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FINAL REPORT

Plant Shutdown Procedure

Smelter and Refinery Decommissioning/Demolition Thompson, Manitoba

Prepared for: Vale Canada Ltd.

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1.0 INTRODUCTION

On November 17, 2010, Vale Canada Ltd. (Vale) announced the plan to permanently close its smelting and refining operations in Thompson, Manitoba by January 1, 2015. In order to prepare for the successful transition to a mine/mill operation, Vale must develop a detailed plan for the decommissioning of the Smelter, Refinery and related infrastructure. Vale retained Conestoga-Rovers & Associates (CRA) to develop the overall decommissioning plan for the Thompson Smelter and Refinery. The following document presents the ramp down and shutdown procedures for the Smelter and Refinery. The location of the Thompson Mine Site is shown on Figure 1.1.

1.1 GENERAL

Vale's advance planning for decommissioning of the Smelter and Refinery provides sufficient time to implement facility ramp down, shutdown work in a well planned and orderly fashion that will allow Vale to maximize the recovery of products/assets and minimize ramp down/shutdown costs.

1.2 PURPOSE

The purpose of this report is to provide Vale with the required the ramp down and shutdown procedures for the Vale Thompson Manitoba Smelter/Refinery complex. The overall objectives and goals of the ramp down/shutdown are to cease operations in an orderly and efficient manner, realize the maximum economic value for all products/process intermediates, minimize shutdown efforts/costs, and prepare the Smelter/Refinery complex for demolition.

1.3 REPORT ORGANIZATION

This report is organized as follows:

- Section 1.0 presents the introduction
- Section 2.0 present shutdown procedures for the south yard
- Section 3.0 presents shutdown procedure for the smelter
- Section 4.0 presents shutdown procedures for the refinery
- Section 5.0 presents resource estimates for the activities described in this report

- Section 6.0 presents the schedule
- Section 7.0 presents a discussion of the concurrent projects

2.0 SOUTH YARD MATERIAL MANAGEMENT

The purpose of the South Yard Material Management is to minimize any direct costs to Vale related to the clearing of the South Yard in advance of the demolition of the Smelter and Refinery Buildings. Additionally, to the extent practical, realize any financial return on the salvage of material currently stored in the South Yard.

CRA believes that it would be to Vales advantage to complete closure of the South Yard prior to closing and demolishing the Smelter and Refinery and demolishing the South Yard building structures for the following reasons:

- Demolition Contractors markup subcontracted work and CRA's experience is that demolition contractors will subcontract the cleanup of the South Yard to waste disposal companies for the removal and disposal of hazardous materials.
- The presence of hazardous materials in the South Yard represents an environmental liability for the site that should be addressed (Table 2.1 presents the results of the August 2011 South Yard Hazardous Materials Inventory).
- There is a significant amount of scrap steel in the South Yard that has value.
- There is an area of Petroleum Hydrocarbon (PHC) contaminated soil that should be addressed in advance of the demolition because crushed concrete processed as a part of the demolition will be used as grading material in the South Yard. The petroleum contaminated soil should be addressed in advance of grading the South Yard with crushed concrete to prevent an increase in cost due to double handling of material. The extent of soil exceeding the Canadian Council of Ministers of the Environment (CCME) PHC Criteria is not clearly defined by sample results. The February 2012 AMEC Soil and Groundwater Remediation Study relies on a qualitative observation of soil characteristics to define a fill area that is believed to contain PHC impacts. This definition may not be accurate.
- The Demolition Contractor will require a large area for equipment storage and staging of material and equipment removed from the Smelter and Refinery as a part of the demolition. The proximity to the Smelter and Refinery as well as the presence of rail spurs in the South Yard makes the South Yard an efficient location for a staging/lay down area.

The South Yard Material Management work will require the letting of contract(s) to complete the work. Vale's contracting strategy will depend on the objectives of South Yard Material Management. If the objective is to complete the work in a short time frame with the minimum of resource requirements on Vale Staff, the preferred contracting option would be to let one contract that would include the following activities:

- Hazardous material removal and disposal
- Empty Drum and Storage Removal
- Scrap Metal Recycling
- Consolidate creosote and non-creosote wood to designated Areas
- Prepare PHC soil excavation plan
- Conduct PHC soil removal/verification sampling
- Copper Pond No. 3

If the objective of the South Yard Material Management work is to maximize the amount of work that Vale can self-perform then dividing the above work into several smaller contracts will allow Vale the most flexibility in using Vale labour to complete the work. However, managing several contracts will require a much larger Vale project management effort.

Completing the South Yard Material Management activities prior to closure of the Smelter and Refinery will require Vale to act as the contracting entity for the South Yard closure activities. Acting as the contracting entity would involve the bidding and management of one or more contractors by a Vale Project Manager (PM) for the tasks described in the following sections. Should Vale not wish to take on this role, the South Yard Material Management could be included in the scope of work for the Demolition Contractor. However, the Demolition Contractor will likely include a mark up for the South Yard closure activities (particularly the hazardous waste management and disposal which would likely be subcontracted work for the Demolition Contractor). The South Yard Material Management is included as a component of the Smelter/Refinery Decommissioning Project. However, this is an opportunity for cost savings should Vale choose to self-perform this work.

2.1 SOUTH YARD CURRENT CONDITIONS

The South Yard is located in the area south of the Smelter and the Refinery. The boundaries of the South Yard are presented on Figure 2.1 – Smelter and Refinery Complexes. CRA completed inspections of the South Yard during the decommissioning planning activities for the Smelter and the Refinery. The following is a listing of the buildings/facilities that are present in the South Yard:

- Hydrogen Sulphide Building
- Copper Pond No. 3 and Copper Pond No. 4
- Warehouse 1-A
- Refractory Storage Warehouse
- Salt Storage Building
- Chlorine Storage Shed
- Rail Scale Shack
- Miscellaneous Storage structures and out buildings

CRA assumes that all structures in the South Yard will ultimately be demolished by the Demolition Contractor. However, Vale may consider retaining the Warehouse 1-A and the Refractory Storage Warehouse for future storage activities.

In addition to the above buildings/facilities listed above, the South Yard has been used as a lay down/storage area for various materials over the operational life of the Smelter and the Refinery. Copper Pond No. 3 contains stockpiles of copper/arsenic material. The Refinery process generates a copper-arsenic-nickel sulphide precipitate from the anolyte purification process. The precipitate is known as the copper-arsenic residue. Vale has stored this product using various methods and locations within the Plant site. Copper Pond No. 4 contains standing water and receives effluent from the Refinery on an intermittent basis.

Roadways in the South Yard are presented on Figure 2.1. Several rail sidings that run from a main rail spur along the south edge of the South Yard are located in the South Yard. The SO_2 Track rail spur servicing the Refinery SO_2 Building is located between the Smelter and Refinery. Five rail sidings are located in the South Yard branching from the south main spur. The five rail sidings service the Hydrogen Sulphide Building, Chlorine Building, Copper Pond No.4, Acid Bay and Shear Shed. Further west in the South Yard, one rail siding runs in a north-south direction to Door 24 of the Smelter west of the flux system from the rail spur. A second rail spur runs along the west side of the South Yard that services the Mill and the north end of the Refinery.

Due to the presence of rail sidings and road ways in the South Yard, the South Yard would be a suitable location for staging of materials and equipment that would be shipped from the Site during the course of the Refinery and Smelter demolition activities. Currently, there is a significant amount of material in the South Yard that requires removal in order to use this area for staging equipment and materials during the demolition work. A list of materials currently located in the South Yard is as follows:

- Hazardous Materials
- Empty 55 – gallon steel drums (100 +)
- Empty 55 – gallon plastic drums (100 +)
- Chemical storage totes
- Miscellaneous scrap metal
- Miscellaneous used process equipment (baghouse, tanks, large tank impellors, process vessels, conveyors, etc.)
- Spare process piping
- Corroded railway rail
- New structural steel
- Corroded structural steel
- Pre-cast concrete
- Foam forms
- Refractory
- Wood (both creosote and non-creosote – stockpiled both is separate piles and intermixed)
- Spools of wire rope
- Derelict mobile equipment (fire truck, loader, scissor lift, trailers)
- Rebar
- Miscellaneous refuse

2.2 HAZARDOUS MATERIALS

CRA has reviewed the hazardous material inventory for the South Yard that was provided by Vale. A complete listing of the hazardous materials present in the South Yard as of August 2011 is presented in Table 2.1. Removal and appropriate disposal of the hazardous materials in the South Yard is recommended as the first task related to the decommissioning of the South Yard.

A cost estimate for the removal and disposal of the hazardous materials in the South Yard based on the August 2011 Vale inventory is presented in the Cost Model Report. The total estimated cost in 2012 dollars is $157,000. In order to obtain competitive pricing for the hazardous material removal Vale could bid the work to waste disposal vendors. The scope of work for the disposal contractor would be as follows:

- Removal, manifesting and disposal of the materials identified on the Hazardous Materials Inventory
- Inspection of the South Yard to identify any additional Hazardous Materials in the South Yard since the August 2011 Inventory

Prior to tendering a contract for the hazardous material removal as a stand-alone contract or as a component of a larger contract, Vale will update the August 2011 hazardous material inventory. A Vale project manager would be required to oversee the tendering process and oversee the waste disposal contractor's work. CRA estimates the tendering process for the Vale PM could be completed in 60 man-hours over a three week period. The actual manifesting, packaging, transportation and disposal of the hazardous materials would occur over a three week period including Site orientation time. Part-time supervision of the disposal contractor by the Vale PM would require approximately 60 man-hours over the three week period. The anticipated durations of the tasks related to the Shutdown Plan are summarized Section 6.0 Shutdown Schedule. The above labour would be deployed over a period of 60 days. An estimate of the Vale labour requirements for the above task and the duration over which the labour would be deployed is presented on Table 2.3a.

2.3 SCRAP METAL/DEBRIS REMOVAL

CRA conducted an inspection of the South Yard on July 26 and July 27, 2012. A photo log and photographs are presented in Appendix A1 and A2 for the July 26, 2012 and the July 27, 2012 inspection activities, respectively. In addition to the hazardous materials identified in the August 2011 Vale Hazardous materials in Table 2.1, the following materials/items were identified in the South Yard.

- Empty 55 – gallon steel drums (100 +)
- Empty 55 – gallon plastic drums (100 +)
- Chemical storage totes
- Miscellaneous scrap metal
- Miscellaneous used process equipment (baghouse, tanks, large tank impellors, process vessels, conveyors, etc.)
- Spare process piping
- Corroded railway rail
- New structural steel
- Corroded structural steel
- Pre-cast concrete
- Foam forms
- Refractory
- Wood (both creosote and non-creosote – stockpiled both is separate piles and intermixed)
- Spools of wire rope
- Derelict mobile equipment (fire truck, loader, scissor lift, trailers)
- Rebar
- Miscellaneous refuse

Some of the process piping and venting in the South Yard is likely spare equipment that is kept on hand in case of failure in the Smelter or Refinery. However, there appears to be a significant quantity of scrap metal in the South Yard that is not required for Site operations. Based on the CRA inspection of the South Yard, an estimated 1 to 2 percent of the total scrap metal present in the Smelter is present in the South Yard (an estimated 200 to 400 metric tonnes). Following the hazardous material removal an inspection of the South Yard by Vale staff should be conducted to identify any process equipment/piping/venting that should remain on hand until the Smelter and Refinery cease operations in 2015. A single storage area should be identified for process equipment that will be retained, if one does not already exist.

In addition to the scrap metal discussed above, there is a significant amount of additional waste material in the South Yard that requires management. A significant volume of wood could be addressed using the existing Site burn permit. However, segregation of creosote treated wood and non-creosote treated wood would need to occur as creosote treated wood cannot be burned on Site. Some of the scrap metal in the South Yard is stored in wooden crates, on wooden platform or intermixed with wood debris. Prior to contracting for the scrap metal recycling, whether as a stand-alone contract or as a component of a larger scope of work, a stockpile area for burnable (non-creosote treated wood) and creosote treated wood should be identified. The contract for the scrap metal recycling should include a clause that requires segregation and stockpiling of wood associated with the scrap metal to prevent double handling of materials.

There are a significant number of 55-gallon steel drums in the South Yard. However, the scrap metal recycling firm may not want to deal with the stockpiled empty drums and totes in the South Yard due to the potential for residuals in the drums and totes to be present. Depending on the contracting strategy Vale elects to pursue, a separate arrangement with a drum recycler may be required. Preliminary pricing for the removal of the drums from the South Yard is on the order of $7,500 for transportation. The drum recycler will not charge any disposal fee for drums that can be recycled. A minimal ($7) fee will be applied to drums that are not suitable for recycling.

Following removal of the scrap metal and empty drums/totes from the South Yard a significant amount of debris (e.g. wood, construction materials (concrete and foam forms), tires, refractory and miscellaneous debris) will require management. These materials will need to be properly disposed of. As discussed above non-creosote treated wood in the South Yard can be managed under the Site's current burn permit. A separate staging area for creosote treated wood should be selected. The creosote treated wood will likely be disposed off Site as hazardous waste. In addition to the creosote treated wood that is currently present in the South Yard, a significant amount of creosote treated wood will be generated during the course of the Smelter and Refinery demolition in the form of railway ties and the wood cribbing of the outer berms of the two copper-arsenic ponds in the South Yard. To achieve an economy of scale with respect the creosote treated wood disposal, removal of the creosote treated wood should occur following the demolition of Copper Ponds No. 3 and No. 4 and the removal of the rail spurs in the South Yard. The location of the creosote treated wood storage area should be located adjacent to the rail spur that runs in a southwest to northeast direction along the southern boundary of the South Yard.

CRA understands that Vale is in the process of implementing/commissioning a new waste management process and landfill at the Site that will have strict diversion requirements. As of the date of this report, the existing Site landfill located at the south end of the Slag Pile remains open. If the South Yard can be cleared prior to the closure of the existing landfill, the remaining debris (construction materials (concrete and foam forms), tires, refractory and miscellaneous debris) could be disposed in the existing landfill. The operating permit for the existing landfill (Permit No. 5-055 Rev. 4 presented in Appendix B) does not include prohibitions on the disposal of any of the above material in the existing landfill with one exception. Section 3) of the operating permit indicates that tires must be sorted and stored separately from the active landfilling area and recycling provisions be made with an approved used tire processor. The Thompson Open Pit has a temporary tire storage area. Any tires identified in the South Yard could be transported to the temporary storage area prior to recycling. The sorting requirements of the new Site waste management system/landfill are appropriate for the generation of existing waste streams but will be burdensome for the materials remaining in the South Yard because these materials were not segregated when generated (i.e., there are piles of mixed debris in the South Yard that would have to be sorted prior to disposal in the new landfill).

As discussed in Section 2.0, depending on Vale's contracting objective the entire South Yard Material Management could be let as one contract. However, for the purposes of this report it is assumed that Vale will elect to self-perform the maximum amount of work practical. An estimate of the Vale labour requirements for the above task is presented on Table 2.3b on the basis that Vale will self-perform work to the extent practical.

The labour estimate includes the following tasks for the Scrap Metal/Debris removal:

- Tender(s) preparation by Vale PM for scrap metal recycling and drum recycling
- South yard inspection for required process equipment by Smelter and Refinery Process/Maintenance Staff
- Relocation of equipment by Vale mobile equipment operator and labour
- Sorting and stockpiling of creosote treated and non-creosote treated wood by Vale mobile equipment operator and labour
- Removal and Disposal of miscellaneous South Yard debris in the on-Site landfill by Vale mobile equipment operator and labour

The duration to complete the above tasks is estimated to be on the order of 180 days.

2.4 SOUTH YARD SURFICIAL SOIL PROCESSING

The AMEC 2003 Mine Closure Plan indicates that nickel-containing soil in the South Yard could be processed through the Smelter. The processing of the soil through the Smelter is unlikely to achieve Commercial Land Use Criteria as outlined in the Canadian Council of the Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for metals in soil. The processing of the South Yard soil through the Smelter should be considered solely on the economics of nickel recovery because a risk assessment will likely be required at final mine closure to address metals exceedances whether or not the South Yard soils are processed through the Smelter. CRA assumes that the South Yard soil could be fed to the furnace at a rate of 20 percent of the current VBN feed rate. Vale operational data for the Smelter from the period of April 1, 2012 through June 30, 2012 is presented in Appendix C. The data set includes Smelter production/usage rates for single furnace operation (April 1, 2012 to April 25, 2012) and dual furnace operation (April 26, 2012 to June 30, 2012). The VBN feed rates for single furnace and dual furnace operation, based on the data provided by Vale are approximately 255 metric tonnes per day and 308 metric tonnes per day, respectively. On a per 100 anodes produced basis VBN usage is approximately equal 32.4 tonnes of VBN per 100 anodes for single furnace operation and 32.6 tonnes of VBN per 100 anodes produced for dual furnace operation. A summary of average Smelter Usage/Production Rates is presented in Table 2.2. Appendix D includes the 2014 planned production data for the Smelter. Based on the 2014 production forecast in Appendix D, the average monthly anode production is 854 anodes per day for the period of January 2012 through October 2012 (production in November is reduced and December is zero and hence these months were not used in the calculation of the average production rates). For the purposes of this report it is assumed that only 90 percent of the planned production will be achieved. Assuming that soil could be processed in the Smelter at 20 percent of the rate of VBN in the Smelter, approximately six tonnes of soil could be processed in the Smelter on a daily basis.

Removing soil from the South Yard Area could result in poor drainage in the South Yard. The plan for scraping the South Yard soils, if conducted, should include restoring the grades in the South Yard to maintain drainage toward the existing storm sewer system surrounding the Smelter and Refinery. The storm sewer locations in the area surrounding the Smelter and Refinery are identified on Figure 2.2. To restore the grades a source of clean fill may be required. If no source of clean fill on Site is accessible, clean fill could be sourced from Vale's gravel pit.

An estimate of the Vale labour requirements for the above task is presented on Table 2.3c. The labour estimate includes the following tasks for the South Yard Surficial Soil Processing:

- For the purpose of developing a labour estimate, scraping the top two feet of soil in the South Yard could be conducted by Vale mobile equipment operator and labour in one week campaigns over a 90 day period
- Restoration of South Yard grades with clean fill
- Coordination by Vale PM

The duration to complete the above tasks will be distributed over the remaining operational life of the Smelter.

2.5 PETROLEUM-IMPACTED SOIL

Petroleum hydrocarbon- (PHC-) impacted soil is present in the South Yard. The AMEC February 2012 Remedial Action Plan for Remediation of Impacted Soil and Groundwater at the Vale Thompson Facilities (AMEC 2012 RAP) identified PHC impacts at locations TP11-12 and TP11-13. The locations of TP11-12 and TP11-13 are shown on Figure 1 of the 2012 AMEC RAP. The AMEC 2012 RAP is presented in Appendix E. The AMEC 2012 RAP recommends land farming as the remedial action for the PHC-impacted soil. The 2012 AMEC RAP indicates that the extent of PHC-impacted soil identified at test hole locations TH11-13 and TH11-12 have not been defined. The report relies on a qualitative assessment of the presence of a deeper deposit of fill to suggest that the PHC-impacted soil is limited in horizontal extent. There is no justification in the 2012 AMEC RAP that supports the presence of PHC impacts being limited to the deeper deposit of fill.

Prior to implementing the soil removal, a plan for the soil removal should be developed and the appropriate license for the land farming remedial action should be obtained. An application for a license under the Manitoba Environment Act must be submitted to the Director of Approvals of Manitoba Conservation. A description of the application requirements are described in the Manitoba Conservation Guideline 96-05 Treatment and Disposal of Petroleum Contaminated Soil. The plan for the soil removal should include the following items:

- A review of existing data to define the initial depth and extent of the excavation

- Verification sampling plan including number of samples (floor and sidewalls of excavation), parameter list for verification samples, analytical laboratory, analytical turn-around time
- Definition of the appropriate environmental standard that will define when the excavation is complete (CCME PHC Standard "Canada-Wide Standards for Hydrocarbons in Soil")
- Air monitoring during excavation including action levels (PEL for benzene is 1 ppm, TLV for gasoline is 300 ppm – CRA screens using a Photoionization Detector (PID) for PHC contaminated soil excavations. Since benzene represents less than 5 percent of gasoline, the action level is set at 10 ppm on the PID) above the action level contingency measures will be implemented consistent with Section 5.1.5 of the Site-Specific Health and Safety Plan for the Smelter and Refinery Decommissioning Project
- Equipment decontamination and management of decontamination water to prevent tracking of contaminated material to other portions of the Site
- Location of the land farming operation
- Appropriate transport route from the excavation to the land farming operation
- Procedures and specifications for placement and grading of material at the land farming location
- A source of clean fill to restore grades to original ground surface

The development of the excavation plan could be implemented immediately. Conducting the actual soil removal should be completed following the removal of hazardous materials, scrap metal and general debris from the South Yard. Removing the material will prevent excavation activities from being delayed if the excavation extends into an area where materials are stored in the South Yard.

An estimate of the Vale labour requirements for the above task is presented on Table 2.3d. The labour estimate includes the following tasks for the PHC-Impacted Soil:

- Vale PM will contract soil removal plan and license application for PHC soil/land farming activity to a qualified consultant
- Excavation of soil conducted by Vale mobile equipment operator at the direction of qualified consultant
- Coordination by Vale PM

The duration to complete the above tasks is estimated to be on the order of 90 days.

2.6 UTILITY RE-ROUTING

The utilities shutdown procedures will be provide to Vale under a separate cover as a part of the Utilities Decommissioning 100 Percent Design Brief Report.

2.7 COPPER/ARSENIC PONDS

There are two copper/arsenic ponds located in the South Yard. Copper Pond No. 3, located on the western side of the South Yard, is not in operation and contains stockpiles of material. Copper Pond No. 4, located on the eastern side of the South Yard, contains standing water and receives intermittent discharges from the Refinery. The copper/arsenic ponds are discussed in Section 7.3 as a concurrent project. Vale is considering processing the material in the Refinery following the cessation of production activities. As a result, the copper/arsenic ponds will not be addressed as a part of the South Yard Material Management activities.

3.0 SMELTER SHUTDOWN

The purpose of the Smelter Shutdown Plan is to minimize to the extent practical residual intermediate products and raw materials present in the Smelter process. Minimizing the residual intermediate products and raw materials, minimizes costs and generates the maximum amount of revenue for the Thompson Mine Site.

The major stages for Smelter ramp down and shutdown are as follows:

- Furnace No. 5 hearth removal and processing
- Furnace No. 1 hearth removal and processing (if the No. 1 Furnace is not in operation prior to Smelter Shutdown)
- Dust Cleaning Campaign
- Dust Cleaning Maintenance
- Copper Calcine Material Removal/Cleaning (material can be removed during production operations in the Smelter)
- Dead Storage/Inspection Potential Solidified Material Removal
- Cottrell Area Hopper Inspection/Cleaning
- Individual processing area shutdowns
- Final shutdown and cleaning

Smelter Area shutdown planning will require support and input from the various projects anticipated or planned. The primary consideration for the Smelter shutdown is the date for the re-routing of the Mill feed to the Concentrate Load-out Facility or a temporary load-out facility and the amount of sulphur dioxide (SO_2) emissions that are available below the 2015 emission limit for processing material that is in the various stages of the Smelter system. Forecasting planned production and production after the Mill feed is re-routed will dictate the level of effort required to empty raw material and process intermediates from the Smelter system.

The overall Smelter shutdown schedule is summarized below. The schedule for material drawdown and utilization depends on the date the Mill feed is re-routed to the Concentrate Load-out Facility. The date for the Mill feed re-route is assumed to occur in February 2014. At the time of the preparation of this plan, Vale was discussing an extension for the continued operation of the Smelter beyond 2015. If negotiations are successful the dates presented in this section will require revision. There are several tasks that could be conducted at any point from the date of this report through to completion of production activities in the Smelter. These activities are identified below as tasks that could be completed immediately. The schedule also assumes that the 2013 Summer Shutdown will be the last shutdown prior to the final shutdown in 2015.

Stage	***Schedule***	***Duration***
Shutdown Planning	January 2013 - December 2014	20 months
Dust Campaign Cleaning	Shutdown 2013	21 days
Maintenance Dust Cleaning	August 2013 – end-of-production	18 months
Dead Storage Inspection/Cleaning	Shutdown 2013	14 days
Furnace No. 5 Hearth Removal	Immediate to August 2014	60 days
Furnace No. 1 Hearth Removal	Furnace shutdown to August 2014	60 days
Copper Calcine Process Residuals	Immediate to end-of-production	60 days
Sample House Shutdown	April 2015	14 days
Feed Drawdown	January 2015	20 days
Thickener Area Shutdown	January 2015	30 days
Roaster Area Shutdown	January 2015	15 days
Furnace Area Shutdown	December 2014 - May 2015	180 days
Converter Area Shutdown	January 2015 – February 2015	30 days
Anode Casting Area Shutdown	January 2015 - February 2015	15 days
ESP/Dust Management Shutdown	January 2015 - February 2015	30 days
Utility Shutdown (Oxygen and Fuel Oil)	May 2015 – June 2015	60 days

The final Smelter shutdown and demolition will occur once all additional Vale projects have been completed and therefore the schedule subject to change. CRA estimates that the final shutdown could occur any time between March 2015 and April 2015 depending upon the timing and extent of the identified additional projects. The above tasks are described in the following sections.

3.1 SMELTER DESCRIPTION

The Smelter is a continuous process that runs 24 hours a day seven days a week. The Smelter casts anodes all year round with the exception of an annual shutdown that occurs for a four week period in late July/early August. The Smelter receives concentrates from the Mill and reverts from the Refinery that are dewatered and then processed through roasters, furnaces and converters to oxidize sulphides present in the concentrate and remove other impurities. Voisey's Bay Nickel (VBN) (an external feed to the Thompson Mine Site) is also a feed to the roasters in the Smelter. Figure 3.1 presents a simplified version of the Smelter Process Flow.

Concentrate from the Mill and reverts from the Refinery are dewatered in one high rate thickener. The underflow density of the thickener ranges from 60 to 70 percent solids. The underflow of the thickener flows to storage tanks in the thickener. Two 1,500 tonne storage tanks are referred to as Dead Storage tanks and the third 1,100 tonne storage tank is referred to as the Live Storage tank because material is actively pumped from the Live Storage tank to the next unit process. The dewatered nickel concentrate is pumped from the Live Storage tank to a plate and frame filter press that further dewaters the concentrate from the thickener to between 88 to 91 percent solids. The dewatered filter cake from the filter press is fed via belt conveyors to two rotary bins that meter the dewatered filter cake to two fluidized bed roasters. VBN and silica sand are mixed with the dewatered filter cake prior to being fed to the rotary bins.

