Chapter 3

STUDY AREA

Study area description

The largest lignite mine in Thailand is located in a basin in Mae Moh District, Lampang Province, approximately 650 kilometers north of Bangkok. It is some 26 kilometers east of Lampang provincial town (EGAT, 1994). The Mae Moh area covers approximately 150 square kilometers with a maximum length of is 18.3 kilometers and maximum width of 8.8 kilometers, and lies between latitude 18^0 18' N, longitude 99^0 2' E (Figures 3 and 4).

The Institute of Environmental Research, (Chulalongkorn University, 1981) described the topography and soil, in the Mae Moh Basin. The north boundary of the basin is surrounded by the Doi Kew-Lom quartzites mountain ridge. The east and west boundaries are bounded by limestone and mudrock mountains of Doi Chang and Doi Luang. The south boundary is bounded by basalt flows overlying the limestone of Doi Pha Hob.

In general, the topography of the basin can be classified as flat, low lying terrain. The elevation ranges between 300 to 350 m above MSL. The basin was formed during the Tertiary period on limestone basement with semi-consolidated sediments. Moreover, within the uppermost 10 meters of the basin, sediments of fluvial origin, namely clay, lateritic soils, and terrace gravel are predominant. Below 10 meters depth

there are lignite with 2 or 3 seams with average ticknesses of 15-20 meters interbedded with claystones or mudstones.

