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For information

South East Kowloon Development
Kai Tak Approach Channel Reclamation
Remediation of Contaminated Sediment

Purpose

This paper presents an update of three remediation methods proposed for the contaminated sediment in the Kai Tak Approach Channel (KTAC), and seeks Members' views on the way forward for field trial.

Background

2. One of the key objectives of the South East Kowloon Development is to develop the site of the Kai Tak Approach Channel in a way that will safely address the approximately 1 million m^3 of contaminated near surface sediment. The source of contamination mainly originates from historical discharges from the Kai Tak Nullah and Jordan Valley Box Culvert of industrial and domestic sewage containing heavy metals, organic micro-pollutants, petroleum hydrocarbons, and high total organic carbon (TOC) concentrations potentially leading to the generation of methane biogas. The thickness of this contaminated sediment layer varies between 0 m and 6.5 m (with an average of approximately 3 m). The greatest thickness of contaminated sediment generally occurs near the mouth of the Kai Tak Nullah, where the concentrations of contaminants and TOC are also highest.

3. The strategy for the remediation of KTAC sediment was set out in the Schedule 3 EIA Report[1] approved under the EIA Ordinance in September 2001. The strategy envisaged three remediation methods in the order of preference of in-situ treatment, ex-situ treatment and fall-back option (now re-named as "encapsulation").

4. In-situ treatment would involve reclamation backfilling atop the sediment and injection of chemical oxidants to accelerate degradation of organic contaminants. Ex-situ treatment would involve dredging of the sediment followed by sediment

[1] EIA Report for Agreement No. CE 32/99 - Comprehensive Feasibility Study for the Revised Scheme of South East Kowloon Development.

washing. The sediment after washing would be returned to KTAC as fill material. Encapsulation is to leave the sediment in place untreated and to proceed directly to reclamation. Monitoring of methane emission rate would then be carried out until safe levels are reached. Gas protection measures, if necessary, would be specified to facilitate future developments above the reclamation.

Findings of Initial Assessment

5. Laboratory bench-scale tests employing the in-situ and ex-situ treatment methods started in July 2002 and were completed in November 2002. Results are highlighted below.

a) ***In-situ Treatment***: Three chemical reagents[2] were tested in the laboratory. Results indicated that in-situ chemical oxidation is not effective in treatment of total organic carbon (indicator of methane generation potential) in the KTAC sediment. Only insignificant to small reductions of total organic carbon content was observed. Besides, toxic hexavalent chromium was detected after treatment for two of the reagents tested. There would also likely be difficulties in distributing a large volume of reagents within the sediment mass, which consists mainly of clayey silt. We have consulted the Environmental Protection Department and academics of The University of Hong Kong and Hong Kong Polytechnic University, and there is general consensus that this treatment method should not be pursued.

b) ***Ex-situ Treatment***: Bench-scale testing indicated that the BioGenesis™ sediment washing technique is effective in remediation of the sediment. The total organic carbon content was reduced by about 80% after treatment. Several issues would however need to be further examined and confirmed in the subsequent pilot test. They include odour control during sediment dredging, treatment of large volume of wastewater arising from the washing process and the logistics required for handling the large quantities of sediment.

6. On ***Encapsulation***, the Schedule 3 EIA Report predicted that it would take about 8 to 9 years after reclamation for the methane emission rate to reach safe levels. The predictions, which are likely to be conservative, are based on theoretical assumptions on decay half-life period and percentage of biodegradable total organic carbon in the KTAC sediment. Academics[3] of The University of Hong Kong were commissioned in January 2003 to conduct laboratory "incubation" tests on the sediment to measure the actual methane generation volume and emission rate. Based on the preliminary results obtained, the academics are of the view that the KTAC has a low risk of methane emission. The maximum and average methane emission rates were measured at 2.7 L/m^2/day and 1.5 L/m^2/day respectively, and are well below the

[2] Modified Fenton's Reagent, Oxygen Release Compound and Potassium Permanganate

[3] Led by Professor Herbert Fang, Chair Professor of Environmental Engineering, Department of Civil Engineering, University of Hong Kong.

recommended safe methane emission rate of 10 L/m^2/day. We have extended the laboratory testing for a further six months. It is also proposed to confirm the findings through on-site methane production measurement at KTAC.