The purpose of the roasters is to oxidize half of the concentrate's sulfur and iron. The oxidation of iron and sulfur is an exothermic reaction. The heat evolved from the oxidation reactions provides all the required heat for the roasting process. The roaster temperature ranges between 600 to 700 degrees Celsius and is controlled by the dewatered filter cake/VBN mixture feed rate. A 60 percent silica flux is added to the concentrate prior to the roasters as sand. Compressed air is injected into the roasters to maintain turbulence in the roaster fluidized bed. The mass of concentrate that does not exit the roaster via the exhaust gas is removed from the roaster as roaster bottoms. Roaster bottoms are fed to one of the two electric furnaces by drag conveyor. Cyclones collect 85 percent of the dust that exits the roasters in the exhaust gas. The material collected in the cyclones is fed to the one of the two electric furnaces by drag conveyor. The dust that is not removed from the roaster exhaust gas flows through an Electrostatic Precipitator (ESP). The ESP achieves over 98 percent dust removal. The dust removed from the ESP is fed by drag conveyor to the two submerged electric arc furnaces.

The main smelting reactions in the furnaces are the reduction of magnetite to ferrous oxide by unroasted iron sulphide and reaction of ferrous oxide with silica and quartz fluxes to form an iron silicate slag. The slag rises to the top of the furnace and is skimmed from the furnace, granulated by quenching and pumped to the Slag Pile located in the area adjacent to the western side of the Smelter. The matte containing 30 to 35 nickel and copper as well as iron, sulphur and cobalt sinks to the bottom of the furnace. The matte is tapped from the furnace to ladles for transfer to the converting process.

There are six air blown converters in the Smelter that accept ladles of matte from the two electric furnaces in the Smelter. Similar to the roasters, the exothermic oxidation reactions heat the converters. The converters remove the iron by selective oxidation. Additional flux and silica is added to the converter for slagging. Air and/or oxygen enriched air can be blown into the back of the converter. The converter matte (Bessemer matte) contains 76 percent nickel, 2.5 to 3 percent copper, 18 to 20 percent sulfur, 0.7 percent cobalt, some arsenic and about 0.5 percent iron. All converter slag is transferred back to the electric furnaces. The matte is poured from the converters to ladles that transfer the molten matte to a casting ladle/tundish that feeds a casting line for the production of anodes for use in the Refinery.

Vale provided production rate/usage information to CRA for development of this Shutdown Procedures Plan. The data is presented in Appendix C. The production/usage data includes data for both single furnace operation for the period of April 1, 2012 to April 26, 2012 and dual furnace operation for the period of April 27, 2012 to June 30, 2012. Table 2.1 presents average, minimum and maximum production/usage rates for the Smelter for both single and dual furnace operation. In general the usage rates of raw materials are lower for single furnace operation as compared to dual furnace operation. For the purposes of estimating the rate at which the Smelter can reduce inventories of raw materials the slower usage rate of the single furnace operation will be used to estimate durations.

Vale also provided CRA the 2014 Thompson Mine Site production forecast (Appendix D). The achievable rate of production affects the overall rate at which materials are used at the Smelter. The 2014 production rate will influence the estimated start date for drawing down material inventories in the Smelter. It should be noted that these production forecasts should be revisited and the schedule presented herein for Smelter shutdown should be revised as necessary in early 2014. The production schedule may change pending the result of Vale negotiations to extend the operation of the Smelter beyond 2015.

3.2 PRE-SHUTDOWN CONSIDERATIONS

3.2.1 ORE CONCENTRATE DRAW DOWN DURATION

The primary feed to the Smelter is ore concentrate from the Mill. The critical shutdown consideration for the Smelter is the date the mill feed is switched from the Smelter to the Concentrate Load-out Facility that is under construction. In order to maximize the financial return to the Thompson Mine Site, the changeover of the feed to the Concentrate Load-out Facility must occur with a sufficient mass of sulfur dioxide emissions, below the regulatory limit, to process the standing volume of concentrate in the higher rate thickener, live and dead storage tanks and utilize VBN and refinery reverts present on Site.

Based on the construction drawings of the high rate thickener, the standing volume of ore concentrate in the high rate thickener is approximately 500 cubic meters. Based on the production/usage data present in Appendix C and summarized on Table 2.1, the average underflow rate to the live and/or dead storage tanks is 1,718 cubic meters (for single furnace operation). The thickener underflow rate represents approximately 21 percent of the total ore concentrate flow rate from the Mill under normal continuous operating conditions. For the purposes of this Shutdown Procedures Plan, it is assumed that through minor adjustments of the thickener operating conditions, following re-routing of the Mill feed, that approximately 20 to 40 percent of the standing volume in the high rate thickener will be able to be dewatered to 60 to 70 percent solids and pumped to the live storage tank for further processing. The average underflow rate of the thickener (single furnace operation) is 1,718 cubic meters per day. Some reduction of the thickener underflow rate to allow for longer settling times to maximize the amount of ore concentrate that can be removed for the thickener should be anticipated once the mill feed is diverted to the Concentrate Load-out Facility. However, the high rate thickener should likely be drained within a day of operation to 80 to 60 percent of the standing volume in the thickener. The remaining volume in the thickener will be removed as described in Section 3.5.

In addition to the standing volume of ore concentrate in the thickener, there are two 1,500 tonne Dead Storage tanks and one 1,100 tonne Live Storage Tank in the Thickener Area. The concentrate stored in the three storage tanks is processed in the filter press prior to being fed to the roasters. The average filter press output for single furnace operation is 485 tons per day. The filter press dewaters concentrate from approximately 70 percent solids to approximately 90 percent solids. For every tonne of dewatered concentrate leaving the filter press approximately 1.3 tonnes of concentrate is fed to the filter press. Therefore the standing ore concentrate in the three Thickener Area storage tanks can be drawn down at a rate of approximately 630 tonnes per day. Assuming 90 percent of the material in the Thickener Area is recoverable, the maximum duration to drain the Thickener Area storage tanks is on the order of seven to eight days.

Following the filter press there is limited in-process storage of concentrate before the concentrate is roasted. There are two rotary bins each with 50 tonne capacity. The 50 tonne capacity of the rotary bin would be utilized in the span of three to four hours. Refinery reverts are processed through the roaster/furnace. The revert bin has a 226 tonne capacity. An allowance should be included in the ramp down plan to account for processing Refinery reverts and any remaining VBN on hand. Assuming reverts/VBN can be fed to the roaster/furnace at a similar rate as the output of ore concentrate from the filter press the processing of Refinery reverts could be completed in a timeframe on the order of two to three days.

Following the final charge of concentrate/Refinery reverts to the roasters, dust present in the dust bins and flues will be fed to the furnaces. Based on the feed rate of ore concentrate, VBN and sand to the roasters at 90 percent solids the daily feed rate of dust to the furnace under single furnace operation is on the order of 980 tonnes per day. Vale provided CRA a month end inventory of material present in the Smelter process. The Smelter month end inventory sheet is presented in Appendix F. The total dust present in the Smelter process (flue dust and furnace calcine) based on the month end inventory sheet is estimated to be on the order of 960 tonnes of dust. Based on the above, an allowance of one to two days to feed dust to the furnace should be included in the ramp down schedule. If, prior to final shutdown of the Smelter, Smelter production switches to single furnace operation only one of the roasters will be operating. When one roaster is in operation portions of the ESP can be blanked off from the process and de-energized to allow for dust cleaning of the ESP. This is an opportunity for Vale to process more of the in-process dust in the Smelter prior to final closure of the Smelter.

The total volume of furnace matte (molten material) in the furnaces ranges between 300 to 500 tonnes. Approximately, 100 to 200 tonnes of material cannot be tapped from the furnace for use in the converters. Assuming one ladle can receive 20 tonnes of molten material per tap of the furnace, the maximum amount of taps of the furnace would be 20 to reduce to the minimum bath level prior to cooling of the furnace. The average number of converter pours per day for single and dual furnace operation is 11 and 13, respectively. Based on the above, the duration to draw down the bath level in the furnace would be on the order of two days for single furnace operation. If both furnaces are operating at the time the mill feed is switched to the Concentrate Load-out Facility there will be a maximum of 400 tons of castable material in each furnace. Assuming a ladle capacity of 20 tonnes and a casting rate of 13 pours per day for dual furnace operation, the duration to draw down the bath level of the furnaces would be on the order of 3 to 4 days.

In summary, the number of days in which the Smelter will operate following the change of the Mill feed to the Concentrate Load-out Facility is as follows:

Task	***Duration (Days)***
Thickener Drawdown	1
Drain Thickener Area Storage Tanks	7 to 8
Rotary and Revert Usage	2 to 3
Dust Usage in Furnace(s)	2 to 3
Furnace Drawdown	3 to 4
TOTAL:	**15 to 19**

Based on the above durations, the diversion of the mill feed to the Concentrate Load-out Facility should occur, at a minimum, on the order of 20 days prior to the Smelter exceeding the annual sulfur dioxide emission limit.

3.2.2 SMELTER DUST CLEANING

Dust is generated through the course of normal operations of the Smelter. Currently, a significant accumulation of fugitive dust is present on surfaces without regular traffic throughout the Smelter. The recovery of dust in the Smelter represents a financial opportunity for the project by reclaiming the dust and processing the dust through the Smelter to recover the nickel content. Recovering the nickel content will allow Vale to recovery some of the costs that would otherwise be incurred if the Demolition Contractor would be required to conduct a cleaning campaign prior to demolishing the Smelter Building. An initial intensive cleaning campaign conducted by Vale will also reduce direct cost related to the demolition. In the Smelter's current condition the Demolition Contractor would likely conduct cleaning prior to removal of equipment and ultimate demolition of the building in order to ensure suitability of the scrap metal for transport and processing. The Demolition Contractor would pass the effort related to cleaning the Smelter to Vale through its demolition pricing structure.

CRA proposes that a dust cleaning campaign should be conducted by Vale consisting of a focused cleaning during the last annual shutdown prior to closure followed by a regular maintenance cleaning up to final Smelter shutdown. The focused cleaning campaign should commence during last annual shutdown. CRA anticipates that if the Smelter sulfur dioxide limit for 2015 does not increase, no shutdown will occur in 2014 and the Smelter will operate through the regularly scheduled annual shutdown in 2014. CRA estimated four cleaning crews consisting of two labourers and one equipment operator organized by a foreman will be required for the four week cleaning campaign. Following the focused cleaning campaign during the 2013 shutdown, regular maintenance cleaning consisting of one week of cleaning for one three man crew should be completed on a monthly basis up to Smelter shutdown. All cleaning would be completed by dry means (i.e., vac-truck, vac-boxes with hoses, floor sweepers, etc.). The labour estimate for the focused cleaning campaign and ongoing maintenance cleaning is presented in Table 3.1a.

3.2.3 DEAD PULP STORAGE INSPECTION/CLEANING THICKENER AREA

The two 1,500 tonne ore concentrate storage tanks that receive the underflow from the thickener, known as the Dead Storage Tanks, are not agitated tanks. Vale personnel have indicated that the Dead Storage Tanks can contain significant accumulations of settled material in the bottom of the tanks. The settled material hardens and must be removed by first draining the tank and chipping out the settled material by mechanical means. It is not known at this time the thickness of solidified material in the Dead Storage Tanks. The Dead Storage Tanks should be drawn down at some point prior to the final annual Smelter shutdown so the bottoms of the tanks can be inspected. If solidified material is observed in the bottoms of the tanks, a cleaning task can be added to the final annual shutdown schedule. Conducting the material removal from the Dead Storage Tanks during the final annual shutdown will allow the material removed to be processed through the Smelter prior to closure. There is no rational basis for estimating the labour for the cleaning task at this time. The time required to clean the tanks is dependent on the amount and hardness of the solidified material in the tanks. Each tank also has a man way entrance. Historic Plans of the Dead Storage Tanks include interior platforms and walkways in each tank. However, the interior platforms and walkways are no longer present in either tank. Exterior walkways are present around the tanks but are no longer structurally sound. The conditions of the man way entrance and exterior walkways will affect the level of effort required to remove material. If significant repairs to the tank are required to allow access to the tank a cost-benefit analysis should be conducted to determine if the value in removing the solidified material prior to shutdown of the Smelter exceeds the revenue generated by processing the material. Assuming the tank is accessible, two laborers with intermittent mobile equipment operator work for a period of two weeks is a reasonable estimate of the labour required to clean the tanks. In order to reduce the amount of solidified material in the bottom of the tanks, the tanks will be agitated by pumping and applying air to the tank to minimize settling in the tank during the drawdown of the liquid level. The labour estimate for the Dead Storage Tank Inspection/Cleaning is presented in Table 3.1b. Not including project planning by the Vale PM to arrange the drawdown and inspection of the tanks, the duration of the actual material removal from the tanks is estimate to be on the order of two weeks.

Following cleaning of the Dead Storage Tanks Vale may elect to place one of the Dead Storage Tanks out of service to minimize the drawdown duration and cleaning effort when the Smelter production operations cease.

3.2.4 COTTRELL HOPPER INSPECTION/CLEANING

The Cottrell Area of the Smelter is located immediately west of the Smelter stack. The Cottrell area consists of the original ESP for the Smelter. The ESP ionizes particles present in the exhaust stream of the Smelter, which are then collected on charged metals rods. Each rod is equipped with a rapping device to remove the particles which are collected in hoppers. During CRA's December 2011 Site inspection Vale production staff indicated that several of the hoppers that collected the dust particles in the Cottrell Area are clogged and have filled with material. The interior of the hoppers could not be inspected during operation of the ESP. During the final annual shutdown the hoppers in the Cottrell Area should be inspected to determine if material has accumulated in the hoppers. If the hoppers can be accessed, the material should be removed and processed through the Smelter for nickel recovery prior to the Smelter shutdown. There is no rational basis for estimating the labour for the cleaning task at this time. The time required to clean the hoppers is dependent on the amount and hardness of the solidified material and the number of hoppers that contain solidified material. If significant modifications to the hoppers are required to allow access to remove the solidified material, a cost benefit analysis should be conducted to determine the value in removing the solidified material prior to shutdown of the Smelter. Assuming the hoppers are accessible, a crew of four laborers with intermittent mobile equipment operator work for a two week period is included as an estimate of the labour required to clean solidified material from the hoppers in the Cottrell Area. The estimate labour for inspection and cleaning of the Cottrell Area is presented in Table 3.1c. The duration over which the labour will be deployed is estimate to be on the order of 30 days.

3.2.5 FURNACE NO. 5 HEARTH/REFRACTORY REMOVAL AND PROCESSING

Furnace No. 5 in the Smelter was not operational at the time of CRA's December 2011 initial Smelter inspection. The solidified hearth of the furnace has not been removed from Furnace No. 5. Vale estimates that approximately 150 tonnes of material are present in the hearth. The material in the hearth can be removed and charged to the converters at a rate of 2 tonnes per converter charge. This task is independent of any other shutdown tasks and could be completed immediately. The hearth would be cut into one tonne pieces and removed from the furnace. The one tonne pieces of hearth can be charged to the converters at a rate of 2 tons per converter charge.

The refractory brick that is typically below the level of the molten bath of the furnace absorbs metals. The brick can be processed to extract the metal content of the refractory material. Following removal of the solidified furnace hearth, the refractory could be sampled to determine whether processing the refractory for metal recovery is viable. Depending on the results of the sampling and the capacity within Vale, the refractory material could be processed at the Site, shipped to another Vale location, or sold to an external market for processing.

The labour estimate includes effort by Vale mobile equipment operators and labourers. An estimate of the Vale labour requirements for the above task is presented on Table 3.1d. The duration over which the labour will be deployed is estimated to be on the order of 60 days.

Prior to the final diversion of the Mill feed from the Smelter, the Smelter production operations may be conducted as a single furnace operation. If the Smelter switches to single furnace operation prior to the diversion of the Mill feed from the Smelter, the hearth of Furnace No. 1 could also be processed in the Smelter. The switch to single furnace operation would have to occur with sufficient time for the drawdown of the furnace, cooling and removal of the hearth with sufficient capacity for the converters to receive and process the hearth. As described above the converters can accept 2 tonnes of hearth per converter charge. The Furnace No. 1 Hearth is anticipated to contain 150 tonnes of material. Based on the Smelter operational data summarized on Table 2.2, during single furnace operation there are 11 converter pours per day. Vale has indicated that two tonnes of furnace hearth can be processed per converter charge. Based on this production rate processing of the furnace hearth would take on the order of one to two weeks to complete.

3.2.6 COPPER CALCINE PROCESS RESIDUALS

The Copper Calcine process is no longer in operation in the Smelter. However, there remains significant volumes of copper containing residuals in the Smelter that could be processed within Vale. The Smelter inventory sheet presented in Appendix F indicates the following process residuals are present in the Smelter:

- Copper Concentrate – 400 Dry Tonnes (trapped in No. 4 Dead Storage)
- Copper Residue – 806 Dry Tonnes
- Sulphur Anode Slimes (SAS) – 605 Dry Tonnes (currently in No. 8 thickener)
- Copper Calcine – 37 Dry Tonnes (trapped in Calcine Silo)
- Brick – 1423 Dry Tonnes (to be shipped to Ontario for sale to Xstrata)
- Roaster Calcine – 37 Dry Tonnes

The above quantities of materials represent a cost to Vale if this material must be managed as waste as a part of the demolition. If the Site does not have the current capacity to process the material or sufficient quantities to sell, Vale should identify if an opportunity exists to process this material at another Vale facility.

This task includes accessing and removing the copper calcine material in the process vessels and staging the material for uses on Site or shipment. Assuming the material can be processed, the removal of material from the No. 8 thickener and the No. 4 Dead Storage will include a final pressure wash of the interior of the units. Wash water can be routed to the existing trench/sump system that directs water to the Mill Sump. The wash water can be routed to the tailings with the thickener overflow for disposal or to the Mill for reuse.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1e. The duration over which the labour will be deployed is estimated to be on the order of 60 days.

3.3 PRE-SHUTDOWN PREPARATION

The Smelter shutdown will commence when the Mill feed is cut off from the Smelter and directed to the Concentrate Load-out Facility. The objective of the pre-shutdown is to complete the necessary production planning required prior to final shutdown. Specifically, Vale will adjust forecasts for raw material usage for the remainder of the

Smelter operations, identify waste materials for characterization and removal and complete pre-cleaning activities prior to final shutdown. Shutdown planning tasks will include:

- Re-assess and adjust forecasted usage and drawdown raw material inventories of quartz, silica sand, Percol (flocculent used in the high rate thickener), scrap in 2014/2015 to ensure that minimal amounts of these materials remain after final shutdown
- Identify required inventories of personal protective equipment for production and shutdown to ensure that enough supplies are available for the completion of the ramp down/shutdown
- Commence South Yard scrap metal, equipment and waste management activities so Vale can process soil through the Smelter if processing soil through the Smelter is economically viable
- Develop utility final isolation and shutdown procedure in early 2014
- Market and sell equipment as identified in the Asset Inventory (provided under separate cover)
- Conduct cleaning and shutdown work as described in this report
- Identify any shutdown work that will be contracted out, prepare and issue bid documents and final contracts in advance of the shutdown
- Stage material for processing either through the Mill or at Vale Ontario that will remain in the Smelter after shutdown of the furnaces
- Identify staging and storage areas for use during Smelter shutdown (the thickener area can be used as a staging area for materials that can be slurried and fed back through the Mill and as an equipment decontamination area by the Demolition Contractor)
- The VBN building located at the south east corner of the Smelter could be used for the storage and staging of dust from cleaning activities and residual raw materials

3.4 SAMPLE HOUSE SMELTER SHUTDOWN AND RELOCATION

The Smelter sample house is located near the south east corner of the Smelter Building approximately 50 meters north of the VBN Building. The sample house processes process-related samples collected in the Smelter to evaluate grades of material produced and raw materials entering the Smelter. The sample house includes various laboratory scale mills, ovens and hoods as well as miscellaneous metallurgical laboratory equipment. Following the final analysis of any Smelter-related process samples any residual sample volume should be discarded consistent with current practices or returned back to the material storage area in the Smelter. The Smelter sample house laboratory could remain operational for the purposes of testing material prior to shipment of saleable process intermediates from the Smelter and Refinery. In order to maintain the sample house laboratory, heating and power will be required. Alternate power supply will have to be identified before production operations cease in Smelter. If modifications to the power and heat supply are not practical or qualified staff for the laboratory is not available at the time of Smelter closure an outside laboratory could be contracted to complete characterization of saleable material prior to shipment from the Site. Following completion of the operation of the laboratory, the laboratory equipment could be removed from the sample house and transferred to another laboratory location at the mine site. The Smelter sample house is heated and includes a safe room and staff breakroom. This area could be used by the Demolition Contractor during the initial hazardous material removal/demolition cleaning/equipment removal phases of the demolition process. In order for the sample house to be usable as a potential office space or staging area for demolition personnel, the sample house will have to remain heated following the Smelter ramp down or the water lines in the sample house will have to be shut off and drained to prevent damage to the plumbing system during freezing conditions. Alternatively, the Smelter administration offices could also be used by the Demolition Contractor as office space during the during the initial hazardous material removal/demolition cleaning/equipment removal phases of the demolition process. The Smelter administration offices' utilities are self-contained. Similarly, the Smelter administrative offices will have to remain heated following the Smelter ramp down or the water lines will have to be shut off and drained to prevent damage to the plumbing system during freezing conditions.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1f. The labour estimate includes the following tasks for the sample house shutdown:

- Vale PM will conduct inspection with Vale lab staff to identify equipment to be transferred and identify any asbestos containing material in the sample house (No equipment/material that contains asbestos will be removed/disturbed without appropriate abatement)
- Vale maintenance staff will conduct equipment disconnects and isolation and draining of the water system
- Vale mobile equipment operator and labourers will remove equipment

The duration to complete the above tasks is estimated to be on the order of 14 days.

3.5 THICKENER SHUTDOWN

The current major operating process equipment in the Thickener Area consists of the following:

- One 15 meter diameter High Rate Thickener
- Percol (Thickener Flocculent) system
- Two 1,500 ton Concentrate Storage Tanks (Dead Storage)
- One 1,100 ton Storage Tank (Live Storage – Concentrate is pumped from Live Storage Tank to Filter Press)
- Plate and Frame Filter Press

In addition to the above major process units the Thickener Area contains various miscellaneous equipment that supports the operation of the above units including pumps, piping, tanks, pressurized air, conveyors, electric motors, valves, sumps, trenches, etc.

As described in Section 3.2.1, following the re-routing of the Mill feed to the Concentrate Load-out Facility there will be approximately 500 cubic meters of material in the high rate thickener. The average thickener underflow rate is 1,718 cubic meters per day. Based on the volume of the thickener and the average flow rate, the average residence time for material in the thickener is approximately 7 hours. Under continuous (normal) operating conditions the underflow rate of the High Rate thickener is approximately 21 percent of the total Mill feed flow rate. The operation of the thickener is controlled to achieve a density in the underflow of 60 to 70 percent solids. Once the feed to the thickener is removed the thickener will no longer be able to remove clarified water via the thickener over flow. As the water level in the thickener drops and as material is removed via the underflow, the rake in the high rate thickener should be lowered at a proportional rate to prevent mixing of settled material with the overlying clarified water. The underflow pumping rate should be reduced to a lower setting of the pump's acceptable operating range. The lower pumping rate will increase residency time in the thickener and allow for increased settling of material. For the period of two to three hours prior to the re-routing of the Mill feed to the Concentrate Load-out Facility the flocculent addition rate to the thickener could be increased to promote settling in the thickener and utilize available flocculent (Percol). However, over flocculation of the thickener can be counterproductive and impede settling rate and bed compaction. If a flocculation study was completed at the time of commissioning of the High-Rate Thickener, the study should be reviewed to determine the maximum dose of Percol per volume of feed in the thickener. Careful planning of the Percol usage can minimize the amount of Percol present at the time of the diversion of the Mill Feed. Process control set points and interlocks may require modification for the drawdown of the thickener level. Once the percent solids level drops below the threshold that is acceptable for the efficient operation of the filter press the thickener draw down should be stopped. The normal operating range of the thickener is 60 to 70 percent solids in the underflow. Smelter process engineers should define the lower limit for percent solids to the filter press. It is anticipated that approximately 60 to 80 percent of the total standing volume of the thickener will require management after underflow pumping is complete.

The material that remains in the thickener after underflow pumping is complete can be pumped from the thickener using the existing piping system or a portable pump and the liquid can be discharged to the existing sump and trench system in the first floor of the Thickener Area. The material can be conveyed to the Mill for blending with the mill feed to the Concentrate Load-out Facility. Following the removal of liquid, the inside of the thickener will be pressure washed. The wash water will be pumped to the sump system for reuse at the Mill.

While the thickener level is being drawn down the underflow rate will be reduced. The flow rate of material to the filter press from the Live Storage Tank will need to be maintained to operate the filter press. The operating level in the Live Storage Tank will be maintained by pumping material from the two 1,500 tonne Dead Storage Tanks. Once the thickener underflow is stopped the Dead Storage Tanks will be pumped to the Live Storage tank until the Dead Storage Tanks are pumped to their minimum level. Once the Dead Storage Tanks are drawn down to their minimum level the Live Storage Tanks will be drawn to its minimum level. As discussed in Section 3.2.1, the drawdown of material from the Dead and Live Storage Tanks will take on the order of seven to eight days. In order for the drawdown to be completed, process interlocks and set points will likely require modification. Following drawdown of material, any residual material in the tanks could be drained to the existing trench and sump system in the Thickener Area for use in the Mill. After the draining of any material, the interior of the storage tanks can be pressure washed. Draining of the Live and Dead Storage residual material and pressure washing should not occur until the final cycle of the filter press is complete as cleaning of process lines could result in liquid draining back to the Live and Dead Storage Tanks. All wash water can be diverted to the trench and sump system for use in the Mill.

The ore concentrate from the Live Storage Tank is fed to an agitated feed tank for the filter press. The volume in the feed tank will be drawn down to the minimum level through the cycling of the filter press. When sufficient volume in the feed tank is not available for a full cycle of the filter press, filter press operation will cease. Following completion of the final filter press cycle, final cleaning and draining of the Live and Dead Storage tanks and filter press feed tank can be conducted. In addition, all process lines in the Thickener Area should be jetted clean to remove residuals. All wash water can be routed to the Mill for re-use. All water lines in the thickener should be drained to prevent damage due to freezing. The filter air pressure tank should be isolated and depressurized. All water containing tanks that support the filter press operation should be drained. Draining of all piping and tanks related to the filter press will prevent potential damage due to freezing conditions and provide the best opportunity for resale of the filter press unit.

The powering down procedure of the Thickener Area should be completed according to Vale lock out/tag out procedures. The locks to the various processes in the Smelter should only be removed once the electrical feed to the Smelter has been removed. Following lock out all oil containing equipment should be drained and disposed consistent with the Waste Management Plan.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1g. The duration to complete the above tasks is estimated to be on the order of 30 days.

