REV.	DESCRIPTION	DATE	PROJ.	EXEC.	CHECK.	APPR.
2	ISSUED	4/4/18	SAG	SAG	KJS	MES
1	FOR REVIEW	7/30/16	SAG	SAG	KJS	MES
0	FOR REVIEW	6/9/16	SAG	SAG	KJS	MES

Pure Fonte Ltée

PURE FONTE LTÉE

PIG IRON PRODUCTION PLANT – FEASIBILITY STUDY

CUSTOMER Nº: 1821

tenova

TECHINT

TENOVA

TECHINT ENGINEERING & CONSTRUCTION

SECTION 1 - SUMMARY

CHAPTER 1.6

ENVIRONMENTAL

ESC.: N/A

JOB: CD-335

REVISION 2

REVISION

CONTENTS

FIGURES AND REFERENCES

Chapter's references:

[1] J. Boulian, "CC BY-SA 3.0," [Online]. Available: https://commons.wikimedia.org/w/index.php?curid=5372400. [Accessed 14 August 2016].

[2] Takraf Tenova, "Delkor F.A.S.T. Filter Presses," 30 July 2016. [Online]. Available: http://www.takraf.tenova.com/en/product/delkor-f.a.s.t.-filter-presses/.

[3] Ravagnan S.p.A., "Water treatment plants," [Online]. Available: http://www.ravagnan.com/en/plant-division/water-treatment-plants.html. [Accessed 30 July 2016].

[4] EWS Steel Aggregate LLC., "2010 COS TBTRA Test Section - EAF Steel Slag All S. Bound Lanes and Left N. Bound Lane / Front Range Aggregates All Other N. Bound Lanes," [Online]. Available: http://www.ewslag.com/project-portfolio.html. [Accessed 30 July 2016].

1.6 Environmental

This section of the summary is intended to provide a general overview of how the environmental topics have been approached in this Feasibility Study. A complete section of this FS has been dedicated to the detailed data and values of the emissions and other environmental considerations. The following chapters discuss generalities of water and atmospheric emissions, as well as noise and the measures that have to be taken during the phase of plant construction and dismantling, as required by local regulations.

There are though very important considerations to be made relevant to some unique features that PURE FONTE LTÉE plant will have that will make this plant a benchmark for the pig iron industry

Figure 1.6-1.: Saguenay river and Cap Éternité, seen from Cap Trinité, Fjord-du-Saguenay national park, Quebec, Canada. [1]

1.6.1 Unique environmental features of PURE FONTE LTÉE plant

Compared to other plants equipped with similar technologies, gas based DRI reduction and an electric arc furnace, the PURE FONTE LTÉE process is characterized by two very important features that will make it a global leader for minimizing the environmental impact of iron making. These features are:

- Internal dust and fines recycling;
- Low water usage and treatment

1.6.1.1 Internal dust, fines and sludge recycling

The IO pellets used by PURE FONTE LTÉE will suffer some minor degradation which will produce fines and dust. Fines will be collected after the screening process while dust will be collected by filters and bags material moves through the production process.
In addition to fines and dust, the sludge from the treatment of the contact cooling water of the direct reduction plant will also be collected.
All of these materials will be stored in a dedicated area of the plant and converted into cold briquettes, that will be reintroduced into the production cycle. The production of these briquettes is estimated to be about 3% by weight of the total input of IO pellets.
The viability of this process has tested and proven at the existing Tenova direct reduction plant installed in the Ternium Monterrey steel plant in Monterrey, Mexico.

Figure 1.6-2.: photos of a FAST filter press by Tenova, used to remove dust from water [2]

1.6.1.2 Water usage

Despite the site being close to the river Saguenay, the industrial area where PURE FONTE LTÉE will be located is not served by a municipal sewer system that process and discharges water into the river. Because of this, PURE FONTE LTÉE will have to discharge water into a small creek to the south of its plant site. Thus, the concentration of chemicals allowed for discharge will need to be extremely low because there is no dilution effect from a sewer system.

