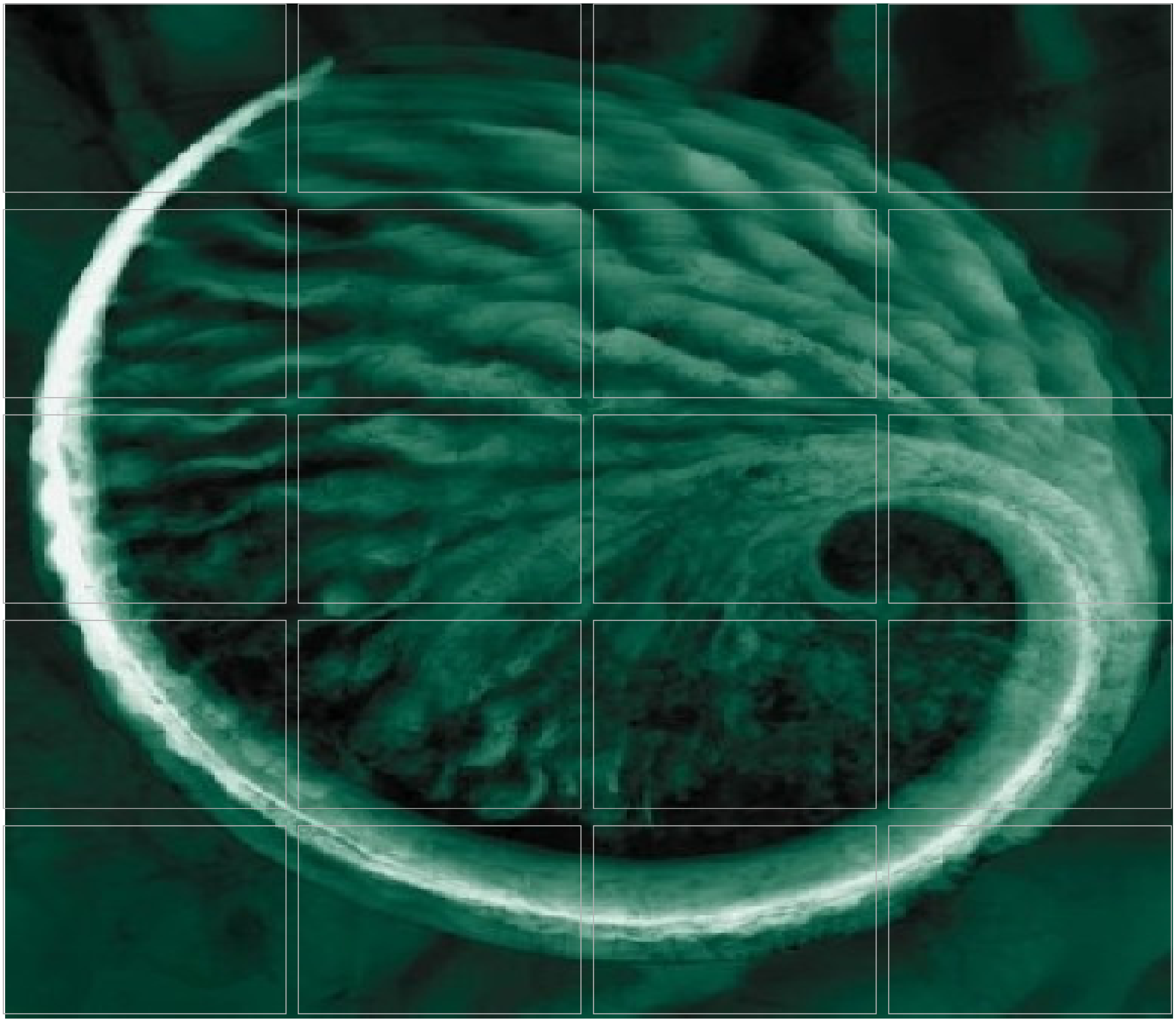

SEIA Addendum for EGA's Bauxite Mining Project: Interim Project Water Balance

Draft

9 August 2016

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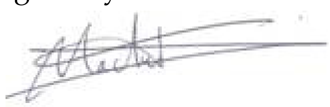
SEIA Addendum for EGA's Bauxite Mining Project: Interim Project Water Balance.

Guinea Alumina Corporation (GAC)

ERM Reference: GMS 0254472

Signed by:



Position:

On behalf of ERM France SAS

Date: 9 August 2016

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1 *INTRODUCTION*

Water is recognised internationally to be a critical resource and hence management of water resources is not only considered "inside the fence" at well-managed operations. Instead, a catchment-scale approach is taken to include consideration of other water users and communities within the area of the operation.

GAC recognise this and consequently have conducted a series of studies to assess the most sustainable options for mine project water supply, taking into account other water users within the Tinguilinta catchment including maintenance of a functional ecosystem.

The project water demands for the GAC bauxite mining construction and operations are relatively modest, being largely driven by haul road dust suppression requirements rather than ore processing. Thus the initial water supply option was to abstract directly from the Tinguilinta. During the ESIA process, however, catchment water modelling indicated that in some years there may not be sufficient water in the Tinguilinta during the dry season to supply the GAC operations and maintain an appropriate social and ecological flow level. GAC therefore commissioned additional work to assess a range of alternative water supply options. Some of this work is still ongoing and hence the Project and Catchment Water Balances are still in draft.

This document represents a summary of the current understanding of these water balances and is designed to be updated as the monitoring plans and supply studies data become available.

2 *REGULATORY REQUIREMENTS AND DATA SOURCES*

2.1 *GUINEAN LEGISLATION*

The Water Code (*Code de l'Eau*) (Law L/94/005/CRTN of the 14 February 1994) establishes a system of water use rights and sets the overall framework for managing water resources. The Code states that a concession is granted by decree for permanent water uses, such as supplying potable water to towns and villages, hydropower, agricultural, industrial or other developments, requiring investments whose amortization period exceeds 10 years.

The Code states that any use of water resources must comply with the guidelines of the development plan of the watershed containing these resources. The Code also addresses the prevention of the harmful effects to waters and the protection of water quality.

The Code addresses groundwater issues, and more specifically the measures governing the exploration, exploitation and protection of groundwater sources. The arrangements for establishing protection perimeters, defining water resource safeguard areas and issuing drilling permits are determined by the National Directorate for Hydraulics (*Direction Nationale de l'Hydraulique*-DNH).

Article 16 of the Mining Code (Law L/2011/006/CNT of 9 September 2011, replacing the version L/95/036/CTRN of 30 June 1995) also provides for the protection of water resources from companies undertaking quarrying and mining activities and associated activities.

In addition, a Ministerial Order is under development on wastewater discharges (*Projet d'arrêté Ministériel fixant les conditions de rejets des eaux usées*) and a Guinean Standards: NG 09-01-010:2012 / CNQ:2004 relating to new standards for waste water discharges (*Norme Guinéenne NG 09-01-010:2012 / CNQ:2004 Rejet des Eaux Usées*) also under development. At this stage of the Project, only a draft of the national regulation on waste water is available.

2.2 *IFC INTERNATIONAL GUIDELINES*

The IFC Environmental, Health and Safety Guidelines (2007) recommend that all mines should focus on appropriate management of their water balance including establishing a project water balance and developing a sustainable water supply management plan which aims to '*minimize impact to natural systems by managing water use, avoiding depletion of aquifers, and minimizing impacts to water users*'.

2.3 *INTERNATIONAL COUNCIL OF MINING AND METALS (ICMM) GUIDELINES*

The ICMM Principles for Water Stewardship (1) comprise four elements:

- transparency and accountability, meaningful disclosures and clear accountabilities throughout the organization.
- proactive and inclusive engagement based on identification of stakeholders to understand their concerns and to provide a basis for partnership approaches to mitigate shared risks.
- careful management of water resources – in a manner that optimizes water usage through exploring and implementing efficiency measures.
- a catchment-based approach to water management incorporating the needs of existing and future water users and taking a holistic view of impacts at the catchment level.

(1) ICMM, 2015. A practical guide to catchment-based water management for the mining and metals industry.

2.4 *DATA SOURCES*

The current understanding of the catchment water balance and project needs and supply options is derived from studies informing the following key documents and supporting references mentioned within them:

- ERM 2015. Social and Environmental Impact Assessment (SEIA) Addendum for GAC's Bauxite Export Project, Guinea.
- NewFields, April 2016. Feasibility-level design for the water supply reservoir. Client draft.
- ERM, 2016. Dam SEIA update.

3 *CATCHMENT WATER BALANCE*

3.1 *INTRODUCTION*

The GAC mine site is located approximately 70 km inland from the port at Kamsar and 25 km south west of the active bauxite mining area at Sangarédi. The concession area is within the Tinguilinta River catchment and the river roughly bisects the concession. The Tinguilinta River is part of the Rio Nuñez basin which flows out to the Atlantic Ocean at Kamsar (*Figure 3.1*). The existing CBG Sangarédi operations take place in a separate watershed: the Kogon River basin, through which the Kogon River flows to the north at Sangarédi, and drains to the Atlantic Ocean approximately 35 km north of Kamsar.

Shallow groundwater systems generally approximately correspond to topographic contours hence the groundwater catchment area for the Project is defined as the same area as the Tinguilinta River catchment. Therefore, for the purposes of the Catchment Water Balance (*Figure 3.2*) the catchment elements described in this report relate to the Tinguilinta River.

The Tinguilinta watershed has an area of approximately 1,850 km^2 with a predominantly hilly and vegetated (forest, shrub and grassland) landscape. The uplands are characterized by wide plateaus and stream valleys with meandering and mildly sloped streams. The top layer of the plateaus is formed by a duricrust, which is a compact and weathered soil with low permeability. Below the duricrust lies a series of varyingly weathered laterites collectively known as the Sangaredi bauxite-bearing group, which is characterized by a porous texture and high permeability. The underlying bedrock layer comprises a set of low permeability formations of siltstone, claystone and dolerite [(1)].

(1) Mamedov, V.I., Chausov, A.A., and Kanishchev, A.I., 2011. Formation Stages of the Unique Sangaredi Bauxite-Bearing Group, Futa Jalon-Mandingo Province, West Africa. Geol. Ore Deposits, vol. 53, no. 3, pp. 177–201.

Figure 3.1 Location of key surface water catchments.