3.6 ROASTER SHUTDOWN

The Roaster System consists of the flowing major process equipment.

- Two 50 ton Rotary bins
- Two fluidized bed Roasters
- Four Cyclones

In addition to the above major process units the Roaster System consists of various miscellaneous equipment that supports the operation of the above units including pressurized air, conveyors, electric motors, valves, emission control equipment meters, etc.

The temperature of the roaster is maintained by the heat evolved from the oxidation reactions of iron and sulfur in the feed from the rotary bins. Once the rotary bins empty the final charge of material to the roasters, the roaster temperature will start to decrease once the rate of oxidation of sulfur and iron begins to decrease. Once the temperature in the roaster begins to fall, the compressed air that creates to the fluidized bed of concentrate in the roaster should be cut and the system depressurized. The material in the bed will fall to the bottom of the roaster and will be removed to the furnace for use in the smelting process by the existing conveyor system. Once the pressurized air is not maintaining the fluidized bed height, no material will reach the cyclones. Any material in the cyclones will fall to the bottom of the unit under the influence of gravity. Vale has developed Standard Procedure Instructions (SPI)s for roaster shutdown. The SPIs have been developed for routine and major maintenance. The current SPIs were developed to ensure an efficient re-start of the roaster systems following maintenance. The roasters will not be re-started following Smelter Shutdown. The purpose of the roaster shutdown is to process the maximum amount of residual material in the roaster in the furnaces. The SPIs provided by Vale as of the date of this report are presented in Appendix G. The SPIs included in this report should be confirmed to be current prior to conducting any work.

Following shutdown and isolation of the roaster system, the rotary bins, roasters and cyclones can be inspected to determine if the interior of the vessels require cleaning. Any material solidified to the interior of the roasters and rotary bins would be removed by mechanical means. Any material removed from the rotary bins could be routed to the Concentrate Load-out Facility or Mill for blending with ore concentrate.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1h.

The labour estimate includes the following tasks for the Roaster Shutdown:

- Isolation of Roaster system electrical, roaster and mechanical systems (conveyors and rotary bins using Vale lock out/tag out procedures (Vale roaster SPIs are presented in Appendix G - SPIs must be confirmed to be current prior to implementing any work)
- Vale PM will conduct inspection of interior of process vessel to determine if cleaning is required
- Vale mobile equipment operator and labourers to conduct cleaning of process vessels (including revert bin)/staging of material

The duration to complete the above tasks is estimated to be on the order of 14 days.

3.7 FURNACE SHUTDOWN

There are two submerged electric arc furnaces in operation in the Smelter as of the date of this report. CRA assumes that both furnaces will be in operation at the time the Mill feed is re-directed to the Concentrate Load-out Facility. Vale has indicated that Furnace No.1 is close to its operation limit in terms of requiring a rebuild. If Furnace No.1 goes down prior to the re-routing of the Mill feed to the Concentrate Load-out Facility, the Furnace No. 1 hearth and refractory could be processed in the Smelter. The furnace shutdown procedure assumes both furnaces will be operating at the time the Mill feed to the Smelter is discontinued. Both furnaces contain approximately 300 to 500 tonnes of molten material in the furnace bath. Approximately, 100 to 200 tonnes of material cannot be tapped from the furnaces for use in the converters and must be allowed to cool in the furnace following shutdown. Inputs to the Smelter include dust collected from the roasting process and ESPs and converter slag. Converter slag is skimmed from the converters and sent back to the furnaces for processing. To allow converter slag to be processed in the furnaces during the draw down of the molten bath, the furnace levels should be drawn down both in series (i.e., draw down the bath level in one furnace to the minimum level followed by draw down of the second furnace). Assuming each ladle can receive 20 tonnes of molten material and the 13 converter pours can be completed daily, each furnace can be drawn down in approximately two days. The slag skimmed from the converters from the drawdown of the first furnace will be returned to the second furnace for processing. The final pours from the second furnace will be not be processed through the anode casting lines because slag from the converters cannot be returned to the furnace once drawn down to the furnaces minimum level. The final pours from the converters will be allowed to cool in ladles or alternate vessel as directed by Vale staff. The material will be broken up and sized for sale as scrap.

Once the furnaces have been drawn down to their minimum level the electrodes of the furnaces will be powered down and the furnaces allowed to cool. The furnace system should be locked out according Vale lock out/tag out protocols. The locks to the various processes in the Smelter should only be removed once the electrical feed to the Smelter has been removed. Vale has developed SPIs for furnace shutdown. The SPIs have been developed for takedown of the furnace for the annual shutdown of the furnace and for rebuilding the furnaces. The SPIs identify the monitoring requirements and adjustment ranges for the tie rods. Proper adjustment of the furnace shell is critical to prevent damage to the refractory roof of the furnace. Damage to the refractory roof lining of the furnace could result in unsafe conditions for the potential removal of the furnace hearth for processing within Vale. The SPIs provided by Vale as of the date of this report are presented in Appendix G. The SPIs included in this report should be confirmed to be current prior to conducting any work.

During the period of Smelter draw down and the processing of the final converter charges the ESP will remain operational. Dust will be captured by the ESP and continue to be transferred via the Smelter pneumatic and conveyor systems to the furnace dust bins. As a result, an amount of dust will be present in the furnace dust bins following furnace shutdown. Following the final pours of the converters and final run of the casting line the dust management system including the ESP and the dust management system (conveyors and pneumatic system) will be de-energized. When the dust management system is de-energized and locked out according to Vale lock out/tag out protocols, the furnace dust bins can be cleaned using a dry vac. The material removed from the dust bins can either be staged in the VBN area for shipment and further processing at Vale Ontario or the dust can be blended with the material produced at the Concentrate Load-out Facility/temporary load-out facility.

Once the furnace hearths have completely cooled and solidified the hearths and refractory (that is below the bath level) should be removed from each furnace as described in Section 3.2.5. The material can be staged in the VBN Building prior to shipping to Vale Ontario for processing. If the Smelter switches to single furnace operation, it is possible that the hearth of one furnace that is currently in operation could be processed in the Smelter provided that heavy machinery can operate in the converter aisle while the Smelter is operational. Otherwise, the Smelter would need to switch to single furnace operation ahead of the 2013 scheduled shutdown so the hearth of the furnace could be removed and processed in the Smelter.

Following furnace power down and cooling the glycol cooling systems will require draining. The glycol removed from the furnaces must be appropriately disposed. The furnace electrode hydraulic system and any other oil containing equipment (electrical equipment) should be drained and the oil appropriately disposed. Details related to the management of hydraulic oil and glycol are presented in Sections 4.1.5 and 4.4.5 of the Waste Management Plan, respectively.

Coke requirements will be monitored during the final year of Smelter operation to limit the amount of Coke on hand when the Mill feed is diverted from the Smelter. The coke system will be locked out and depressurized. Any residual coke should be removed from the coke handling system/silo using a dry-vac. The material will be containerized and disposed off Site or in the on-Site landfill consistent with the procedures described in the Waste Management Plan.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1i. The duration to complete the above tasks is estimated to be on the order of 180 days. The labour estimate assumes the Furnace No. 1 hearth will be removed and processed in the Smelter.

3.8 CONVERTER SHUTDOWN

There are five Pierce-Smith air blown converters in operation in the Smelter as of the date of this report. Process inputs to the converters include molten matte from the furnace, scrap, quartz and silica sand. The converter uses air and/or oxygen-enriched air to control the temperature of the matte in the converter. The converter has one product stream – the Bessemer matte that is transferred by ladle to the casting line. Emissions from the converters are captured by the converter hoods and routed through the Cottrell Area ESP before being emitted to the stack. Slag from the converter is returned to the furnaces for processing. When the furnaces have been tapped to their minimum level, slag from the converters cannot be returned to the furnaces. As described in Section 3.7 Furnace Shutdown, the final pour from the converters will be allowed to cool in ladles or alternate vessel as directed by Vale staff. The material will be broken up and sized for sale as scrap.

As discussed in Section 3.3, the accuracy of forecasting production rates will dictate the amount of silica sand, quartz and scrap that will be present in the storage bins located at each converter. Average usage rates for single and dual furnace operation for the various Smelter raw materials are presented on Table 2.1. Following the last converter pours any residual raw materials will be removed from the converter aisle storage bins. Crews of two labourers and one small equipment operator will be used to remove any residual material in the converter bins. The quartz and silica sand removed from the Smelter can be used as fill material in the South Yard. Fill material will be required to backfill the PHC impacted soil removed from the South Yard as a part of the Land Farming remedial action. To prevent dust generation the silica sand should not be left as the surface layer. Residual scrap will be removed from the converter bins and staged in the VBN Building prior to shipment within Vale for processing.

Following the final converter pour from each converter, each converter will be de-energized and locked out consistent with Vale lock out/tag out procedures. The pressurized air system will be isolated (refer to the Utility Disconnect Work Packages for details regarding Smelter utility closure). Smelter Maintenance Staff will drain and properly dispose of any oil contained in equipment.

The liquefied oxygen tanks located on the exterior of the north-west corner of the Smelter Building may contain residual amounts of liquefied oxygen. Vale will coordinate with the liquefied oxygen (LOX) supplier to remove residual LOX following the converter shutdown. The LOX tanks should be depressurized following removal of the residual LOX by a licensed contractor. The oxygen lines related to the converter operation will be purged with inert gas (nitrogen) as described in Section 3.12.1.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1j. The duration to complete the above tasks is estimated to be on the order of 21 days.

3.9 ANODE CASTING SHUTDOWN

The anode casting line receives ladles of matte from the converters. The ladles pour matte into a tundish that continuously supplies molten material to the casting line. Following receipt of the final ladle of matte from the converters, the tundish will cast anodes to its minimum operating level. The cast anodes will be cooled and loaded for shipment to the Refinery consistent with current Vale production procedures. Once the final anode has been removed from the casting line, the line will be de-energized and locked out consistent with Vale lock out/tag out procedures. Any residual material present in the tundish will be allowed to cool. Following lockout, any oil containing equipment will be drained and the oil will be appropriately disposed.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1k. The duration to complete the above tasks is estimated to be on the order of 7 days.

3.10 ESP SHUTDOWN

There are two ESPs located in the Smelter. The original ESP is located in the Cottrell Area is the final emissions abatement process prior to discharge of emissions to the Smelter Stack. The second ESP is located on the roof of the Smelter and receives emissions from the ore roasting process. Particulate removed from the gas stream in both ESPs is collected in the Smelter dust management system. During the period of Smelter drawdown and the processing of the final converter charges the ESP will remain operational. Dust will be captured by the ESP and continue to be transferred via the Smelter pneumatic and conveyor systems to the furnace dust bins. Following cool down of the converters neither ESP will be required to control emissions from the Smelter. Following the final pours of the converters and final run of the casting line the dust management system including the ESP, conveyors and pneumatic system will be de-energized by Smelter Electrical Staff. When the dust management system is de-energized and locked out according to Vale lock out/tag out protocols, the dust management system can be cleaned using a dry vac. The material removed from the dust management system can either be staged in the VBN area for shipping and further processing at Vale Ontario or the dust can be blended with the material produced at the Concentrate Load-out Facility.

Any oil containing equipment in the ESP will be drained and the oil appropriately disposed.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1k. The duration to complete the above tasks is estimated to be on the order of 30 days.

3.11 SMELTER SUPPORT FACILITIES SHUTDOWN

Smelter support facilities include the Thaw Shed, VBN Building and Refractory Storage. The raw materials that are managed in the Thaw Shed are silica sand, quartz and scrap. As discussed in Section 3.6 Converter Shutdown, any residual silica sand and quartz rock, used as flux in the smelting process, will be used as backfill for the PHC impacted soil excavation. Any residual scrap present in the Smelter support buildings will be staged in the VBN Building prior to shipment to Vale – Ontario for processing. Vale will complete an unused refractory material inventory one year prior to the diversion of the Mill Feed from the Smelter. A forecast of Smelter refractory material requirements for the one year period prior to shutdown will be completed to minimize the amount of unused refractory materials in the Smelter and Smelter Support Facilities. Inert refractory materials can be disposed in the existing on Site landfill. The refractory bricks that are used in the roasters, furnaces and converters are manufactured with minerals that have the potential to contain naturally occurring radio-active material (NORM). If no beneficial use for the refractory bricks can be identified, the bricks will be evaluated for the presence of NORM prior to disposing the material as described in Section 9.0 of the Waste Management Plan. Any remaining refractory material can be shipped internally to another Vale facility for use or likely returned to the supplier for the cost of shipping.

An estimate of the Vale labour requirements for the above task is presented on Table 3.1m. The labour estimate includes the following tasks for the Smelter Support Facilities Shutdown:

- Isolation of conveyor system using Vale lock out/tag out procedures by Smelter maintenance and electrical staff
- Vale mobile equipment operator and labourers to conduct cleaning of storage bins/staging of material

The duration to complete the above tasks is estimated to be on the order of 30 days.

3.12 UTILITIES SHUTDOWN/RE-ROUTING

The utilities shutdown procedures are provided to Vale under a separate cover in the Utilities Decommissioning 100 Percent Design Brief Report. Process utility shutdown procedures that are specific to the Smelter are described below.

3.12.1 OXYGEN LINES

Oxygen has two separate uses in the Smelter. Oxygen lances are used by Smelter Furnace staff for tapping of slag and furnace matte. An oxygen system is also used for converter operation to control converter temperature. Oxygen enriched air is blown through the converter to increase converter temperature. The source of oxygen for the lances and the oxygen enriched converter air are liquefied oxygen (LOX) tanks located on the exterior of the Smelter. The LOX tank for the lances is located on the exterior of the building adjacent to the northeast corner of the Thickener Area. The LOX storage tanks for the converter blow air system are located exterior to the northeast corner of the Smelter. For both LOX systems, the liquefied oxygen is piped to vaporizers that supply the latent heat required to change the state of the oxygen from liquid phase to the gas phase.

For the oxygen lance system an oxygen header runs from the exterior LOX bulk storage tank at column line B2 east toward column line D. From this point the main oxygen header runs in a north-south direction from column line 13 to column line 33. There are six oxygen lines that branch from the main oxygen header. There is a branch line in the slag granulating area of Furnace No. 1, No. 2, No. 4 and No. 5. The remaining two branch lines from the main oxygen header run east west along column lines 16 and 31 between Furnaces No. 1 and No. 2 and Furnaces No. 4 and No. 5, respectively. Both lines running between the furnaces branch at column line K and provide oxygen for the oxygen lances used to tap the furnaces. The description of the oxygen system and piping used for lancing the furnaces is based on Vale drawing 69-221-G-4347 Rev.1. Furnace No. 4 and Furnace No. 5 are no longer in operation. It is not known whether the oxygen lines associated with these furnaces have been decommissioned.

For the converter oxygen enriched blow air system, oxygen from the vaporizers located adjacent to the north east corner of the Smelter feed the main oxygen header that runs in a north-south direction adjacent to column line N between column lines 8 and 29. Branch lines run west from the main header to each of the five operating converters. The description of the oxygen system is based on the following Vale drawings:

69-231-B-12505 Rev. 3
69-231-F-12446 Rev. 3
69-231-F-12447 Rev. 5
69-231-F-12494 Rev. 4
69-231-F-12498 Rev. 4
69-231-F-12499 Rev. 4
69-231-F-12500 Rev. 4
69-231-F-12501 Rev. 4
69-231-F-12502 Rev. 5
69-231-F-12531 Rev. 3

Following the final draw down and cooling of the furnace and the final pours from the converters the oxygen systems in the Smelter can be decommissioned. LOX usage should be tracked leading up to closure to minimize the amount of LOX present in the bulk storage at the time of closure. To decommission the oxygen system the liquefied oxygen tank should be isolated from the vaporizer using Vale lockout/tag out procedures to eliminate the production of gaseous oxygen to the oxygen headers. The vaporizers should be de-energized using Vale lockout/tag out procedures. A licensed contractor will be retained to drain the LOX tanks and remove any residual LOX from the Site. The oxygen lines will then be decommissioned by purging the oxygen lines with an inert gas. Following purging of the lines that carry gaseous oxygen (i.e. after the vaporizers) the valves of the oxygen system should be locked and tagged out in the open position.

There is an estimated 360 linear meters of oxygen lines related to the oxygen lance system. The main oxygen header is 1 inch diameter pipe (approximately 130 linear meters) and the branch lines are 0.5 inch diameter lines (approximately 230 linear meters). There is an estimated 190 linear meters of oxygen lines related to the converter blow air oxygen system. The main oxygen header is a 10 inch line (approximately 150 linear meters) and smaller diameter branch lines that feed the converters (approximately 40 linear meters).

An estimate of the Vale labour requirements for the shutdown of the Oxygen Systems and associated lines is presented on Table 3.1n. The labour estimate includes the following tasks:

- Isolation of oxygen systems using Vale lockout/tag out procedures including vaporizers
- Retain a qualified contractor to perform the draining of the LOX tanks and inert gas purging of the oxygen system
- Coordinate draining of liquefied oxygen tanks by a qualified contractor
- Develop plan and complete purging of oxygen system lines with inert gas
- Contractor Oversight

3.12.2 FUEL OIL LINES

Fuel oil has numerous uses within the Smelter. The roasters, furnaces and converters are all equipped with burners that are fed by fuel oil lines. Fuel oil is used for heating at several locations in the smelter including material storage bins and the flux unloading system. The fuel oil lines in the Smelter are heat traced with steam lines. CRA's understanding of fuel oil usage in the Smelter is based on the following drawings provided by Vale:

69-201-G-9365
69-221-G-1637
69-231-G-0240
69-222-G-3737
69-221-G-1639
69-221-F-1614

Heavy fuel oils need to be warmed in order to flow. Storage tanks contain heating coils and when cleaned, typically will contain a significant amount of heavy oil residue or sludge that requires manual removal. The three fuel oil tanks located adjacent to the northwest corner of the Smelter building will be shutdown as part of this program. Vale will retain a Manitoba licensed fuel contractor to complete this work. The following is a general process for the shutdown of the fuel oil tanks:

- Isolate the fuel oil lines from the storage tanks by closing existing supply valve
- Licensed contractor to transfer residual fuel oil in storage tank to a mobile tanker
- Contractor to perform manual cleaning to remove residue from the tanks and removal of tanks from the Site

Vale will require the contractor to develop a detailed procedure for this decommissioning and emergency plan specifically tailored for the fuel oil service.

An estimate of the Vale labour requirements for the Fuel Oil System is presented on Table 3.1o. The labour estimate includes the following tasks for the Fuel Oil System Shutdown:

- Isolation of the Fuel Oil System using Vale Lockout/Tag Out procedures
- Retain a qualified contractor to perform the draining of the fuel oil tanks and cleaning of residual fuel oil/sludge from the fuel oil tanks
- Contractor Oversight

CRA estimates that there is approximately 1,800 linear meters of fuel oil lines in the Smelter. Approximately 60 meters of the total are underground lines that run from the oil tanks located in the area adjacent to the northwest corner of the Smelter to the Smelter. Due to the high viscosity of the fuel oil, the fuel oil lines cannot be effectively cleaned or flushed in place. Cleaning of fuel lines can be most efficiently performed during dismantling of the Smelter. The fuel oil lines within the Smelter will be cut and the interior of the piping will be scoured by mechanical means using a mechanical rotating brush inserted into the cut fuel oil line. Residual build up removed from the pipe will be collected and appropriately disposed. The mechanical cleaning of the fuel lines to remove build up will allow the piping to be shipped to the scrap metal recycler. However, the mechanical cleaning will not completely remove all residual material from the fuel oil lines. As a result, the fuel oil lines will be lowered and capped to prevent any potential for released of residual material during transport to the scrap recycler. The 60 meters of underground fuel oil line will be removed by excavation by the Demolition Contractor.

3.13 MANAGEMENT AND UTILIZATION OF INTERMEDIATE PRODUCTS AND MATERIAL

Management and utilization of intermediate products and materials are described in Sections 3.4 through 3.9. Utilization rates of Smelter raw material are presented in Table 2.1 for both single furnace and dual furnace operation. With respect to drawdown, as described in Section 3.2.1, a minimum of 20 days of raw material operating inventory will be required in order to process the standing volume of ore concentrate and intermediates present in the Smelter. Residual materials will be managed/disposed as follows:

- Clarified water in the high rate thickener following thickener drawdown will be pumped to the mill sump – the mill sump requires a piping change to allow for the reuse of water at the Mill
- Ore concentrate residuals - Material will be directed to the Mill for re-processing/blending
- Residual Dust removed from the system will be directed to Vale – Ontario for processing or blended at the Concentrate Load-out Facility
- Silica Sand and Quartz will be used as backfill in the South Yard
- Scrap will be staged and shipped to Vale – Ontario for processing
- Furnace No. 2 and potentially Furnace No. 1 hearth and refractory will be shipped to Vale - Ontario for processing
- Residual Coke removed from coke silo/system can be disposed off Site or disposed in the on-Site landfill
- Liquefied Oxygen returned to supplier
- Glycol and oil drained form equipment appropriately disposed of consistent with Vale current practices

3.14 WASTE MANAGEMENT

Wastes present in the Smelter will be managed consistent with the procedures identified in the Waste Management Plan. A Waste Management Decision Tree is presented on Figure 3.2.

3.15 FINAL SMELTER CLEANING/INSPECTIONS

Smelter cleaning and inspections are described in Sections 3.2 through 3.10. A summary of cleaning activities/inspection activities are as follows:

- Smelter Dust Focused Cleaning Campaign
- Smelter Dust Maintenance Cleaning (one week per month following Dust Focused Cleaning Campaign)
- Cottrell Dust Hopper Cleaning of Hoppers in the Cottrell Area that are reportedly clogged with dust
- Dead Storage removal of solidified material in bottoms of tanks
- Copper Calcine thickener and No. 4 Dead Storage Tank pressure wash
- High Rate thickener pressure washing following drawdown of material
- Dead Storage Tanks pressure washing following drawdown
- Filter Press cleaning including feed tank
- Jetting process lines from thickener to filter press
- Roaster cleaning by mechanical means
- Dust removal from Furnace dust bins by dry vac
- Draining of LOX tanks
- Purge oxygen lance and converter oxygen blow air systems with inert gas
- Clean fuel residual from fuel oil tanks
- Dust removal from Smelter dust drag conveyor system by dry vac

Additional final cleaning activities for the Smelter that could be conducted by Vale if resources are available or could be included in the scope of work for the Demolition Contractor include the following:

- Jetting of Mill feed line to the Smelter – the Mill feed line will likely contain ore concentrate and should be jetted clean prior to closure of the feed line.
- Removal of ladle, converter, tundish skulls – the hearths of No. 1 and No. Furnaces will be shipped to Vale – Ontario mechanical cleaning could be conducted.
- Final Dust Cleaning of converter aisle – the converter aisle will not be accessible during the weekly maintenance cleaning of the Smelter and dust accumulation could in the areas surrounding the converters.

- Evaluate feasibility of process residual in non-operational thickener and filter area. CRA anticipates the level of effort to remove process residuals from the piping in the thickener area will be prohibitive. Ultimately solidified lines will likely be taken down and disposed of in sections by the Demolition Contractor.

A data gap exists with respect to the process lines related to the former operation of the seven thickeners that previously operated in the Smelter. It is not known if these lines contain liquid. Similarly, process lines related to the former operation of the Doerr-Oliver filters (the Doerr-Oliver Filters were replaced by the plate and frame filter press) in the Smelter appear to remain. If material is present in the lines, the ore concentrate could be recovered and re-processed in the Mill as described above.

A final inspection of the Smelter should be completed by Vale electrical and maintenance staff to ensure that all process equipment has been de-energized and locked out and all water lines have been drained. In addition the glycol system and all oil containing equipment should be drained as a part of the shutdown activities. Completing the final inspection should ensure that there is no ongoing usage of utilities in the Smelter Building during cold closure.

3.16 ISOLATION AND CONTROL OF SMELTER POST-SHUTDOWN

Following completing of production activities in the Smelter all process units should be powered down and locked out consistent with Vale lock out/tag out procedures. Power should remain available to the Smelter for lighting for the purposes of the bidding process for the demolition work, potential equipment removals and hazardous materials sweep including asbestos abatement of the interior of the building.

Following completion of the activities described in this plan, access to the Smelter should be restricted. All doors and access point should be locked to prevent unauthorized access to the Smelter. The tag in/tag out procedure for the Smelter should be modified to require tag in at an operating Vale facility when authorized personnel enter the Smelter.

4.0 REFINERY SHUTDOWN

The Refinery Complex is scheduled for closure at the beginning of January 2015. Vale's advance planning for decommissioning of the Refinery provides sufficient time to implement facility ramp down, shutdown and decommissioning work in a well-planned and orderly fashion that will allow Vale to maximize recovery of assets and minimize decommissioning costs.

Material and product inventories in the Refinery will be depleted to the extent possible during the ramp down phase to minimize handling these materials during the decommissioning. Extensive facility cleaning will be performed by Vale forces during the ramp down phase in order to recover as much metal-rich material as possible that can be processed through the Refinery prior to shutdown or sent to other Vale facilities for processing.

Following shutdown, pre-demolition activities will be completed by Vale's Demolition Contractor including additional cleaning, draining of materials from pipes, pits, tanks, equipment, removal of hazardous waste materials, and disconnecting utilities in order to get the facilities to a cold-closure state pending final demolition.

The following sections detail the ramp down and shutdown procedures for the Refinery Complex. The overall objectives and goals of the Refinery shutdown are as follows:

- Process all anodes produced prior to shutdown
- Cease all Refinery operation in an orderly and efficient manner
- Realize the maximum economic value for all process intermediates such as anolyte, purified electrolyte, ground matte etc.
- Minimize shutdown efforts and costs
- Remove/process all raw materials and intermediates prior to final shutdown
- Make necessary process and equipment changes to complete all additional projects (i.e., production of nickel carbonate, groundwater remediation and copper arsenic sulphide ponds)
- Prepare the Refinery for demolition

The major stages for Refinery ramp down and shutdown are as follows:

- Ramp down shutdown planning
- Refinery ramp down

- Initial preparation and cleaning
- Individual processing area shutdowns
- Modifications to Refinery equipment and process to complete additional projects (nickel carbonate production, groundwater treatment and copper arsenate sulphide ponds)
- Final shutdown and cleaning

Refinery shutdown planning will require support and input from the various projects anticipated or planned. Vale project teams involved in these projects will be consulted and specific project needs will be identified and addressed as part of shutdown planning. There is the potential for one or all of these projects to greatly affect the Refinery shutdown.