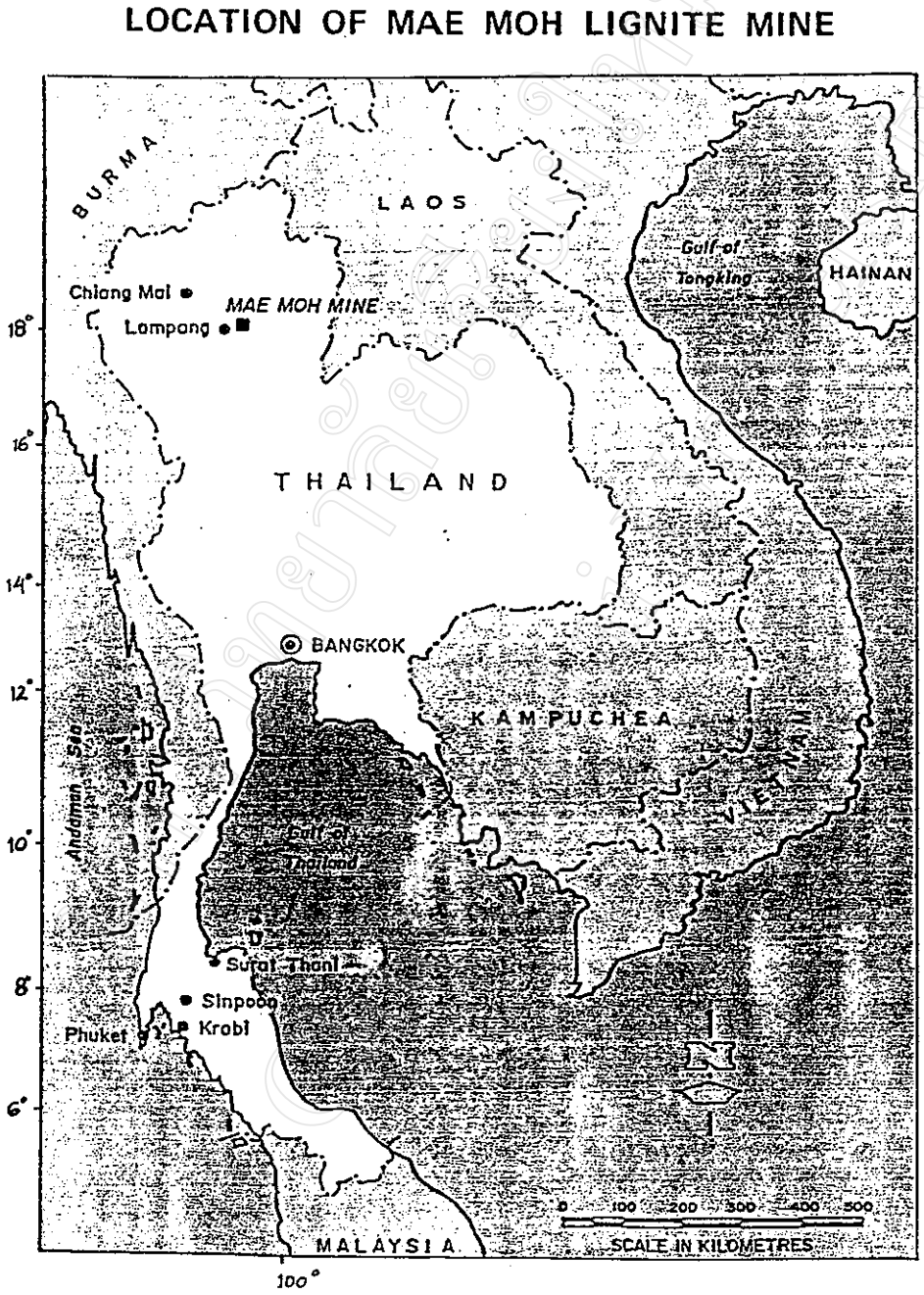

Figure 3. Map of Thailand showing location of Mae Moh Lignite Mine

(Source: EGAT, 1991)

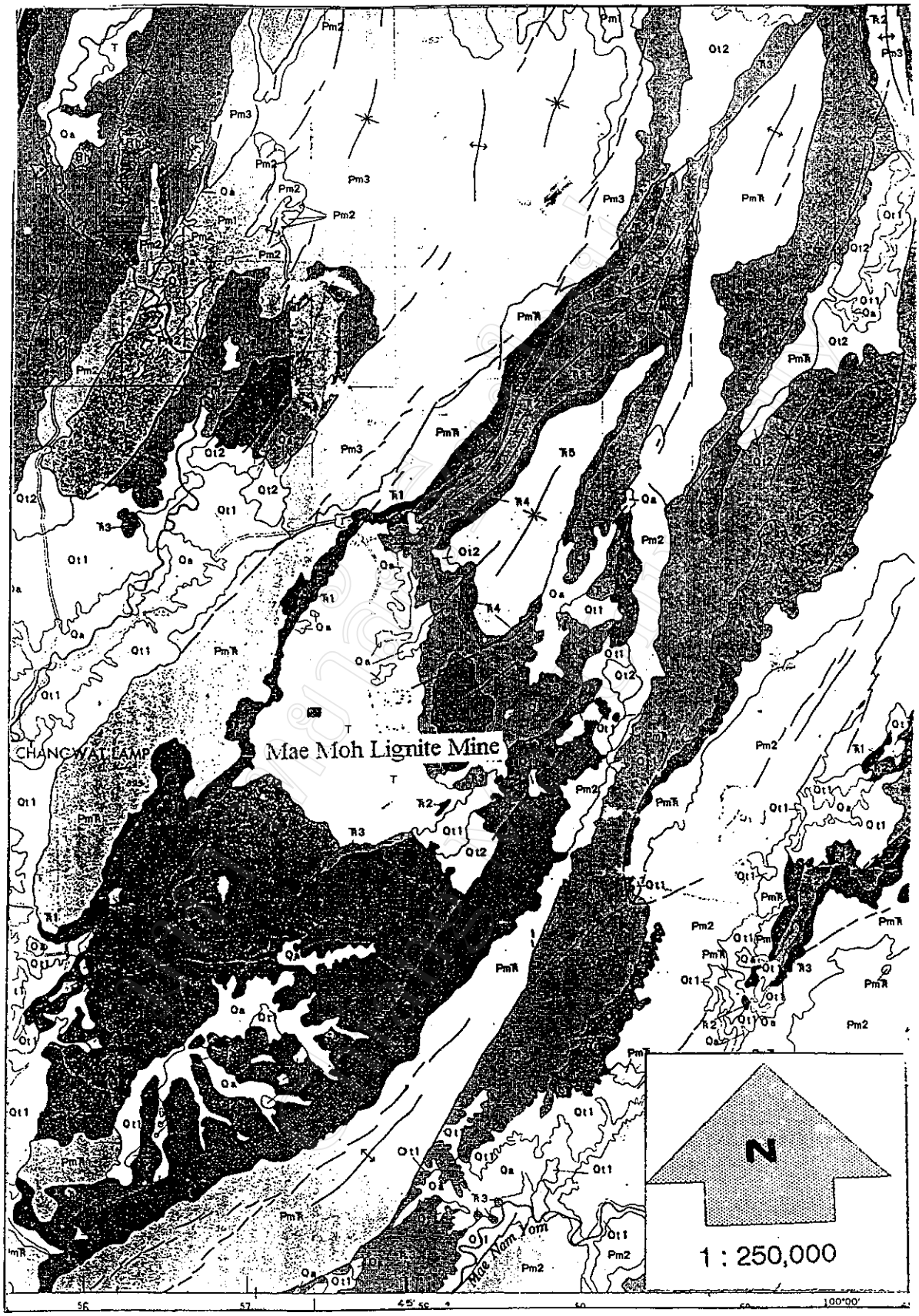

Figure 4. Geological map of Mae Moh Lignite Mine (after Piyasin, 1972)