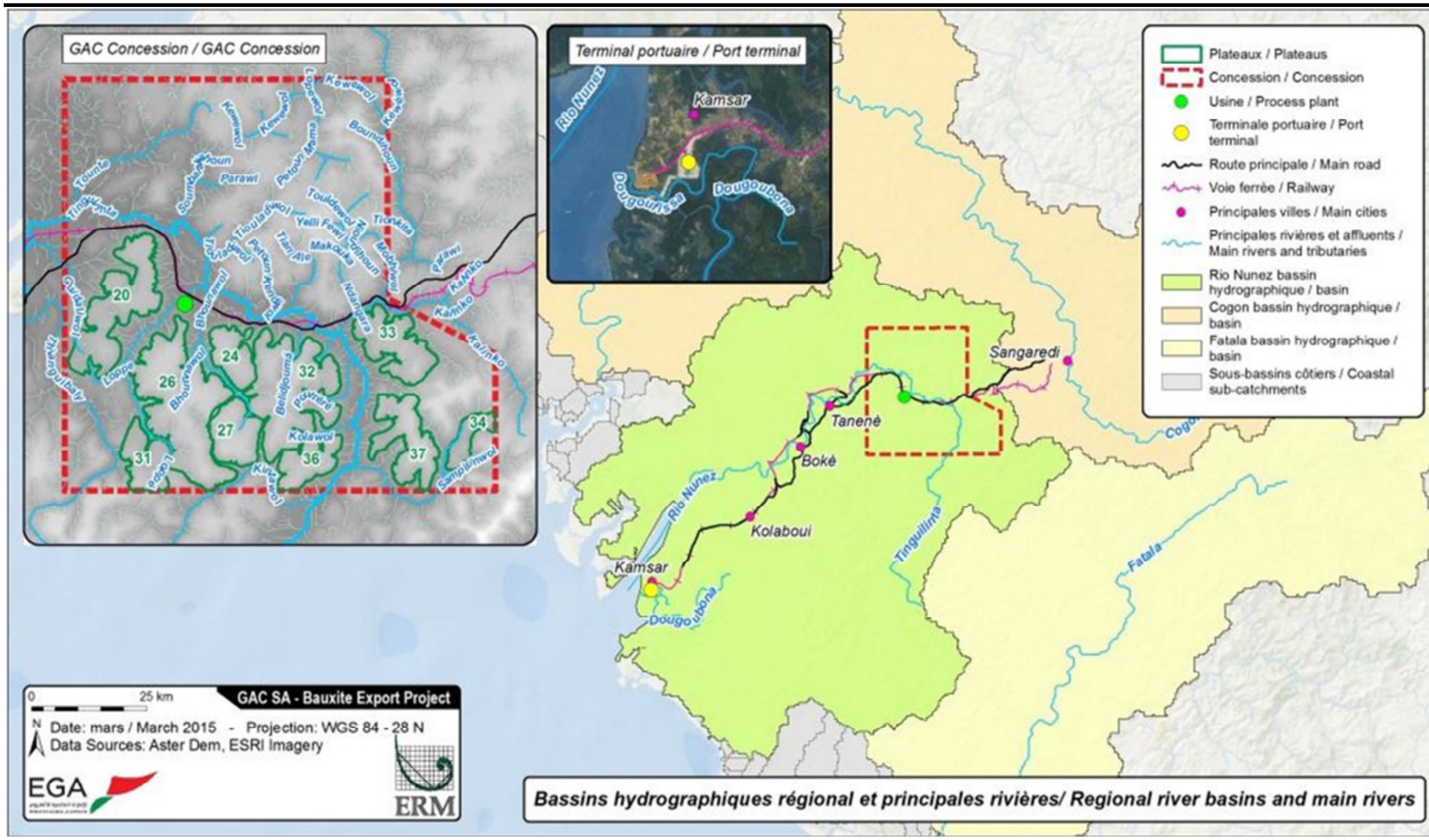
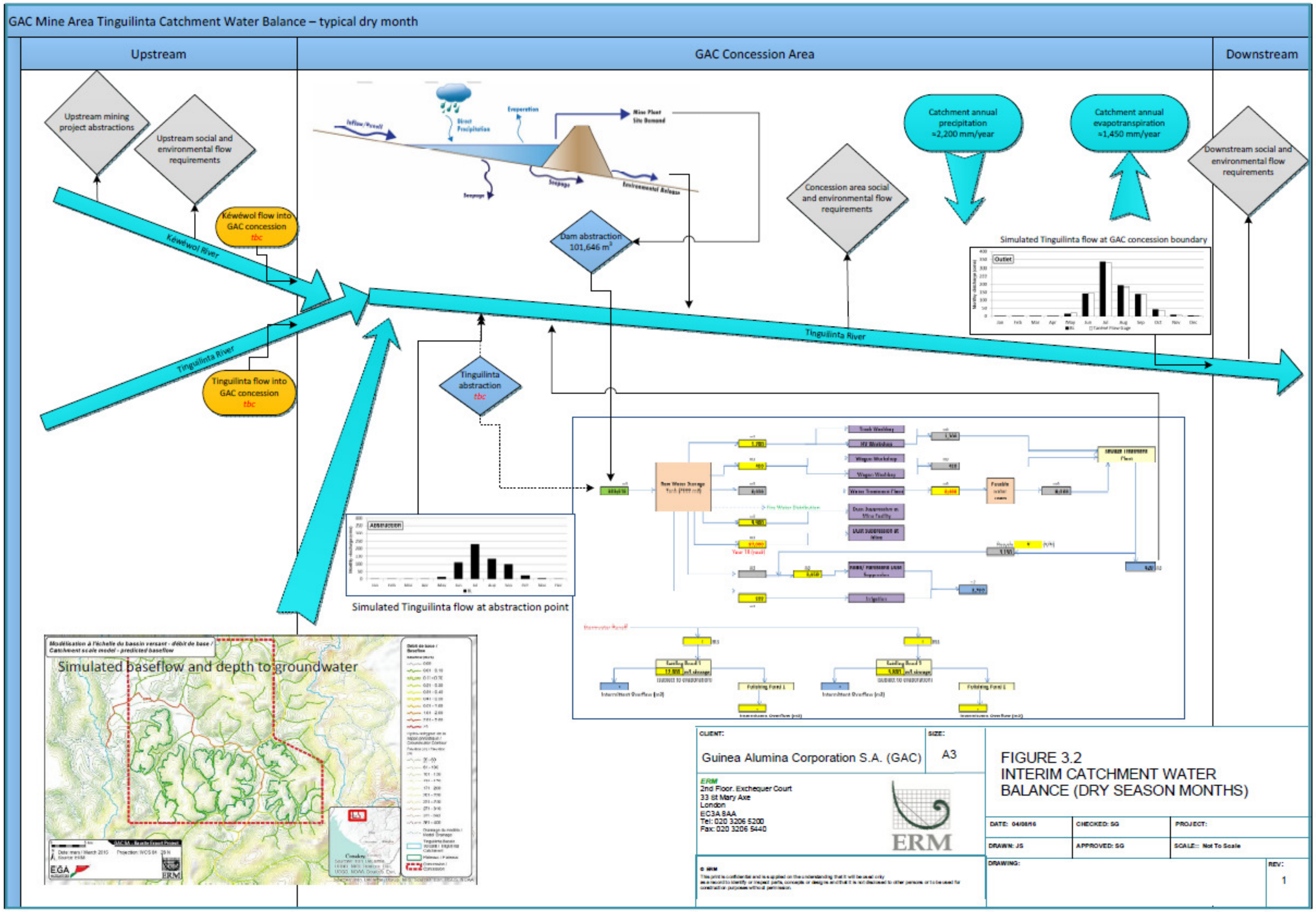
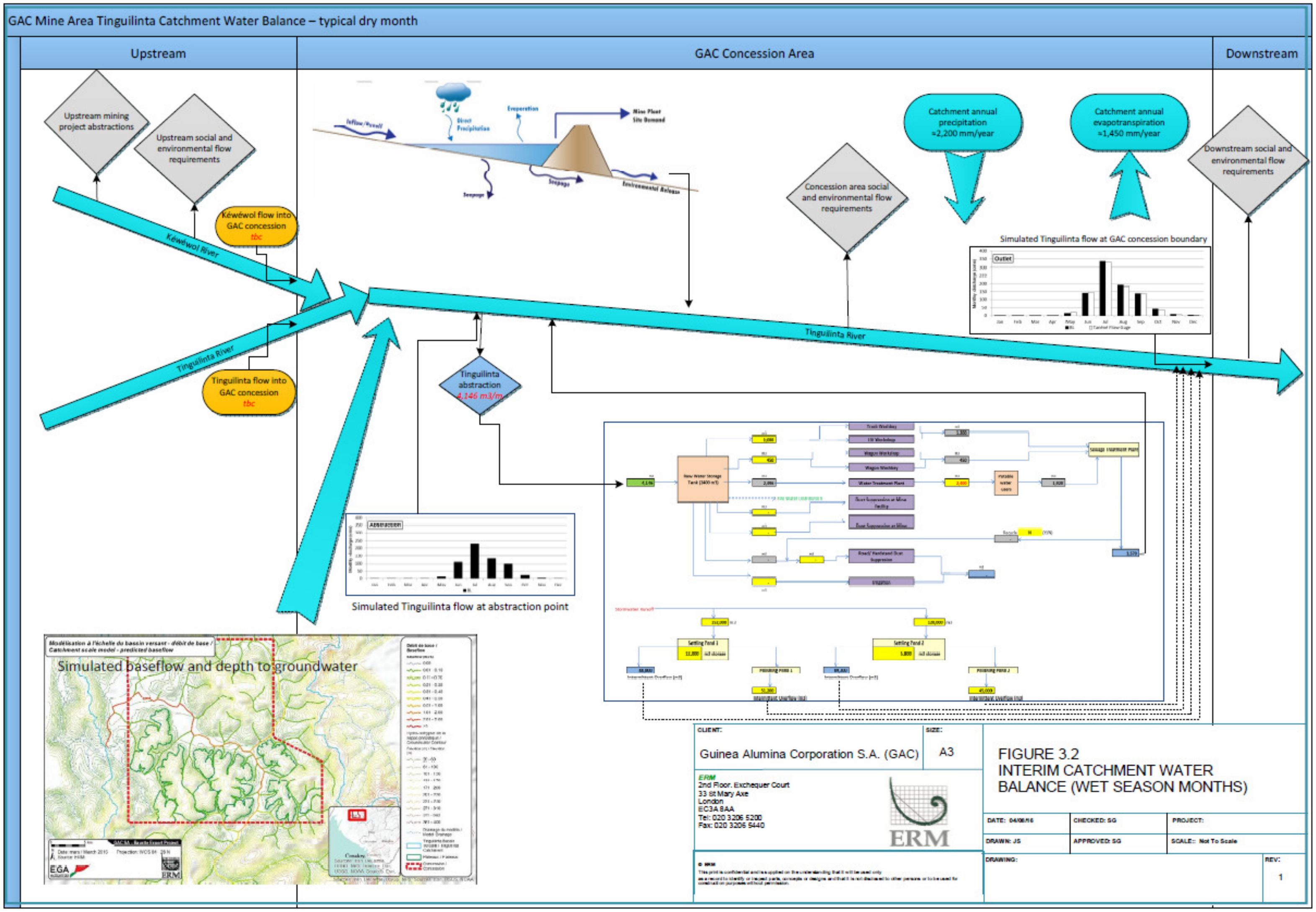