The overall Refinery shutdown schedule is as follows:

Stage	*Schedule*
Shutdown Planning	January 2013 - August 2014
Initial Preparation and Cleaning	August 2014 - December 2014
Processing Area Ramp Down and Shutdown	January 2015 - March 2015
Final Refinery Shutdown	March 2015 - June 2015
Optional	***Concurrent Projects***
Cobalt Iron Cake	March 2015 - May 2015
Nickel Carbonate	May 2015 - August 2015
Groundwater Remediation 2016	November 2015 - March 2016
Copper Arsenic Sulphide Ponds	March 2016 - February 2019

The final Refinery shutdown and demolition will occur once all additional Vale projects have been completed and are therefore subject to change. CRA estimates that the final shutdown could occur any time between March 2015 and December 2018 depending upon the timing and extent of the identified additional projects.

4.1 REFINERY DESCRIPTION

The Refinery is a large steel frame structure with transite siding that was constructed in the early 1960s and has been in operation since. The building has approximate dimensions of 358 m by 99 m (1,175 feet by 325 feet). It has four levels, a concrete floor slab with a 1.2 m (4 feet) high concrete foundation wall and has an approximate maximum height of 27 m (90 feet). The Refinery Complex includes the following additional infrastructure:

- Scrap wash
- Stripping floor and mandrel plant
- SAS filters
- Tank house
- Purification
- Shear Shed
- Cold Storage
- Soda ash storage
- Refinery office/administration building
- Hydrogen Sulphide Building
- SO_2 Building
- Chlorine Building
- Copper pond No. 4

The Refinery processes anodes received from the Smelter and produces plated nickel, cobalt hydrate and copper cake. A simplified Refinery process flow diagram is presented in Appendix H.

The following presents a brief description of each of the main processing areas within the Refinery.

Scrap Wash

Nickel anodes are received in the first floor of the scrap wash area of the Refinery and are prepared for use in electroplating operations in the tank house. The anodes are transferred to the second floor of the scrap wash area and are placed in bags and staged for placement within individual plating tanks. Spent anodes are cleaned and crushed in this area. Crushed anodes are ground into a fine powder for use in anolyte processing and production of purified electrolyte.

Stripping Floor and Mandrel Plant

The stripping floor and mandrel plant operations involve cleaning, painting and production of mandrel starter sheets used in S and R round nickel plating production and slab starter sheets used in nickel slab production. Plated S and R rounds are received from the tank house and stripped from the mandrel sheets. Slab starter sheets are received and cut down to the appropriate size prior to final plating.

SAS

Wash waters and spent liquids generated in the scrap wash area are transferred to the SAS area. These liquids are stored in large holding tanks and processed through the automated SAS filters. Solids generated from this process contain high concentrations of semiprecious heavy metals. The filter cake generated from the SAS filters is sold by Vale under contract.

Tank House

The tank house contains 684 plating tanks used to electroplate nickel. Anodes are loaded into each tank and purified electrolyte containing dissolved nickel is circulated throughout each tank. A direct electronic current is applied and the nickel is plated out of solution onto cathodes as either a round or a slab. The anodes and cathodes are loaded into and out of each tank using eight overhead bridge cranes.

Purification

Operations within the purification area of the Refinery are the processing of anolyte into purified electrolyte, the production of cobalt hydrate and the removal of copper, arsenic, lead and iron and lead anolyte. Specifically nickel in the anolyte is replenished by dissolving nickel in the ground matte back into solution. Copper, arsenic and lead are precipitated out of solution prior to the large thickeners and filter using plate filters. Cobalt and iron are precipitated out of solution using chlorine and filtered again using a series of plate filters.

Shear Shed

Slabs of plated nickel, S and R rounds are transported from the scrap wash to the Shear Shed for final cleaning, sizing, grading and packaging. The nickel slabs are cut up using large presses and packaged in the Shear Shed.

Cold Storage

The Cold Storage warehouse is located immediately west of the Shear Shed and is used for the storage of out-of-service equipment, spare parts and miscellaneous items.

Soda Ash Storage

The soda ash storage area is located south of the purification area. Two large tanks and one smaller tank are located in this area of the Refinery. Soda ash used in the Refinery and the mill is stored in these tanks.

Refinery Office/Administration Building

The Refinery office/administration building is a separate metal clad structure located east of the tank house. Offices, a lunch room and a laboratory are located within this building.

Hydrogen Sulphide Building

The Hydrogen Sulphide Building is a separate transite clad structure located south of the main Refinery building. Rail cars containing hydrogen sulphide are offloaded and stored in this building.

SO_2 Building

The SO_2 Building is a corrugated metal clad structure located west of the main Refinery building. Rail cars containing SO_2 are offloaded and stored in this building.

Copper Pond No. 4

Copper Pond No. 4 is located south of the main Refinery building. Residual liquid wastes from the copper purification area have been historically transferred and stored within this pond.

4.2 PRE-SHUTDOWN CONSIDERATIONS

The Refinery Complex shutdown will commence with the receipt and processing of the last anode from the Smelter. The objectives of the pre-shutdown are to complete the necessary planning required prior to final shutdown. Specifically Vale will identify necessary planning requirements for additional projects (Nickel Carbonate, Groundwater Remediation and Copper Arsenic Sulphide Ponds), forecast raw material usage for the remainder of the Refinery operations, identify waste materials for characterization and removal and complete pre-cleaning activities prior to final shutdown.

Initial pre-shutdown considerations are identified as follows:

- Identify production and storage areas of the Refinery that will need to be maintained and the time frame for continued operation of these areas. The soda ash storage tanks and associated system will be required for a minimum period of two months or longer until an alternative storage location is brought online. The cobalt portion of the purification area may be operated for an extended period of time generating a cobalt iron cake product, a nickel carbonate product and a copper filter cake (See Section 7.0). The Chlorine and SO_2 Buildings will need to be maintained and remain operational to support the completion of the optional concurrent projects. Any concurrent projects implemented by Vale (see Section 7.0) will also require portions of the Refinery Complex to remain operational.
- Forecast usage and drawdown raw material inventories of soda ash, chlorine, sulphuric acid, hydrogen sulphide, SO_2, and sodium sulphate in order to ensure that minimal amounts of these materials remain after final shutdown.
- Identify required inventories of personal protective equipment for production and shutdown to ensure that enough supplies are available for the completion of the ramp down/shutdown.
- Identify and transfer to the Smelter all inventories of waste filter cloth, wood pallets, platting sticks, wood panels prior to Smelter shutdown in order to minimize the amounts of these materials that will require disposal as wastes during decommissioning and demolition. Any materials that remain in the Refinery after the shutdown has been completed i.e. filter cloth, wood, solids generated as part of cleaning will have to sorted staged and shipped off Site as either a waste or to Vale operations in Ontario for additional processing. Wood waste will be burned on Site and the ash will be shipped to a Vale approved location for processing or disposal Residual quantities of raw materials and chemicals will be removed and stored in an appropriate location (Shear Shed or Cold Storage warehouse) for final disposal. A complete list and estimated inventory of these materials and final disposal requirements are presented in the Waste Management Plan (provided under separate cover).
- Complete necessary planning and scheduling for additional activities such as the filter cloth washing, mandrel cleaning and transfer to the converters.

- Complete thorough pre-cleaning of Refinery sumps and pits and transfer all solids material to the Smelter three to six months prior to shutdown. Recover plated nickel rounds located in the exterior areas of the Refinery by scraping and processing surface soils. CRA notes that the sumps in the tank house are located within an area that requires an entry permit. CRA anticipate that these sumps will take up to a week to pre-clean. The remainder of the Refinery sumps will take another full week to clean. Vale staff can undertake this pre-cleaning work, or alternatively Vale can contract out this additional work. The pre-cleaning will remove accumulated solids and liquids within these sumps and therefore reduce the final effort and costs associated with the final shutdown of these areas. It is anticipated that this pre-cleaning task will take Vale staff up to 30 days to complete. The sumps will be the last areas cleaned as any spills etc. from cleaning the filter presses and tanks will be collected and contained in these areas.
- Complete necessary pilot scale trials for Nickel Carbonate Production, Groundwater Remediation and Copper Arsenate Ponds.
- Identify and purchase required materials to complete additional projects that will be undertaken by Vale prior to the Refinery closure. (i.e., carbonate, filter cloth etc.), and produce nickel carbonate.
- Identify purification areas requiring modifications for the completion of the additional projects. In most cases a portion or all of the purification area of the Refinery will be required to complete these projects. Develop utility final isolation and shutdown procedure in early 2014.
- Market and sell equipment as identified in the Asset Inventory (provided under separate cover).
- Evaluate and identify cleaning and shutdown work that will be contracted out, prepare and issue bid documents and final contracts in advance of the shutdown.
- Identify products and intermediates (Cobalt Iron Cake, Nickel Carbonate, Copper Arsenate Sulphide etc.) that have potential value. Quantify potential value and identify potential markets/buyers. Estimate final quantities and issue bids and contract documents as necessary.
- Identify staging and storage areas for use during Refinery shutdown. Multiple areas will be designated and may include the Shear Shed, the Cold Storage warehouse, the SO_2 Building, the first floor of the scrap wash and the exterior area located immediately north of the main Refinery building.

Dust, dirt, grime and solidified electrolyte are deposited on Refinery building surfaces and equipment throughout the course of normal operations. A significant accumulation of dust, dirt, grime and solidified electrolyte is present on surfaces throughout the

Refinery. In addition large quantities of plated nickel are scattered throughout the exterior areas of the Refinery. The surface soils should be scraped and the material processed through a screen to recover the plated nickel. The recovery of this material presents a financial opportunity for the project by reclaiming the material and processing it through the Smelter to recover the nickel content. An initial intensive cleaning campaign conducted by Vale will also reduce direct cost related to the demolition. In the Refinery's current condition the Demolition Contractor would likely conduct cleaning prior to removal of equipment and ultimate demolition of the building in order to ensure suitability of the scrap metal for transport and processing. The Demolition Contractor would pass the effort related to cleaning the Refinery to Vale through its demolition pricing structure. The processing of these materials by Vale prior to shutdown could reduce the amount of VBN required by the Smelter allowing VBN feed to be directed to Vale Ontario operations.

CRA proposes that an initial pre-cleaning campaign should be conducted by Vale consisting of a focused cleaning during the annual shutdown followed by a regular maintenance cleaning up to final shutdown. The focused cleaning campaign should commence during the 2013 shutdown or alternatively be scheduled for completion six months prior to ramp down/shutdown. CRA estimated one cleaning crew consisting of four labourers and one equipment operator organized by a foreman will be required for the 30 day cleaning campaign. All cleaning would be completed by using wet means (i.e., pressure washer, portable steam cleaner, wet vac, vac-truck, portable sump pumps, floor sweepers, skid steers etc.).

The labour estimate for the initial cleaning campaign is presented in Table 4.1a.

4.3 PRE –SHUTDOWN WASTE CHARACTERIZATION

The goal of the pre-shutdown waste characterization program is to identify and characterizes all waste materials that will remain after the final Refinery shutdown. At a minimum, Vale should collect the following solid waste samples or alternatively ensure that the waste characterization information is available:

- Ground matte (residual amounts will be present in the ball mill, feed tanks and pump lines)
- Filter cloth
- Anode boxes
- Anode bags

- Mandrel sticks
- Washed and used filter cloth
- Composite solids from floor, pits, sumps, tank bottoms, and process piping

CRA anticipates that composite solids from the sumps, tank bottoms and piping will be dewatered through the appropriate filter presses and stockpiled in the Refinery for assay testing as this material may be shipped to other Vale facilities for processing or sold under contract. Vale personnel perform an annual metals inventory, which includes the sampling and analysis of solids in sumps, tanks and other wastes. The most recent or complete metals survey information will be used to identify materials that will be staged and either reprocessed at the Site (e.g. Mill) or shipped to other Vale operations outside of Manitoba for processing. A small portion of this material (less than 5 percent) likely will be present in piping, tanks and equipment after the final shutdown is complete. These materials can either be accumulated in a central location and be tested for metals concentrations and potential sale or alternatively will have to be disposed as waste. The quantity and associated value of these materials will be evaluated by Vale prior to determining the final disposition of these materials. CRA estimates the waste characterization work can be completed in 5 days. A crew of two Vale personnel, an operator and labourer would be tasked with completing the sample collection work. A Vale supervisor would oversee the waste characterization work on a part-time basis. The actual manifesting, packaging, transportation and disposal of the hazardous materials would occur over a 10 day period. Part-time supervision of the disposal contractor by the Vale PM would require approximately 20 hours over 10 days. The labour estimate for waste characterization is presented in Table 4.1b.

The receipt of the last anode from the Smelter to the Refinery will trigger the overall shutdown of the existing processes, however certain areas of the Refinery may remain operational for a period of up three years depending upon which, if any, additional projects Vale selects to complete at the Refinery. The potential projects are discussed in further detail in Section 7.0 of this report.

4.4 PROCESSING AREA SHUTDOWN PROCEDURES

The following sections describe specific ramp down and shutdown procedures for each area of the Refinery. Copies of Vale's detailed summer shutdown procedures are provided in Appendix I of this report.

4.4.1 MANDREL PLANT SHUTDOWN

The Stripping Floor and Mandrel Plant area of the Refinery is used to prepare mandrel sheets for the plating of S and R Rounds and to strip plated nickel from mandrel sheets. Vale intends to cease the production of S rounds in the Refinery prior to ramp down or shutdown. Therefore S rounds will not be considered further in this plan. Vale will determine the require mandrel sheet inventory and material required for production in the last six months of 2014 (assume approximately 100 R round plating tanks will be in use at ramp down/shutdown). Vale will cease printing mandrel sheets three months prior to the shutdown. Vale personnel will wash all excess sheets not required for production and transfer these sheets to the Smelter converter for processing. The ink line and ovens will be shutdown at this time. The stripping mandrel washer operations will continue until the last sheet has been removed from the tank house, washed and is stripped. CRA anticipates that the last mandrel sheet will be pulled at least 14 days (2 weeks) after the last anode has been received at the Refinery. Stripping of the ink from the Stripping Floor and Mandrel Plant will take two weeks to complete. Vale should commence final mandrel stripping and cleaning at the same time as the last anode is received at the Refinery. CRA estimates that Vale personnel consisting of four labourers and one equipment operator organized by a foreman will be required for the 10 day mandrel ramp down cleaning and shutdown. The follow list presents a step-by-step process of the shutdown for the Stripping Floor and Mandrel Plant:

- Determine final working inventory of required mandrel sheets six months prior to shutdown.
- Cease painting mandrel sheets at least three month prior to shutdown. Shut off and disconnect ovens after last mandrel sheet has been painted and the ink has been cured.
- Approximately 4,000 mandrel sheets need paint stripped prior to recycling the stainless steel sheets. Vale personnel can clean up to 400 mandrel sheets a day using existing equipment.
- Final paint stripping will take from between 2 weeks to complete.
- Decommission mandrel ink stripping line and washer. Remove residual ink, grit, and caustic from the area. Dispose unused ink in trays as waste. Adjust the pH in the acid tank by adding lime. Drain the neutralized acid tank contents by flushing contents to Mill and pH adjust as necessary.
- Stockpile cleaned mandrel sheets is a designated area (Shear Shed or Cold Storage warehouse).

- Shutdown all steam, water and air to this area of the Refinery once the mandrels have been cleaned and staged and all waste and raw materials have been removed.
- Clean floors and equipment of all dust and debris and transfer all solids to central indoor storage area.

The labour estimate for the shutdown of the mandrel plant is presented in Table 4.1c. Additional shutdown procedures for the Stripping Floor and Mandrel Plant are provided in Appendix I of this report.

4.4.2 SCRAP WASH SHUTDOWN

The scrap wash area of the Refinery is used to prepare anodes for plating, cleaning of plated nickel and the crushing and grinding of corroded anodes. Operations in this area of the plant will continue for a period of up to 20 days after the receipt of the last anode. The crushing and grinding of anodes will cease two weeks prior to the receipt of the last anode. Used filter cloth generated in the purification area will be sent to the scrap wash area for final washing prior to staging and disposal as a solid waste. Wash water generated from the washing of used filter cloth will be sent to the Mill. CRA estimates that Vale personnel consisting of four labourers and one equipment operator organized by a foreman will be required for the 40 day filter cloth washing and scrap wash ramp down, cleaning and shutdown.

The follow list presents a step-by-step process of the shutdown for the scrap wash area:

- Scrap wash tanks will have to be emptied and cleaned after the last anode is processed. All solids from these tanks should be collected and transferred to the scrap wash area for final processing through the Perrin or Hazco filter press.
- Process all scrap anodes and clean sumps screen and run all belts empty.
- Wash all filter cloth as it is received from the purification area.
- Empty matte storage and feed bins and send all material to Vale - Ontario for further processing and metal recovery.
- Grind out/empty the ball mill and send all material to a Vale - Ontario facility for further processing and metal recovery.
- Stored liquids and liquid wastes to be neutralized with lime and discharged to the Mill.

- Solid wastes to be processed through the ball mill and leach train if possible; alternatively send to the Mill or Vale - Ontario for reclamation of metals or ship out as waste.
- Clean all copper production bars and load into bins and stage for sale as scrap copper.
- Clean floors and equipment of all dust and debris and transfer all solids to central indoor storage area (i.e. Shear Shed or Cold Storage warehouse).
- Empty bag house and transfer all dust to central indoor storage area (e.g. Shear Shed or Cold Storage warehouse).

The labour estimate for the shutdown of the scrap wash area is presented in Table 4.1d. Additional shutdown procedures for the scrap wash area are provided in Appendix I of this report.

4.4.3 SAS

The SAS area of the Refinery is used to collect sulphur and process precious metals from the scrap wash area. Specifically the solids, slimes and liquids generated after the initial crushing and washing of corroded anodes are transferred to this area for processing and filtration. Operations in this area of the plant will continue for a period of up to 20 days after the receipt of the last anode. CRA estimates that Vale personnel consisting of one labourer and one equipment operator organized by a foreman working on a part time basis will be required for the 20 day SAS ramp down, cleaning and shutdown. Solids generated from this area will continue to be processed, collected and sold under contract to Vale customers. The following list presents a step-by-step process of the shutdown for the SAS area:

- Tanks will be emptied and cleaned after the last anode is crushed and washed - approximately 25 days from the receipt of the last anode
- Open SAS filters and clean as required
- Check pH and neutralize as required using lime and flush as wash water to sewer
- Clean floors and equipment of all grime and debris used wet cleaning methods and transfer all liquids to the Mill for metals recovery
- Shutdown steam, air and water utilities after the filters have been cleaned

The labour estimate for the shutdown of the SAS filters is presented in Table 4.1e. Additional shutdown procedures for the SAS area are provided in Appendix I of this report.

4.4.4 TANK HOUSE SHUTDOWN

The tank house is an area of the Refinery where pure nickel is plated as cathode sheets or R rounds. Production operations in this area of the plant will continue for a period of up to 20 days after the receipt of the last anode. The final processing, tank emptying and cleaning activities will commence and continue for a period of up to 80 days after production in this area has ceased. The process of cleaning tanks and removing solids from each tank is labour intensive and require the use of pumps, hand tools and pressure washing equipment. For the tank house cleaning and shutdown, CRA estimates that Vale personnel consisting of 36 labourers for two-twelve hour shifts and two foremen will be required for 80 days.

Vale may want to develop a final plating sequence that will allow cathodes and anodes to be pulled while working up or down the tank house plating circuit. Adjusting production towards this final sequence will take some time (up to 6 months in total) and may require that production in the tank house be reduced over this period of time. The implementation of this sequence would reduce the number of partially spend anodes that are generated during the ramp down/shutdown.

CRA anticipates that electrical plating circuits within the tank house will have to be taken off line one by one until the final circuit with the last anode/cathode has been removed. Anolyte and purified electrolyte within the tank house will have to be temporarily staged in plating tanks until tanks and vessels in the purification area are emptied and become available for storage use. Liquids and solids in the plating will be transferred to the thickeners for final processing. The first floor of the tank house will be pumped out, pressure and steam cleaned and the liquids will be managed as anolyte through thickeners and leach train. The following list presents a step-by-step process of the shutdown for the tank house:

- Develop a shutdown sequence and shutdown electrical circuits as necessary.
- Can operate with a minimum of 40 tanks on one circuit.
- Shutdown and cleaning of tanks will commence up to 84 days 12 weeks after last anode shipped from smelter to Refinery (may have to be delayed if plating tanks are used for the storage of anolyte. The tank cleaning is a labour intensive procedure

and requires the use of pumps, steam/pressure washer and hand tools to physically remove all solids from each plating tank.

- Liquid wastes to be neutralized (pH adjusted) using available acids or bases and discharge to thickeners and/or Mill.
- Solid wastes to be processed through Perrin or Hazco press filters, if possible. Alternatively send to the Mill/Vale - Ontario for reclamation of metals or ship out as waste. Alternatively wet solids can be placed in boxes within the tank house and allow to dewater. The boxed material can be transferred to an outdoor storage area (south yard) once liquids have been allowed to drain.
- Clean floors, cranes and associated equipment of all grime and debris and transfer all liquids to the thickeners.

The labour estimate for the shutdown of the tank house is presented in Table 4.1f. Additional shutdown procedures for the tank house are provided in Appendix I of this report.

CRA notes that partially spent anodes that have not been completely processed within the tank house may not be able to be processed in the scrap wash area. If a final plating sequence is not developed and implemented in the Refinery the number of partially spent anodes will significant. Both the final plating sequence and partially spent anodes represent a risk/opportunity to Vale in terms of economic return and final management of this material.

Vale estimates that approximately 3,500,000 litres of combined purified electrolyte and anolyte are present within the tank house. In addition, Vale estimates that 800,000 kilograms of solids are present within the plating tanks and piping. The solids, purified electrolyte and anolyte contain significant quantities of nickel, copper and cobalt. Vale also estimates that approximately 870,000 kilograms of solids are present within tank, bins conveyors and piping. The solids contain significant quantities of nickel, copper and cobalt. These materials will be recovered and stockpiled for determination and sale as a product. Recovery and sale of this material represents a significant economic opportunity to Vale. The majority of this material will be recovered in the leach train and cobalt areas located in the purification area. All tanks bottoms recovered during the cleaning process will be processed through the Perrin, Hazco Press or SAS filters and segregated and stored in the Shear Shed for shipment to Vale operations outside Manitoba, sold as a product or alternatively slurried and send over to the Mill for processing and metals recovery. These materials and alternatives represent a risk/opportunity to Vale in terms of achieving the value of these materials.

4.4.5 PURIFICATION SHUTDOWN

The purification area of the Refinery is used to process anolyte into purified electrolyte, produce cobalt hydrate copper cake. Operations in this area of the plant will continue for a period of up to 80 days after the receipt of the last anode. The cobalt and copper processes within the purification area will continue to operate for an additional 30 days after the last anode has been pulled from the tank house. CRA estimates that three shifts of Vale personnel consisting of four labourers and one equipment operator organized by a foreman will be required for the 30 day purification cleaning and shutdown.

Vale estimates that approximately 5,500,000 litres of combined purified electrolyte and anolyte are present within the purification area. In addition, Vale estimates that 2,900,000 kilograms of solids are present with the tanks and piping. The solids, purified electrolyte and anolyte contain significant quantities of nickel, copper and cobalt. Vale proposes to process purified electrolyte into a nickel carbonate product. This process will require that pilot testing is completed prior to shutdown. The purification area will have to undergo piping modifications prior to the processing of this material. Vale estimates that it will take 6 months to process the purified electrolyte into nickel carbonate. Most tanks located within the purification area and the tank house will have to be used for storage purposes until this project is complete.

In addition to nickel carbonate production, Vale is also considering the use of this area to produce a cobalt iron cake. This process will require that pilot testing is completed prior to shutdown. The purification area will have to undergo additional piping modifications prior to the processing of this material. If implemented, Vale estimates that it would take approximately 3 months to complete this project.

The following lists a step-by-step process of the shutdown for the purification area:

- Empty sumps, tanks, matte settlers, head tanks, tub filters, thickeners and piping of any residual solids or liquids.
- Empty acid tanks to sewer, neutralize and flush content to Mill.
- Dilute hypochlorite generated at the scrubber and add blend into stored electrolyte.
- Remove filter cloth media and clean all filter presses, flush wash water to the Mill.
- Shutdown steam air and water utilities.
- Shutdown Racine tank hydraulic pumps. Empty hydraulic fluid from Racine tank. Drain all hydraulic lines within the purification area. Collect all used hydraulic fluid in drums and transfer to the drum storage area prior to shipment from the Site as a

waste. Clean floors, cranes and associated equipment of all dust and debris and transfer all solids to the central indoor storage area.

Once the thickeners and tanks in the purification area have completely drained cleaned and emptied Vale personnel or a subcontractor will have to remove the brick interior lining from the thickeners and tanks. The material can be staged for waste characterization prior to disposal as a waste. Alternatively the material can be assayed for metals prior to shipping to Vale - Ontario for processing. CRA estimates that Vale or subcontractor personnel consisting of four labourers and one equipment operator organized by a foreman will be required for the 20 days brick lining removal and staging program. CRA notes that this project can only be completed once all the thickeners and tanks are emptied of their contents and will no longer be required for any concurrent projects.

Vale is currently evaluating the potential for the use of the cobalt portion of the purification area to process liquids stored in the Copper Arsenic Sulphide ponds. This project would require further modifications to this area and may require that this portion of the Refinery remain operational for an additional three years. Shutdown procedures for this additional project have not been considered or developed.

The labour estimate for the shutdown of the purification area is presented in Table 4.1g. Additional shutdown procedures for the purification area are provided in Appendix I of this report.

CRA notes that the concurrent projects (see Section 7.0) may require that this area remains operational for an extended period of time. If Vale proceeds with one or all of the concurrent projects the final shutdown of this area can only be completed once these projects have been completed. The decision to proceed with any or all of the concurrent projects represent potential economic gains and risks to Vale in terms of additional operations, costs and final closure.

4.4.6 SHEAR SHED SHUTDOWN

The Shear Shed of the Refinery is used to size and package plated nickel. Operations in this area of the plant will continue for a period of up to 20 days after the receipt of the last anode. CRA estimates that Vale personnel consisting of four labourers and one equipment operator organized by a foreman will be required for the 20 day Shear Shed cleaning and shutdown.

The follow list presents a step-by-step process of the shutdown for the Shear Shed:

- Process final plated nickel products.
- Empty residual quantities of soda ash and send material to the Mill. Fill the soda ash tank with water and dump the tank contents to the Mill. CRA notes that this soda ash storage area may be required for an extended period of time until a replacement Mill soda ash tank has been installed and commissioned.
- Neutralize the acid and wash tanks contents and discharge contents to sewer.
- Shutdown steam air and water utilities after all nickel products have been processed.
- Clean floors, cranes and associated equipment of all dust and debris and transfer all solids to the central indoor storage area.

The labour estimate for the shutdown of the Shear Shed is presented in Table 4.1h. Additional shutdown procedures for the Shear Shed are provided in Appendix I of this report.