PURE FONTE LTÉE has decided to adopt a very advanced water treatment plant that will use air coolers in addition to evaporation towers, to minimize evaporation and water consumption. Advanced water treatment equipment will be employed to minimize chemicals concentrations and to ensure that any water that must be discharged meets or exceeds all required standards.

Figure 1.6-3.: Photos of air coolers, the alternative to evaporation towers, used to avoid water loss from evaporation [3]

1.6.2 Water Treatment Plant

1.6.2.1 Water uses

The water systems in the facility are designed to minimize the amount of fresh water consumed from the municipal water supply as well as the amount discharged into the environment. A variety of cooling strategies will be used to accomplish this goal, taking into account the limitations of the potable water supply, the minimization of the environmental discharge and the specific or particular needs of the production process equipment. Air coolers will be used in addition to cooling towers in an open circuit, in direct and indirect contact, as well as closed cooling circuits in indirect contact.

Figure 1.6-4.: photos of a circular decanter and a pumping station in a Water Treatment Plant [3]

The ultimate objective of the facility's water management strategy is to reuse 100% of the wastewater generated for a zero-discharge plant. Despite efforts to achieve this goal, a residual flow must be discharged. There will be three discharge points, one for process wastewater, one for runoff water and one for sanitary wastewater. The three effluents will be discharged to water course number 5. Potable water originating from the municipal water supply of the City of Saguenay will be used as industrial water, with and without treatment. Approximately 130 m3/h of fresh water from the municipal supply will be required for the facility's various industrial water needs, which are mainly for cooling of process equipment, through direct and indirect contact, treating gas and for the production of demineralized water. Approximately 0.5 m3/h will be used for sanitary and laboratory needs.

One of the strategies for reducing the total flow of consumed water and the flow of the final effluent is to soften a portion of the make-up water to the cooling towers in order to be able to increase the number of cooling tower concentration cycles. This strategy will be used in the indirect contact cooling circuit for the EAF equipment, which will allow the blowdown flowrate to be reduced by more than 80%.