Figure 3.2 Catchment Water Balance (dry and wet season months)




GAC Mine Area Tinguilinta Catchment Water Balance – typical dry month
Upstream
GAC Concession Area
Downstream
Upstream mining project abstractions
Upstream social and environmental flow requirements
Kéwéwol flow into GAC concession tbc
Kéwéwol River
Tinguilinta River
Tinguilinta flow into GAC concession tbc
Tinguilinta abstraction
Concession area social and environmental flow requirements
Catchment annual precipitation ≈2,200 mm/year
Catchment annual evapotranspiration ≈1,450 mm/year
Downstream social and environmental flow requirements
Simulated Tinguilinta flow at GAC concession boundary
Simulated Tinguilinta flow at abstraction point
Simulated baseflow and depth to groundwater
CLIENT:
Guinea Alumina Corporation S.A. (GAC)
SIZE:
A3
ERM
2nd Floor, Exchequer Court
33 St Mary Axe
London
EC3A 8AA
Tel: 020 3206 5200
Fax: 020 3206 5440
FIGURE 3.2
INTERIM CATCHMENT WATER BALANCE (WET SEASON MONTHS)
DATE: 04/08/16
CHECKED: SG
PROJECT:
DRAWN: JS
APPROVED: SG
SCALE: Not To Scale
DRAWING:
REV:
1

The Tinguilinta River headwaters are approximately 30 kilometers to the south of GAC's concession area. Intermittent and permanent streams within small valleys on the edges of the plateaus contribute to flow in the main river, and flows and water levels vary considerably between the wet and dry seasons in all of the rivers and streams. During the wet season the lowlands and valleys can be flooded; by contrast, during the dry season, some streams draining the plateaus run dry and the flows within the main river and its larger tributaries (the Kéwéwol and Kalinko Rivers) are greatly reduced.

This section of the report summarizes the key elements of that catchment including known inflows and outflows.

3.2 *Precipitation*

A particular aspect of the Tinguilinta catchment is that it is subject to a monsoonal regime. The climate is generally hot and humid and the year is divided distinctly between a wet season and a dry season. The wet season runs from June to November and is characterized by heavy precipitation grouped into intense and short storms with south-westerly winds. The dry season runs from December to May and is characterized by very high temperatures and dry air with north-easterly Harmattan winds. The catchment is particularly affected by this climate and its hydrological response follows the wet/dry seasons cycles: high flows and floods during the wet season and very low flows with some watercourses running out of water during the dry season.

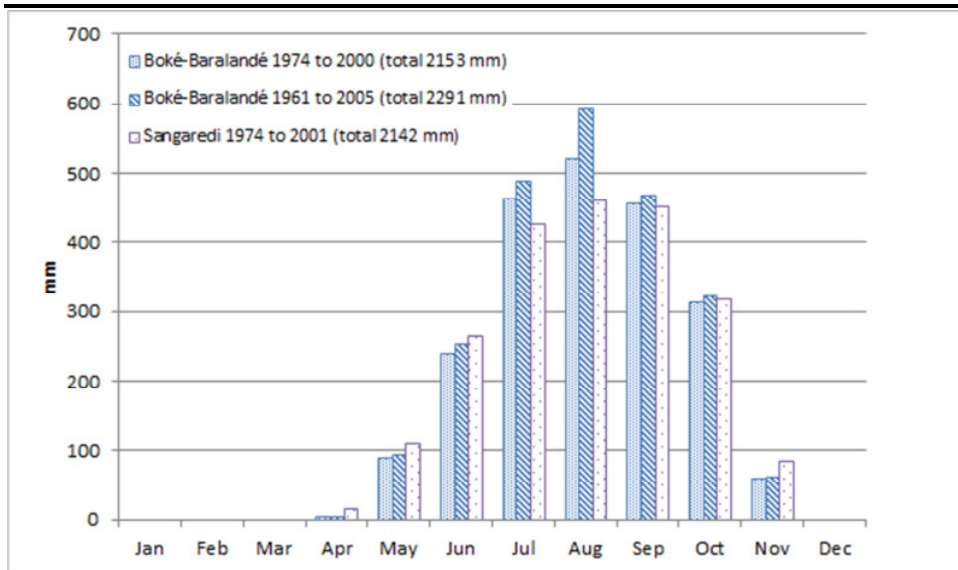
Long time series rainfall data are available for the Tinguilinta catchment from a monitoring location (Boké-Baralandé) approximately 35 km WSW of the GAC concession area. Data from the next catchment to the east (Kogon) are available for the period 1980 to 2000 from a station at Sangaredi, located approximately 30 km ENE of the GAC concession area. *Figure 3.3* plots the monthly averages of these datasets.

Two short-term precipitation datasets are available from the GAC project area:

- Mobiwol 2005 – 2008 (annual average 1,048 mm)
- Pioneer Camp 2011 (annual 1,284 mm)

These datasets are not long enough to make robust long term predictions on precipitation and there are potential data quality concerns about both monitoring stations (Pioneer Camp station was observed during a 2015 baseline programme to be leaning, Mobiwol station was installed amongst trees). Therefore it is not considered appropriate to use these data in the water balance estimate, despite their proximity to the mine site.

Figure 3.3 Monthly precipitation profile for the Boké-Baralandé station



***Note**: Boké- Baralandé station 1974 to 2000 data provided by CBG and Direction Nationale de la Météorologie [1];Boké-Baralandé 1961 to 2005 data provided by GAC [2]; and Sangarédi 1974 to 2001 (1979 missing) data provided by SNC Lavalin [3].*

3.3 *Run-off coefficient*

During a rainfall or storm event a percentage of the precipitation runs off the land to surface water drainage channels. The portions of precipitation that do not reach rivers and streams are called abstractions. They include interception by vegetation, evaporation, infiltration, storage in surface depressions, and long-time surface retention.

The runoff coefficient represents the fraction of the precipitation, in excess of the deep percolation and evapotranspiration, which becomes surface flow and drains to perennial or intermittent surface water bodies.

Based on the greenfield catchment conditions within the project area, the summation of the components of the runoff coefficient have been estimated as 0.45 using the typical rural catchment characteristics given in Chow [4].

The runoff coefficient can also be estimated using the ratio of total stream flow volume to the total precipitation over a certain area and time. Using mean monthly flow at a station approximately 20 km downstream of the concession

(1) CBG and Direction Nationale de la Météorologie, 2001.
(2) GAC FEL 2 Study Report, July 2014. Prepared by HATCH for GAC.
(3) SNC Lavalin, 2004. Bac Alumina Refinery Project. Hydrological Verification and Reservoir Operation Studies. Sangarédi, Guinea. Draft Report – R3-Lower.
(4) Vent a Chow, 1964. Handbook of Applied Hydrology, McGraw-Hill

boundary the calculated runoff coefficient is 0.48 (see the SEIA Addendum, 2016, for full discussion of the calculation).

3.4 *Evapotranspiration*

Evaporation and potential evapotranspiration data are not available for the GAC concession. Annual potential evapotranspiration for Boké is reported as 1,450 mm [(1)]. Table 3.1 shows the monthly data for this location.

Table 3.1 Potential Evapotranspiration for Boké

Potential Evapotranspiration (mm)												
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
139	143	169	158	133	101	93	89	91	100	108	127	1,450

This represents the amount of rainwater which, if available, would be utilised by crops to facilitate their growth. If the amount of potential evapotranspiration is less than the total infiltration then there is an excess of water which will recharge groundwater. If there is a deficit then the vegetation will consume water from the soil in addition to that percolating from rainfall. If there is insufficient moisture in the soil then the wilting point of the vegetation may be exceeded at which point die-back of vegetation will occur.

3.5 *Surface water flow – within and downstream of the GAC concession area*

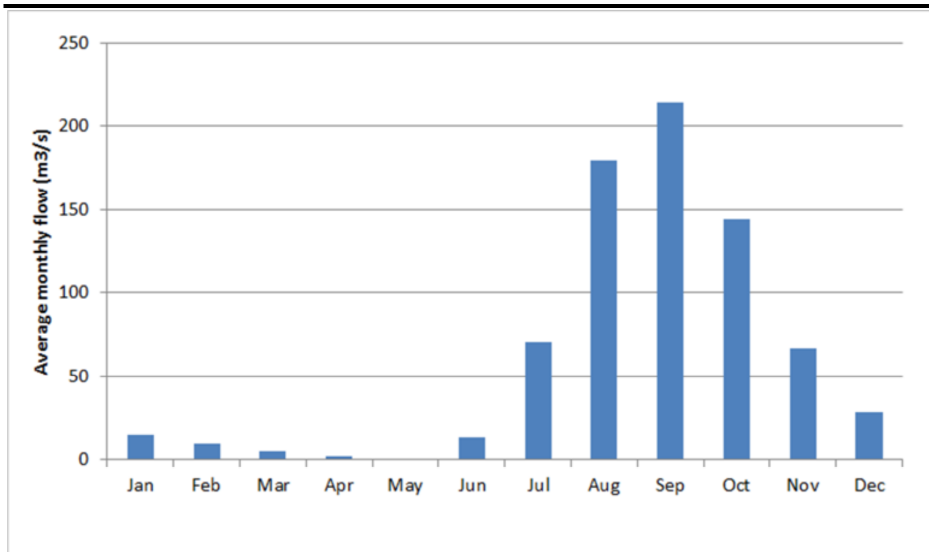
Daily and mean monthly flow data from the Tinguilinta River gauging station at Tanéné (*Figure 3.1*) are available for 1973-1999 [(2)]. The mean monthly flows display strong seasonal variability (*Figure 3.4*). For example the recorded mean monthly flow for September is 214 m^3/s, whilst in May it is close to zero.