(Source: Department of Mineral Resources)

Explanation:

Qa Riverrine gravel, sand, clay, and mud

Qt1 Lower terrace, gravel, sand and silt, clay

Qt2 Higher terrace, gravel, sand, silt, clay (Mae Taeng Group)

T Fresh-water sandstone, shale, carbonaceous shale limestone, viviporous beds, lignite (Mae Moh Group)

Tr5 Reddish-brown sandstone, shale, conglomerate, greenish-gray siltstone, shale, sandstone (Pha Daeng Formation Group)

Tr4 Limestone, limestone conglomerate, medium gray to pinkish-gray with fossils of gastropod, brachiopods (Doi Chang Formation, Lampang Group)

Tr3 Greenish-gray shale, sandstone, tuffaceous sandstone, laminated shale, conglomerate with fossils of *Halobia*, *Daonella*, *Posidonia*, *Trachyceras*, *Paratrachyceras*, *Jaonnites*, etc. (Hong Hoi Formation, Lampang Group)

Tr2 Limestone, massive or banded, dark gray to medium gray: shale, sandstone, calcareous, gray to grayish-brown, well stratified, with fossils of brachipoids, *Claria*, *Halibia, Daonella, Posidonia, Ammonites* (Pha Kan Formation, Lampang Group)

Tr1 Basal conglomerate, redish-brown sandstone, shale, agglomerate, tuff Pm3 shale, calcareous shale, carbonaceous shale, tuffaceous shale, tuffaceous shale and sandstone, laminated shale with fossils of *Dielasma, Leptodus, Orthotichia, Echinochus, Neospirifera, Schizopoira, Aviculopecten*, etc.(Huai Thak Formation, Ranburi Group) and Bs basalt, vessicular, amygdaloidal.

Climate

The climate in the Mae Moh basin is typical to northern Thailand. The area is located in the monsoon zone which is influenced mainly by two monsoons, namely the southwest and northeast, and while cyclonic storms and intertropical fronts are, secondary factors.

EGAT Mining Office, Mae Moh District, Lampang, reported that from 1990 to 1996, the average rainfall varies from 1.90 to 200.25 mm per month with the minimum during December due to dry cool air mass movements in the area. The maximum rainfall occurs in August as a result of storms from the Indian Ocean. The rainy season lasts from May to September and approximately 85 to 95% of the annual rainfall occurs through three causes, namely orographic, convective, and cyclonic. The cool-dry and hot-dry seasons prevail from October to April. During 1997, the hot-dry season prevailed until July, while the rainy season was from August to October caused by an El Niño event. The temperature ranges from 6^0C minimum in December to 41^0C maximum in April, with a mean monthly temperature of 37^0C. Based on data from 1994, from January to September the wind direction is south and from October to December to the north. A maximum wind speed of 120 km/hr occurs during March and April and minimum wind speed during November and December. Moreover, the average wind speed in the Mae Moh basin is relatively low throughout the year with an average of 5 - 6 km / hr (Appendix 1).

Site descriptions

Four study sites were chosen in the Mae Moh Mine, and each has three sub-sites while one site, in Lamphun Province was chosen as a control site. One reservoir was chosen due to the function of the reservoir where all the drainage system finally flows to these reservoir. Three settling pond and wetlands were chosen because of the characteristic of the wastewater which were treated there. In order to assess the effect of heavy metals accumulated in sediment and plants at Mae Moh Mine, one control site was chosen which is assumed there is no effect cause by activities of Mae Moh Mine. Figure 5 shows a map of the locations of the Mae Moh study sites.

