

An Integrated Approach for CPDC An-Shun Site Remediation and Re-Development

Chih C. Chao¹, K. H. Lin¹, W. J. Lee², Juuen Chang¹, H. J. Jhang³

¹Sustainable Environment Research Center, ²Department of Environmental Engineering, National Cheng Kung University, Tainan, Taiwan, ³Tainan City Environment Protection Bureau, Tainan, Taiwan

Introduction

CPDC An-Shun Plant site in northwest Tainan City, is located in an area close to the shoreline of Taiwan Strait and Lu-Erh-Men Creek, where aqua farming is the main livelihood of the local residents for a long time. In 1940's to 1970's, CPDC's predecessor was very active in producing caustic soda, hydrochloride, liquid chlorine, and pentachlorophenol, based on a chloroalkaline and add-on process. The production activity generated a number of toxic wastes, containing mercury, pentachlorophenol and dioxin. This plant was officially shut down in 1982, but the site was left un-cleaned. The site investigation initiating in 1982 revealed that, pentachlorophenol had reached subsurface and mercury and dioxin were found in surface water, groundwater, soils and sediments. In 2003, high levels of PCDD/PCDFs were found in the blood of local residents. On 19 March 2004, Taiwan's Environmental Protection Administration (TEPA) declared the 38.4 ha site to be a contaminated soil remediation site, by definition requiring an immediate remedial action. This paper reviews the status of the site assessment and emergency cleanup done so far. It further discusses an integrated approach for an overall site remediation and re-development plan.

Site Investigation and Assessment

The CPDC An-Shun site includes 11.5 ha of chloroalkaline plant, 4 ha of pentachlorophenol plant, 4.7 ha of vegetation area, 2.7 ha of grass area, and 15.5 ha of seawater storage area¹ (Figure 1). Extensive site investigations^{1,2,3,4} have been done within and around the site, covering the surrounding aqua farms, Lu-Erh-Men Creek, and Chu-Fa-Gang Creek.

The results of the contaminant distribution are shown in Figure 1. The highest mercury concentration was found in the chloroalkaline plant with a level as high as 3,370 mg/kg in soil, way above the soil control standard of 20 mg/kg. The worst dioxin contamination was found in the pentachlorophenol plant with levels as high as 64,100,000 ng-I-TEQ/kg in soil, whereas the soil control standard is 1,000 ng-I-TEQ/kg. Pentachlorophenol concentration within this plant was found to be as high as 51,4000 mg/kg. The sediment of sea water storage pond was found to contain dioxin as high as 6,560 ng-I-TEQ/kg and mercury as high as 1,410 mg/kg.

In order to help ease the public concern over the quality of aquatic products from the vicinity, for a period of three years since 2005, TEPA together with Tainan City Environmental Protection Bureau (TCEPB) conducted a series of investigation^{1,2,3,4} on the sediment of aqua farms surrounding the CPDC An-Shun site. In total, 142 sets of sediment samples were analyzed for dioxin and mercury, covering an aqua farm area of 68 ha.

The average dioxin concentration in the sediment was found to be 12.6 ng-I-TEQ/kg. Figure 2 shows the dioxin concentration loop in the surrounding aqua farms. The average dioxin concentration in the sediment of the east aqua farms was found to be 7.95 ng-I-TEQ/kg. The aqua farms to the west and south sides of the sea water storage pond had higher dioxin concentration. The average dioxin concentration in the sediment of the west aqua farms, located between the sea water storage pond and Lu-Erh-Men Creek, was found to be 62.3 ng-I-TEQ/kg. The higher dioxin concentration could be traced back to the non-removal of original soil contaminated with dioxin, while developing aqua farms between 1975 and 1982. At present, the west and south aqua farms are classified as "no fishing" area with regular patrol, to minimize the public risk.

Figure 3 shows the mercury concentration loop in the surrounding aqua farms. Excluding the non-detectable 65 samples, the average mercury concentration in the 77 sediment samples was found to be 0.52 mg/kg. The

mercury distribution appears to be very similar to that of dioxin. The higher mercury concentration was found in the west and south aqua farms, due to the same reasons described above. Mercury concentration in 44 of the sediment samples taken from the east aqua farms was found to be below detection limit, indicating that generally this area had not been contaminated yet.