The 95th percentile (Q_{95}) represents the flow which is exceeded 95% of the time based on long term flow monitoring. This is typically taken as being representative of low flow conditions. Conversely the 5% flow condition (Q_5) is only exceeded 5% of the time and is more typical of flows following heavy rainfall events. The following statistical information can be extracted from the graph in (*Figure 3.4*):

Q_{50}= 21.1 m^3/s - river flow exceeds 21.1 m^3/s, 50% of the time (Median Flow)
Q_5= 226.0 m^3/s - river flow exceeds 226.0 m^3/s, 5% of the time (High Flow)
Q_{95}= 0.8 m^3/s - river flow exceeds 0.8 m^3/s, 95% of the time (Low Flow)

(1) BAC Alumina Refinery Development. Hydrological Report - Petoun Nyalbi.
(2) Guinean Direction Nationale de la Gestion des ressources en eau (DNGRE).

Figure 3.4 Mean monthly flows of the Tinguilinta River at Tanéné



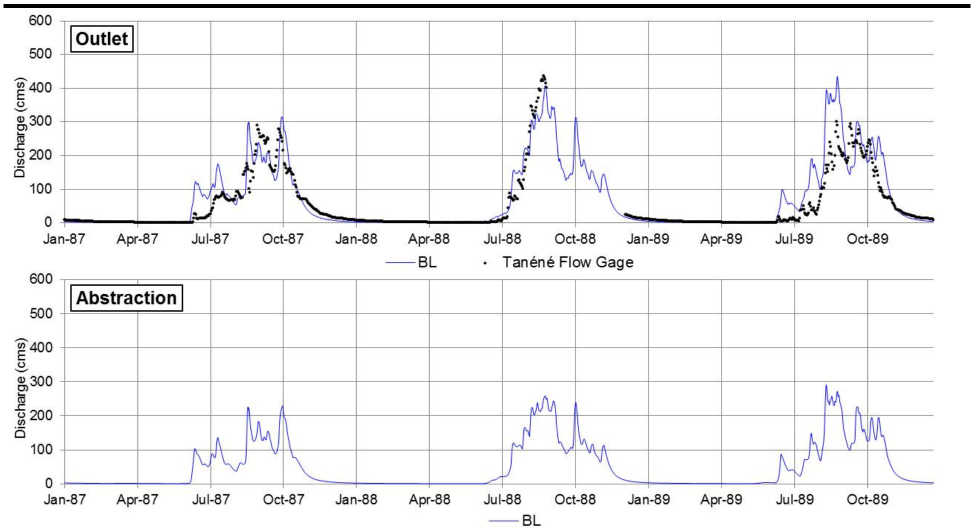
During the 2015 ESIA Addendum [(1)] process a catchment model for the concession area was set up using the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model, developed and maintained by the U.S. Army Engineer Research and Development Center (ERDC) Hydrologic Modeling Branch in the Coastal and Hydraulics Laboratory [(2)]. The GSSHA model was run under the Graphic User Interface (GUI) Watershed Modeling System 9.1 (WMS) developed by Aquaveo [(3)].

The simulated daily hydrograph results allow the estimation of minimum and maximum flow conditions at the watershed outlet of the concession, potential project abstraction point and tributaries. Simulated daily hydrographs of the Tinguilinta River at the downstream GAC concession boundary ('outlet') and the proposed GAC project abstraction point close to the plant area ('abstraction') are shown in *Figure 3.5*, and the minimum and maximum simulated flows are summarized in *Table 3.2*.

It should be noted that there is no historical flow gauging at the proposed abstraction location and therefore only the simulated flow data is presented. At the outlet the data from the Tanéné gauging station are used to illustrate the calibration achieved through the modelling process (*Figure 3.6*).

(1) See Annex 8.1A and B of that document for fuller discussions of the modelling including input data, calibration and results.
(2) USACE, 2015. GSSHA - Gridded Surface Subsurface Hydrologic Analysis. US Army Corps of Engineers. CHL Coastal and Hydraulics Laboratory. http://chl.erdc.usace.army.mil/gssha
(3) Aquaveo, 2015. Watershed Modeling System. The All-in-one Watershed Solution. http://www.aquaveo.com/software/wms-watershed-modeling-system.

Figure 3.5 ***Simulated Hydrographs at the Outlet, Potential Abstraction Point and Tributaries: Baseline Conditions***



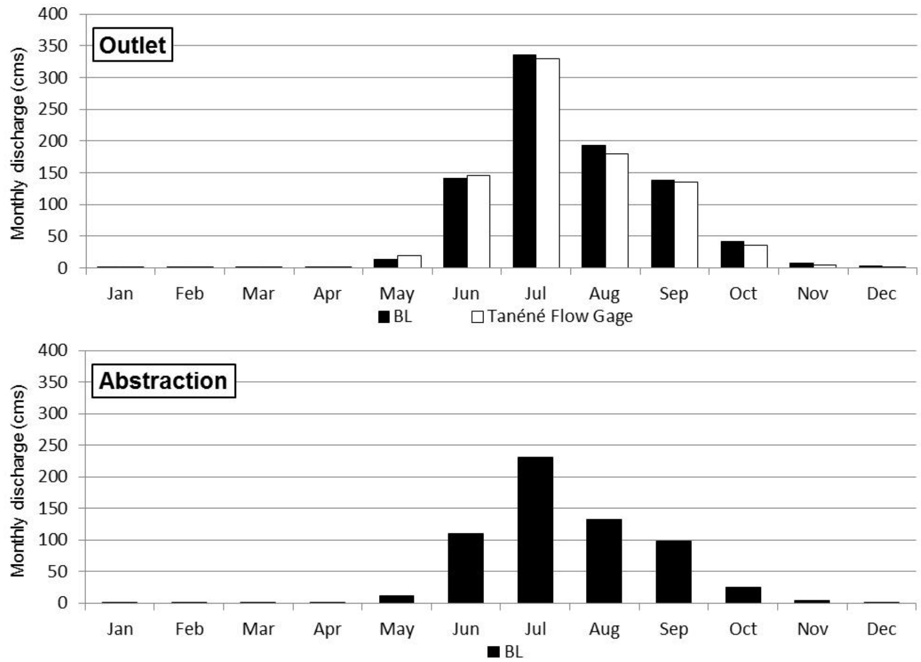
**BL – Baseline condition simulated from the GSSHA modelling exercise.*

The baseline hydrographs for three-year model runs utilizing data from the years on record with wetter than average rainy seasons (1987 to 1989), indicate that during the wet season (June to November) the flow can reach a daily peak of over 580 m^3/s (cms) at the watershed outlet and around 400 cms at the potential abstraction point. For the same years, the maximum flow for the tributaries ranged between 7 cms and 15 cms, that is, between 1% and 3% of the peak flow at the outlet of the Tinguilinta River. During the dry season (December to May/June), the river is characterized by very low flow conditions, and the daily minimum at the watershed outlet is 0.9 cms and 0.4 cms at the potential abstraction point. The tributaries tend to run dry during the dry season because of the extreme heat and nearly zero precipitation.

Table 3.2 ***Minimum and Maximum Flows for Outlet, Potential Abstraction Point and Tributaries. Baseline Conditions***

Location		**Minimum daily flow (dry season)**	**Maximum daily flow (wet season)**
Outlet	(cms)	0.9	580
Abstraction	(cms)	0.4	398

Figure 3.6 *Simulated Monthly Flows at the Watershed Outlet and Abstraction Point: Baseline Conditions*



3.6 *Surface water flow – upstream of the GAC concession area*

There is a potential for cumulative impacts to occur on surface water quality and flow associated with the development of concession areas to the north and east of the GAC Project concession and as a result of impacts from the Project. The impacts of potential significance relate to water use (abstraction), management, and erosion control associated with mining developments in the headwaters of the Tinguilinta and Kéwéwol rivers. Water requirements, management (including treatment) and other additional mitigation for these projects have not been confirmed and therefore the magnitude of potential cumulative impacts is not possible to predict at this stage although it is likely to exacerbate the scarcity of water during the dry season.

The Tinguilinta flows into the GAC concession area from the south and a significant tributary of the Tinguilinta, the Kéwéwol, flows into the concession area in the north-east (*Figure 3.7*). Data from these locations are currently limited to spot quality sampling conducted during the ESIA baseline programme (*Figure 3.8*).

A surface water monitoring plan has been designed based on findings from the ESIA Addendum incorporates continuous stream flow and regular quality monitoring at these two points (*Figure 3.9*). The monitoring equipment has been set up and monitoring commenced in May 2016.

