PART 7: CONCLUSIONS

As mentioned earlier in the problem statement, p. 6, the water quality of the Hex River and its tributaries has progressively deteriorated due to the location of the Hex River catchment within a highly developing urban, industrial as well as mining area of the North West province. With continual industrial, residential and mining intensification within the North West province the Hex River catchment can become detrimental to the aquatic environment and unsustainable for specified land users.

Owing to the North West being an arid province with increasing demands on water resources and the River Health Programme (2005) depicting the Hex River in an already ecological unsustainable state the deterioration in the water quality within the study area have become a concern to local authorities and primary water users. The was discussed in section 4.4, p 45. The extent of the water quality deterioration as well as the effect on the water users within the catchment needed to be ascertained so that rehabilitative and mitigatory measures could be proposed.

Regarding the above the study's main aim as stated in Part 1, p. 4 was to determine the present day physical, chemical and biological water quality of the Hex River catchment. In order to reach the main aim presented above a phased approach were followed where certain objectives as stated in part 2, p. 6 had to be met. The following section summarizes the main findings obtained in this study to meet these objectives as well as the general conclusions drawn from the study.

The findings from the literature review conducted on existing information regarding water quality and water quality management are presented in part 3, p. 9 to 26 of this study. The literature review focused on water quality in general, water quality management in South Africa with reference to legislative requirements and a discussion of the various Target Water Quality Guideline Ranges as identified for the study. The literature review further included a discussion on each of the chemical, physical and biological water quality constituents analyzed for the study area and graphically represented and evaluated for the Hex River and its associated tributaries in part 6, p. 73 to 131 of this study.

For the purpose of identifying sources of pollution within the catchment the study area was described. The findings of the site-assessment as well as gathering of existing information on the study area are

presented in part 4, p. 28 to 45 of the study. Specific attention was given to the location of the Hex River and its associated tributaries as well as the physical features and land uses within the catchment. It was deemed necessary to describe the study area in detail to gain insight into the various water users which can be affected by a deterioration in water quality. Existing information on the water quality conditions of the study area were examined so that a comparison could be made between historic as well as current water quality conditions. It was found that the Hex River has an already poor in stream habitat integrity and well as fish assemblage integrity owning to high levels of development and mining activities that cause water quality deterioration. To prevent further deterioration of the already impacted water quality rehabilitative measures need to be implemented.

The water suitability for use by domestic users, irrigation as well as livestock watering purposes were also assessed as these form the main water users within the catchment. Further, the water's suitability for the well-being of the aquatic environment was determined as decreased biotic integrity as discussed in Part 4, p. 45 is evident from previous studies within the area. In order to achieve the aim of this study and for effective recommendations an understanding of the physical, chemical and biological constituents affecting the use of water for domestic, irrigation and livestock watering purposes as well as the fitness for the aquatic environment were reviewed. The recommended Target Water Quality Guideline Ranges for the identified users as well as aquatic ecosystems were reviewed and discussed.

To determine the deterioration of the water quality within the Hex River catchment over a four year period as well as the current water quality conditions water quality data were obtained for selected constituents during July 2002 to June 2006. The water quality data were obtained from Clean Stream Environmental Services that are responsible for the water monitoring of the applicable study area. Only selected constituents having affects on domestic use, irrigation, livestock watering and the aquatic environment were analyzed and evaluated. The constituents analyzed and evaluated include pH, Total Dissolved Solids, Turbidity, Chloride, Sulphate, Nitrate, Ammonium, Ortho-phosphate, Iron, Aluminium, Manganese, Fluoride and hardness concentrations as well as Total Coliform, Faecal Coliform and E. Coli counts.

The evaluation of the recent water quality results showed that only selected water quality constituents cause adverse effects on the water quality of the Hex River, and will influence the water use by identified users. Table 23, p. 128 as well as Figure 44, p. 129 indicates the various problematic constituents for the various TWQGR. Of the fourteen chemical and physical constituents analyzed for

the study area ten exceeded the TWQGR for domestic use. These include salts (TDS, Cl and SO_4), nutrients (NO_3, PO_4 and NH_3), metals (Mn and Al) Fluoride and hardness concentrations. Of the fourteen chemical and physical constituents analyzed six exceeded the TWQGR for aquatic ecosystems including TDS, Cl, PO_4, NH_3, Mn and Al concentrations. Four (TDS, Cl, SO_4 and Mn) of the fourteen physical and chemical variables exceeded the TWQGR for irrigation and three (TDS, SO_4 and Cl) of the fourteen the TWQGR for livestock watering. Further all three of the bacteriological constituents analyzed for the Hex River exceeded the TWQGR for domestic use.

