Executive Summary

The KT-5 drainage channel at Kam Tin, Yuen Long, has been reported to have a serious odour problem. The present Study was undertaken to investigate the cause and degree of the problem and to develop possible odour control solutions. In the Study, a literature review was conducted on the swine odour problem and current sediment odour control technologies, site investigation and flow measurement were carried out at the KT-5 channel, the water quality in relation to the odour problem was analyzed, laboratory tests and field trials were conducted on sediment odour mitigation by dosing ferric iron-based chemicals, and batch experiments and full-scale field trials were carried out in KT-5 with Fenton reaction for water treatment and odour control.

Based on the literature review, odour nuisance is a common problem from agricultural and livestock activities. Among a variety of chemical compounds which are associated with the malodour, sulfides (S^{2-}) and volatile fatty acids (VFAs) are the most important odourous substances that are also commonly used as the odour markers. Odour control at the source should be the most effective, economic and sustainable solution. Besides source control, a number of physical, chemical and biological methods have been developed for sediment and water odour reduction with different levels of cost and success. Chemical treatment appears to be the most common and cost-effective method for the odour control purpose.

According to the flow measurement in October 2012, the KT-5 channel has a dry weather flow of around 2600 m^3/d. The flow has an hourly variation of about 30% with peak flows found in late evening and mid-night. During the peak hours, the water quality parameters, including suspended solids (SS), total organic carbon (TOC), S^{2-} and VFAs, can increase by 6-25 times (for example, S^{2-} increased from 0.8 mg/L to 13.7 mg/L and VFAs from 51.9 mg/L to 349.3 mg/L), together with a strong swine odour from the water. The swine wastewater discharge from the upstream area was found as the main cause of the odour problem in KT-5.

For sediment odour control during the field tests in November-December 2012, ferric iron salts ($FeCl_3$ and $Fe(NO_3)_3$) and lime could be easily sprayed in the form of solution or slurry onto the sediment surface in KT-5. A total of 125 kg of $Fe(NO_3)_3$ and 100 kg of $FeCl_3$, together with 175 kg of $Ca(OH)_2$, was dosed on the sediment within the ~300 m^2 trial area. Ferric precipitates deposited on the sediment surface to form a red-brown cap layer. The olfactory assessment scores indicated a clear reduction of the swine odour from the treated sediment. A remarkable result was achieved for the reduction of the S^{2-} flux and H_2S odour from the sediment. While the background S^{2-} flux from untreated sediment was in the range of 11-35 mg/m^2-d, the S^{2-} flux from the treated sediment could not be detected. The flux of VFAs from the treated sediment was also reduced in comparison to the background sediment.

The field trial results demonstrated that the ferric iron-based chemical dosing is a simple and effective measure to suppress the S^{2-} flux dominated odour emission from the sediment, although it may be less effective to reduce VFAs dominated odour emission. The chemicals dosed are environmentally safe without apparent adverse ecological impacts in KT-5.

For water treatment by the Fenton reagent for odour control, batch tests and field trials were conducted from November 2012 to January 2013. The results showed that Fenton treatment is effective for S^{2-} removal and VFA reduction in water. A minimum H_2O_2 of 140 mg/L with an H_2O_2: Fe^{2+} molar ratio of 6:1 is required for relatively less polluted water in the channel, while a higher H_2O_2 dosage of 200 mg/L can have more significant odour reduction. For the heavily polluted water with swine wastewater discharge, an even higher H_2O_2 dosage (e.g. 250 mg/L) will be needed for the odour control purpose. Fenton reaction is a simple chemical treatment that can be easily adopted in the field. The chemicals are of low cost and are safe for water application with little adverse impact on the aquatic environment. Additional tests suggest that ozonation or pH adjustment by acid addition can be used as an aid to Fenton reaction in water treatment for an enhanced odour control result.

Based on the results of the Study, a more cost-effective strategy is recommended to control the odour problem in the KT-5 area. The proposed engineering measures include both swine wastewater treatment and sediment odour control. For the swine wastewater, an existing intercepting sewer is to be used to collect the wastewater before it enters the KT-5, and a high dose of Fenton reagent (H_2O_2>300 mg/L) will be applied to treat the wastewater. The chemical cost of the Fenton treatment will be around $460K per year, and the total cost is expected to be $1.5M or less per year. For the foul sediment, ferric iron-based chemicals will be dosed on the sediment surface for odour control. A temporary by-pass flow channel may be needed through the sediment section to minimize the chemical washout from the sediment. The iron precipitate layer will be maintained on sediment for 6 months, while 3 series of the chemical spraying will be conducted. The chemical cost for the sediment odour control is around $30K and the total cost should be within $200K.