Figure 3.7 SEIA Addendum baseline surface water monitoring locations

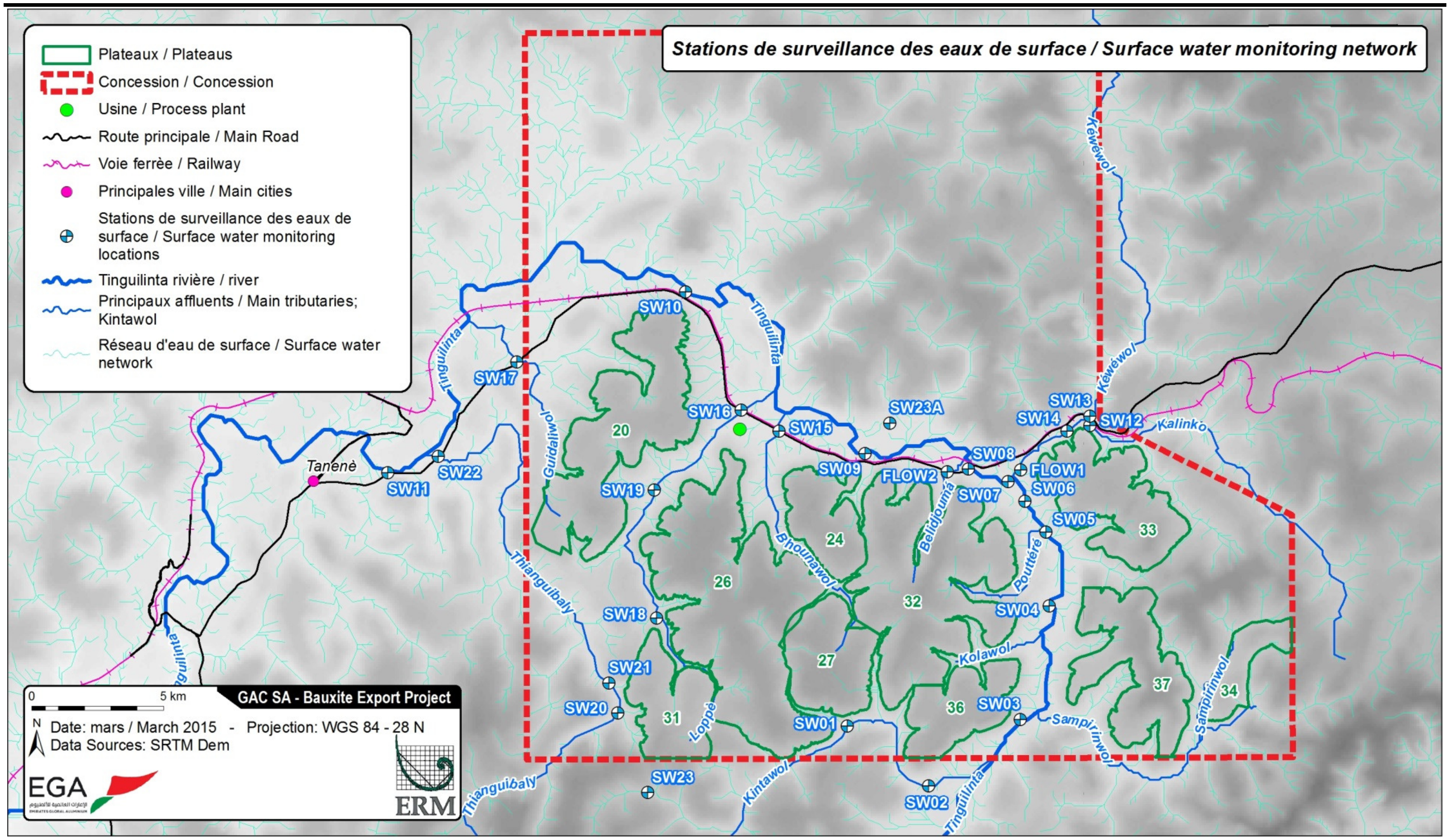
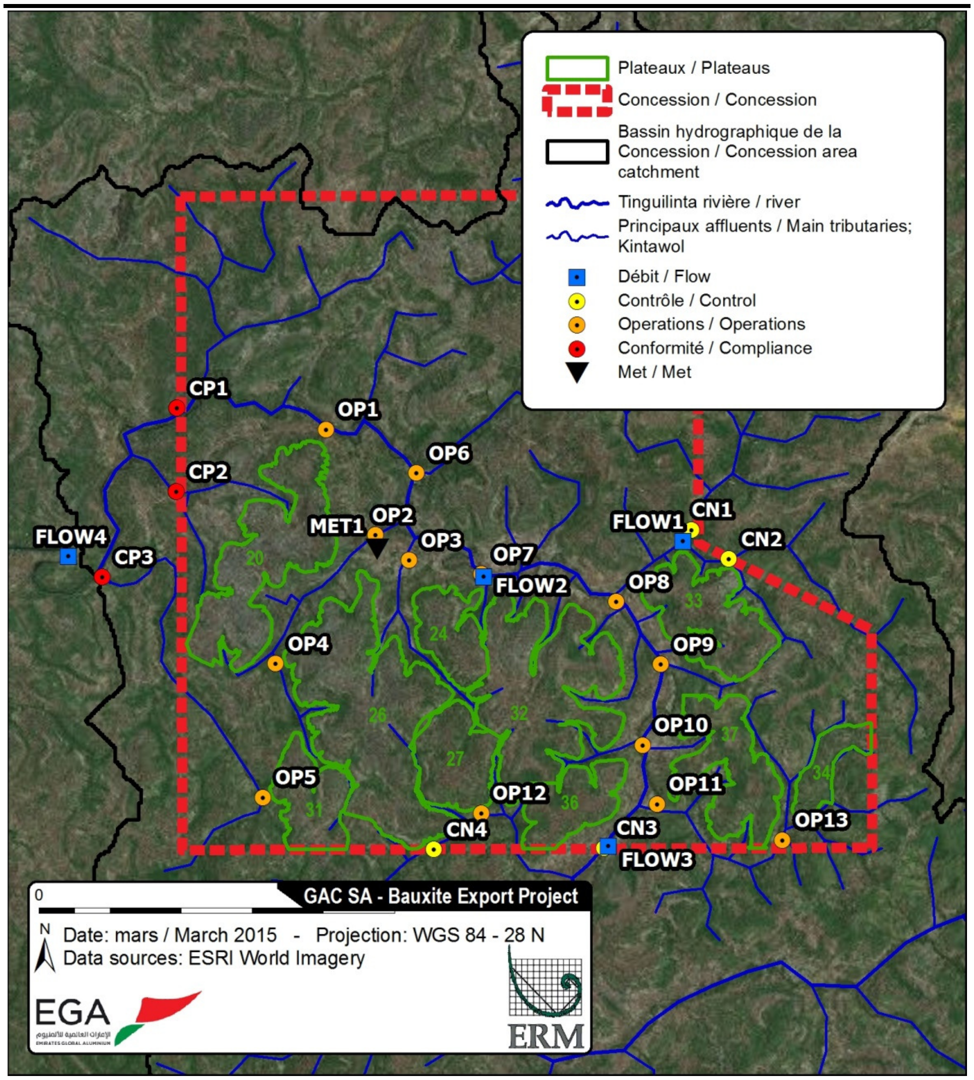


Figure 3.8 Tinguilinta water quality results, dry season 2015, Tinguilinta inflow (SW03) and Kéwéwol inflow (SW13) to GAC concession area

Parameter	units	SW03	SW13
Physico-chemical:			
Electrical Conductivity @25C	uS/cm	31	53
Total Suspended Solids	mg/l	<10000	<10000
Total Dissolved Solids	mg/l	<10	<10
pH	pH units	6.82	7.09
Dissolved metals:			
Aluminium (Al)	µg/l	22	5.8
Antimony (Sb)	µg/l	<2	<2
Arsenic (As)	µg/l	<0.9	<0.9
Barium (Ba)	µg/l	<3	<3
Beryllium(Be)	µg/l	<0.5	<0.5
Boron(B)	µg/l	<2	<2
Cadmium (Cd)	µg/l	<0.03	<0.03
Calcium (Ca)	µg/l	500	500
Cobalt (Co)	µg/l	<0.1	<0.1
Copper (Cu)	µg/l	<3	<3
Lead (Pb)	µg/l	0.5	<0.4
Magnesium (Mg)	µg/l	300	300
Manganese (Mn)	µg/l	<1.5	<1.5
Mercury (Hg)	µg/l	<0.5	<0.5
Molybdenu(Mo)m	µg/l	<0.2	<0.2
Nickel (Ni)	µg/l	<0.2	<0.2
Phosphorus (P)	µg/l	<0.7	<0.7
Potassium (K)	µg/l	<100	<100
Selenium (Se)	µg/l	<1.2	<1.2
Sodium (Na)	µg/l	500	400
Thallium (Tl)	µg/l	<0.9	<0.9
Vanadium (V)	µg/l	<0.6	<0.6
Zinc (Zn)	µg/l	<1.5	<1.5
Total Chromium (Cr)	µg/l	<0.2	<0.2
Total Iron (Fe)	µg/l	203.1	99.7
Anions and non-metallic cations:			
Free Cyanide	µg/l	<5	<5
Total Cyanide	µg/l	<10	<10
Chloride	µg/l	<300	<300
Nitrate as NO3	µg/l	600	600
Fluoride	µg/l	<300	<300
Ammoniacal Nitrogen as NH4	µg/l	30	50
Sulphate	µg/l	280	280
Ortho Phosphate as PO4	µg/l	<60	<60
Total Alkalinity as CaCO3	g/l	54	56
Organics:			
Fats Oils and Grease	µg/l	<10	<10

Figure 3.9 Surface water monitoring plan sampling locations



***Source**: GAC SA Bauxite Export Project SEIA: Surface Water Monitoring Plan Draft 1.0 July 2015*

Mitigation measures described within the surface water and groundwater impact assessment sections of the ESIA Addendum rely on an understanding of incoming water flows and quality to will help to ensure that the potential for increasing cumulative effects due to Project activities is avoided, minimized or compensated for. Thus the data from these two monitoring points will be used to update the Catchment Water Balance as it becomes available.

An important aspect of any water balance is to understand the influence of water quality and its potential to change over time as a result of abstractions or changes in recharge regimes. Whilst not considered in detail at this stage the analytical data obtained from the inflows to the GAC concession area will also be used to help assess the suitability of water for the mine's use and the impact that this use may have on the resultant quality downstream.

3.7 *Groundwater*

Three types of regional aquifer system have been described [1]:

