Water and sediment quality at Kamsar

The field measurements were very similar among all of the Kamsar stations sampled in both the Dougoufissa River and the Rio Nuñez Estuary, with some subtle dilution occurring at the mouth of the river due to mixing in the estuary. A slightly basic pH of 8.0 was measured in both the river and the estuary, which falls within acceptable pH levels for the protection of both freshwater and marine aquatic life. Surface waters at all stations were supersaturated with respect to dissolved oxygen and concentrations generally met recommended values for warm aquatic biota. The average surface water temperature measured in mid-April was about 29 ^{o}C. The very high specific conductivity of these surface waters is consistent with the high levels of dissolved salts and TDS.

The majority of metal samples were under detection levels, however the detection limits are fairly high and can exceed the more conservative criteria. Metal constituents that were detected included boron and strontium in all samples, aluminum and vanadium in most samples from both the river and estuary, and zinc in river samples only. Of these, only zinc has a water quality criterion. The criterion is 81 μg /L and was exceeded at the most upstream stations in the Dougoufissa River. Similar concentrations of boron, strontium and vanadium were generally measured between all of the stations in both the Dougoufissa River and the Rio Nuñez Estuary, suggesting that based on the available data these levels are not affected by the activities at the plant.

High concentrations of aluminum (1,200 μg / L) and zinc (2,300 μg / L) were measured in the most upstream station on the Dougoufissa River, but decreased to below detection limits near the mouth of the river, and all along the estuary in the case of zinc. This suggests that aluminum and zinc are entering the river from the surrounding watershed or other sources upstream of the processing facility. As zinc was not detected in the vicinity of the river mouth and all stations within the estuary, the processing facility does not appear to be influencing zinc levels. In the case of aluminum it is evident that activities at the processing facility are influencing aluminum levels in the estuary as concentrations increased moving away from the river mouth toward the ship loader to the west.

The lowest aluminum concentration in the estuary was measured at station K-04 (9400 μg /g) along the jetty. Concentrations along the west transect ranged from

20,000 to 28,000 μg /g while concentrations along the north transect were slightly lower ranging from 16,000 to 20,000 μg /g. The same trend in concentrations was generally noted for all of the metals included in the figure with the lowest concentration measured at station K-04.

Prior studies found values of chemical parameters for well water that generally met the WHO guidelines for drinking water with the exception of chlorine, iron and coliform bacteria. The high levels of chlorine were interpreted as likely intrusions of salt water and an increase in brackish water during the dry season. In some cases there are also exceedances for lead and aluminum.

Water and sediment quality at Sangarédi

The pH measurements in the Sangarédi river were acidic, ranging from 5.03 to 6.47. The pH increased moving downstream of the mining operations to the east and north along the Cogon River where the highest pH value was recorded. The pH measured at all river stations in the mining area fell below the acceptable range of 6.5-9.0 for the protection of freshwater aquatic life recommended by the U.S. EPA and CCME.

Surface waters at all river stations were undersaturated with respect to dissolved oxygen, which ranged in concentration from 3.8 to 7.7 mg/L. These dissolved oxygen concentrations generally fell below acceptable levels recommended by the U.S. EPA and CCME for the protection of freshwater warm aquatic biota for all life stages.

Water temperatures of the surface water during June were between 25.9 °C and 29.9 °C.

Ammonia levels do not appear to be elevated in surface waters, at least at the time of sampling, as might be expected with the use of explosives for blasting purposes during mining operations.

In comparing total metal concentrations to available criteria and guideline values, exceedances were noted for iron, lead, silver and zinc concentrations at station SW5 in the Pora River. Exceedances were also noted for iron at station SW2 (1100 μg /L) near Bowal 22 (Koobi) in the west end of the mining area, station SW6 (565

μg /L) downstream in the Lafou River, and station SW8 (480 μg /L) downstream in the Cogon River.

Levels of metals in the sediment were analyzed. The observed levels were compared to Canadian benchmarks for the protection of populations of benthic invertebrates living in sediments. Two benchmarks are given: the Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PELs).