4.4.7 HYDROGEN SULPHIDE BUILDING SHUTDOWN

The Hydrogen Sulphide Building is used to offload and store hydrogen sulphide used at the Refinery. The material is received in rail cars. Vale will monitor hydrogen sulphide usage and purchase sufficient material to continue operations until the end of January 2015. The follow list presents a step-by-step process of the shutdown for the Hydrogen Sulphide Building:

- Isolate pressurized lines from the rail car
- Pressurize header and piping with nitrogen
- Pressurize the line using an inert gas (i.e. nitrogen) and force remaining line contents to the thickener (Vale to complete this activity while thickeners are still operational)
- If pressure in the hydrogen sulphide tanks increases above 375 pounds per square inch the bulk nitrogen storage tanks may have to blown down periodically to counteract this pressure gain
- Remove rail cars
- Close all building doors

Vale will develop a detailed procedure for this decommissioning and emergency plans specifically tailored for this gas service.

CRA estimates that Vale personnel consisting of one labourer, one equipment operator and a foreman will be required for one day Hydrogen Sulphide Building ramp down, cleaning and shutdown.

The labour estimate for the shutdown of the Hydrogen Sulphide Building is presented in Table 4.1i. Additional shutdown procedures for the Hydrogen Sulphide Building are provided in Appendix I of this report.

4.4.8 SO2 BUILDING SHUTDOWN

The SO_2 Building is used to offload and store material used at the Refinery. The material is received in rail cars. Vale will monitor SO_2 usage and purchase sufficient material to continue operations until the end of January 2015. The follow list presents a step-by-step process of the shutdown for the SO_2 Building:

- Close all building doors
- Disconnect SO_2 rail cars
- Remove rail cars
- Purge SO_2 lines to Cobalt purification tanks using nitrogen (Vale to complete this activity while Cobalt purification tanks are still operational)

Vale will develop a detailed procedure for this decommissioning and emergency plans specifically tailored for this gas service.

CRA estimates that Vale personnel consisting of one labourer, one equipment operator and a foreman will be required for one day SO_2 Building ramp down, cleaning and shutdown.

The labour estimate for the shutdown of the SO_2 Building is presented in Table 4.1j. Additional shutdown procedures for the SO_2 Building are provided in Appendix I of this report.

4.4.9 CHLORINE BUILDING SHUTDOWN

The Chlorine Building is used to offload and store material used at the Refinery. The material is received in rail cars. Vale will monitor chlorine usage and purchase sufficient material to continue operations until the end of January 2015. The follow list presents a step–by-step process of the shutdown for the Chlorine Building:

- Close all building doors
- Disconnect chlorine car
- Remove chlorine rail car
- Purge chlorine lines to Cobalt purification tanks using nitrogen (Vale to complete this activity while Cobalt purification tanks are still operational).

Vale will develop a detailed procedure for this decommissioning and emergency plans specifically tailored for this gas service.

CRA estimates that Vale personnel consisting of one labourer, one equipment operator and a foreman will be required for one day for Chlorine Building ramp down, cleaning and shutdown.

The labour estimate for the shutdown of the Chlorine Building is presented in Table 4.1k. Additional shutdown procedures for the Chlorine Building are provided in Appendix I of this report.

4.5 FINAL REFINERY CLEANING

As part of the decommissioning of the Refinery, the Demolition Contractor will purge, pressure/steam clean equipment, rinse all bulk storage and process tanks, piping, ducts, pits, floor trenches, sumps, and surfaces prior to demolition. This cleaning will remove accumulated solid residue, liquids and oils that otherwise may be released during demolition.

Vale should remove and clean all material from the various filter presses, thickeners, leach train, process tanks and storage tanks prior to or immediately following shutdown of the Refinery to recover all material that can be processed.

Techniques for cleaning will include low volume, high-pressure water blasting, steam cleaning and washing with detergent or degreasing soap. Wastewater will be contained and directed to the closest sump. Wastewater is anticipated from decommissioning cleaning of the following areas:

- Cleaning of concrete and purging of hydraulic oil and glycol residue from pipelines within the Refinery.
- Cleaning of pits, trenches, and sumps located throughout the Refinery.
- Cleaning of stained concrete in the purification area (first and second pass presses).
- Cleaning of PCB-oil stained concrete in the copper building near the Racine pump. All wash water from this cleaning will be collected using a wet vacuum or alternatively the drain in this area will be piped to a small polyethylene tank that will be used to contain the wash waters. These wash waters will be collected and stored separately from any wash waters which may contain PCBs.
- Cleaning of non-PCB oil stained concrete under pumps and process equipment, if present.
- Cleaning of all process, storage and dip tanks and piping systems.
- Cleaning of equipment and surfaces in the Refinery.
- Cleaning of interior liners of the stack prior to dismantling.

Cleaning should be completed in two stages. Initial cleaning would occur while the facility is energized, such as cleaning of pipes and breaching. Final cleaning would consist of cleaning that requires the area to be de-energized such as washing of the interior building walls. During final cleaning, temporary power would be required for lighting and washing equipment operations. Cleaning and washing activities completed during the winter months (January-March) may necessitate the use of temporary heaters to ensure the wash waters do not freeze.

The interior of the process and storage tanks will be accessed by cold cutting an opening in the tank wall. Cleaning wastewater will be segregated if certain contaminants are anticipated (i.e., if any PCB-contaminated surfaces should be identified). Segregation may also be necessary if wastewaters are suspected of containing high concentrations of metal dust (i.e., arsenic). In general, wastewaters will be sent to the wastewater sewer; however, wastewater that may contain PCBs will be collected and disposed at a licensed facility.

Pits, trenches, and sumps are located in the Refinery including the scrap wash, tank house, and purification areas. Pits, trenches, and sumps will be vacuumed to remove any residual liquids and then pressure washed, followed by final vacuuming. If required, pits, trenches, and/or sumps containing oil or grease may need to be washed/scrubbed with a degreasing soap.

Vale should clean the pits, trenches, and sumps in these Refinery areas in order to recover all material for processing. CRA estimated two shifts of cleaning crew consisting of four labourers and one equipment operator organized by a foreman will be required for the 30 day cleaning campaign. All cleaning would be completed by a subcontractor or Vale using wet means (i.e., pressure washer, portable steam cleaner, wet vac, vac-truck, portable sump pumps, floor sweepers, skid steers etc.). Final cleaning of the Refinery is estimated to take 30 days.

The labour estimate for the final cleaning of the Refinery is presented in Table 4.1l.

4.6 UTILITIES SHUTDOWN

The propane and liquid nitrogen tanks located south of the Refinery building will be shutdown as part of this program. The following presents procedures and consideration for the shutdown of these pressurized tanks.

Vale will have to retain a licensed fuel contractor in Manitoba to complete the propane tank shutdown. The following list presents the general step–by-step process of the shutdown for the propane tank:

- Isolate the propane lines from the storage tank by closing existing supply valve
- Allow the propane in the isolated line to be consumed in the Refinery (i.e. burn off propane by continuing to operate heating equipment)
- Purge propane lines to using nitrogen (licensed contractor to complete this activity while the Refinery is operational)
- Licensed contractor to transfer remaining propane in storage tank to a mobile tanker and depressurize vessel

Once all work pertaining to the shutdown of the Hydrogen Sulphide, SO_2 and Chlorine Buildings has been completed, Vale will proceed with the shutdown of the liquid nitrogen tank. The pressurized nitrogen lines connected to this tank will be isolated by closing the appropriate valve. Vale will have to contract with the liquid nitrogen supplier to remove any remaining nitrogen in the tank before this unit can be powered down. The following list presents the general step–by-step process of the shutdown for the liquid nitrogen tank:

- Isolate the nitrogen lines from the storage tank by closing existing supply valve
- Vent the remaining nitrogen in the line to the ambient air using an exterior pressure relief valve
- Supplier/contractor to transfer remaining liquid nitrogen in storage tank to a mobile tanker and depressurize vessel
- Shutdown power to the tank and associated equipment

Vale will require the contractor to develop a detailed procedure for this decommissioning and emergency plan specifically tailored for this gas service.

CRA estimates that Vale personnel consisting of one labourer, one equipment operator and a foreman will be required for one day for the propane tank ramp down and shutdown. CRA estimates that the labour for the shutdown of the liquid nitrogen tank will be similar. The labour estimate for the shutdown of the propane and liquid nitrogen tanks is presented in Tables 4.1m and 4.1n, respectively.

Utilities shutdown procedures for water, steam, electrical, air services will be provided to Vale in the Utilities Decommissioning 100 Percent Design Brief Report**.** The labour estimate for the shutdown of the Refinery utilities is presented in Table 4.1o.

4.7 ISOLATION AND CONTROL OF REFINERY POST SHUTDOWN

Following completing of production activities in the Refinery all process units should be powered down and locked out consistent with Vale lock out/tag out procedures. Power should remain available to the Refinery for lighting for the purposes of the bidding process for the demolition work, potential equipment removals and hazardous materials sweep.

Following completion of the activities described in this plan, access to the Refinery should be restricted. All doors and access point should be locked to prevent unauthorized access to the Refinery. The tag in/tag out procedure for the Refinery should be modified to require tag in at an operating Vale facility when authorized personnel enter the Refinery.

5.0 SHUTDOWN RESOURCE AND COST ESTIMATES

5.1 SOUTH YARD MATERIAL MANAGEMENT

Table 5.1 presents a resource estimate for the South Yard Material Management. The methodology used to develop this estimate is based on measured, priced, parameter quantities, where possible, and is considered to have an accuracy range of +/-25 percent.

5.2 SMELTER

Table 5.2 presents a resource estimate for shutdown of the Smelter. The methodology used to develop this estimate is based on measured, priced, parameter quantities, where possible, and is considered to have an accuracy range of +/-25 percent.

5.3 REFINERY

Table 5.3 presents a resource estimate for shutdown of the Refinery. The methodology used to develop this estimate is based on measured, priced, parameter quantities, where possible, and is considered to have an accuracy range of +/-25 percent.

6.0 SHUTDOWN SCHEDULE

6.1 SOUTH YARD MATERIAL MANAGEMENT

The South Yard Material Management is summarized below. The South Yard Material Management work will require the letting of contact(s) to complete the work. Vale's contracting strategy will depend on the objectives of South Yard Materials Management Activities. For the purposes of providing an estimate of scheduling CRA assumes Vale will self perform work to the extent practical. A tentative shutdown schedule is presented on Figure 6.0.

Stage	*Schedule*
Hazardous material removal and disposal	April to May 2013
Empty Drum and Storage Removal	June 2013
Scrap Metal Recycling	July 2013
Consolidate creosote and non-creosote wood to designated areas	August 2013
Debris Disposal	September 2013
Prepare PHC soil excavation plan	August 2013
Conduct PHC soil removal/verification sampling	October 2013
South Yard Soil Processing	Present - shutdown

6.2 SMELTER

The overall Smelter shutdown schedule is summarized below. The schedule for material drawdown and utilization depends on the date the Mill feed is routed to the Concentrate Load-out Facility. The date for the Mill feed re-route is assumed to occur in January 2015. However, as of the date of this report Vale is negotiating an extension of the operation of the Smelter. As a result, the date of the Mill feed re-route may change. There are several tasks that could be conducted at any point from the date of this report through to completion of production activities in the Smelter. Those activities are identified as tasks that could be completed immediately below. The schedule summary also assumes that the 2013 Shutdown will be that last Smelter annual shutdown completed prior to the completion of production operations in 2015. A tentative shutdown schedule based on re-routing the mill feed in January 2015 is presented on Figure 6.0.

Stage	*Schedule*	*Duration*
Shutdown Planning	January 2013 - December 2014	20 months
Dust Campaign Cleaning	Shutdown 2013	21 days
Maintenance Dust Cleaning	August 2013 – end-of-production	18 months
Dead Storage Inspection/Cleaning	Shutdown 2013	14 days
Furnace No. 5 Hearth Removal	Immediate to August 2014	60 days
Furnace No. 1 Hearth Removal	Furnace shutdown to August 2014	60 days
Copper Calcine Process Residuals	Immediate to end-of-production	60 days
Sample House Shutdown	April 2015	14 days
Feed Drawdown	January 2015	20 days
Thickener Area Shutdown	January 2015	30 days
Roaster Area Shutdown	January 2015	15 days
Furnace Area Shutdown	December 2014 - May 2015	180 days
Converter Area Shutdown	January 2015 – February 2015	30 days
Anode Area Shutdown	January 2015 – February 2015	15 days
ESP/Dust Management Shutdown	January 2015 - February 2015	30 days
Utility Shutdown (Oxygen and Fuel Oil)	May 2015 - June 2015	60 days

The timing for the above items include all tasks including cleaning.

6.3 REFINERY

A detailed ramp down/shutdown schedule for the Refinery is presented as Figure 6.1. The following presents a summary of the overall Refinery shutdown schedule:

Stage	*Schedule*
Shutdown Planning	January 2013 - August 2014
Initial Preparation and cleaning	August 2014 - December 2014
Processing area ramp down and shutdown	January 2015 - March 2015
Final Refinery Shutdown	March 2015 - June 2015

Optional	*Concurrent Projects*
Cobalt Iron Cake	March 2015 - May 2015
Nickel Carbonate	May 2015 - August 2015
Groundwater Remediation	November 2015 - March 2016
Copper Arsenic Sulphide Ponds	March 2016 - February 2019

As stated above, the overall shutdown schedule will be subject to Vale's decisions regarding the Nickel Carbonate project, the proposed groundwater remedy and copper arsenate pond project. The following presents a detailed shutdown schedule for the processing areas of the Refinery:

Process Area	*Shutdown Commences*
Scrap Wash	20 days after the receipt of the last anode
Stripping Floor/Mandrel Plant	10 days after the receipt of the last anode
SAS filters	25 days after the receipt of the last anode
Tank House	20 after the receipt of the last anode
Purification	20 days after the receipt of the last anode
Shear Shed	25 days after the receipt of the last anode

7.0 CONCURRENT PROJECTS

7.1 COBALT IRON PRODUCTION

Vale currently has a significant quantity of a cobalt intermediate that has been generated as part of past production operations. Vale proposes to process this material into a cobalt iron cake product. This process will require pilot testing be completed prior to shutdown. The purification area will have to undergo piping modifications prior to the processing of this material. Vale estimates that it will take 2 months to process this material into a cobalt iron cake product.

7.2 NICKEL CARBONATE PRODUCTION

Vale estimates that approximately 5,500,000 litres of combined purified electrolyte and anolyte will be present within the purification area after the Refinery has been shutdown. In addition, Vale estimates that 2,900,000 kilograms of solids will be present with the tanks and piping. The solids, purified electrolyte and anolyte contain significant quantities of nickel, copper and cobalt. The cobalt and copper processes within the purification area will continue to operate for an additional 30 days after the last anode has been pulled from the tank house.

Vale proposes to process purified electrolyte into a nickel carbonate product. This process will require pilot testing be completed prior to shutdown. The purification area will have to undergo piping modifications prior to the processing of this material. Vale estimates that it will take 6 months to process the purified electrolyte into nickel carbonate. Most tanks located within the purification area and the tank house would be used for storage purposes until this project is complete.

7.3 GROUNDWATER REMEDIATION

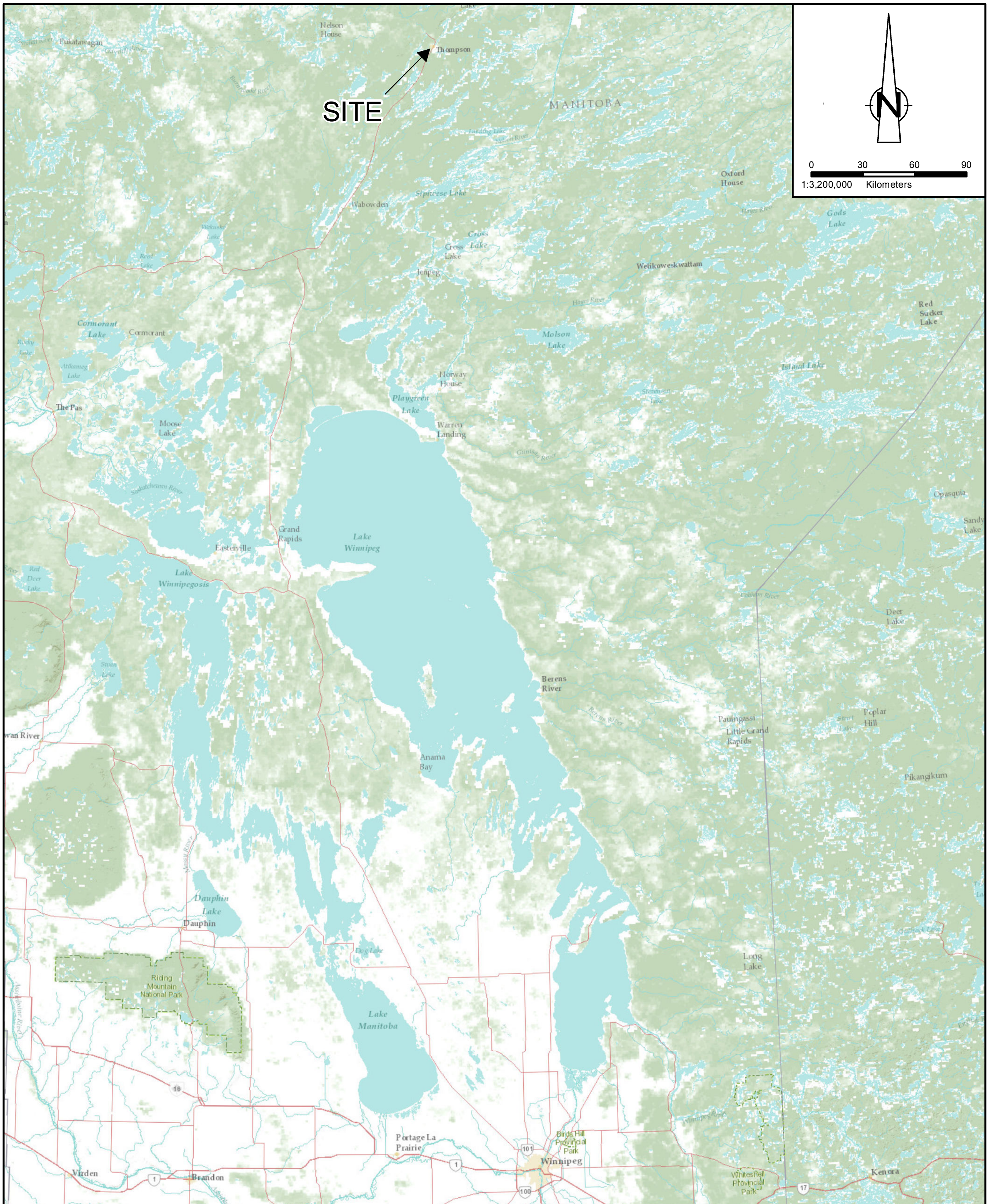
Vale is currently evaluating a groundwater remedial option that involves the removal and treatment of nickel impacted groundwater through processing in the Refinery. Groundwater will be removed through the installation and pumping of a series of recovery wells for reprocessing. This action is proposed solely for a "one-time" recapture of metals in the fill and granular deposits below the Refinery to remove the bulk of the existing metal impacts to groundwater. Additionally the groundwater remedy would result in the production and sale of a nickel product and provide a positive cost recovery from the remedial program. According to the AMEC document entitled "Remedial Action Plan for Remediation of Impacted Soil and Groundwater at the Vale Thompson Site" dated February 2012, groundwater impacts at the Site do not represent an environmental risk to human and ecological receptors. An estimated 25 recovery wells will be installed in the fill adjacent to the sewer outflow and along the main sewer trenches located east and south of the Refinery building. The groundwater recovery well network will be operated for an estimated 90 non-consecutive days (i.e., up to 180 days in total). Groundwater will be pumped directly into the Refinery for processing and generation of a nickel product (i.e., nickel carbonate).

7.4 COPPER/ARSENIC PONDS

Vale has completed a pilot scale study for the processing and refining of liquids and solids located within the copper/arsenic ponds. The process involves an alkaline leaching of this material, removal of arsenic and the production of a copper filter cake. The material can be further processed at a Vale facility in Ontario and sold as a copper anode. The cobalt portion of the purification area, with required modifications could be used to treat and process these materials. Vale anticipates that this portion of the Refinery could operate for a period of three years processing these materials.

7.4 EXTENDED OPERATION OF SMELTER THICKENER

In the situation where the Concentrate Load-out Facility is not operational prior to the Smelter approaching its SO_2 emission limit in 2015, the thickener area including the filter press will operate for an extended time period after the rest of the Smelter processes have ceased. In this case, alterations to the conveyor system after the filter press will be required to allow for the staging and shipping of ore concentrate from the filter press. In order to process the material that is in the Smelter process from the filter presses through the casting area, 10 days of Smelter operation will be required. The drawdown from the filter press onward in the Smelter process can proceed as described in this report if extended operation of the thickener is required. Similarly, the thickener area can be drawdown consistent with the process described in this plan when the Concentrate Load Facility is operational. The only difference in the final output of the filter press following the re-routing of the Mill feed to the Concentrate Load-out Facility will be concentrate that will be shipped off site as opposed to fed to the roasters as described in this plan.



Source: ESRI Topographic Basemap, Accessed 2012; Coordinate System: NAD 1983 UTM Zone 14N

figure 1.1

SITE LOCATION MAP
VALE-MANITOBA OPERATIONS
Thompson, Manitoba

75756-00(007)GIS-OT001 September 21, 2012

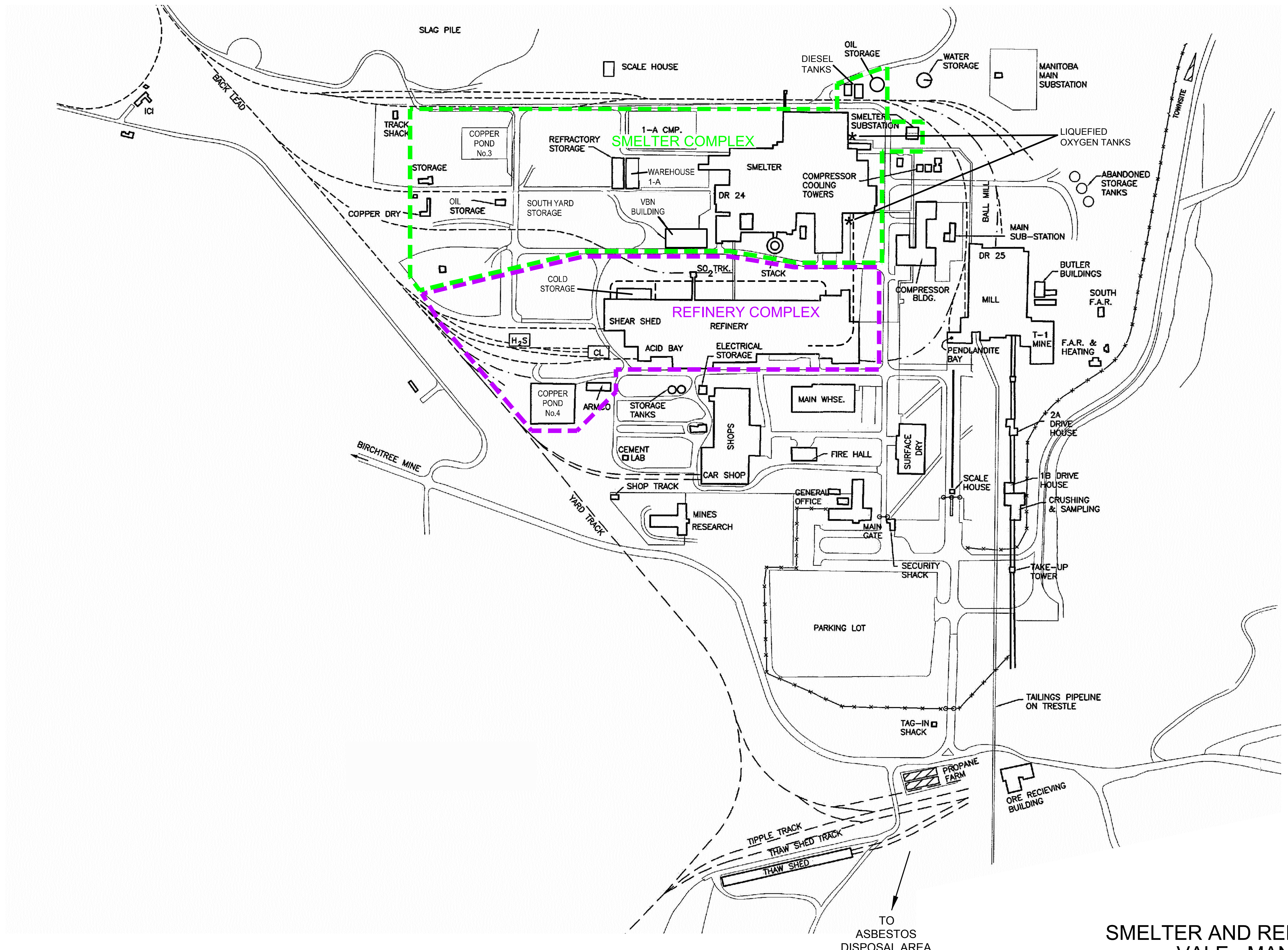
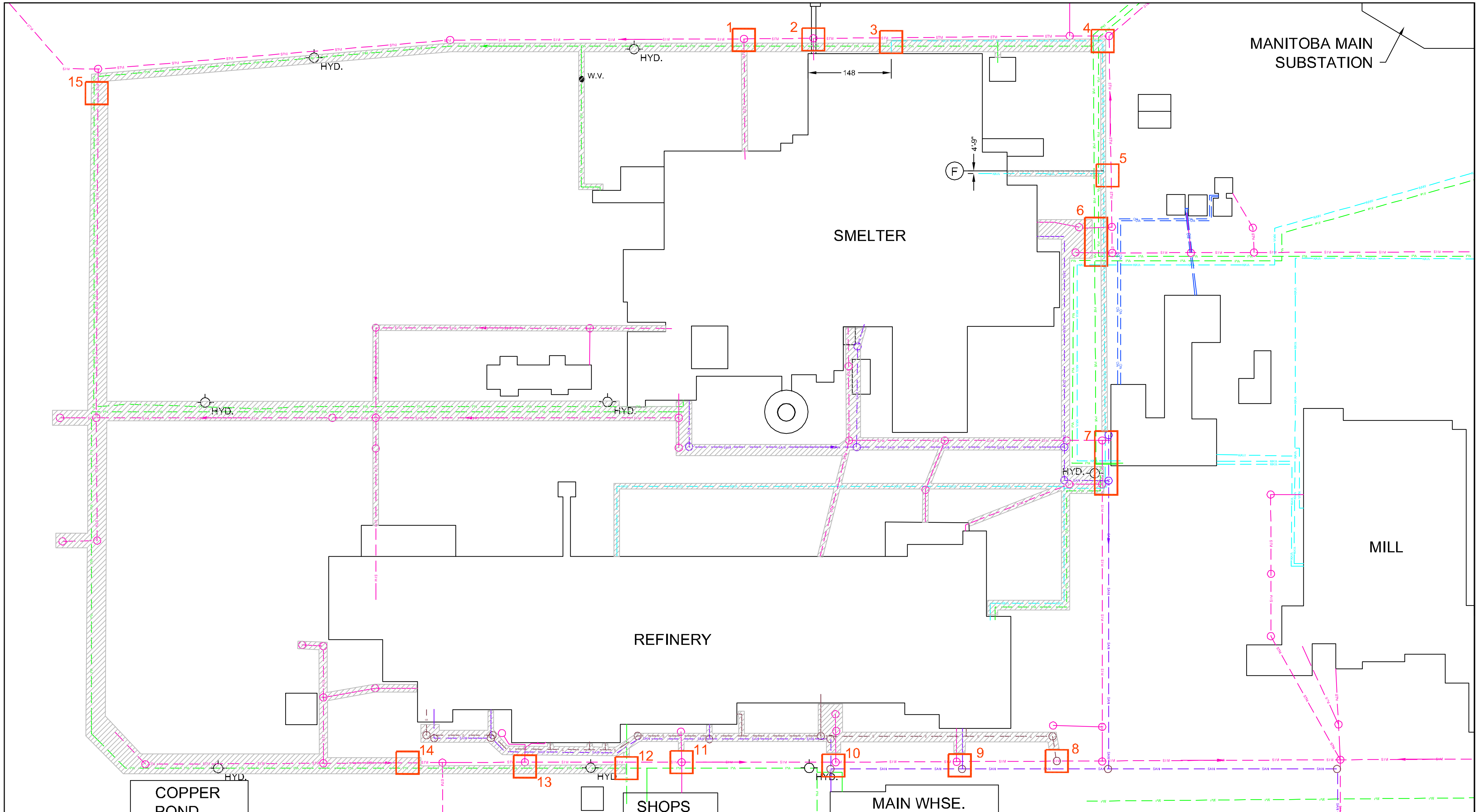


figure 2.1

SMELTER AND REFINERY COMPLEXES
VALE - MANITOBA OPERATIONS
Thompson, Manitoba

SOURCE: AMEC EARTH & ENVIRONMENTAL LIMITED, 2003 MINE CLOSURE PLAN, THOMPSON PLANT, SITE PLAN.