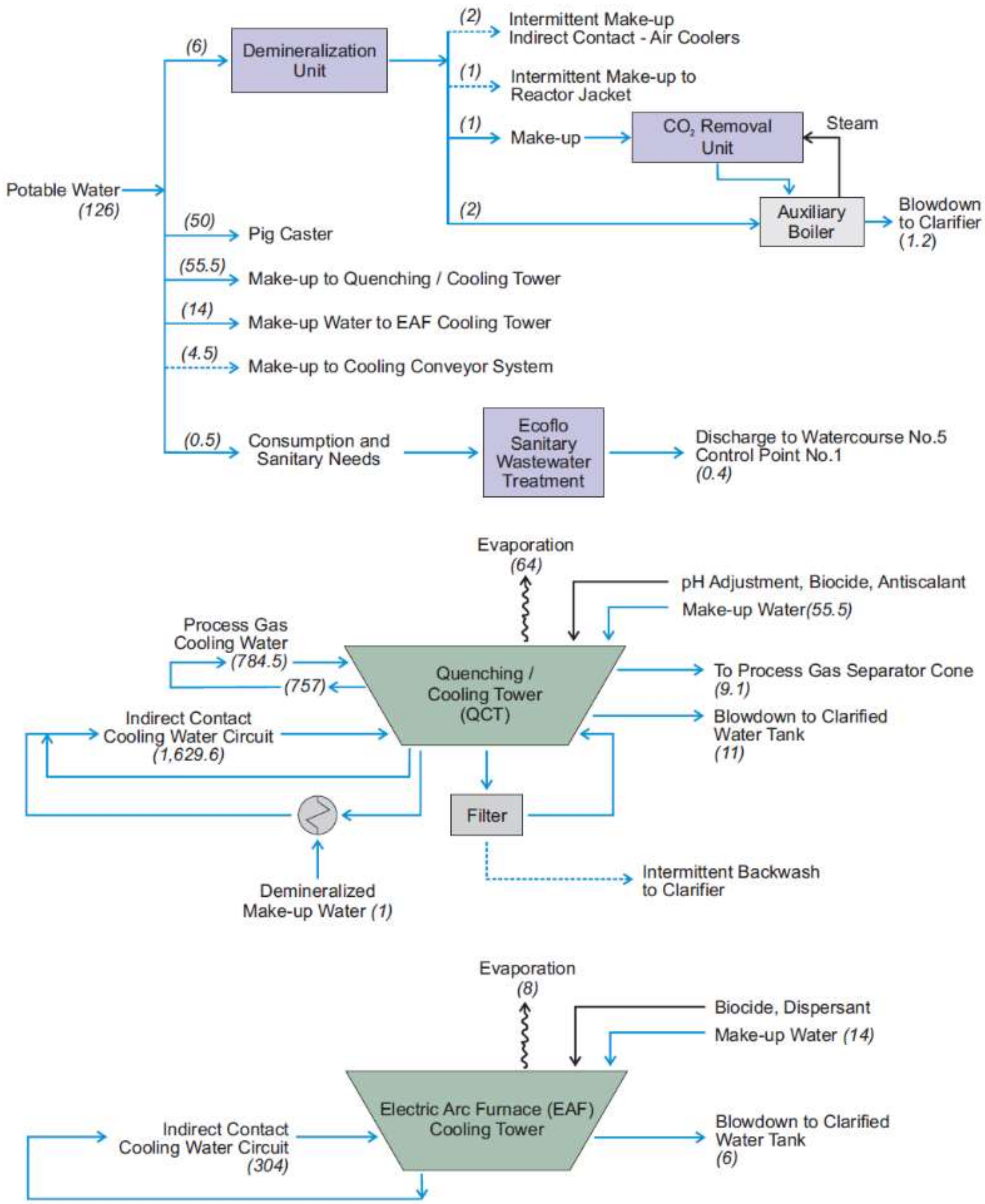

Figure 1.6-5.: Water uses, as defined by Tenova and SNC Lavalin for this FS (flows in m3/h)

1.6.2.2 Industrial wastewater

Industrial wastewater is mainly generated through the use of water to directly cool and clean process gas streams. As water is in direct contact with process gas, solids, contained in the gas are present in the wastewater. The treatment process consists principally of removing solids through the use of a primary clarifier and addition of a polymer to flocculate the solids. Sludge that is generated will be sent to an accumulation basin which will feed the sludge thickener, flowed by a belt filter press. The filtrate will be returned to the primary clarifier and the sludge will be recovered in an agglomeration unit to be made into briquettes and recycled to the reactor. The moisture content of the sludge is around 50% at the filter press exit.

Water exiting the primary clarifier flows to the clarified water tank. Sulfuric acid is added here to adjust the pH. A portion of the clarified water is then returned to the reduction sector to quench and cool the process gases while another portion undergoes a secondary treatment.

The effluent contains a certain ammonia concentration that comes from the reduction module. Under certain conditions, ammonia can be generated during the cracking of natural gas. Ammonia is found in the process gases and then condensed in the quenching and cooling water. Ammonia in the effluent will be removed in an extraction tower by an upward moving air current. Ammonia will be transferred from the water to the air. A sulfuric acid scrubber will allow the air to be treated before being released to the atmosphere. The scrubbing solution, 0.8 m3/d, will be collected in a tank of 12,000 liters.

The effluent is treated and sent to a second clarifier, called the lamellar clarifier, where through pH adjustment, as well as addition of coagulant and flocculant the heavy metals are transformed into non-soluble oxides that are deposited on the bottom of the clarifier when the water passes into the lamellar section. The sludge will be collected and sent to the primary sludge clarifier.

At the exit of the lamellar clarifier, the pH will again be adjusted and the clarified water will pass through a sand filter. The filter will be periodically cleaned with filter water flowing backwards and the cleaning effluent will be returned upstream of the lamellar clarifier.

From the exit of the sand filter, 8 m^3/h will be used for the spray cooling of the electrodes, so the water will be lost through evaporation. This flow is almost continuous; the electrodes being cooled more than 90% of the time. Another 3 m3/h will be used for the pellet coating where the water is consumed to form cement. The flow can vary depending on the humidity of the pellets.