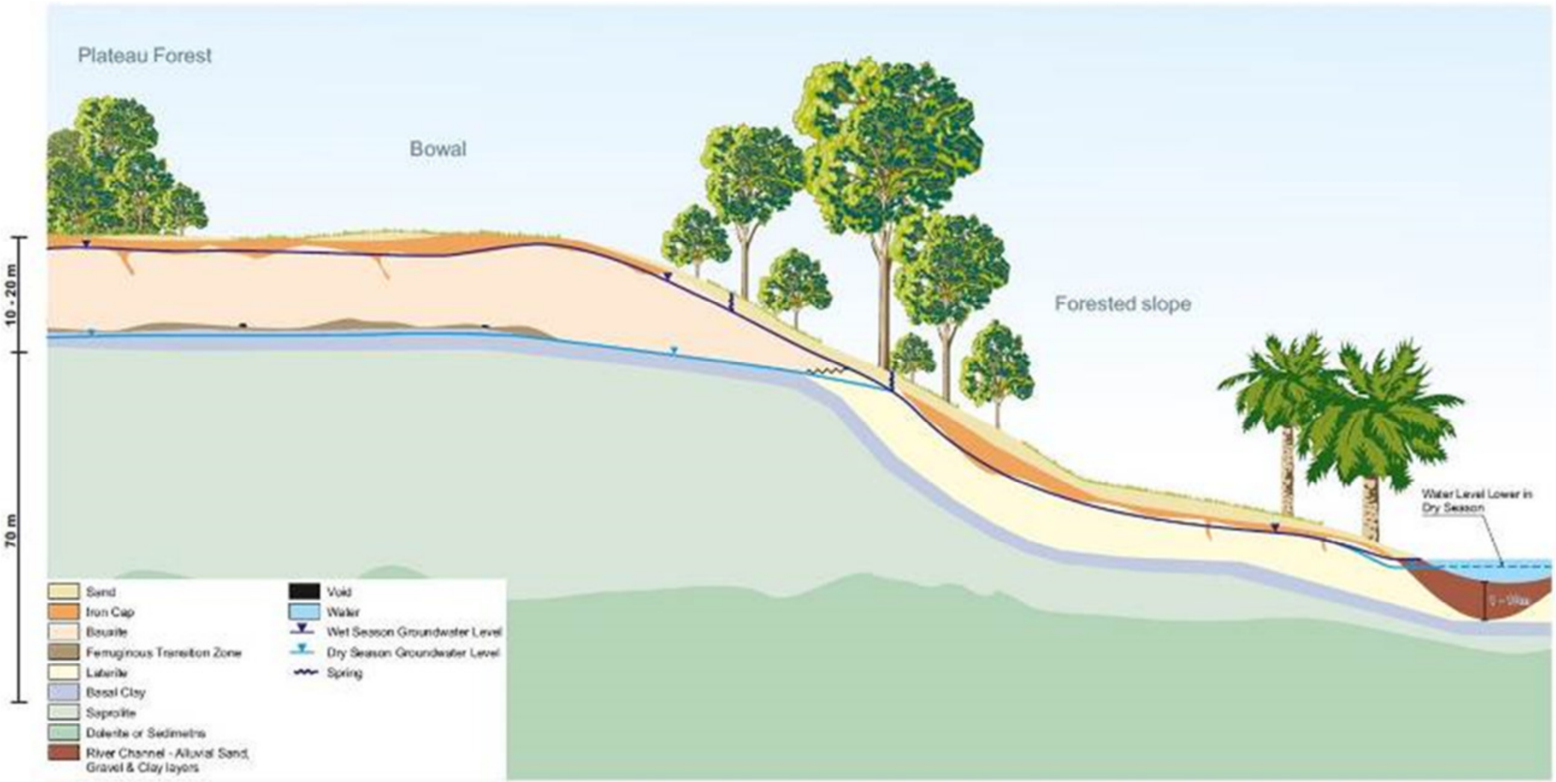
- **Discontinuous aquifers in fractured bedrock**. These are associated with increases in permeability due to the presence of fracture networks or weathered contact zones between intrusive rocks and the sediments they have intruded. Yields are potentially highest within vertical to sub-vertical fracture zones coincident with the major river valleys and may reach 15-25 m^3/h in the Tinguilinta River valley within the GAC concession area. The groundwater in these aquifers is assumed to be hydraulically connected with the superficial deposits.

- **Continuous aquifers in the weathered crust on the plateaus** (*Figure 3.10*). Granular aquifers in the range of 3 to 30 m thick occur with the weathered crust on the plateaus where granular material remains after the leaching of soluble minerals. A low permeability clay layer associated with the lateritic crust is usually found beneath them. The water table fluctuates seasonally in these aquifers, from near surface during the wet season to more than 5 to 13 m below ground level during the dry season. These aquifers become saturated to surface over large areas during periods of heavy rains of long duration. The basal clays are mostly saturated year-round and allow gradual recharge into underlying Devonian metasediments where their porosity is increased by fracturing. However, the permeability contrasts at the upper and lower contacts of the clay are high and most groundwater flow is lateral along the upper contact of the clay with the bauxites. Groundwater flows towards local discharge areas: the tops of deep gullies on the plateau flanks, at breaks in slope on the plateaus sides, and on valley flanks. This tends to result in springs forming which tend to be highlighted by changes in the density of vegetation. The springs at higher elevations tend to dry out as the groundwater levels recede in the dry season whilst those lower down on the slopes can continue to discharge well into the dry season.

- **Continuous aquifers in granular deposits** within Quaternary alluvial deposits (*Figure 3.10*) along the valleys of large rivers (e.g. Kogon and Tinguilinta) **(***Figure 3.1***)**. The deposits consist of gravel and sand with some clay layers of thicknesses between 1 and 10 m. The depth of the water table in these deposits is usually between 0.5 and 3 m.

(1) SNC-Lavalin International, 2008. Groundwater Supply Evaluation for the Sangaredi Refinery. 2005-2006 activities. Final Report.

Figure 3.10 Conceptual model of the shallow groundwater system in the GAC mine area



***Source**: SEIA Addendum, 2016.*

Groundwater modeling[1] of the catchment area has been used to simulate overall regional groundwater elevations and provide estimates of baseflow to the Tinguilinta River and major tributaries. Potential discharge to surface water courses as baseflow simulated by the model indicate that under mean conditions most tributaries receive at least some baseflow. The model suggests that some of the smaller tributaries draining the plateaus and some sections of larger tributaries are losing streams, that is, the groundwater table is below the level of the stream bed and water flowing in the stream will likely to partially infiltrate into the ground beneath the stream bed. These results are supported by observations in the field that certain tributaries, particularly the smaller ones on the sides of the plateaus, dry up in the dry season. The degree of water loss from these streams will be governed by the flow and the hydraulic conductivity of the materials forming the stream bed.

3.8 Water users

Baseline studies for the ESIA Addendum [2] indicate that 63% of people living along the main Boké – Sangarédi road and 73% of those living in the interior access surface water for all of their water needs (such as drinking, washing, watering crops, etc.).

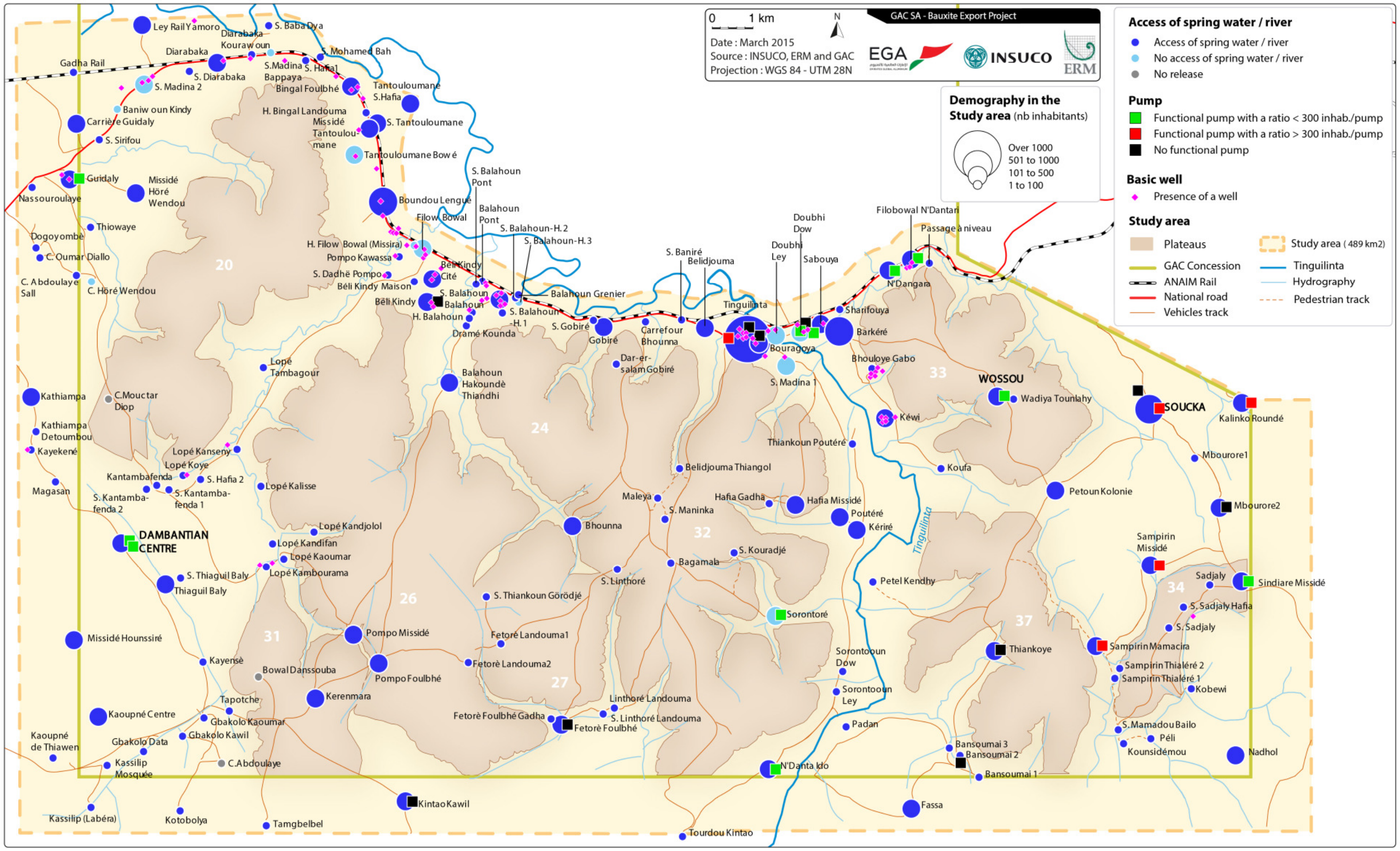
The surface water resource also supports diverse and potentially sensitive populations of flora and fauna.

Groundwater provides an important water resource to several villages throughout the year, but particularly during the dry season when surface water courses dry up. Groundwater is sourced from springs, shallow depressions dug into dry river beds to create soaks, traditional hand dug wells and formal boreholes installed by donors or mining companies. Traditional wells are hand dug into the water-bearing formations in the upper, surface aquifer located in the overburden (at the base of the bauxite deposits) on the plateaus and in alluvial deposits in the river valleys. Along the main road just under 40% of households use water from traditional wells, and just under 30% use professional-installed foot pump wells (PMH). This contrasts with communities living away from the main road where only 4% of households have access to traditional wells (*Figure 3.11*).

As groundwater baseflow provides effectively all of the surface water towards the latter part of the dry season, it is an essential resource in maintaining ecological flow to support a wide diversity of flora and fauna as well as the economically and socially important species found within the project area of influence.

(1) See Annex 8.1A and B of that document for fuller discussions of the modelling including input data, calibration and results.
(2) Note that the Addendum studies focussed on the southern part of the concession area, south of the main Boké - Sangarédi road.