75756-10(007)GN-WA001 JAN 23/2013



EXCAVATION PIT	CAP ITEM	PIPE DIAMETER
1	STORM SEWER	24" Ø
2	STORM SEWER	12" Ø
3	RAW WATER (PROCESS WATER)	20" Ø
4	POTABLE WATER	14" Ø
5	RAW WATER (PROCESS WATER)	24" Ø
6	STORM WATER	18" Ø
		18" Ø
7	POTABLE WATER	6" Ø
	RAW WATER (PROCESS WATER)	30" Ø
	SANITARY SEWER	10" Ø
	STORM SEWER	10" Ø
		18" Ø

EXCAVATION PIT	CAP ITEM	PIPE DIAMETER
8	ACID SEWER (PROCESS SEWER)	18" Ø
9	SANITARY SEWER	6" Ø
	STORM SEWER	12" Ø
10	SANITARY SEWER	8" Ø
	STORM SEWER	18" Ø
11	STORM SEWER	18" Ø
12	POTABLE WATER	8" Ø
13	STORM SEWER	18" Ø
14	STORM SEWER	24" Ø
15	STORM SEWER	24" Ø

Nº	Revision	Date	Initial

0 50 100ft
APPR.

LEGEND

- STORM SEWER
- SANITARY SEWER
- ACID SEWER (PROCESS SEWER)
- POTABLE WATER
- RAW WATER (PROCESS WATER)
- COOLING WATER
- HYD. HYDRANT
- W.V. WATER VALVE
- SERVICE LINE TO BE REMOVED
- EXCAVATION PIT

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

VALE THOMPSON MINE SITE

THOMPSON, MANITOBA

UTILITY DECOMISSIONING
SUBSURFACE WATER & SEWER CAP LAYOUT

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

Project Manager: D.BERRINGER	Reviewed By: D.BERRINGER	Date: SEPTEMBER 2012	
Scale: AS SHOWN	Project Nº: 75756-10	Report Nº: 007	Drawing Nº: figure 2.2

75756-10(007)GN-WA002 SEP 21/2012

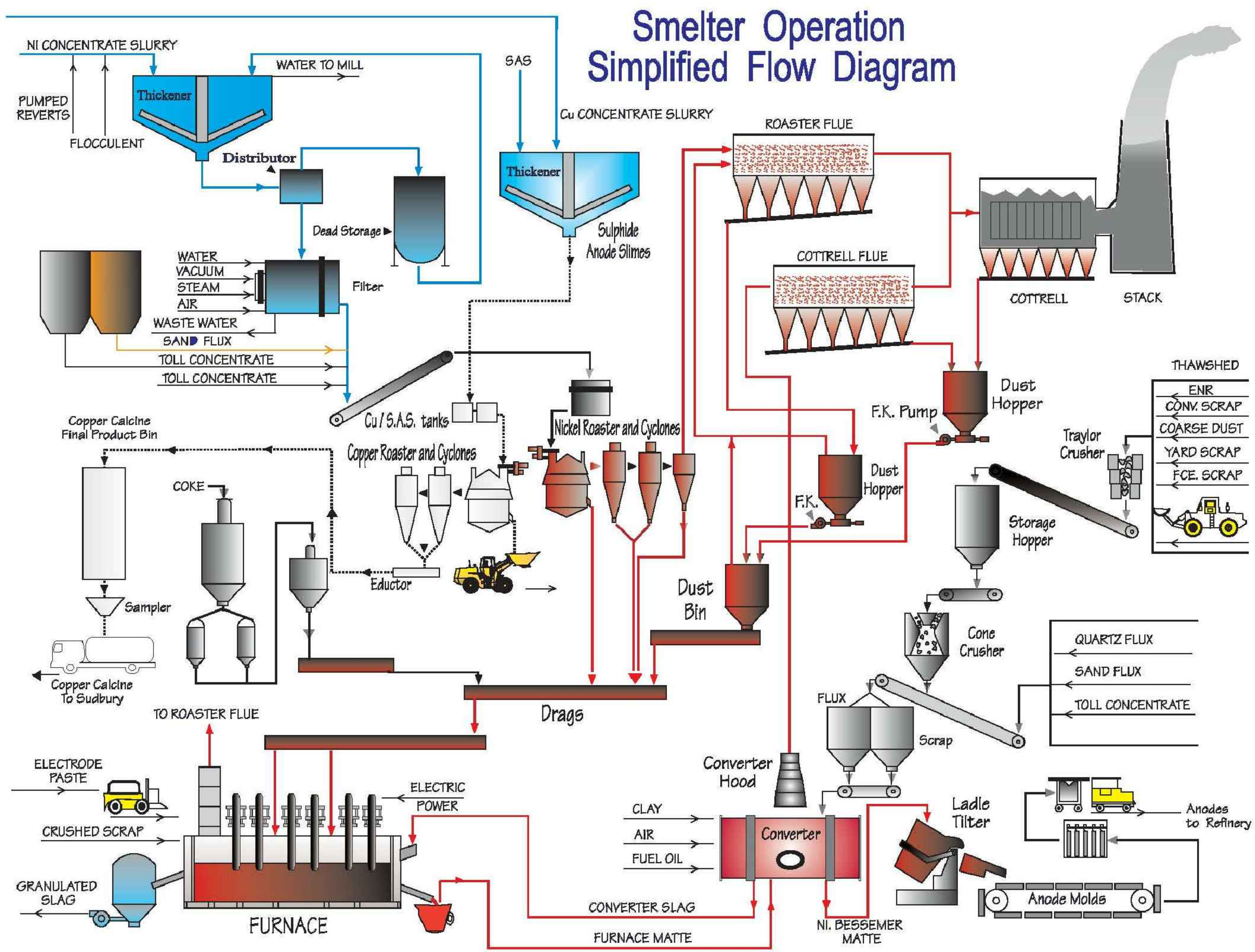


figure 3.1

SMELTER SIMPLIFIED PROCESS FLOW DIAGRAM
VALE - MANITOBA OPERATIONS
Thompson, Manitoba

CRA

75756-10(007)GN-WA003 SEP 21/2012

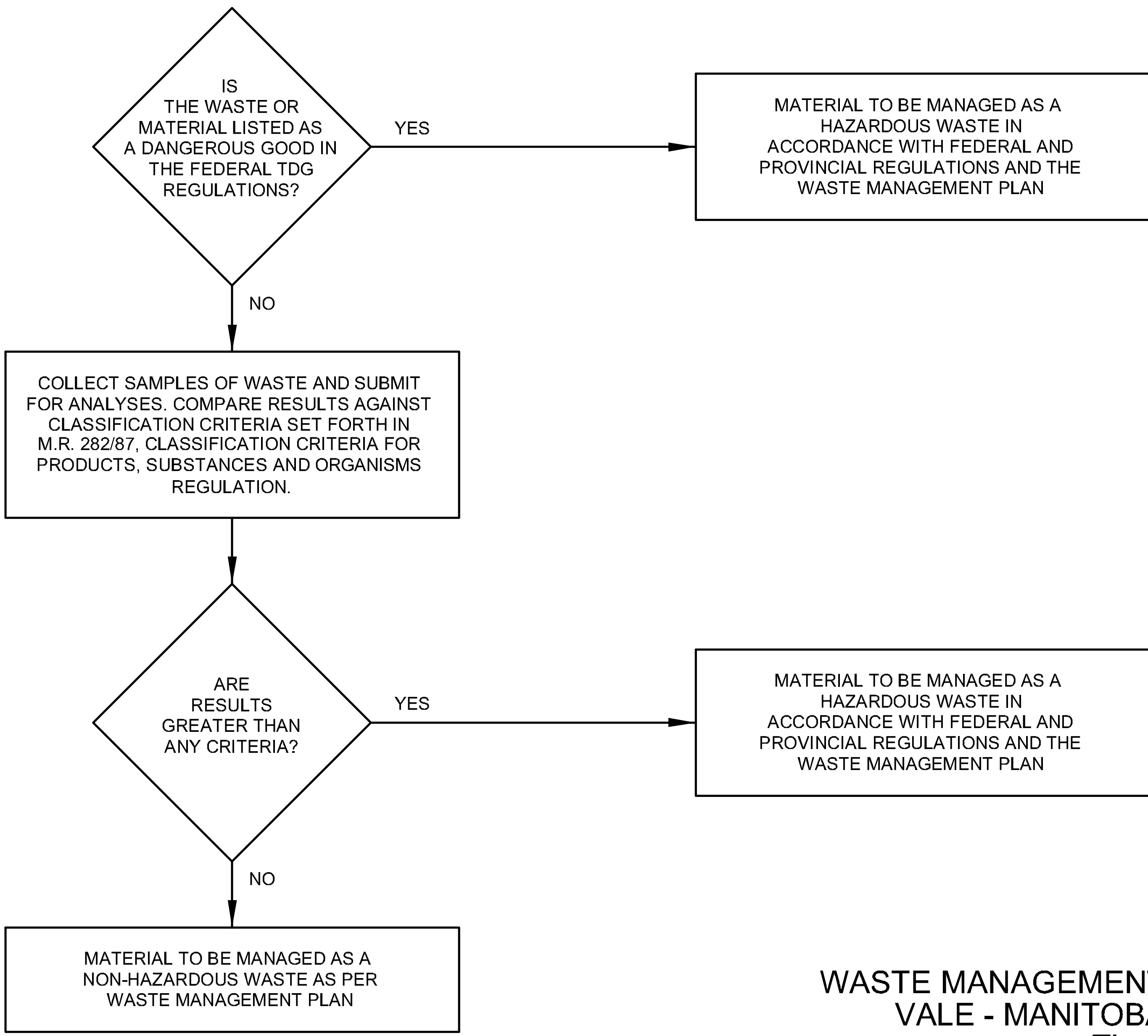


figure 3.2

WASTE MANAGEMENT FLOW CHART
VALE - MANITOBA OPERATIONS
Thompson, Manitoba

75756-10(007)GN-WA004 JAN 3/2013

ID	Task Name	Duration
1	**Vale Thompson Smelter/Refinery Decommissioning**	**2225 days**
2	**Closure Planning**	**730 days**
3	Salvageable equipment marketing	730 days
4	Raw material inventory reduction	365 days
5	**Pre-Mill Feed Re-Routing Activities**	**724 days**
6	**South Yard Material Management**	**270 days**
7	Hazardous Material Removal and Disposal	60 days
8	Scrap Recycling and Debris Removal	120 days
9	Petroleum Hydrocarbon Contaminated Soil Removal	90 days
10	**Reroute Power to South Buildings**	**92 days**
11	Install new overhead lines	30 days
12	Install new pad mounted transformer	30 days
13	Connect new pad mounted transformer and overhead lines to TOP line	1 day
14	Shutdown and disconnect existing Transformer	1 day
15	Connect new overhead line to existing overhead line	1 day
16	Testing and commissioning of new power feeder system	14 days
17	**Copper Calcine Process Residual Removal**	**60 days**
18	Copper Concentrate Removal No. 4 Dead Storage	60 days
19	Copper Residue Staging (806 Dry tonnes)	60 days
20	Remove SAS from No. 8 Thickener (605 Dry tonnes)	60 days
21	Copper Calcine Removal from Calcine Silo (37 Dry tonnes)	60 days
22	Copper Calcine Brick Staging (1423 tonnes)	60 days
23	Roaster Calcine Staging (37 Dry tonnes)	60 days
24	**Dead Storage Tanks Build-up Removal**	**205 days**
25	Drawdown and inspect Dead Storage tanks while operating	90 days
26	Aerate/recirculate storage tanks to minimize buildup leading into 2013 annual shutdown	30 days
27	Mechanical removal of buildup during 2013 Shutdown	10 days
28	**Cottrell Hopper Solidified Material Removal 2013 Shutdown**	**30 days**
29	Coordinate and conduct inspection of hoppers	20 days
30	Remove solidified material 2013 Shutdown	10 days
31	**Hearth Removal and Processing**	**284 days**
32	Remove Furnace No. 5 Hearth	60 days
33	Process 150 tonnes of No. 5 Hearth in converters	10 days
34	Remove Furnace No.1 Hearth (if single furnace operation)	60 days
35	Process 150 tonnes of No. 1 Hearth in converters	10 days
36	**Removal of Reusable Process Dust**	**528 days**
37	**2013 Shutdown Dust Cleaning Campaign**	**20 days**
44	**Monthly Dust Cleaning Maintenance**	**496 days**
62	**Re-routing of Mill Feed to Concentrate Load Out Facility/Temporary Facility**	1 day
63	**Smelter Shutdown Activities**	**180 days**
64	**Ore Concentrate Drawdown**	**64 days**
65	Thickener Drawdown	1 day
66	Drain Thickener Area Pulp Storage Tanks 1 and 2	8 days
67	Rotary bin and Revert Drawdown	3 days
68	Dust Usage in Furnace(s)	3 days
69	Furnace Drawdown	4 days
70	Furnace Structural Monitoring	45 days
71	Smelter Production Ceased	0 days
72	**Thickener Area Shutdown**	**30 days**
73	Preparation and Planning	5 days
74	De-energize equipment (lock out/tag out)	5 days
75	Cleanout of thickener	3 days
76	Clean out of Pulp Storage tanks 1 and 2 and pipelines	12 days
77	Cleaning of filter press	2 days
78	Cleaning of pits, sumps and trenches	3 days
79	**Roaster Area Shutdown**	**15 days**
80	De-energize equipment (lock out/tag out)	1 day
81	Inspection of Roasters/reverts bin for residual Process Material	1 day
82	Remove residual Process Dust/Reverts (if present)	13 days
83	**Furnace Area Shutdown**	**180 days**
84	Preparation and Planning	60 days
85	De-energize equipment (lock out/tag out)	1 day
86	Operating Furnace(s) Hearth(s) Removal/Shipping	60 days
87	Empty Glycol and Hydraulic Systems	5 days
88	Depressurize and Vac Coke System	5 days
89	**Converter Area Shutdown**	**21 days**
90	Preparation and Planning	9 days
91	De-energize equipment (lock out/tag out)	4 days
92	Clear Scrap and Flux Bins	10 days
93	**Anode Casting Area Shutdown**	**15 days**
94	De-energize equipment (lock out/tag out)	7 days
95	Remove casting line skulls for processing as scrap	8 days
96	**ESP/Dust System Shutdown**	**30 days**
97	Preparation and Planning	2 days
98	De-energize equipment (lock out/tag out)	2 days
99	Dry vac dust and stage for shipment	26 days
100	**Support Facility Shutdown**	**30 days**
101	Preparation and Planning	2 days
102	De-energize equipment (lock out/tag out)	2 days
103	Remove Materials from storage bins for use on-site or shipment off-site	26 days
104	**Sample House Shutdown**	**14 days**
105	Preparation and Planning	4 days
106	De-energize equipment (lock out/tag out)	2 days
107	Remove Laboratory Equipment	8 days
108	**Oxygen System Shutdown**	**76 days**

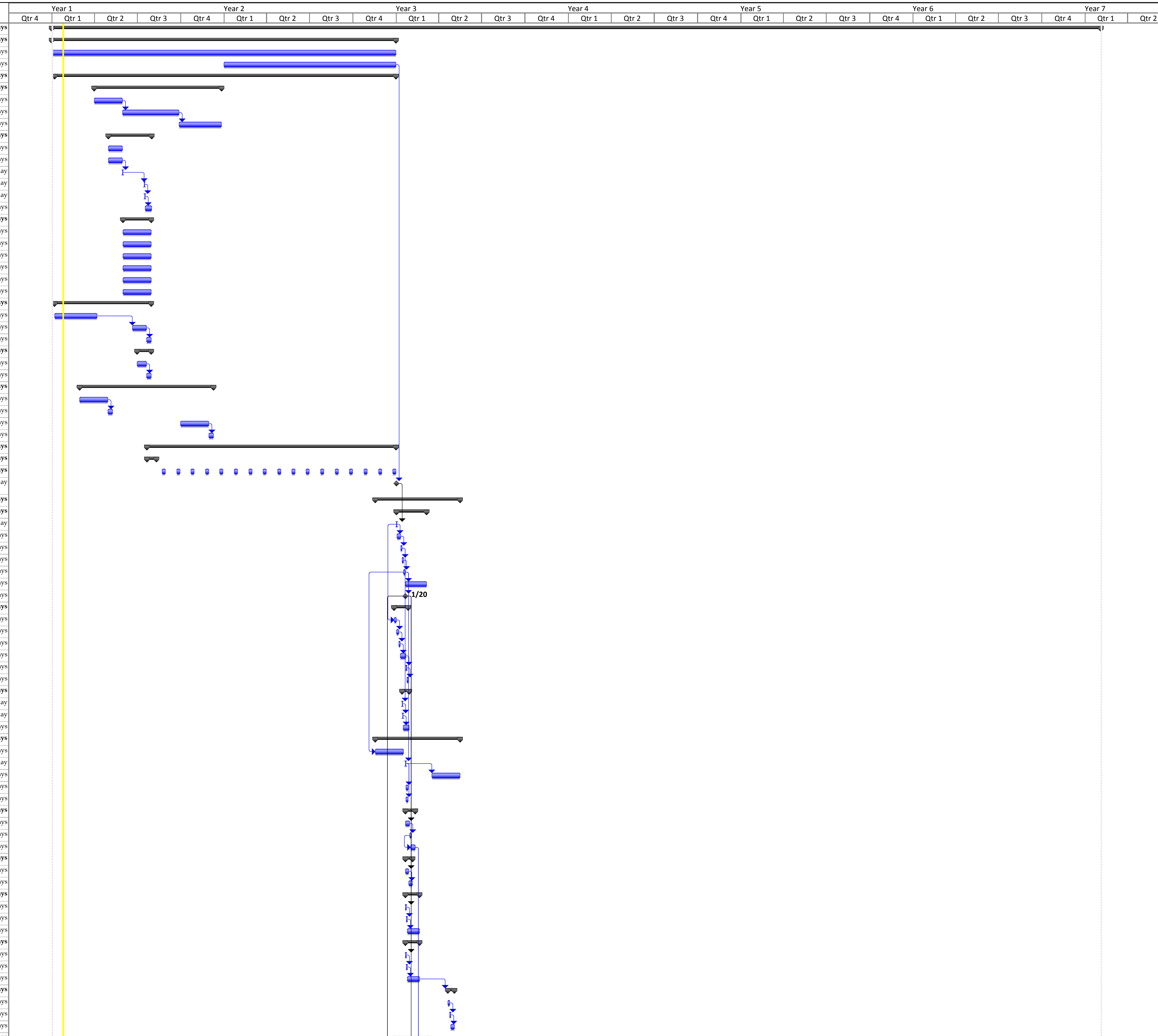


FIGURE 6.0
SOUTH YARD, SMELTER AND REFINERY SHUTDOWN SCHEDULE
VALE - MANITOBA OPERATIONS, THOMPSON,

ID	Task Name	Duration
109	Preparation and Planning	30 days
110	De-energize equipment (lock out/tag out)	1 day
111	Removal of LOX and inert oxygen system by contractor	14 days
112	**Fuel Oil System Shutdown**	**76 days**
113	Preparation and Planning	30 days
114	De-energize equipment (lock out/tag out)	1 day
115	Removal of Fuel Oil Tanks by contractor	14 days
116	**Refinery Shutdown Activities**	**910 days**
117	Initial Preparation and Planning	578 days
118	Initial Cleaning of Refinery Sumps and Building	150 days
119	**Receipt of Last Anode From Smelter**	0 days
120	**Production Ramp Down**	**132 days**
121	Mandel Plant ink line and ovens de-energize equipment	2 days
122	Final Stripping and De-inking of Mandrel Sheets/stockpile cleaned sheets	10 days
123	De-energize Stripping and De-inking Line	2 days
124	**Scrap Wash**	**60 days**
125	Spent anode crushing De-energize equipment	2 days
126	Preparation of anodes for electrolytic cells	20 days
127	Clean all copper cathode tubes	20 days
128	**Tank house**	**22 days**
129	Sequential Shutdown of Circuits in Tank House	20 days
130	De-energize final plating circuit(s)	2 days
131	**Sulphur Anode Slimes Area**	**27 days**
132	Sulphur Anode Slimes processing ramp down	25 days
133	De-energize Sulphur Anode Slimes Area	2 days
134	**Purification Area**	**82 days**
135	Purification Area production ramp down	80 days
136	De-energize Purification Area	2 days
137	**Shear Shed Area**	**22 days**
138	Shear Shed processing of plated cathodes/rounds	20 days
139	De-energize Shear Shed Area	2 days
140	**Support Building Shutdown**	**21 days**
141	Hydrogen Sulphide Building Process Ramp down	20 days
142	De-energize Hydrogen Sulphide Building/inert lines	1 day
143	Chlorine Building Process Ramp down	20 days
144	De-energize Chlorine Building/inert lines	1 day
145	Sulphate Building Process Ramp down	20 days
146	De-energize Sulphate Building/inert lines	1 day
147	**Regular Production Operations in Refinery Cease**	0 days
148	Waste Characterization	5 days
149	**Draining/Cleaning of Process Areas**	**188 days**
150	**Stripping Floor and Mandrel Plant**	**20 days**
151	Remove residual ink, grit , copper sulphate and acid from area	20 days
152	Clean equipment of all dust/debris and transfer to staging area	20 days
153	**Scrap Wash**	**40 days**
154	Clean and empty scrap wash tanks	10 days
155	Empty matte storage bins a stage for shipping	10 days
156	Lime neutralization of liquid wastes and transfer to Mill	2 days
157	Grind out/empty ball mill and stage for shipping	2 days
158	Clean equipment of all dust/debris and transfer solids to staging area	5 days
159	Filter Cloth Washing	35 days
160	**Sulphur Anode Slimes (SAS)**	**20 days**
161	Empty tanks and clean	20 days
162	Open filters and clean	20 days
163	Clean floors using wet methods	20 days
164	**Tank House**	**80 days**
165	Empty liquid from tanks to purification	80 days
166	Physical removal of solids from tanks	80 days
167	Staging of solids for shipping for processing/disposal	80 days
168	Clean equipment of all solids and transfer solids to staging area	80 days
169	**Purification**	**30 days**
170	Empty Process vessels	30 days
171	Empty Soda Ash Tank	30 days
172	Neutralize acid tanks and flush to Mill	30 days
173	Remove Filter Media and Clean all Filter presses	30 days
174	Dilute Scrubber Hypochlorite and blend with electrolyte	30 days
175	Clean equipment of all solids and transfer solids to staging area	30 days
176	**Shear Shed**	**20 days**
177	Empty soda ash and transport to Mill	20 days
178	Fill Soda Ash Tank with water and drain to Mill	20 days
179	Neutralize acid and wash tanks and discharge to sewer	20 days
180	Clean equipment of all solids and transfer solids to staging area	20 days
181	Propane and Liquid Nitrogen Tank Shutdown	2 days
182	Utilities Shutdown	2 days
183	Final Refinery Cleaning	30 days
184	**Potential Optional Refinery Concurrent Projects**	**1436 days**
185	Electrolyte Processing - Nickel Carbonate	120 days
186	Cobalt Iron Cake Production	75 days
187	Groundwater Remediation	180 days
188	Copper Arsenic Pond Processing	1070 days
189	Smelter and Refinery Placed in Cold Closure pending final dispostion	0 days