The residual flow (0 to 12 m3/h) will be discharged to water course

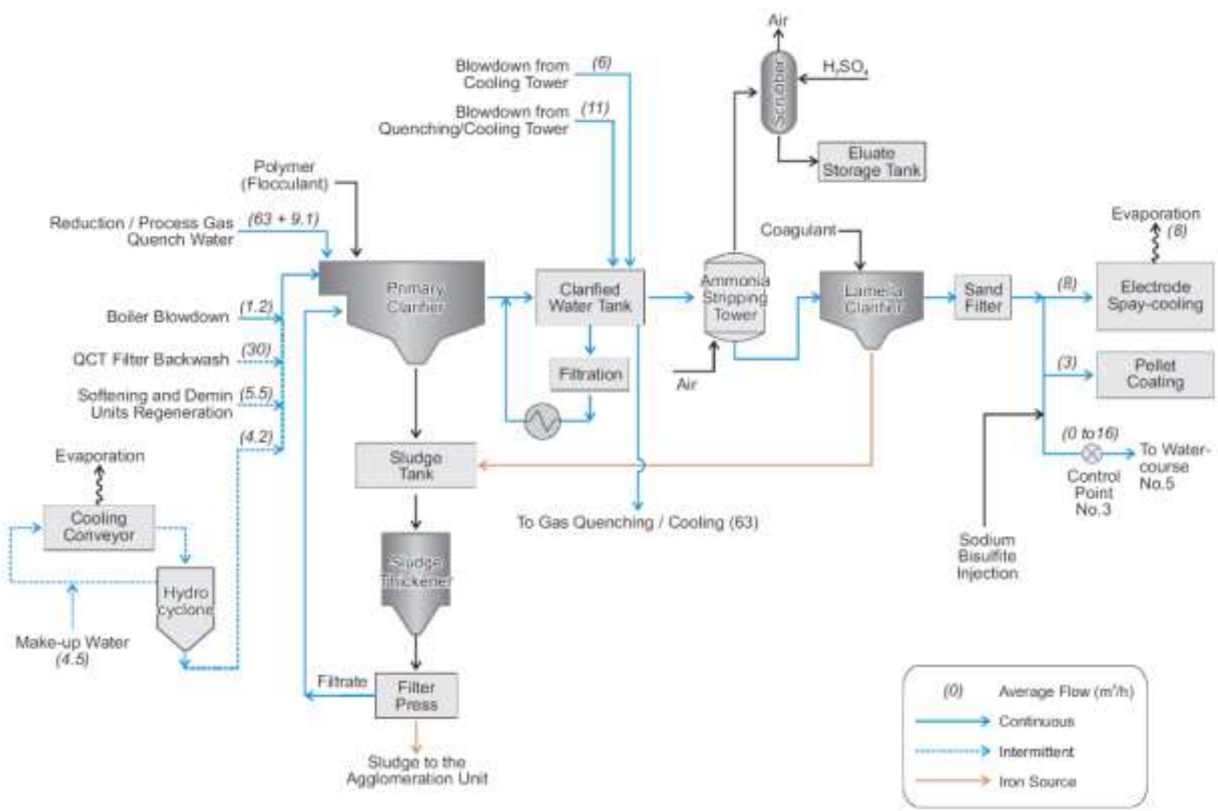

Figure 1.6-6.: industrial wastewater treatment as defined by Tenova and SNC Lavalin for this FS

1.6.2.3 Sanitary water and run-off water management

For both the sanitary water and run-off water management, the company Norda Stelo has conducted a detailed study analysis, in accordance with Quebec regulations, which is attached in this Feasibility study.