Emergency Cleanup

During the period of 1995 to 2005, hot spots containing high levels of dioxin, mercury and pentachlorophenol were removed and contained in safe storage including RC tank and impermeable covered and lined area. In total, 5,400 m³ soil from the pentachlorophenol plant, 600 m³ soil from the grass area, and 22,650 m³ soil from the Secondary Road #2, were re-stored for further treatment.

Development of An Integrated Site Remediation Plan

For heavily contaminated area such as CPDC An-Shun site, the development of a suitable site and groundwater remediation plan has to take into account of the ultimate land end-use, compatible risk criteria, contaminant movement pathway, objectives for contaminant treatment, and affordability of the remediation task. In view of the heritage value of the general area and its fishery and ecological assets, it is important to help the affected community to re-vitalize the regional development in a sustainable manner, bringing in a vision and hope for a brighter future. A comprehensive approach is being shaped up at this moment, incorporating land end-use planning, public/stakeholder consultation, health care and promotion, remediation system evaluation and risk assessment, as partners of an integrated effort to arrive at a plan that satisfies all parties concerned.

One option for land end-use planning is likely to involve governmental resources to develop a heritage park system in the general area, which is to include an educational environment museum built on the reclaimed CPDC An-Shun site. As for the remediation plan, three options are being considered. They are: (1) carrying out full-blast soil and groundwater remediation; (2) applying on-site sealing and storage; and (3) conducting necessary remediation in conjunction with sealing. The choice of these options is dependent of the land end-use, risk acceptability, and cost affordability.

Health and ecological risk associated with each of the above three remediation options is to be assessed and compared. Remediation activities requiring assessment include: excavation, dredging, treatment, storage and sealing. Contaminant source, pathway and receptor for each activity are then to be identified and evaluated, while respective risk of each activity is to be summarized. The sum of risk for each of the three options is then tabled for overall assessment, serving as a basis for selection of an optimum option.

Acknowledgements

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References

1. "FY95 CPDC An-Shun Site Remediation Project" Final Report, Environmental Protection Bureau, Tainan City, Taiwan, 2007.
2. "Investigation Report on Contamination of Fish Farm and Waterway Southwest of CPDC An-Shun Site", Report #EPA-96-GA12-03-A181, Taiwan Environmental Protection Administration, 2007.
3. "Project II on Supervision and Monitoring of CPDC An-Shun Site Pollution Control" Final Report, Environmental Protection Bureau, Tainan City, 2006.
4. "Project on Investigation of Soil and Groundwater Contamination and Recommendation of Remediation Plan for CPDC An-Shun Site, Report #EPA-93-GA12-03-A203, Taiwan Environmental Protection Administration, 2006.