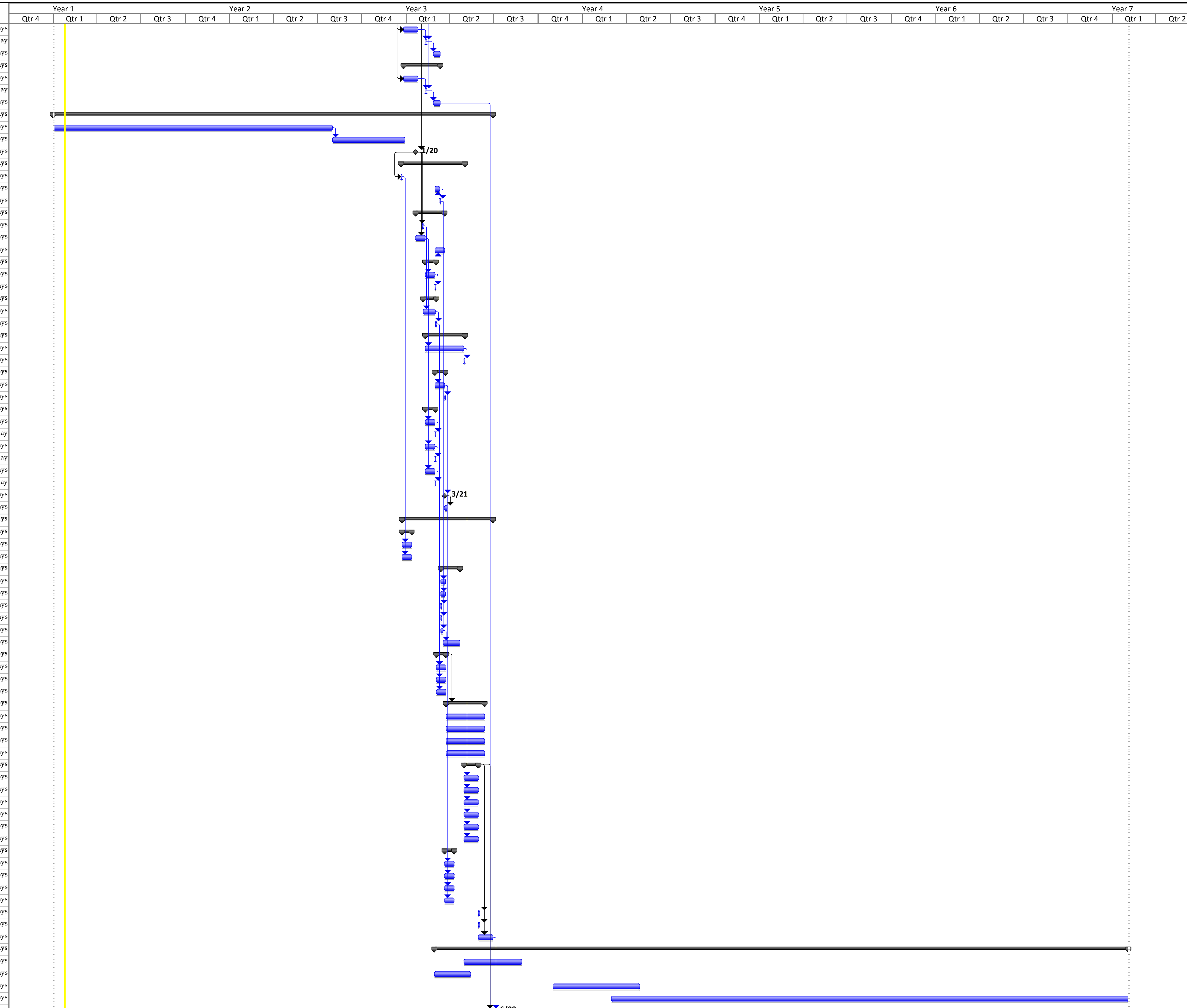


FIGURE 6.0
SOUTH YARD, SMELTER AND REFINERY SHUTDOWN SCHEDULE
VALE - MANITOBA OPERATIONS, THOMPSON,

TABLE 2.1

SOUTH YARD HAZARDOUS MATERIALS INVENTORY
AUGUST 2011
DECOMMISSIONING PLANNING PROJECT
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Type	*Barcode/Identifier #*	*Units*	*Photo*
refrigerant gas kerosene can- 13.6 kg cylinder	134A barcode: 744073100198	2	1
tetrofluoroethane 13.6kg cylinder	barcode: 744073100204	1	1
mercaptan stench gas cartridge - small	model #: MWD-100-E-134A-SC-240	9	2
mercaptan stench gas cartridge - large	model #: MWD-500-E-134A-SC-240	16	2
calibration gas cylinders - 2 cu. Ft.	UN 1956	37	3
liquid scale dissolver - 1 gallon	4845-K8	3	4
protect water storage systems (pink jug) - 1 gallon	4-691	2	4
varathane can - 1 gallon	-	1	5
ESSO antifreeze coolant - 5 gallon	-	1	5
holmatro fluid (jug without label) - 1 gallon	-	1	5
paint cans (industrial enamel) - 1 gallon	-	7	6
paint thinner- glyptaln (square can) - 1 gallon	-	1	6
Thompson's water seal (waterproofer plus) - 1 gallon	-	1	6
plastic 1 gallon jug of antifreeze	-	1	7
CO2 cartridge - large	part #: 423432	1	8
propane cans - 20 pounds	UN 1978	6	9
liquid petroleum gas - 30 pounds	-	1	9
drums - unlabelled 45 gallon	-	8	10
small cans pallet -uscothne 5680 - 1 litre	curitive cans	12	12
	resin cans	12	12
assorted small propane cylinders and gas cartridges in bin	-	150	11
electric refrigerator - large	-	1	13
carrier heaters - 2' x 3'	-	2	13
paint cans in crate - 1 gallon	-	76	14
drywall compound 20L	-	1	14
Electrohome air conditioner unit (CFCs)	R134094	1	15
Kenmore refrigerator - large	-	2	16
varsol drums - 45 gallon	-	2	17
Crystal Mountain water cooler unit - tall	18072270094	1	18
air conditioner unit	BFR141A1	1	19
mini Salton fridge	-	1	19
semi Danby fridge	54101512	1	19
Greenway water cooler unit - short	60208210070	1	20
refrigerators (full sized)	-	5	21
carrier heaters - 2' x 3'	-	1	21
Canadian tire semi fridge	96401717	1	21
Woods freezer - large	01925126FU	1	22
Thermoplus heater units - large	B2003030405	3	23
Thermoplus heater units - large	2000030059		23
Thermoplus heater units - large	B2002010207		23
Whirlpool Fridge - large	-	1	24
Simplicity fan unit	model #: SPAC 8006	1	25
Danby/IGNIS fridge - small	-	3	25
Greenway water cooler - tall	GW860W	2	26
GE fridge -small	KG600202	1	26
Citation odourless solvent 140 - 20L pails	safety data sheet: 03906	9	26
PVC cement (small cans) - 1 litre	-	4	26
pail of clear sealant (chil-loik clear) - 20L	36-2400-0005	2	27
paint cans (cloverdale) - 1 gallon	-	13	27
pails of tar - 20L	-	5	27
pails of traffic marking paint - 20L	batch # 9-E-2989	15	27
Capbond-e 20L pails		11	

TABLE 2.1

SOUTH YARD HAZARDOUS MATERIALS INVENTORY
AUGUST 2011
DECOMMISSIONING PLANNING PROJECT
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Type	*Barcode/Identifier #*	*Units*	*Photo*
Rheobuild 1000 highwater reducing admixture - 20L pail		1	
Chil-sorb asbestos remover - 20L	-	1	27
45 gallon drums of assorted aerosol cans	-	2	
paint cans - 1 gallon	-	39	
wintergreen stench gas cartridges - small	MWD-500-W-134-LC-200	9	28
mercaptan stench gas cartridges - large	MWD-500-E-134-LC-400	5	28
mercaptan stench gas cartridges - small	MWD-500-E-134-LC-200	2	28
drums varsol (Mobil and ESSO) - 45 gallons	-	2	29
heavy duty antiseize (bottle) - 1 litre	51605	2	30
croma-tap 2 - 1 litre	-	2	32
IPEX (CPVC cement) pipe glue - 1 litre	part # 074008	2	30
International Nickel heat cure apoxy inc. (pails) monteith - 20 L pails	white 6153	16	33
DR-133 polymer (blue jugs) - 5 gallon	-	31	35
International Nickel heat cure apoxy inc. (grey) monteith - 20L pails	-	8	36
Primer 100 (bottle) - 2 litres	-	1	37
paint cans - 1 gallon	-	16	38
large calibration gas cylinders	UN 1956	35	39
Small calibration gas cylinders	UN 1956	18	39
International Nickel heat cure apoxy inc. (pails) monteith - 20 L pails	-	45	38
45 gallon drum aerosol cans	-	1	41
turbo torch map-gas (yellow) cylinder	part # 0916-0122	1	42
paint cans - 1 gallon	-	3	43
drywall compound - 2 gallon pail	-	1	44
P1500 adhesive kit (2cans/box) - 1 litre	-	20 sets	44
Small calibration gas cylinders (red)	part # 459943 lot # 82676-15	12	44
large calibration gas cylinders	UN 1956	182	44
paint cans - 1 gallon	-	21	46
wirelock rope capping kit - 1 litre	batch # 243	7	45
20L metal pails with lids - no labels	-	21	-
Scotty Speciality Gases- air carbon monoxide mixture cylinders	-	2	-
disposable cartridge filters for crushed lamps in boxes	-	2	47
Bernzomatic propane/calibration gas 400g		55	48/49
odourless solvent 140 - 20L pails	-	6	50
Kodak ethanethiol (15% intrichloro fluoromethane) in red stench gas box - 1 litre glass bottle	-	11	52
stench gas (large cylinders)	-	10	-
varsol (white steel cans) - 45 gallons	-	1	53
Safe solve plus - 4 gallons	-	2	54
paint cans (open) - 1 gallon	-	7	55
45 gallon plastic drum of aerosol cans	-	1	56
varsol white plastic pails - 45 gallon drum	-	2	-
plastic cement #625 - 1 litre	-	1	57
ESSO XD-3 motor oil (black pail) - 20L	-	1	59
Oatey ABS cement - 1 litre	387533152	1	57
Weld-On primer P70 for LVC - 1 litre	-	5	57
Devcon FL-20 primer - 1 litre	part # 15985	4	58

TABLE 2.1

SOUTH YARD HAZARDOUS MATERIALS INVENTORY
AUGUST 2011
DECOMMISSIONING PLANNING PROJECT
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Type	*Barcode/Identifier #*	*Units*	*Photo*
IPEX XIRTEC II primer - 1 litre	part # 074363	2	57
IPEX XIRTEC VII primer - 1 litre	part # 074337	3	57
IPEX orange - 1 litre	part # 074008	7	57
small gas calibration cartridges in drum	-	68	-
large propane cylinder - 60 pound	172T7040	1	34
EXXSOL D60 Solvent Imperial Oil (378502)	-	1	
INTERFROTH drums - 45 gallon	prod # IF6-3	1	
INTERFROTH drums - 45 gallon	prod # IF6-0	1	
Ice free switch (black barrel) - 45 gallon	-	1	
drums (not labeled) - 45 gallon	-	8	
yellow drum - 45 gallon	-	1	
drums (unlabeled) - caution PCB tags - 45 gallon	-	4	
ballasts in yellow 'used batteries' container	-	approx. 200	63
green transformers	serial # 631789	3	71
green transformers	serial # 54672		71
green transformers	missing plate		71
pails of aerosol cans - 20 L	-	1	
IPEX XIRTEC XI primer	-	1	
Lepage contact cement	LCP 506	1	
International Nickel heat cure apoxy inc. (pails) monteith - 20 L pails	-	68	
paint cans in crate - 1 gallon	-	100	
Sikadur 42 grout PAK A	-	1	
Sikadur 32 High mod B	-	2	
Texaco Threadtex (black pail)	CPS# 22230	1	
Rope Patch 20L pail	810-47	1	
wirelock rope capping kit 1000CC	-	12	
Seal Tight 1220 white pigmented compound (green pails) - 20 L pails	prod # 3350-241	9	
drums with possible crushed fluorescent light - 45 gallon	-	3	
Spectrus BD 1500 (white pails)	-	8	
Resin	-	1	
Sikatop 111/121/122/123 (yellow jug)	-	1	
International Nickel heat cure apoxy inc. (pails) mor	-	15	
Club Pack Bleach no name (white jug) 1.89L	-	1	
Seal Tight 1220 white pigmented compound (green pails) - 20 L pails	-	1	
Sikadur 32 High mod B (yellow) - 20 L	-	5	
Deraweld C - 1 L	-	1	
20L pails without labels	-	10	
Endura EX-2C component B 20 L	-	2	
Dibasic Ester -ashland chemicals drum 45 gal	1990-0904	1	
Hetron Resin 197Pr drums 45 gal	mat. Data sheet: 30060	32	
diesel fuel (blue barrels) 4 gal	-	7	
pallet of 1GP-12 cement - 1 L	-	36 bags	
black drums (unlabeled) 45 gal	-	6	
blue drums (unlabeled) 45 gal	-	2	
black propane tank - 60 pounds	-	1	

TABLE 2.2

AVERAGE SMELTER PRODUCTION RATES/USAGE RATES
SHUTDOWN PROCEDURES PLAN
VALE THOMPSON SMELTER/REFINERY DECOMMISSIONING
THOMPSON, MANITOBA

		Single Furnace Operation			*Dual Furnace Operation*		
Description	*Units*	*Average*	*Min*	*Max*	*Average*	*Min*	*Max*
Thickener Feed Volume	Cubic meters per day	8,171	6,071	8,800	8,461	6,540	9,385
Thickener Underflow	Cubic meters per day	1,718	1,281	1,980	1,821	1,411	2,077
Roasting	Hours	17.3	7.00	23.67	19.58	2.07	32.19
Filter Press 10C	Tons per day	485	176	667	636	80	1,131
VBN	Tons per day	255	110	342	308	38	512
Sand	Tons per day	351	177	513	355	38	642
Matte Taps	Furnace taps per day	28	7	46	29	2	44
LM	Tons per day	22	0	35	44	0	96
Fce Scrap	Tons per day	33	0	48	47	0	88
PSC Scrap	Tons per day	31	3	68	46	0	150
ENR	Tons per day	12	0	60	15	-1	81
Silica	Tons per day	100	18	161	109	0	173
Anodes	Anodes per day	788	303	1,166	943	-3	1,459
Acceptable feed rate of Yard Recyclables Not Currently fed based on VBN feed rate	Tons per day	43	18	57	51	6	85
Casting Data - Total Converter Pours	Pours per day	11	4	16	13	0	20
Total Percol Addition	Liters/day	17,777	17,040	18,481	17,601	16,134	18,412

Notes:

Single Furnace Operation Time Period from April 1, 2012 to April 25, 2012
Dual Furnace Operation Time Period from April 26, 2012 to June 30, 2012
Data from April 22, 2012 was not used

TABLE 2.3a

VALE LABOUR ESTIMATE - SOUTH YARD HAZARDOUS MATERIALS
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	15	120
Smelter Maintenance Manager	8	2	16
Refinery Maintenance Manager	8	2	16
Vale Environmental Personnel	8	5	40
Mobile Equipment Operator	8	10	80
	TOTAL LABOUR		**192**
			DAYS
	DURATION[1]		**60**

Notes:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
Vale Waste Management Personnel will update the August 2011Hazardous Materials Inventory prior to tendering of South Yard Material Management contract(s).
Vale Project will manage the Tendering process related to the Material Management tender(s) that will include the removal of Hazardous Materials.

TABLE 2.3b

VALE LABOUR ESTIMATE
SOUTH YARD SCRAP METAL AND DEBRIS REMOVAL
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	30	240
Refinery Process/Maintenance Staff	8	2	16
Smelter Process/Maintenance Staff	8	2	16
Mobile Equipment Operator 1	8	20	160
Mobile Equipment Operator 2	8	10	80
Labourer 1	8	20	160
Labourer 2	8	20	160
Labourer 3	8	10	80
Labourer 4	8	10	80
	TOTAL LABOUR		**992**
			DAYS
	DURATION[1]		**180**

Notes:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

- Vale Project Manager and Refinery/Smelter Maintenance/Process Staff conduct inspection of South Yard to identify equipment required for operation of the Smelter and Refinery
-Vale Project will manage the tendering process related to the Material Management tender(s) that will include the removal of empty drums/totes and scrap metal recycling. The remaining tasks below could be tendered separately or as one tender package. For the purposes of this manpower estimate it is assumed that Vale will self perform the below listed tasks.
- Address the presence of non-creosote wood in the South yard under the existing Site burn permi
-Identify location for creosote wood stockpiling and consolidate creosote wood in one location
- remaining debris disposal in existing Site landfill

TABLE 2.3c

VALE LABOUR ESTIMATE
SOUTH YARD SURFICIAL SOIL PROCESSING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	2	16
Mobile Equipment Operator 1	8	30	240
Mobile Equipment Operator 2	8	30	240
Labourer 1	8	30	240
Labourer 2	8	30	240
	TOTAL LABOUR		**976**
			DAYS
	DURATION[1]		**90**

Note:
over the duration identified to complete the tasks described in the Shutdown Procedures Report.

-Manpower estimate includes only the manpower required to scrape the top two feet of soil in the South Yard consistent with the 2003 AMEC Closure Plan.

TABLE 2.3d

VALE LABOUR ESTIMATE
SOUTH YARD PHC SOIL REMEDIAL ACTION
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	10	80
Mobile Equipment Operator 1	8	20	160
Labourer 1	8	20	160
Labourer 2	8	20	160
	TOTAL LABOUR		**560**
			DAYS
	DURATION[1]		**90**

Notes:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
-Vale Project Manager will prepare tender to qualified outside consultant to prepare excavation/verification plan to CCME Petroleum Hydrocarbon standard.
- Vale equipment operator and labours can perform excavation and restoration activities at the

TABLE 3.1a

VALE LABOUR ESTIMATE - SMELTER DUST CLEANING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	5	40
Electrician	8	4	32
Foreman	8	21	168
Mobile Equipment Operator 1	8	21	168
Mobile Equipment Operator 2	8	21	168
Mobile Equipment Operator 3	8	21	168
Mobile Equipment Operator 4	8	21	168
Labourer 1	8	21	168
Labourer 2	8	21	168
Labourer 3	8	21	168
Labourer 4	8	21	168
Labourer 5	8	21	168
Labourer 6	8	21	168
Labourer 7	8	21	168
Labourer 8	8	21	168
Labourer 9	8	21	168
Labourer 10	8	21	168
Labourer 11	8	21	168
Labourer 12	8	21	168
Labourer 13	8	21	168
Labourer 14	8	21	168
Labourer 15	8	21	168
Labourer 16	8	21	168
Maintenance Cleaning 5 Days per month for 18 months			
Mobile Equipment Operator 5	8	90	720
Labourer 1	8	90	720
Labourer 2	8	90	720
	TOTAL LABOUR		**5,760**
			DAYS
	DURATION[1]		**540**

Note:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

Vale Personnel to conduct campaign cleaning during 2013 shutdown using four cleaning crews (1 equipment operator and two labours) followed by monthly maintenace cleaning conducted by one cleaning crew for one week every month until Smelter production ceases

TABLE 3.1b

VALE LABOUR ESTIMATE
SMELTER DEAD STORAGE INSPECTION/CLEANING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	5	40
Smelter Process Staff	8	5	40
Smelter Electrical Staff	4	2	8
Mobile Equipment Operator 1	8	5	40
Labourer 1	8	10	80
Labourer 2	8	10	80
	TOTAL LABOUR		**288**
			DAYS
	DURATION[1]		**14**

Note:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
Vale Project Manager to coordinate with Smelter Process staff to coordinate drawdown of Dead Storage tanks in advance of 2013 Shutdown and conduct inspection.

TABLE 3.1c

VALE LABOUR ESTIMATE
SMELTER COTTRELL HOPPER INSPECTION/CLEANING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	2	16
Electrian	8	2	16
Mobile Equipment Operator 1	4	10	40
Labourer 1	8	10	80
Labourer 2	8	10	80
Labourer 3	8	10	80
Labourer 4	8	10	80
	TOTAL LABOUR		**312**
			DAYS
	DURATION[1]		**30**

Note:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

Vale Project Manager to coordinate with Smelter Electricial staff to coordinate inspection of Cottrell Ar Hoppers during 2013 Shutdown and conduct inspection.

TABLE 3.1d

VALE LABOUR ESTIMATE
FURNACE NO. 5 HEARTH REMOVAL
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	10	80
Mobile Equipment Operator 1	8	30	240
Mobile Equipment Operator 2	8	30	240
Labourer 1	8	30	240
Labourer 2	8	30	240
	TOTAL LABOUR		**1,040**
			DAYS
	DURATION[1]		**60**

Note:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

Labour Esitmate based on six week time frame for complete removal of hearth and build up.

TABLE 3.1e

VALE LABOUR ESTIMATE
COPPER CALCINE MATERIAL REMOVAL/CLEANING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	5	40
Smelter Maintenance Staff	4	5	20
Material Removal			
Mobile Equipment Operator 1	8	20	160
Labourer 1	8	20	160
Labourer 2	8	20	160
Thickener/Tank Cleaning			
Labourer 1	8	10	80
Labourer 2	8	10	80
	TOTAL LABOUR		**700**
			DAYS
	DURATION[1]		**60**

Note:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

Material removed from Copper Calcine Process to be shipped from the Site for processing.

TABLE 3.1f

VALE LABOUR ESTIMATE
SMELTER SAMPLE HOUSE SHUTDOWN INSPECTION/CLEANING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	2	16
Vale Maintenace Staff	8	5	40
Mobile Equipment Operator 2	8	1	8
Labourer 1	8	2	16
Labourer 2	8	2	16
	TOTAL LABOUR		**96**
			DAYS
	DURATION[1]		**14**

Notes:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
- Vale Maintenance Staff to Disconnect and Drain plumbing system and disconnect any lab equipment to be relocated
-Mobile equipment operator and labours to relocate equipment

TABLE 3.1g

VALE LABOUR ESTIMATE
SMELTER THICKENER AREA SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	10	80
Smelter Electrical Staff	8	5	40
Smelter Maintenance Staff	8	5	40
Labourer 1	8	20	160
Labourer 2	8	20	160
Labourer 3	8	20	160
Labourer 4	8	20	160
	TOTAL LABOUR		**800**
			DAYS
	DURATION[1]		**30**

Notes:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

- Vale electirical and maintenance staff to perform power down consistent with Vale lock out/tag ou procedures of thickener area and draining of oil containing equipment/depressurization of process
- Labourers to preform cleaning of high rate thickener, live and dead storage tanks, filter press, draining of filter press tanks and cleaning as necessary and jetting of process lines

TABLE 3.1h

VALE LABOUR ESTIMATE
SMELTER ROASTER AREA SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	5	40
Smelter Electrical Staff	8	5	40
Smelter Maintenance Staff	8	5	40
Mobile Equipment Operator	4	15	60
Labourer 1	8	15	120
Labourer 2	8	15	120
	TOTAL LABOUR		**420**
			DAYS
	DURATION[1]		**15**

Notes:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

- Vale electirical and maintenance staff to perform power down consistent with Vale lock out/tag out procedures of roaster area and depressurization of process air.
- Vale Project Manager to perform inspection of Roaster/cyclones
- Labourers to preform cleaning (if necessary) of roasters and cyclones and final emptying of revert

TABLE 3.1i

VALE LABOUR ESTIMATE
FURNACE AREA SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Furnace No. 1 Hearth Processing			
Vale Project Manager	8	10	80
Mobile Equipment Operator 1	8	30	240
Mobile Equipment Operator 2	8	30	240
Labourer 1	8	30	240
Labourer 2	8	30	240
Furnace No. 2 Hearth Removal and Shipping			
Vale Project Manager	8	10	80
Mobile Equipment Operator 1	8	30	240
Mobile Equipment Operator 2	8	30	240
Labourer 3	8	30	240
Labourer 4	8	30	240
Equipment Lock out			
Smelter Electrical Staff	8	5	40
Smelter Maintenance Staff	8	5	40
Empty Glycol and Hydraulic Systems			
Smelter Maintenance Staff 1	8	5	40
Smelter Maintenance Staff 2	8	5	40
Depressurize and Vac Coke System			
Smelter Maintenance Staff 3	8	5	40
Smelter Maintenance Staff 4	8	5	40
Labourer 5	8	10	80
Labourer 6	8	10	80
	TOTAL LABOUR		**10,080**
			DAYS
	DURATION[1]		**180**

Note:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
- Labour Estimate based on six week time frame for complete removal of hearth and build up.

TABLE 3.1j

VALE LABOUR ESTIMATE
SMELTER CONVERTER AREA SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	10	80
Smelter Electrical Staff	8	5	40
Smelter Maintenance Staff	8	5	40
Mobile equipment Operator	8	10	80
Labourer 1	8	10	80
Labourer 2	8	10	80
	TOTAL LABOUR		**400**
			DAYS
	DURATION[1]		**21**

Notes:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

- Vale electirical and maintenance staff to perform power down consistent with Vale lock out/tag out procedures of Converter area, draining of oil containing equipment/depressurization of process air and isolatin of oxygen system for draining of LOX system.
- Labourers to preform clearing of scrap and flux bins

TABLE 3.1k

VALE LABOUR ESTIMATE
SMELTER ANODE CASTING AREA SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	2	16
Smelter Electrical Staff	8	5	40
Smelter Maintenance Staff	8	5	40
	TOTAL LABOUR		**96**
			DAYS
	DURATION[1]		**7**

Notes:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures
- Vale electirical and maintenance staff to perform power down consistent with Vale lock out/tag out procedures of Anode Casting Area.
- No manpower has been incldued for the removal of skulls from molds or tundish after cooling

TABLE 3.1l

VALE LABOUR ESTIMATE
SMELTER ESP SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	5	40
Power Down of ESP and Dust Management System			
Smelter Electrical Staff 1	8	5	40
Smelter Electrical Staff 2	8	5	40
Smelter Electrical Staff 3	8	5	40
Smelter Electrical Staff 4	8	5	40
Smelter Maintenance Staff 1	8	5	40
Smelter Maintenance Staff 2	8	5	40
Dust System Vac			
Mobile Equipment Operator			
Labourer 1	8	15	120
Labourer 2	8	15	120
Labourer 3	8	15	120
Labourer 4	8	15	120
	TOTAL LABOUR		**760**
			DAYS
	DURATION[1]		**30**

Notes:
1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
- Vale electirical and maintenance staff to perform power down consistent with Vale lock out/tag out procedures of ESP and dust management conveyors and pneumatic system.
- Crew of 4 Labourers supported by one mobile equipment operator to complete dry vac of dust

TABLE 3.1m

VALE LABOUR ESTIMATE
SMELTER SUPPORT FACILITIES SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	2	16
Electrian	8	2	16
Mobile Equipment Operator 1	4	5	20
Mobile Equipment Operator 2	4	5	20
Labourer 1	8	5	40
Labourer 2	8	5	40
Labourer 3	8	5	40
Labourer 4	8	5	40
	TOTAL LABOUR		**192**
			DAYS
	DURATION[1]		**30**

Note:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.

-Electrical Staff to perform lock outs including raw material conveyors and operators/labourers to empty material for raw maerial bins and stockpile prior to backfilling or stage prior to shipment.