From the analysis of the water quality results it was evident that the salt (TDS, Cl, SO_4) contribution to the Hex river originates from associated mining activities within the area, mostly that of platinum operations as well as runoff and effluent discharge from the industries situated within the Rustenburg Northern industrial zone as identified in Part 4, p. 42. All processes where ores are heated (to combust, melt of calcine specific minerals present in the ores) produce contaminated water. These substances settle out in the receiving environment where they may have direct impacts on the surface water of the area. In addition these substances are often mobilized during rainfall and transported by runoff into nearby watercourses where they have additional effects on the components of the aquatic ecosystems as well as other water users (MMSD, 2001) The high contribution of nutrient (NO_3, PO_4 and NH3) concentrations to the Hex River catchment can be ascribed to the various waste water treatment works situated within the study area as specified in Part 4, p. 42 – 43. High metal concentrations of which primarily Aluminium and Manganese occur in selected areas of high mining activities within the study area. From the evaluation of the water quality results it is evident that the greatest adverse impact on the water quality of the Hex River during the monitoring period is evident from the effluent discharged by the Rustenburg waste water treatment works, impacting between the upstream locality (Hex4) and the downstream Paardekraal Angling Dam (Hex5) (Figure 27, p. 63 and Figure 28, p. 65).

Anthropogenic impacts enter the Hex River system as it progresses towards the Bospoort Dam. These impacts can mainly be ascribed to industrial effluent, agricultural run-off and domestic waste water. Noteworthy is the actual ‘limited’ observed impact towards the Hex River compared to the must greater intrinsic risk contained at the various tributaries of the Hex River. The sources feeding the tributaries contain water of inferior quality with a direct environmental risk associated with it – but it seldom reaches the Hex River. Thus the system contains the risk potential associated with inferior water quality and with a specific environmental event could be released resulting in a significant environmental impact. Therefore a significant mine water related impact is noted in the Hex River after

the confluence with tributaries draining mining areas. Untreated and partially treated sewage water is considered to be a major problem in the catchment. This impact is noticeable in the Hex River when considering nutrient concentrations. TDS, Hardness, Sulphate and Chloride concentrations increase progressively towards the Bospoort Dam. However, it is evident that the salt (TDS, Cl and SO_4) concentrations recorded for Hex11, the Bospoort Dam, is lower than that recorded downstream at Hex10. Although high nutrient concentrations were recorded for the Hex River just prior to the Bospoort Dam, lower concentrations were recorded for Hex11. Low metal concentrations were evident in the Bospoort Dam. These findings indicate the assimilative capacity of the receiving water body as reduction of high constituent concentrations by high volumes of water in the dam is evident. However, as evident from Figure 44, p. 129 various constituents including TDS, Cl, nutrients, Fluoride, and hardness are problematic in the Bospoort Dam as decreases the assimilative capacity of the receiving water body.

Rehabilitative and mitigatory measures proposed are aimed at improving the current water quality conditions of the Hex River as well as limiting additional impacts to the already sensitive aquatic environment. For the implementation of rehabilitative measure continuous monitoring of the water quality trends in the study area are important to demarcate source of pollution towards the Hex River and its primary tributaries. Recommendations and mitigatory actions are given in the following section Part 7, p. 136 of this study.

PART 8: RECOMMENDATIONS

From the evaluation of the water quality results the following recommendations as well as mitigation management practices are proposed to limit further deterioration of the Hex River, and improve the current water quality conditions of the Hex River and its associated tributaries.

- Continuous water quality monitoring on a sequential basis should be conducted to determine if further deterioration in water quality from the demarcated pollution sources occurs.

- Inferior water quality conditions including contribution to the salt (TDS, Cl, SO4) as well as nutrient and metal concentrations within the Hex river, is evident from the Dorp Spruit draining the Rustenburg Northern Industrial Zone. It is essential to determine the source of pollution from this area which involves determining which industries situated within this area discharge effluent into the Dorp Spruit as well as the composition of the effluent being discharged.

- The source of sewage pollution on the Klipfontein Spruit should be investigated as it is evident that no effluent is discharged from the Purified Sewage for the Waterval waste water treatment works situated in the vicinity of the monitoring locality Klipf4.

- It is possible that poor management actions of the mining activities in the vicinity of the Naude Dam (monitoring locality Klipf5) result in the high constituent concentrations recorded during the monitoring period (see Figure 44, p. 129). Better management actions include better storm water management actions to reduce storm water runoff and seepage flows directly into the dam. The overflow of polluted mine water contained in the Naude Dam into the Hex River is in contravention to legislative requirements and must be mitigated by the relevant parties and mining authorities.