Site 1, Mae Moh Reservoir

Mae Moh Reservoir is a natural lake which is located in the southern part of the region about 5 kilometers from the power plant. It has been a reservoir for 30 years. The reservoir is used mainly to store water. Furthermore, the wastewater from the mine and power plants which is treated from the settling ponds is discharged into Mae Moh Reservoir which is mixed together with water from Huai Pet Reservoir and Huai Sai Reservoirs. The three sub-sites are located on the eastern (1), western (2), and dam (3). The most common aquatic plants in the reservoir are *Eichhornia crassipes, Ipomoea aquatica* Forssk. (Convolvulaceae), *Typha angustifolia* L. (Typhaceae), *Nymphea pubescens* Willd. (Nymphaeaceae), *Ludwigia hyssopifolia* (G. Don) Exell (Onagraceae), *Pistia stratiotes* L. (Araceae), and *Nymphoides indica* (L.) O. K. (Gentianaceae/ Menyanthaceae). The water is quite clear and almost one-third of the

surface area is covered by vegetation while the surface of the substrate is covered with shells. Figure 6 shows the Mae Moh Reservoir study site.

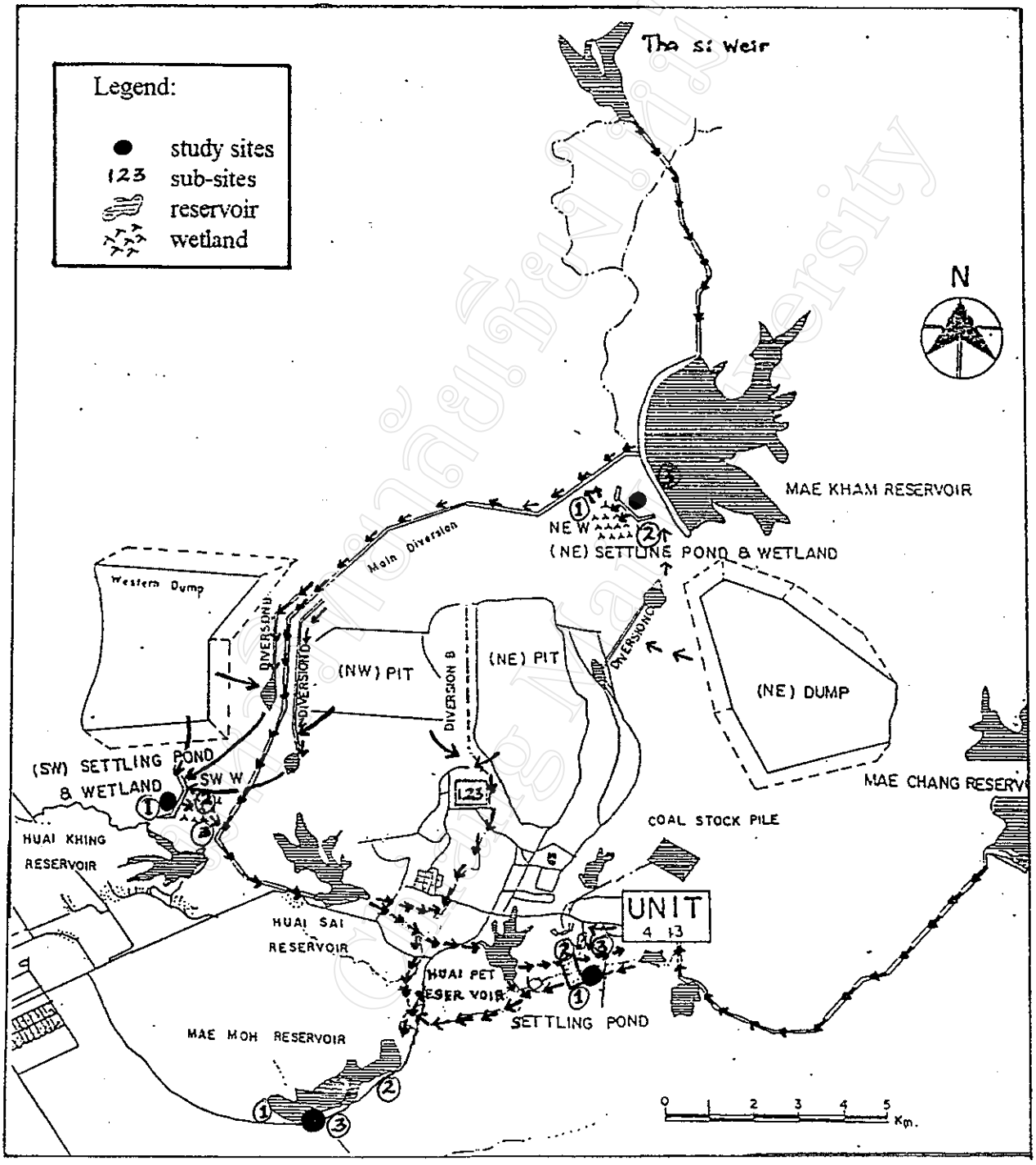

Figure 5. Map of location of the study sites at Mae Moh (after EGAT, 1997)