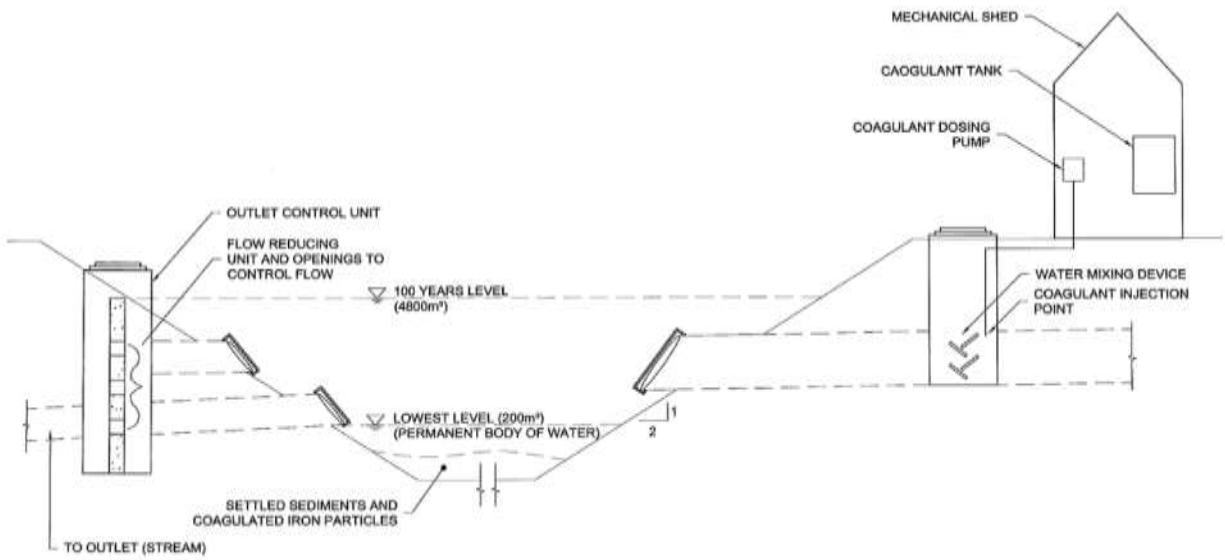

Figure 1.6-7.: Elements of a retention/treatment pond, as proposed by Norda Stelo to PURE FONTE LTÉE for this FS

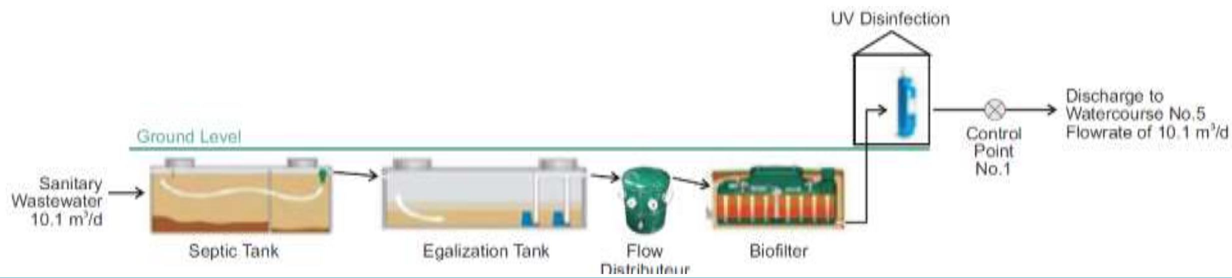

Figure 1.6-8.: sanitary waste water as proposed by Norda Stelo to PURE FONTE LTÉE for this FS

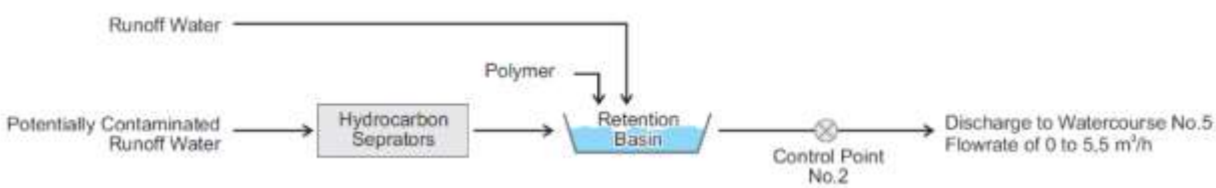

Figure 1.6-9.: run-off water treatment, as proposed by Norda Stelo to PURE FONTE LTÉE for this FS

1.6.3 Atmospheric emissions

The PURE FONTE LTÉE facility will have sources of emission to the atmosphere.

