less than natural stable angle of the slope. The height of the slope generally should be less than 4m.

(5) The spoils produced in the excavation should be properly stored to prevent losses, which could be used for backfilling material to fill pits in the construction site after excavation is completed.

(6) After stocking yard excavation is finished, restoration of the construction site should be comprehensively carried out. The new measures for water and soil conservation need to be conducted upon requirements. The scheme of improvement including the engineering measures should be adopted in the unstable slopes with complicated geographical condition.

9.6.2 *Preventive Measures for Spoil Disposal*

(1) Water and soil erosion issue should be considered in choosing the spoil ground, which should not cause any adverse impacts on water and soil conservation in the area.

(2) From the location of the spoil pile-up and the topographic characteristics, the screening works should be carried out to effectively control water and soil erosion.

(3) Drainage ditch should be constructed in surrounding area of the spoil ground for drainage.

(4) After completion of soil disposal, soil should be covered on the surface of the

spoil ground and vegetation should be restored.

9.6.3 *Preventive Measures for Construction of River Course, Embankment and Rematch Project*

(1) Wet cut is to be adopted in the old river channel excavation. Proper dredging equipment should be used to minimize the discharge and re-suspending of sediments in dredging.

(2) When excavating in new river channels or for rematch projects, dry cut inside cofferdam is recommended to prevent water and soil erosion.

(3) Dredging and excavation should be arranged in dry season as much as possible.

(4) The field that is not liable to erosion by run-off should be selected to specially store the silts and soils excavated. Temporary drainage ditch needs to be built in surrounding area to drain water.

(5) Measures for prevention leakage should be adopted in transporting spoil.

(6) Vegetation on outer slope of the new built dyke should be made, and drainage facility should be built.

9.6.4 *Preventive Measures for Material Storage*

(1) Measures for preventing leakage should be adopted in transporting material.

(2) The field that is not liable to erosion by run-off should be chosen to pile the material in open space, and the material should be covered .

(3) Temporary drainage ditches should be built in surrounding area of the material stock ground .

9.6.5 *Restoration of the Construction Site*

When construction is finished, restoration of the construction site should be carried out in time to beautify the environment.

(1) Rubbish and waste material in construction site should be cleared.

(2) Surrounding area, bare land, vacant land, and unused land in the Project Area

should be leveled and covered with soil. The plan will be made to blend with the characteristics of local situation. The land should be transformed to farmland, woodland, lawn, fishpond or for other uses.

(3) Greenbelt should be established on both sides of roads. From the requirement of width of the road and the overall environmental requirement, the type of trees, spacing for individual plants and rows can be ascertained.

(4) The overall beautification design in the construction site should be carried out. Different kind of trees, flowers and grass are to be planted and reasonably arranged in pairs or groups in order to beautify the environment.

9.7 Conclusion

Due to rapid urban development in Shenzhen City, large scale earth borrowing, quarry, road construction, house building and other construction activities have been widely conducted in this region. As a result, the original vegetation in upper reach region has been destroyed, and the topography and structure of the land are significantly disturbed. These man-made influence in combination with the natural factors, have resulted in and further aggravated the water and soil erosion in this area.

During the construction of Stage III Project, due to river dredging, spoil disposal, dyke construction, material pile-up and other construction activities, the present configuration of the earth's surface and land utilization pattern in relevant regions will be changed to centain extent. In addition, the original vegetation and some of water and soil conservation facilities might be damaged, and the land will loss its original function for water and soil conservation. If no proper water and soil conservation measures are adopted, new water and soil erosion will be resulted.

It is expected that water and soil loss could be controlled and avoided as long as water and soil conservation measures are adopted.