Figure 3.11 Access to drinking water in the southern part of the GAC concession area



4 MINE WATER DEMAND

4.1 Introduction

The GAC mining process is a relatively simple one which does not require large quantities of water for the process. The mine water management system is essentially one of managing run-off in the wet season and minimising dust generation in the dry season. Since the volumes of water required are fairly minimal GAC originally planned to abstract it when needed from the Tinguilinta River, however integrated groundwater and surface water catchment modelling for the SEIA Addendum suggested that this option may not be sustainable under all probable conditions. As a result the mine water management plan under development is a balanced approach around surface water abstraction, groundwater management and water storage. The least impactful approach currently appears to be to balance abstraction from the Tinguilinta in periods of high to moderate flow with water harnessed in the wet season through construction of a dam and storage of run-off water from the mining areas where practical.

This section summarises the mine water management elements from the SEIA Addendum document (2016) and will be updated as required during the design, construction and operation phases.

4.2 Mine water management

GAC does not expect mining activities to generate significant quantity of minewater, since most of the bauxite reserves are located above the saturated zone.

Consistent with other mining operations in tropical environments, the mine schedule has been designed to allow for uphill mining in the wet season to allow for adequate draining of operating areas. Lower areas will be mined in the dry season when the water table is at a minimum and the lower levels of the bauxite have drained.

Storm water run-off from mine surfaces and haul roads will be collected in ditches and sumps, to allow for the settlement of suspended solids (TSS), prior to controlled release of clarified overflow into the natural drainage network. Ditches will be equipped with sediments traps.

During the wet season, excavations will accumulate water. Any pit dewatering water will be collected and controlled for TSS before releasing to the environment.

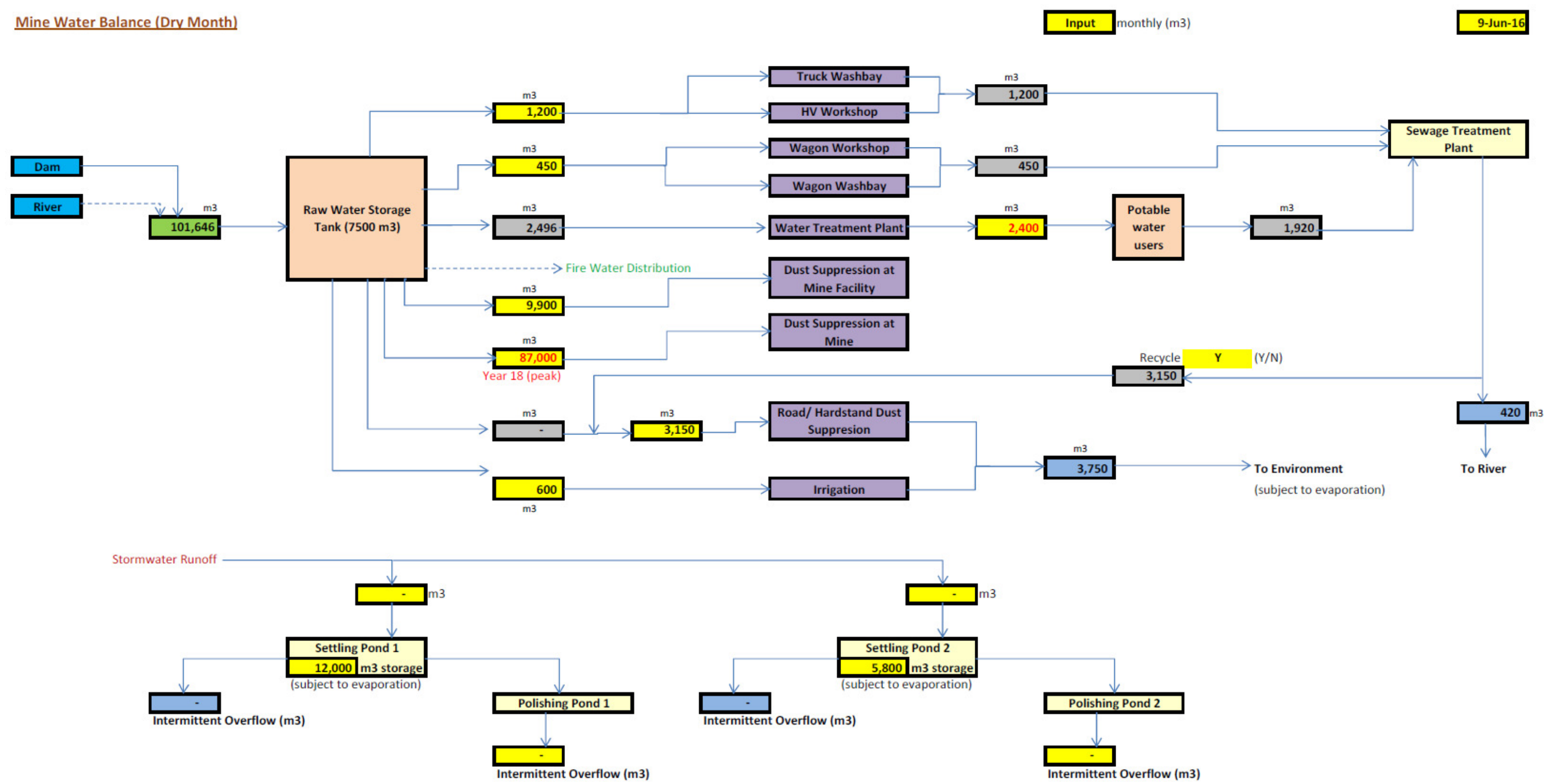
Water sprayed on working mine surfaces and haul roads for dust control are unlikely to generate any significant runoff into the natural environment; it will be adsorbed onto mineral particles, and partly evaporate.

The proposed process at GAC does not require large quantities of water and as such the large majority of water required is for dust suppression on the haul roads.

Draft Mine Project Water Balances have been derived for a typical wet season and dry season month. The anticipated dry season in terms of mine water demand is November to April [1]. These are displayed in *Figure 4.1* (dry season) and *Figure 4.2* (wet season). The water demand and mine water management aspects are summarised in the sections below.

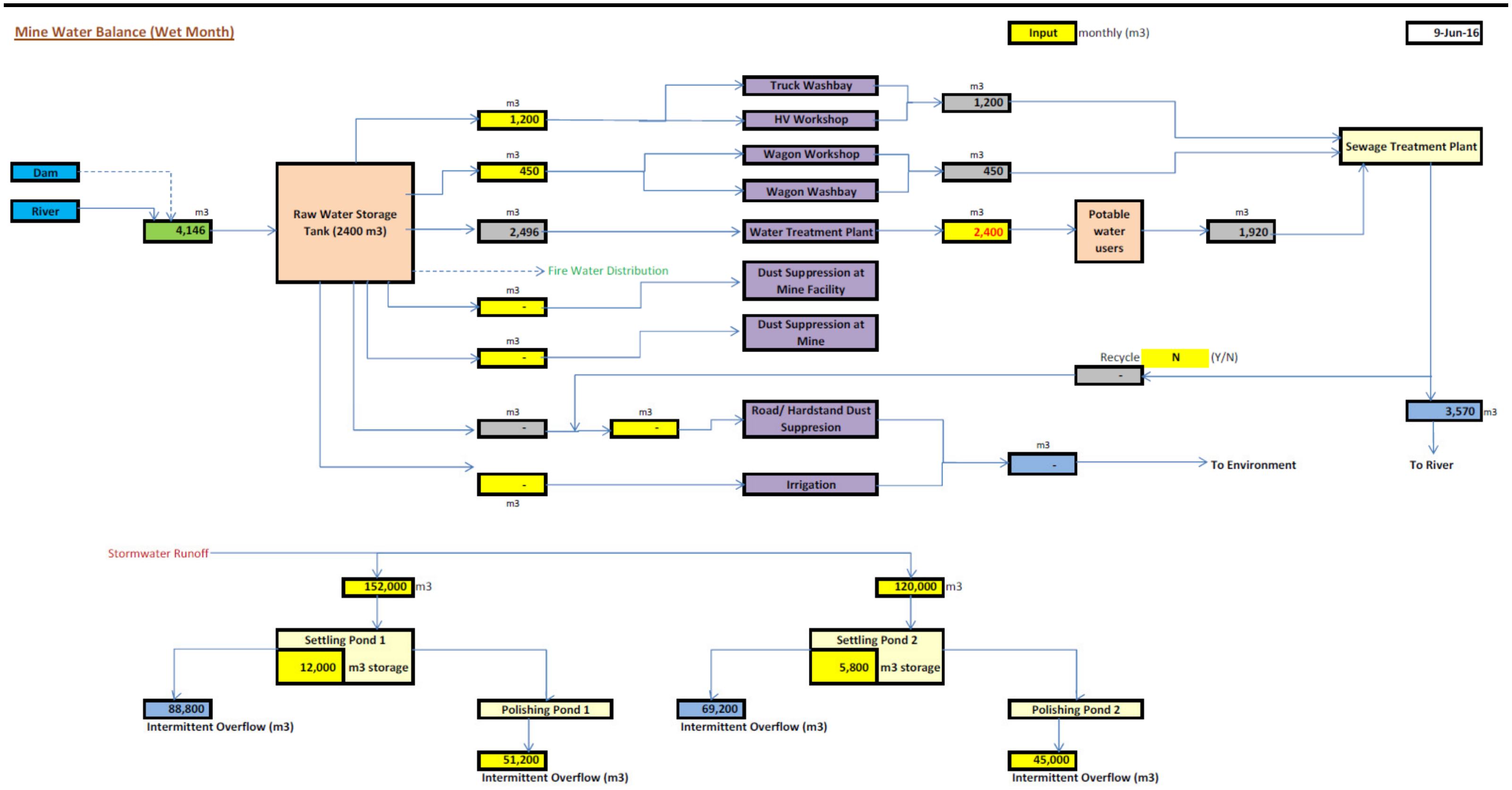
(1) For design of the proposed Tiouladiwol dam. NewFields, April 2016. Feasibility-level design for the water supply reservoir. Client draft.

Figure 4.1 *Draft Mine Site dry season monthly water balance*



Source*: GAC, email, June 2016.*

Figure 4.2 *Draft Mine Site wet season monthly water balance*



Source: *GAC, email, June 2016.*

4.3 *Water supply*

The mine site will make use of various water supplies of different quality to support the operations and staff onsite. Water requirements include:

- dust suppression;
- process water;
- fire water; and
- potable demand.

The total abstraction (1) needs for the Export Bauxite Project at the mine site is estimated at 3,400 m^3/d during the dry season months and 140 m^3/d during the dry season months.