All atmospheric emissions have been carefully evaluated and the required equipment to collect dust and reduce the flow to the atmosphere have been considered in this Feasibility Study to calculate the capex and opex for the project.

The principal continuous emission points from the reduction sector, smelting and casting are the following:

- combustion gas from the process gas heater (process gas composed of 16.4% methane and natural gas);
- gases given off during smelting, from the opening of the EAF and the caster, are collected and sent to the EAF baghouse;

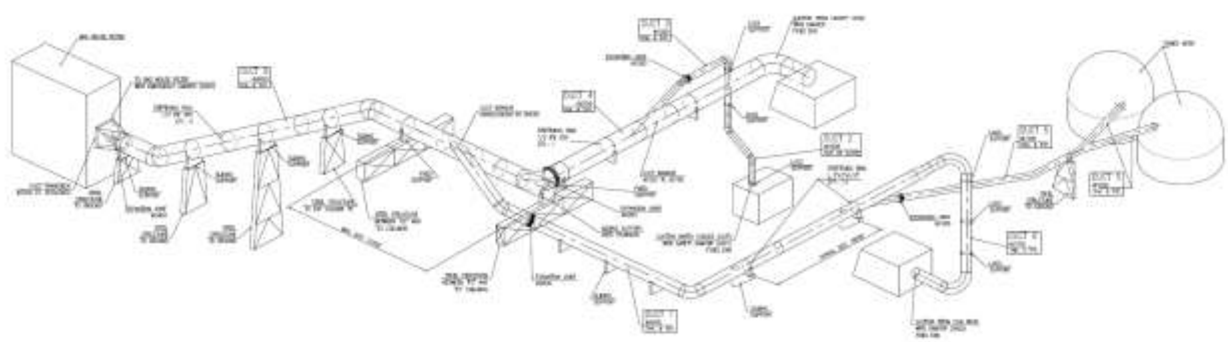

Figure 1.6-10.: Isometric drawing of the ducting system for the main buildings of PURE FONTE LTÉE's plant

Other continuous emission points from reduction, melting and casting are the following:

- combustion gas after oxidation of hydrogen sulfide contained in the gases in the outlet of the CO_2 removal plant;
- combustion gas from the package boiler;
- flare pilot fed by natural gas;
- combustion gas from the casting ladle heating apparatuses and from the wastewater sludge drier;
- fugitive emissions from process micro-leaks, containing methane and volatile organic compounds (VOCs);
- ammonia emissions from the acid scrubber in the wastewater treatment plant;
- The sources of dust linked to the transfer of materials (pellets, fines and DRI):
- unloading of pellets in the transfer building whose vent is linked to a baghouse;
- loading of pellets in the storage building whose vent is linked to a baghouse;
- screening and coating of pellets is inside a building vented to a baghouse
- vent of the fines storage silo is linked to the screening and coating building whose vent is linked to a baghouse;
- vent of the briquetting plant building is linked to a dedicated baghouse or towards the EAF baghouse;
- vent of the reactor and EAF feed hoppers is linked to the gas collection system of the EAF baghouse;

Figure 1.6-11.: photo of an existing baghouse of similar size of the one which will be adopted by PURE FONTE LTÉE, currently installed in a plant of the Ternium group (photo by Tenova)

The intermittent sources that exist during emergencies, shutdowns and start-up, or during process upsets are:

- dust emissions generated during the off-spec DRI conveyor cooling are sent to the EAF baghouse;
- flare for process gases used as a combustible (combustion products of a gas rich in methane);
- diesel engine exhaust of the emergency generator, light heating oil (diesel) combustion products;
- Intermittent sources linked to trucking activities:
- Slag transport between the casting building and the storage area.

Pellets and pig iron are trucked between the facility and the jetty, so also the combustion emissions from the heavy trucks used for transport are considered.

1.6.4 Slag and other solid wastes

1.6.4.1 EAF Slag

EAF slag will be the major solid waste of PURE FONTE LTÉE plant and it will be stored in accordance with the applicable regulation outside on an impermeable surface.

The storage area is in the southeastern part of the facility. In this sector, a layer of clay around 6 to 9 meters deep can be found. The storage capacity of the slag will be equivalent that produced in 21 days of production, or around 4,500 to 5,000 tons of slag.