Low concentrations were generally measured for several metals including bismuth, boron, cadmium, mercury, selenium, silver, and tin. The chromium concentration in all Sangarédi sediment samples exceeded both the ISQG and PEL. The ISQG for arsenic was exceeded in all river samples except in sediment from the Boundou-Waadé River (SW10) and the stream near Bowal 9 (Mooule) (SW11) in the north end of the mining area. In addition, the PEL for arsenic was exceeded at the downstream station (SW1) in the Tiapikhouré River and at the upstream station (SW7) in the Cogon River. Exceedances of the ISQG were also noted for copper at SW5 in the Pora River and SW11, lead at SW1 and SW5, and zinc at SW5. The greatest number of guideline exceedances were noted in the Pora River, at station SW5 which occurs downstream of the Tiapikhouré, Boundou-Waadé and Lafou rivers. At this station, arsenic, copper, lead and zinc concentrations exceeded respective ISQG values while the chromium concentration exceeded the PEL.

Aluminum concentrations ranged from 32,000 μg /g at stations SW1 downstream in the Tiapikhouré River to 76,000 μg /g at station SW11 in the stream near Bowal 9 (Mooule) in the northern portion of the mining area. Concentrations appear to decrease moving eastward towards the Pora River. It is noteworthy that the concentrations of all of the metal constituents were higher at station SW7 in the Cogon River which is upstream of the main mining operations relative to station SW8 which occurs downstream of the confluence with the Pora River and mining operations.

For the two traditional wells (Horé Lafou and Hamdallaye) that were sampled by the CBG in the spring of 2014, iron (1100 μg /L) and manganese (110 μg /L) concentrations in the well sample from Hore Lafou both exceeded the EU guideline values of 200 μg /L for iron and 50 μg /L for manganese. Neither well had high aluminum or other dissolved metal concentrations. This may reflect the depth of the well water being tapped (for example, under the laterite deposits).

0.2.3 Description of the VECs for the physical environment

0.2.3.1 Air quality

The Project will result in an increase of the quantity of contaminants that will be discharged into the air as a result of the increase in the mining activities, the treatment of bauxite and the transport and shipping activities. Air quality is important for the health and security of people living close to the Project sites and the mine roads. Air quality is also important for the local fauna and vegetation.

For this assessment, air quality has been identified as a VEC and it is divided into two subcomponents: particulates and metals, and gases. Both are judged to be of "High" value.

0.2.3.2 Noise and vibration

The Project will result in an increase of the levels of local noise and vibrations because of the increase in mining activities, the treatment of bauxite and the transport and shipping activities. Noise is often associated with nuisance effects; however, noise can have indirect effects on human health by increasing stress (for example sleeping problems and disturbance to communication).

Vibrations are also generally associated with nuisance effects; however, it is also possible to have structural damage to buildings depending on their magnitude. The perception that there may be structural damage can also lead to health problems from stress.

Noise and vibration can also be an important factor for the fauna, in particular during the use of explosives for the mining operation.

For this assessment, noise and vibrations each represent one subcomponent of the VEC and both are judged to be of "High" value.

0.2.3.3 Water and sediments

Surface and groundwater are an essential resource.

There are a number of identified interactions between water and sediments and the Project. Amongst the most important:

- The deposit of dust containing metals, including both direct deposition over water and deposition on land that will eventually be transported down towards the surface water and sediments;
- The deposition of SO_2 and NO_2 that can affect water quality;
- The change in groundwater movements as a result of the quarries;
- The dredging of the ship basin in Kamsar.

For this assessment there are three VECs and seven subcomponents for water and sediments (see Table 0-4).

0.2.3.4 Soils

Soil is an important resource, as much for the local vegetation as for potential agricultural activities. Soils take a long time to form and it is not easy to replace them when they are destroyed. In addition, while *in situ*, soils contain the seeds of plants adapted to local conditions. This bank of future vegetation must be considered a valuable product. The loss of soil is an important aspect especially in the context of the new mining areas at Sangarédi where large quantities of soil will be stripped on the mine sites.

Soils that are *in situ* but close to the operations, have the potential to be affected by the deposition of atmospheric particulates or gases from the activities of the Project or from accidental releases during those activities. This pollution can affect the use of the soil by natural vegetation and by farmers.

There are two subcomponents for the soil VEC. The first subcomponent is the soil as a resource and it is judged of "High" value. The second is the quality of the soil and it is considered less critical than the complete removal of the soil and it is therefore judged of "Medium" value.