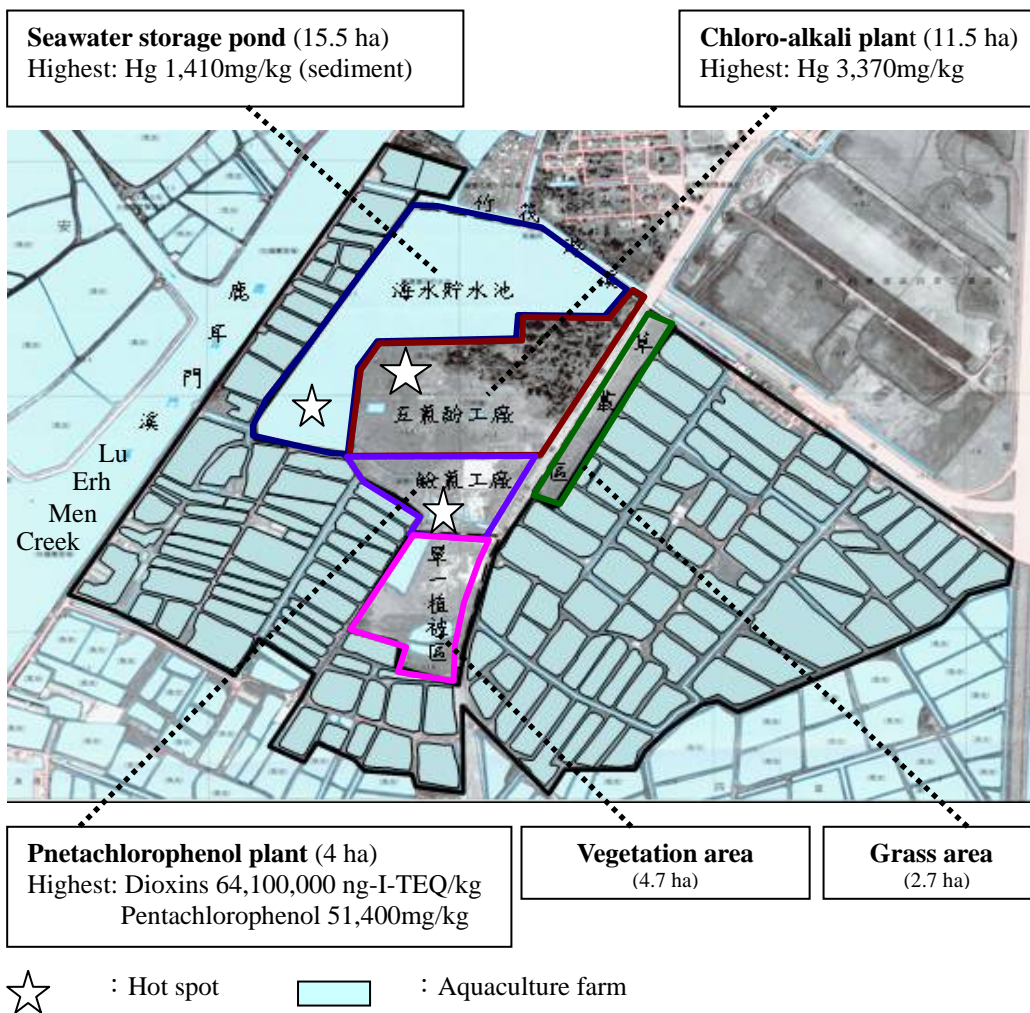


Figure 1. Highest concentrations of mercury and dioxins at the CPDC An-Shun Site

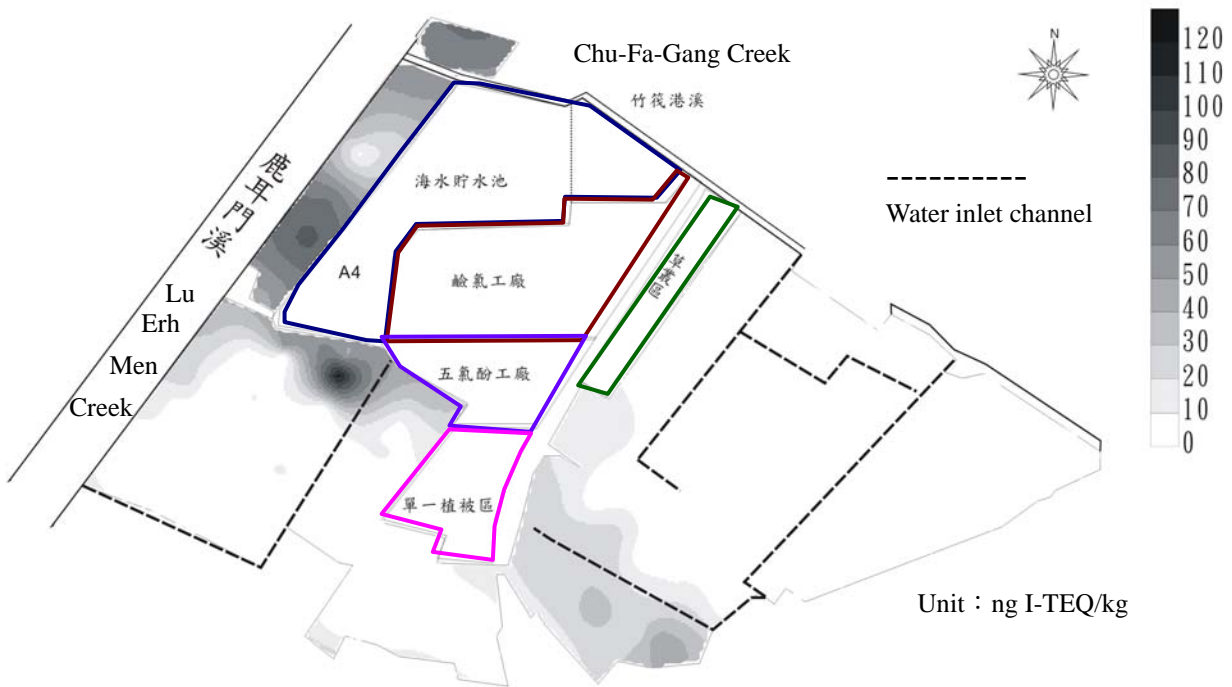