Between 70,000 and 85,000 tons per year of slag will be produced depending on the production rate of pig iron, either average or maximum.

Between 8 and 10 trucks per day will transport the slag from the facility to an outside site. The slag that will be produced by PURE FONTE LTÉE does not have the characteristics of a hazardous waste. Slag from steel mills and foundries are usually repurposed as aggregate, in Quebec and elsewhere in the world.

The present FS assumes that the slag will be repurposed as an aggregate and that it will not need to be managed as a hazardous waste, either in storage, handling or disposal.

Figure 1.6-12.: photo of asphalt treated draining base made with EAF slag in Colorado Springs, 2010 [4], and photo of Moving 1200°F hot slag to a cooler pile in Charleston, SC with a 988H Wheel Loader

1.6.4.2 Screening fines

As said above, the fines from iron pellet screening will be recovered in a silo to be later made into briquettes. A total of approximately 26,000 t of fines will be recovered annually.

1.6.4.3 Sludge from waste water treatment

The design of the facility foresees that 100% of the sludge from the wastewater treatment plant (industrial and storm) and 100% of the dust captured by the baghouse are recovered in the briquettes that will be reinserted into the DR reactor.

1.6.4.4 Other solid wastes

Other solid wastes that will be generated in PURE FONTE LTÉE plant have all been carefully evaluated and the required treatment of these wastes have been studied by SNC and considered in this FS:

- Around 300 cubic meters per year of Scrubbing solution.
- Around 15 tons per year of centrifugation sludge will be generated.
- Around 600 tons of waste refractory bricks will be generated annually. The bricks do not have the characteristics of hazardous waste. They will be either recycled or eliminated in a dry landfill.
- Activated Carbon and Catalysts. The quantity to dispose of will be approx. 50 m3.
- Waste oil and solvents. It is difficult at this stage of the project to provide an estimation of the quantities that will be generated annually. Used solvents will be stored temporarily on site then transported off-site by an authorized firm.
- Domestic Waste. In view of the future prohibition of organic waste landfilling announced in the Québec Policy on Waste Management, PURE FONTE LTÉE intends to work with the City of Saguenay and align itself with the measures undertaken by the City in view of the ban, as stated in its 2016-2020 Revised Waste Management Plan of the City of Saguenay and the Fjord du Saguenay RCM.

1.6.5 Additional environmental considerations

This Feasibility study has also taken into considerations the following topics to the extent of Capex and Opex calculations:

- Noise emissions from any potential noise source as
  - Natural Gas supply
  - Electricity supply
  - Water supply
  - Port and conveyor facilities
  - Trucks

- Emissions during facility pre-start-up activities as:
  - Hydrostatic testing of piping and equipment;
  - Rinsing and cleaning of lines and pipes;
  - Checking of leaks in critical lines;
  - Purging of process lines with nitrogen;
  - Blowing of steam lines
  - Checking of instrumentation;
  - Load testing of all motors, fans, etc.

- Emissions during construction activities as:
  - Mobilization & Site preparation
    - Detailed excavation
    - Construction of temporary access roads
    - Implementation of temporary facilities; construction site trailers, offices and sanitary facilities
    - Earth works and ditching
    - Preparation of foundation, drain systems
  - Construction works;
    - Erection of foundations
    - Engineering works; process area, electrical substation, administration building and electrical room, loading area, etc.
    - Process, mechanical, electrical, instrumentation work
    - Testing
    - Pre-commissioning and commissioning
  - Demobilization:
    - Dismantling of temporary facilities

- Emissions during plant closure activities at the end of the plant life as:
    - Preparation of a decommissioning plan for the disposal of assets of closed operations;
    - Dismantling and demolition of facilities;
    - Recycling of dismantled materials and equipment still reusable where feasible;
    - Disposal of other materials, obsolete equipment and demolition debris;
    - Clean-up and rehabilitation of site if required - contaminated soils and groundwater;
    - Clearance and reinstatement of site;
    - Reuse of site for an industrial facility or other compatible use.