7. Risk assessment for the KTAC sediment has been carried out. Preliminary results indicate that none of the non-methane chemicals of potential concern measured in KTAC sediment pose an unacceptable health risk to the three types of hypothetical post-remediation receptors (construction worker, commercial worker, resident) assessed. In addition, the findings of the assessment indicate that methane generation in untreated sediment would be unlikely to pose an unacceptable hazard to future occupants of the reclamation developments, based on the "incubation" test data. This will be further confirmed by the proposed on-site methane production measurement at KTAC.

Review of Remediation Strategy

8. In parallel with the "incubation" test and the preparatory work for the ex-situ treatment pilot test, we have undertaken a review of the sediment remediation strategy. The review was prompted by a number of factors including the laboratory bench-scale test results, the present economic climate and a more relaxed programme on housing developments above KTAC reclamation. As a result, three potential sediment remediation options (i.e. encapsulation, ex-situ treatment and marine disposal) were considered. Salient points are given below.

Encapsulation (Estimated order of cost HK$250 million)

9. Encapsulation is the least expensive option. It has minimal disturbance to the surrounding environment and obviates the need for sediment dredging, except possibly in localised areas where drainage culverts are to be constructed. The cost estimate allows for the provision of a gas extraction system above the sediment layer, if necessary. Following the completion of the first phase of laboratory "incubation" tests and the risk assessment, it is recommended that this option be further assessed through field trial.

Ex-situ Treatment (Estimated order of cost HK$500 – HK$700 million)

10. The ex-situ treatment method remains a viable option despite its potentially high cost. Apart from sludge arising from wastewater treatment, no sediment disposal would be necessary. Pilot tests are needed to further examine and confirm the various issues identified in the bench-scale test.

Marine Disposal (Estimated order of cost HK$450 million[4])

[4] Marine disposal estimated cost includes management costs of the contaminated mud disposal facility.

11. Marine disposal is also a possible option, depending on the quantity and timing of the disposal. In fact, the Schedule 3 EIA Report allowed for dredging and off-site disposal of small quantities of sediment underneath major structures on stability grounds.

12. The existing disposal requirements for Hong Kong stipulate proper pre-treatment of the sediment before disposal. Extensive worldwide experience in the dewatering of sediment and in the use of geosynthetic containers/tube for sediment confinement indicates that the marine disposal option is technically feasible. Further testing will be needed to confirm the performance of the geosynthetic containers under local conditions. Investigation of the existing and planned mud pits in Hong Kong indicates that they are able, as far as capacity is concerned, to accommodate the KTAC sediment. However, the remaining capacity of the pits to receive further dredged mud arising in future would be significantly reduced, and such an impact would need to be carefully assessed if in the unlikely event it is necessary to dredge and dispose all the sediment.

13. The possibility exists for combining or varying the above three options. For example, a hybrid option of encapsulation plus partial dredging in localised areas with high methane generation potential might be considered.

Programming Consideration

14. The construction period for the marine disposal option is about 3 years; whereas that for the encapsulation / ex-situ treatment options is about 4 years (including surcharge and subsequent removal). Irrespective of the option chosen, the KTAC reclamation can be completed by end-2008.

15. Housing developments are planned on top of the KTAC reclamation according to the relevant statutory outline zoning plan. The earliest housing completion date is targeted at end-2012. As the KTAC reclamation would be available by end-2008, we will be able to achieve this housing target.

Way Forward

16. The "incubation" test preliminary results show that the methane generation risk at KTAC is low, and the risk assessment results indicate that there are no unacceptable human health risks to receptors from the other chemicals of potential concern. We therefore consider there is a case to accord priority in taking forward the encapsulation option via on-site measurement of methane generation. The ex-situ treatment pilot test would be pended until result of the encapsulation field trial is obtained.

17. In the meantime, we are continuing our discussions with other Government departments on technical requirements in the event that it may be necessary to dispose

of a small quantity of sediment (i.e. sediment underneath new drainage culverts) to marine mud pit or landfill site.

Advice Sought

18. Members are requested to note the current position of the project. We also welcome Members' views on the proposed way forward.

Territory Development Department
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