The mine water management system will consist of an integrated distribution network and water treatment facility, sourcing from water multiple sources, and discharging through dedicated discharge points.

The Mine Water Operating Methodology will consist of a wet season and dry season operation methodology. In the wet season, water will be retained and stored through multiple water retention structures throughout the mining area. During the dry season the retained water will be drawn from and distributed through a network system to support the operations.

The sources of primary mine water supply considered for the Project are:

- raw water abstraction from a dedicated weir in the Tinguilinta River (predominates in the wet season);

- raw water storage (predominates in the dry season) using a dam associated to a dedicated fresh water reservoir, constructed in the middle Tiouladiwol valley in the northern part of the concession (around 6 km to the north of the national road from Sangarédi to Boké);

- collection of water run-off from disturbed areas and mine water from the pit, to be stored and used for dust suppression on haul road; and

- collection of water run-off from undisturbed areas partially captured to support the mine clean water requirements.

Water supply studies are still ongoing, and the distribution of anticipated supply rates from the different potential sources is not yet finalized. These sources options are considered as possible complementary solutions to provide operational flexibility to the Project, and assist in minimising the potential impact of the Project on water availability and quality during wet and dry seasons.

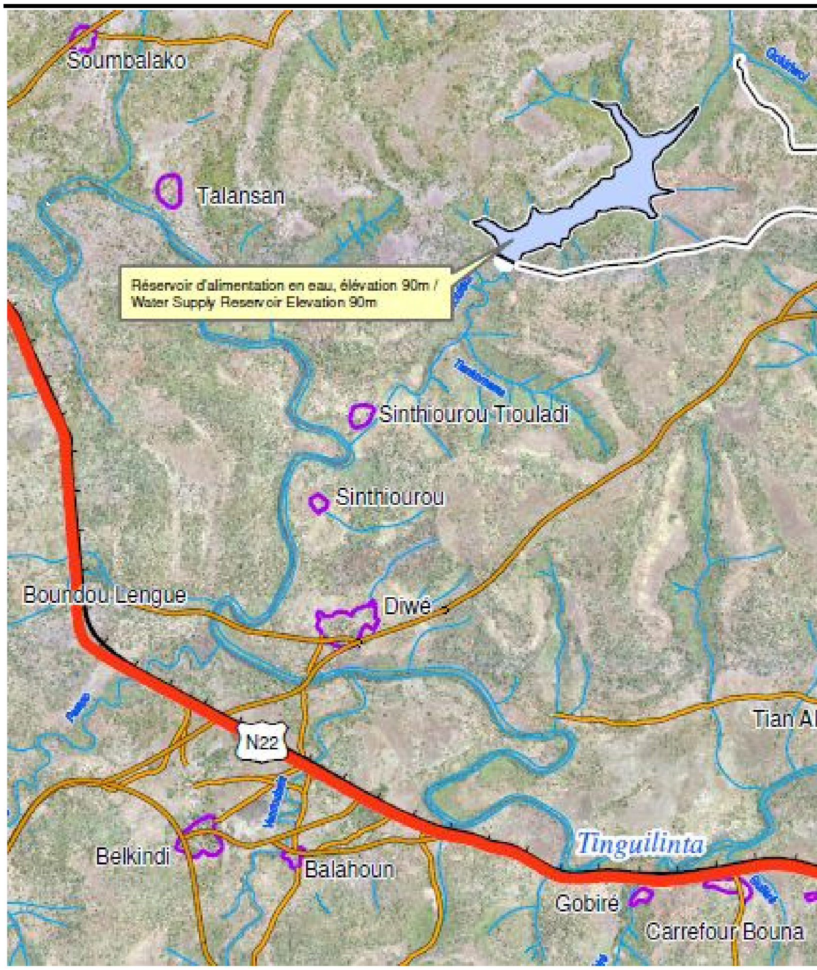
(1) Note that certain proportions of this will be returned to the environment after use (see the Mine Water Balance figures).

In particular, water abstraction from the Tinguilinta River would be subject to restrictions with regards to necessary minimal flow to be maintained during dry season, so as to ensure communities needs and ongoing environmental downstream demands. The cut-off flow level at which supply from the Tinguilinta will be stopped has not been defined yet. To define this minimum level requires a better understanding of the flow regime within the Tinguilinta as well as the sensitivities of the ecology and other users of the water resource to the background flows. A conservative approach until these data are available is to avoid abstraction during the dry season (at a minimum December through April, inclusive) through the use of alternative sources, eg stored water in from the mining areas or the Tiouladiwol Dam.

The dam that is envisaged to be constructed for the Project was initially studied by GAC and authorized by the Guinean Ministries in 2006.

The approximate dam location is shown on following *Figure 4.3*.

Figure 4.3 ***Water dam location on the northern part of the GAC's concession***



Source: Impact Assessment, Knight Piésold, 2008

The preliminary design is for a reservoir with a live storage capacity of approximately 750,000 m³, which includes approximately 120,000 m³ of dead storage for future sedimentation over the life of the facility. The resulting impoundment surface is approximately 21 ha. The maximum design crest elevation for the embankment is 75.5 m, including 0.5 m camber [(1)].

It can be envisaged to build this dam in several steps to fulfil first the Export Bauxite Project needs and then to be expanded to fulfil the eventual further need of the GAC's projects.

ERM prepared an Environmental Flow Assessment (EFA) to evaluate the potential impacts on ecological conditions in the Tiouladiwol due to the construction of the proposed dam [(2)]. The results indicate that a release of 10 l/s from the reservoir during the dry season would mitigate potential impacts to ecological habitats and fisheries downstream of the reservoir. Therefore, an environmental release of 10 l/s was included in the feasibility design of the dam for the months of November through April (the typical dry season) [(3)].

Forward simulations of the dam indicate that in very dry years it may not be sufficient to provide the Project's water needs. For this reason a groundwater supply option is currently being investigated, however, results to date are not promising. Consequently it is proposed that during very dry years if the dam cannot supply enough water GAC will use a dust suppressing binder on the roads to lower the water requirement [(4)] .

4.4 *Drinking water treatment unit*

The site will be equipped with a drinking water treatment unit, to produce a reliable supply of water fit for human consumption from raw water.

Based on current projected workforce requirements, the unit will need to treat up to approximately 300 m^3 of water per day.

4.5 *Fire water system*

Fire water will be stored in a 3,000 m^3 fire water tank, from where it will be distributed across the site's fire water network.

4.6 *Storm water management*

Storm water management at the mine can be divided in two categories:

(1) NewFields, April 2016. Feasibility-level design for the water supply reservoir. Client draft.
(2) ERM, 2016. Dam SEIA update.
(3) NewFields, April 2016. Feasibility-level design for the water supply reservoir. Client draft.
(4) N.Adendorff email 12 July 2016

- rain water that falls on potentially contaminated areas, including bauxite concentration areas (crushing area, stockpiles etc.), fuel loading / unloading areas, maintenance yard, vehicle parking areas, temporary waste storage yard; and

- rain water that falls on non-contaminated areas (such as roofs and undeveloped surfaces within the mine infrastructure area).

Storm water treatment and ultimate disposal will be as summarized in *Table* 4.1.

Table 4.1 Storm water treatment & ultimate disposal

Origin of Storm Water	Type of flow and quantity	Treatment	End discharge
Contaminated storm water running off from mine terraces.	Intermittent.	First flush 17,800 m^3 settling pond for abatement of suspended solids. Finer sediments settled out in subsequent polishing ponds.	Treated water used for dust suppression Overflow discharged to stream.
Contaminated water runoff from fuel loading / unloading areas. Contaminated storm water from mine infrastructure area surfaces including maintenance yard, washbay, parking areas.	Intermittent.	1. 240 m^3 contaminated water settling tank for abatement of suspended solids 2. Oil/ water separator for abatement of hydrocarbons. 3. Mine sewage treatment system rated for approx. 40 m^3/d for abatement of COD and BOD. 4. First flush 17,800 m^3 settling pond for abatement of suspended solids.	Overflow from settling pond into piped discharge to stream.

4.7 *Sewerage system*

The sewerage system will collect grey & black water from buildings as well as water that has been processed in the oil/water separator. This will consist of a packaged sewerage biological plant. Sewerage treatment sludge will be recovered periodically. Given the absence of a municipal sludge treatment plant, project-specific sludge treatment options will be investigated (e.g.

drying beds, compost production for agricultural or mine rehabilitation use, natural biodegradation by spreading on a dedicated managed surface).

The effluent quality will be managed in order to comply with the treated wastewater guidelines specified in the International Finance Corporation Environmental, Health and Safety Guideline (2007).

4.8 Dust suppression

Dust suppression at the mine site, haul roads and mine infrastructure areas will be by means of raw water spraying. This will be needed mostly during the dry season, whilst dust suppression needs will be minimal during the wet season. Studies of alternative techniques for dust abatement are currently ongoing and dust treatment options may be implemented to enable minimization of water needs and consumption in an efficient and cost effective manner.

There will be no dust suppression required for the bauxite crusher and stockpile, as the relative moisture of bauxite mined is expected to limit dust arising from run-of-mine material.

5 CONCLUSIONS AND RECOMMENDATIONS

The GAC mine project is located near the top of the Tinguilinta catchment, but with inflows from the north and south which may be affected by other water users upstream of the Project area. Within the concession area, surface water and groundwater provide essential resources for communities and ecosystems.

The mitigation measures described within the surface water and groundwater impact assessment sections of the ESIA Addendum will help to ensure that the potential for increasing cumulative effects due to Project activities is avoided, minimized or compensated for. In particular, GAC are in the process of defining a water management plan and water abstraction from the Tinguilinta River would be subject to restrictions with regards to necessary minimal flow to be maintained during dry season, so as to ensure communities needs and ongoing environmental downstream demands. In addition, monitoring at specific inflow and outflow points of GAC's concession will be conducted and subsequent mitigation requirements will be identified and implemented over the lifetime of the Project.

Further work required to complete and update this document include:

- Implementation of the water monitoring plan to inform project water inflows and quality.

- Finalisation of the groundwater study including assessments of potential impacts to the environment or communities through the abstraction of groundwater if that is a viable solution or the use of dust supressing additives if not.

- Preparation of a control decision tree to define when abstracting from the Tinguilinta for project requirements is allowed.

- Establishment of contingency plans using a risk-based approach.

- Identify accountabilities and responsibilities.

- Description of reporting procedures, including the schedule of updates to the catchment water balance