(Source: Mine Environmental Operation Section, EGAT Mae Moh)

Figure 6. Mae Moh Reservoir study site with *Typha angustifolia* (1) and *Nymphoides indica* (2)

Site 2, Power plant settling ponds

The settling ponds are located about 1 kilometer from power plant units 4 - 13 and are used to collect discharged wastewater from the mine and power plant. After recycling the treated water is pumped to the main water supply and can be used for the cooling system and other activities. It was constructed about 5 years ago. The places where wastewater is discharged from power plant units 4 - 13 flows into the inlet of the settling ponds, were chosen as a sub-sites 2 and 3 of the study site. The outlet where the wastewater is discharged into the aerobic pond was chosen as sub-site 1. Some aquatic plants there are: *Eichhornia crassipes, Ipomoea aquatica, Typha angustifolia, Canna* hybrid (Cannaceae), and *Ludwigia hyssopifolia*. Figure 7 shows the settling pond study site with some aquatic plants.

Figure 7. Power plant settling ponds study site with *Typha angustifolia* (1), *Ipomoea aquatica* (3), and *Eichhornia crassipes* (4)

Site 3, Northeast (NE) wetland

The settling ponds and wetland were constructed about 4 years ago for water quality control in the NE part of the area. Wastewater from the NE dumping site is discharged through a diversion canal to the NE settling ponds and wetlands. After recycling, the treated water is discharged into the main diversion and mixed together with water from Mae Kham Reservoir, as a water supply to the other reservoirs. It was designed in a bed systems with 8 rows with inlets from settling ponds and the outlet of the wetland flows to the biological ponds which were chosen as a sub-sites 1 and 2. Furthermore, as a comparison site, sub-site 3 was chosen in the Mae Kham Reservoir. The wetlands were planted with *Typha angustifolia*. In the biotreatment pond some other aquatic plants are found, e.g. *Ipomoea aquatica*, *Canna* hybrid, *Phragmites*

vallatoria (Pluk. ex L.) Veldk. (Gramineae), *Azolla pinnata* R. Br. (Azollaceae), *Salvinia cucullata* Roxb. ex Bory (Salviniaceae), and *Nymphoides indica*. Figure 8 shows the northeast wetland study site with some aquatic plants.

Figure 8. Northeast (NE) wetland study site with *Typha angustifolia* (1), *Ipomoea aquatica* (3), and *Eichhornia crassipes* (4).

Site 4, Southwest (SW) wetland

Construction of the wetland in the southwest part of Mae Moh Mine had the same purpose, i.e. to treat wastewater which is discharged from the western dumping sites and northwest pit. The treated water is then discharged into the main diversion canal and goes to Huai Sai Reservoir and the other reservoirs. This was done about 3 years ago with the same design as the NE wetland. The inlet of the wetland comes from the settling ponds and was chosen as a sub-site 1, and the outlet as a sub-site 2.

Moreover, sub-site 3 is a settling pond that receives water from the wetland. The most abundant vegetation there is *Typha angustifolia*, with fewer *Ipomoea aquatica* and *Canna* hybrid. Figure 9 shows the southwest wetland study site with *Typha angustifolia*.

Figure 9. Southwest (SW) wetland study site with *Typha angustifolia* (1)

Site 5, Control sites

The control site is located about 500 meters away from Lamphun railway station which is an open area 300 meters away from highway no. 1136. It is a degraded marsh with *Typha angustifolia* and *Ipomoea aquatica*. Figure 10 shows this control site with *Typha angustifolia*. Due to the fact that *Typha angustifolia*, *Ipomoea aquatica*, and *Eichhornia crassipes* could not be found in the same place, another area had to be found which had *Eichhornia crassipes*. About 500 meters away from this place is the Mae Nam Kuang (river) which was chosen as another control site where *Eichhornia*

crassipes was found. The river water is yellowish-brown, slightly stagnant, and is polluted with domestic sewage. Figure 11 shows Mae Nam Kuang with *Eichhornia crassipes*.

Figure 10. Control site with *Typha angustifolia* (1)

Figure 11. Mae Nam Kuang study site with *Eichhornia crassipes* (4)