Figure 2. Dioxin concentration distribution in the surrounding aquaculture farms

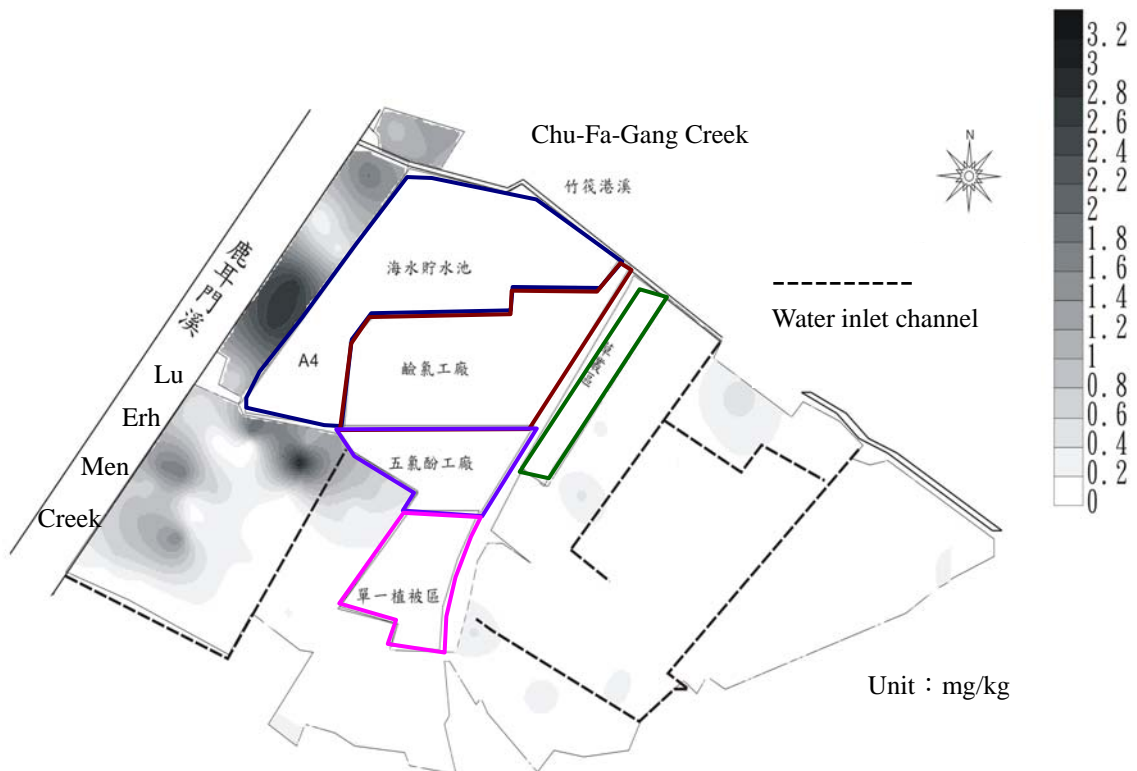


Figure 3. Mercury concentration distribution in the surrounding aquaculture farms