TABLE 3.1n

VALE LABOUR ESTIMATE
SMELTER OXYGEN SYSTEM DECOMMISSIONING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	10	80
Smelter Electrical Staff	8	1	8
Smelter Maintenance Staff	8	1	8
	TOTAL LABOUR		**96**
			DAYS
	DURATION[1]		**60**

Notes:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
-Vale Project Manager will prepare tender to qualified outside contractor to perform removal of residual liquefied oxygen for the LOX tanks and purge oxygen lance and converter blow air oxygen

- Vale electrical and maintenance staff to perform power down consistent with Vale lock out/tag out procedures of the oxygen system vapourizers and mechanical systems

TABLE 3.1o

VALE LABOUR ESTIMATE
SMELTER FUEL OIL SYSTEM DECOMMISSIONING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	*HOURS/DAY*	*DAYS*	*TOTAL HOURS*
Vale Project Manager	8	10	80
Smelter Electrical Staff	8	1	8
Smelter Maintenance Staff	8	1	8
	TOTAL LABOUR		**96**
			DAYS
	DURATION[1]		**60**

Notes:

1 - The estimated hours identified in the Total Labour provided in this table will be deployed over the duration identified to complete the tasks described in the Shutdown Procedures Report.
-Vale Project Manager will prepare tender to qualified outside contractor to perform draining, cleaning and removal of fuel oil tanks

- Vale electirical and maintenance staff to perform power down consistent with Vale lock out/tag out procedures of the fuel oil electrical and mechanical systems

TABLE 4.1a

VALE LABOUR ESTIMATE - INITIAL CLEANING OF REFINERY
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	30	240
Operator 1	8	30	240
Labourer 1	8	30	240
Labourer 2	8	30	240
Labourer 3	8	30	240
Labourer 4	8	30	240
		TOTAL LABOUR	**1,440**

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1b

VALE LABOUR ESTIMATE - WASTE CHARACTERIZATION
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	2	10	20
Operator 1	8	5	40
Labourer 1	8	5	40
		TOTAL LABOUR	100

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1c

VALE LABOUR ESTIMATE - MANDREL PLANT SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	10	80
Operator 1	8	10	80
Labourer 1	8	10	80
Labourer 2	8	10	80
Labourer 3	8	10	80
Labourer 4	8	10	80
		TOTAL LABOUR	480

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1d

VALE LABOUR ESTIMATE - SCRAP WASH SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	20	160
Operator 1	8	40	320
Labourer 1	8	40	320
Labourer 2	8	40	320
Labourer 3	8	40	320
Labourer 4	8	40	320
		TOTAL LABOUR	1,760

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1e

VALE LABOUR ESTIMATE - SHUTDOWN OF SAS FILTERS
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	5	40
Operator 1	8	20	160
Labourer 1	8	20	160
		TOTAL LABOUR	360

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1f

VALE LABOUR ESTIMATE - TANK HOUSE SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	24	80	1,920
Foreman	24	80	1,920
Tankman 1	24	80	1,920
Tankman 2	24	80	1,920
Tankman 3	24	80	1,920
Tankman 4	24	80	1,920
Tankman 5	24	80	1,920
Tankman 6	24	80	1,920
Tankman 7	24	80	1,920
Tankman 8	24	80	1,920
Tankman 9	24	80	1,920
Tankman 10	24	80	1,920
Tankman 11	24	80	1,920
Tankman 12	24	80	1,920
Tankman 13	24	80	1,920
Tankman 14	24	80	1,920
Tankman 15	24	80	1,920
Tankman 16	24	80	1,920
Tankman 17	24	80	1,920
Tankman 18	24	80	1,920
Tankman 19	24	80	1,920
Tankman 20	24	80	1,920
Tankman 21	24	80	1,920
Tankman 22	24	80	1,920
Tankman 23	24	80	1,920
Tankman 24	24	80	1,920
Tankman 25	24	80	1,920
Tankman 26	24	80	1,920
Tankman 27	24	80	1,920
Tankman 28	24	80	1,920
Tankman 29	24	80	1,920
Tankman 30	24	80	1,920
Tankman 31	24	80	1,920
Tankman 32	24	80	1,920
Tankman 33	24	80	1,920
Tankman 34	24	80	1,920
Tankman 35	24	80	1,920
Tankman 36	24	80	1,920
		TOTAL LABOUR	72,960

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1g

VALE LABOUR ESTIMATE - PURIFICATION AREA SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Purification Cleaning and Shutdown			
Foreman	24	30	720
Operator 1	24	30	720
Labourer 1	24	30	720
Labourer 2	24	30	720
Labourer 3	24	30	720
Labourer 4	24	30	720
Brick Removal			
Foreman	8	20	160
Operator 1	8	20	160
Labourer 1	8	20	160
Labourer 2	8	20	160
Labourer 3	8	20	160
Labourer 4	8	20	160
		TOTAL LABOUR	5,280

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1h

VALE LABOUR ESTIMATE - SHEAR SHED SHUTDOWN
VALE -MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	20	160
Operator 1	8	20	160
Labourer 1	8	20	160
Labourer 2	8	20	160
Labourer 3	8	20	160
Labourer 4	8	20	160
		TOTAL LABOUR	960

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1i

VALE LABOUR ESTIMATE -
SHUTDOWN OF HYDROGEN SULPHIDE BUILDING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	1	8
Operator 1	8	1	8
Labourer 1	8	1	8
		TOTAL LABOUR	24

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1j

VALE LABOUR ESTIMATE - SHUTDOWN OF SO2 BUILDING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	1	8
Operator 1	8	1	8
Labourer 1	8	1	8
		TOTAL LABOUR	24

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1k

VALE LABOUR ESTIMATE - SHUTDOWN OF CHLORINE BUILDING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	1	8
Operator 1	8	1	8
Labourer 1	8	1	8
		TOTAL LABOUR	24

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1l

VALE LABOUR ESTIMATE - FINAL CLEANING
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	16	30	480
Operator 1	16	30	480
Labourer 1	16	30	480
Labourer 2	16	30	480
Labourer 3	16	30	480
Labourer 4	16	30	480
		TOTAL LABOUR	**2,880**

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1m

VALE LABOUR ESTIMATE - SHUTDOWN OF PROPANE TANK
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	1	8
Operator 1	8	1	8
Labourer 1	8	1	8
		TOTAL LABOUR	24

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1n

VALE LABOUR ESTIMATE - SHUTDOWN OF LIQUID NITROGEN TANK
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	1	8
Operator 1	8	1	8
Labourer 1	8	1	8
		TOTAL LABOUR	24

Note:
Duration is estimated based on anticipated scope of work.

TABLE 4.1o

VALE LABOUR ESTIMATE - UTILITIES SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

LABOUR	HOURS/DAY	DAYS	TOTAL HOURS
Foreman	8	2	16
Operator 1	8	2	16
Labourer 1	8	2	16
		TOTAL LABOUR	48

Note:
Duration is estimated based on anticipated scope of work.

TABLE 5.1

LABOUR ESTIMATE - SOUTH YARD MATERIAL MANAGEMENT
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

TABLE	SOUTH YARD MATERIAL MANAGEMENT	LABOUR HOURS	DURATION (Days)
2.3a	Hazardous Material Removal and Disposal	192	60
2.3b	Scrap Recycling and Debris Removal	992	180
2.3c	Surficial Soil Processing	976	90
2.3d	Petroleum Hydrocarbon Contaminated Soil Removal	560	90
TOTAL ESTIMATED SOUTH YARD MATERIAL MANAGEMENT LABOUR		**2,720**	

TABLE 5.2

VALE LABOUR ESTIMATE - SMELTER RAMPDOWN/SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

TABLE	SMELTER RAMP DOWN / SHUTDOWN	LABOUR HOURS	DURATION (Days)
3.1a	Dust Cleaning	5,760	540
3.1b	Dead Storage Tanks Inspection and Cleaning	288	14
3.1c	Cottrell Hopper Cleaning	312	30
3.1d	Furance No.5 Hearth Removal	1,040	60
3.1e	Copper Calcine Process Residuals	700	60
3.1f	Sample House Shutdown	96	14
3.1g	Thickener Area Shutdown	800	30
3.1h	Roaster Area Shutdown	420	15
3.1i	Furnace Area Shutdown	10,080	180
3.1j	Conveter Area Shutdown	400	21
3.1k	Anode Casting Area Shutdown	96	7
3.1l	ESP Shutdown	760	30
3.1m	Support Facilities Shutdown	192	30
3.1n	Oxygen System Decommissioning	96	60
3.1o	Fuel Oil Decommissioning	96	60
	TOTAL ESTIMATED SMELTER RAMP DOWN/SHUTDOWN LABOUR	**21,136**	

TABLE 5.3

VALE LABOUR ESTIMATE - REFINERY RAMP DOWN / SHUTDOWN
VALE - MANITOBA OPERATIONS
THOMPSON, MANITOBA

TABLE	REFINERY RAMP DOWN / SHUTDOWN	LABOUR HOURS	DURATION (Days)
4.1a	Initial Cleaning of Refinery Sumps and Building	1,440	30
4.1b	Waste Characterization	100	5
4.1c	Stripping Floor and Mandrel Plant	480	10
4.1d	Scrap Wash	1,760	40
4.1e	Sulphur Anode Slimes (SAS)	360	20
4.1f	Tank House	72,960	80
4.1g	Purification	5,280	30
4.1h	Shear Shed	960	20
4.1i	Hydrogen Sulphide Building	24	1
4.1j	Sulphate Building	24	1
4.1k	Chlorine Building	24	1
4.1l	Final Refinery Cleaning	2,880	30
4.1m	Propane Tank	24	1
4.1n	Liquid Nitrogen Tank	24	1
4.1o	Utilities	48	2
TOTAL ESTIMATED REFINERY RAMP DOWN/SHUTDOWN LABOUR		86,388	

APPENDIX A

JULY 26 AND JULY 27, 2012
SOUTH YARD INSPECTION PHOTOLOG

6:00 (001 – 002)
001 & 002 - Refrigerators (3 items), Chest Freezers (3 items), Water Coolers (3 items), and Water Fountains (2 items)

6:40 (003 – 014)
003 – Oil Storage and Recycling Building
004 – Two Large Waste Oil Tanks
005 - Two Large Waste Oil Tanks
006 – Miscellaneous Items
007 – Five White Drums Containing Unknown Material
008 – Approximately 15 Barium Carbonate Microflow Enclosed in Bags
009 – Approximately 14 Green Drums Labeled as "Ueartherm PM 6195"
010 – Rubber Tire
011 – Scrap Metal
012 – Concrete Blocks
013 – Fork lift
014 – Fork lift

6:44 (015 – 033)
015 – 20L Industrial Oil Labelled as "Cylesstic TK 680" (26 Items)
016 – 20L Mobil Trans Oil
017 - 20L Air Tool Oil
018 – Misc. 20L Containers
019 – Wooden Skids
020 – Batteries
021 – Stacked Empty Containers (20L)
022 – Drums Containing Waste Acetone
023 – Drums Containing Waste Varsol
024 – Drums Containing Crushed Fluorescent Lights
025 – Drums Containing Waste Air/Oil Filters
026 – Scrap Metal
027 – Drums Containing Crushed Waste Oil Filters
028 – Drums Containing Waste Grease
029 – Drums Containing Waste Zorball
030 – Drums Containing Punctured Aerosol Cans
031 – Drums Containing Glycol
032 – Drums Containing Waste Oil Rags
033 – 1000L Plastic Totes

6:52 (034 – 041)
034 – Two Large Metal Fans
035 - Two Large Metal Fans
036 – Electric Lights and Fixtures
037 – Metal Conduits and Valves
038 – Metal Beams
039 – AL Gas Vaporizer
040 – Plastic Conduits
041 – Short Metal Conduits

6:57 (042 – 044)
042 – Scrap Refrigerators, Air Conditioning Units and Water Coolers
043 – Metal I Beams
044 – Metal I Beams

7:00 (045 – 058)
045 – PCB & Hazardous Waste Material Stored in Large Crate
046 - PCB & Hazardous Waste Material Stored in Large Crate
047 - PCB & Hazardous Waste Material Stored in Large Crate
048 – Miscellaneous Waste Materials
049 – Ethyl Mercaptan Stored in Two Crates
050 – Rubber Pipes
051 – Scrap Metal Machinery
052 – Scrap Metal Machinery
053 – Four Large Motors Labeled as "Hamilton Gear"
054 - Scrap Metal Machinery (press)
055 – Scrap Metal Machinery
056 – Scrap Metal Machinery (Crusher/Breaker)
057 – Scrap Metal Container
058 – Scrap Metal Pumps

7:08 (059 – 078)
059 – Various Empty drums
060 – Concrete Pipes (Less than 1m in Diameter)
061 - Concrete Pipes (Less than 1m in Diameter)
062 - Various Empty drums
063 - Various Empty drums
064 – Large Metal Pipes
065 – Various Empty drums
066 – Metal Beams
067 - Metal Beams

068 – Various Empty drums
069 – Metal Beams and Freight Container
070 – Fire Truck
071 – Stockpiled Wood
072 - Various Empty drums
073 - Various Empty drums
074 - Various Empty drums
075 - Various Empty drums
076 - Various Empty drums
077 - Various Empty drums
078 – Scrap Wood

7:18 (079 – 096)
079 – Scrap Metal
080 – Wire Rope Wrapped on Metal Spools (75 Items)
081 - Wire Rope Wrapped on Metal Spools (75 Items)
082 – Scissor Lift
083 - Wire Rope Wrapped on Metal Spools (75 Items)
084 - Wire Rope Wrapped on Metal Spools (75 Items)
085 – White Canvas Bags Containing Unknown Material
086 – Metal Beams and Wire Wrapped on Wooden Spools
087 - Wire Rope Wrapped on Wooden Spools
088 – Three Freight Containers
089 – Scrap Metal
090 – Stacked Metal Sheets
091 – 50 lb Packages of Granules Labeled as "Black Diamond" (12 skids)
092 - 50 lb Packages of Granules Labeled as "Black Diamond" (12 skids)
093 – Large Metal Wheels
094 – Large Metal Spools
095 – Large Metal Wheels
096 - Wire Rope Wrapped on Wooden Spools

APPENDIX B

LANDFILL OPERATING PERMIT
(PERMIT No. 5-055- REV. 4)

Waste Disposal Ground Operating Permit

Manitoba Conservation

Permit No: 5 – 055 Rev. 4

OPERATING PERMIT

In accordance with the Manitoba Waste Disposal Grounds Regulation, made under the Environment Act, Inco Ltd. Is hereby permitted to operate a Private Class 2 Waste Disposal Ground facility, to be known as Inco Thompson Waste Disposal Ground , situated at Parcels 2 and 3 of Survey Plan No. 4725 in parts of Townships 77 and 78 and Range 2 and 3 WPM and so described on Manitoba Certificate of Title No. 125403 in the Province of Manitoba.

This OPERATING PERMIT is subject to being AMENDED, SUSPENDED, or REVOKED under Section 6 of the Waste Disposal Ground Regulation (Manitoba Regulation 15/91).

This OPERATING PERMIT is issued subject to the following TERMS AND CONDITIONS:

1) Provisions for Disposal -

The owner/operator shall direct all general solid waste within its jurisdiction to this waste disposal ground facility unless otherwise approved by the Director. The following conditions shall apply:

a) The general solid waste disposal site shall be enclosed within an area bounded by the coordinates N19799/E5142; N19799/E5901; N19734/E5807; N19005/E5311; and N19005/E5122 of the INCO Grid System.

2) Burning -

The Owner/Operator shall ensure that controlled burning is carried out in accordance with the Attached "Appendix A", *Burning At Waste Disposal Grounds*, and the following terms and conditions:

a) the burning of domestic garbage, derelict vehicles, tires, or other items of metal, rubber or plastic is prohibited;

b) only separated and readily combustible materials as approved in Appendix A shall be burned in in an area bounded by N20839.159/E5515.428;N20817.916/E5309.454;N20927.766/E5290.778; and N20921.734/E5447.049 of the INCO Grid System.

c) materials known as "*Refinery Burnables*" are an approved "*burnable*" material;

d) unless otherwise approved in writing by the Director only Refinery Burnables and an accelerant may be burned for the purposes of nickel recovery in an area separate from the area described in Clause 2b;

e) the Refinery Burnables area shall be bounded by N20043/E5547; N20043/E5735; N19847/E5529; and N19847/E5547 coordinates of the INCO Grid System;

f) ash from a controlled Refinery Burnables burn shall be recovered for reprocessing; and

g) advise workers in the area and the INCO Safety Department prior to the starting of controlled burns.

3) Tires -

Used tires must be sorted and stored in a separate area from the active site. Recycling provisions should be made with an approved used tire processor for removal of as many tires as possible from the tire storage area. Waste tires may be stored temporarily at the Thompson Open Pit Site under the following terms and conditions.

a) the Thompson Open Pit Tire Storage area shall be enclosed with an area bounded by coordinates N23851/E9622; N23977/E9622; N23977/E9853; and N23851/E9853 of the INCO Grid System; and

b) the tires shall not be kept in one large pile to reduce the potential of a large tire fire. The tires shall be kept in small piles isolated from one another.

4) Sludge -

Municipal Wastewater Sludge shall be disposed of in accordance with specific requirements by the Director. De-watered sludges shall be landfilled and covered immediately.

5) Automotive Waste Storage Area –

Automotive wastes including waste oil, waste antifreeze and waste batteries shall be stored in an area bounded by coordinates N20118/E6038; N20406/E6038; N20406/E6269; and N20118/E6269; of the INCO Grid System prior to final disposal or recycling. The following terms and conditions apply:

a) this area shall also be known as the "Waste Oil Storage Area",

b) waste oil shall not be disposed of at the facility;

c) waste antifreeze and scrap batteries shall not be disposed of at the facility; and

d) each waste type shall be segregated from one another and clearly identified.

6) Liquid Waste –

The following terms and conditions shall apply:

a) no liquid sewage waste shall be disposed of at the facility; and

b) other liquid waste shall not be deposited at the site unless otherwise approved by the Director.

.../3

7) Hazardous Waste –

Hazardous Waste shall not be disposed at the site unless in accordance with the Dangerous Goods Handling and Transportation Act and Regulations.

8) Asbestos Disposal –

The owner/operator shall ensure that waste containing asbestos is disposed of under the following terms and conditions:

a) the asbestos disposal area shall be enclosed within an area bounded by N22616/E15044; N22616/E15438; N23170/E15662; N22788/E16325; N22225/E15438; and N22225/E15044 of the INCO Grid System; and

b) disposal of asbestos shall conform to the attached "*Asbestos Disposal Criteria*" (Appendix B), where applicable.

9) Petroleum Contaminated Soils –

In the event that petroleum contaminated soils are being disposed of at the site the following terms and conditions shall be followed:

a) the petroleum contaminated soil treatment area shall be enclosed within an area bounded by the coordinates N22151/E11050; N22163/E11197; N21726/E11216; and N21714/E11069 of the INCO Grid System;

b) treatment of petroleum contaminated soils shall conform to the Guideline 96-05 – *Treatment and Disposal of Petroleum Contaminated Soil* (June 1996) revised April 2002; and

c) prior to any disposal of petroleum contaminated soils at the facility, approval for disposal shall be obtained from an Environment Officer.

10) Metallic Waste –

Metallic wastes shall be handled under the following terms and conditions:

a) the metallic waste area is bounded by N20745/E6204; N20745/E6305; N20479/E6305; and N20479/E6204 of the INCO Grid system; and

b) metallic waste collected shall be removed for recycling at regular intervals and shall not exceed 1 year storage unless otherwise approved by the Director.

11) Public Access/Site Control –

The INCO Thompson Waste Disposal Ground shall not be open to the general public

12) Fencing -

As the entire waste disposal grounds is subject to controlled access, the fencing requirement of the Regulation is waived.

If in the future wind blown litter in the general solid waste are shown to be a problem, the Director may require fencing around the active area of the general solid waste site to control litter.

13) Litter/General Site Clean-up –

At least once each spring and once each fall or more frequently if required by the Director, a general clean-up of the site must be undertaken to confine solid waste, including all litter, to the smallest possible area within the active site.

14) Scavenging –

Scavenging shall not be permitted at the working face of the general solid waste disposal area.

15) Interim Covering –

At least once each month, between May 1 and October 31 of each year, all solid waste shall be compacted and covered with a minimum of 15 cm (6 in.) of suitable material approved by the Director.

16) Final Covering –

A uniform layer of earth cover capable of supporting revegetation shall be compacted to a minimum depth of 0.6 meters and shall be placed over the entire covered surface of each portion of the final lift. This shall be done not later than 90 days following the completion of a section of the fill area.

17) Final Grades –

The final covering shall be sloped, preventing the ponding of run-off waters on the surface of the fill area.

Date: March 16, 2004

Stephen Kearney
Director
Northeast Region
Environmental Operations

APPENDIX A

BURNING AT WASTE DISPOSAL GROUNDS

TERMS AND CONDITIONS

Burning of waste materials will be allowed at waste disposal grounds at the operators discretion and subject to the following terms and conditions:

- Burning at Class I waste disposal grounds is prohibited, unless otherwise approved by the director.
- Only separated and readily combustible materials such a boughs, leaves, straw, paper products, cardboard, non-salvageable wood and packaging materials derived from wood may be burned, and only when there is an appropriate volume of this type of waste to warrant burning.
- Burning of garbage, rubber tires, railway ties, derelict vehicles, and similar large metal objects, waste oil, and pesticide containers is prohibited.
- Burning to occur when weather conditions permit taking into consideration wind direction and velocity being favourable such that no nuisance to any neighbouring resident and/or highway occurs.
- Burning must take place within the confines of a trench or in a berm-confined area and not on or above the prevailing grade.
- The burning operation to be restricted to daylight hours only.
- The burning operation must be under constant supervision.
- Manitoba Conservation's regional office and residents in close proximity to the waste disposal ground are to be notified of the proposed controlled burning prior to the actual time and date the burning is to occur.
- Appropriate signs must be posted at the waste disposal ground to advise persons using the facility not to initiate any fire that would lead to an uncontrolled burn at the facility.
- If burning is started as a result of vandalism or act of God, the fire is to be extinguished as quickly as possible by the most appropriate means.
- The operator shall keep a record of all controlled burns during a calendar year and provide to the regional director a report indicating date and duration of each burn, volume of waste disposed of by burning and the type of waste burned on each occasion, within thirty days following the end of that calendar year.

Open burning not in compliance with the terms and conditions above is contrary to Manitoba Regulation 150/91 and is subject to enforcement action as deemed appropriate by the director. It is further noted that any liability that accrued from the decisions to burn would be borne by the permit holder.

APPENDIX B
ASBESTOS DISPOSAL CRITERIA

These disposal criteria apply only to friable (easily crumbled or pulverized) asbestos material. Material that contains asbestos bound up in a form which cannot easily be broken up is exempt from these criteria. Asbestos waste from a household is also exempt from these criteria.

TRANSPORTATION

- Shipments of regulated asbestos materials shall be transported in accordance with any pertinent requirements in the federal Transportation of Dangerous Goods Regulations.
- The transport of waste asbestos materials in Manitoba is not included in the hazardous waste tracking system (i.e. exempt from the hazardous waste manifest and does not require a licenced hazardous waste transporter).
- Waste asbestos should be placed in sealed containers or 6 mil poly bags and should be transported in enclosed trucks.

DISPOSAL SITES

- Only waste disposal grounds registered under Manitoba Regulation 150/91 (Waste Disposal Grounds Regulation) will be considered as asbestos disposal sites.

DISPOSAL

- Owner of the waste disposal ground should be notified prior to hauling asbestos waste to the site.
- Asbestos waste should not be stockpiled at a disposal site for burial at a later date.
- The hauler should ensure that equipment for burying asbestos is available before any asbestos waste is hauled to the disposal ground.
- Asbestos waste should be unloaded into the active area or into a specially excavated hole for immediate burial.
- Caution should be exercised to ensure that bags or containers are not broken open before they are covered with earth.
- An initial layer of cover material or fill should be placed over the asbestos waste before heavy equipment passes over the packages.
- The asbestos waste should be covered with two feet of compacted fill. If asbestos waste is deposited in the active area, up to 50% of the fill may consist of refuse.

Note re. handling asbestos: Persons involved in the handling of asbestos material must wear protective equipment as specified by the Manitoba Department of Labour - see "Guidelines for Working with Asbestos" prepared by the Workplace Safety and Health Division.

APPENDIX C

SMELTER PRODUCTION DATA

TABLE B.1

SMELTER PRODUCTION DATA
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Date	Roasting hrs	10C Tons	VBN Tons	Sand Tons	Total Tons	Feed Rate 10C	Feed Rate VBN	Feed Rate Sand	A2 Received from Mill	Matte Taps ~Volume		Moved From	Matte Level Inches	Slag Level Inches	Moved From Inches	Matte Level Inches	Slag Level Inches	Skim hrs	~Volume	Slag Return	LM (tons)	Leached Matte Feed Rate Tons/rst hr	Fce Scrap Tons	Blowing Time (h)	PSC Scrap Tons	ENR Tons	Silica Tons	Anodes (by day)	Acceptable feed rate of Yard Recyclables Not Currently fed based on VBN feed rate	Casting Data ~Total converter pours	~Volume per charge Tons /Ladle
4/1/2012	20.37	611	342	268	953	30	17	13	642	16	41	S FCE 1	3	0	S FCE 2	27	16	18.4	13	41	25	2	48	23.5	49	8	129	1166	57	16	20
4/2/2012	19.88	593	328	346	921	30	16	17	615	16	40	S FCE 1	3	0	S FCE 2	27	13	17.2	13	30	11	2	24	23.4	25	0	124	957	55	13	20
4/3/2012	21.32	620	292	434	912	29	14	20	624	16	46	S FCE 1	3	0	S FCE 2	22	13	24.0	13	46	21	2	48	27.2	59	0	161	983	49	14	20
4/4/2012	23.20	642	330	451	972	28	14	19	266	16	27	S FCE 1	3	0	S FCE 2	24	15	24.0	13	27	30	2	48	19.6	47	0	118	977	55	14	20
4/5/2012	14.28	410	219	301	629	29	15	21	657	16	24	S FCE 1	3	0	S FCE 2	24	17	14.6	13	18	20	2	48	16.7	46	1	94	671	36	9	20
4/6/2012	17.62	492	269	368	761	28	15	21	653	16	30	S FCE 1	3	0	S FCE 2	22	17	16.9	13	18	32	2	48	19.4	12	7	100	665	45	9	20
4/7/2012	22.65	655	337	467	992	29	15	21	478	16	25	S FCE 1	3	0	S FCE 2	29	14	24.0	13	17	26	2	48	16.0	13	8	83	1139	56	16	20
4/8/2012	22.03	650	329	439	979	29	15	20	284	16	35	S FCE 1	3	0	S FCE 2	26	14	24.0	13	30	23	2	48	23.9	36	21	135	957	55	13	20
4/9/2012	15.33	436	227	312	663	28	15	20	580	16	28	S FCE 1	3	0	S FCE 2	27	14	14.6	13	18	4	2	48	17.7	49	0	98	1087	38	15	20
4/10/2012	20.82	570	310	421	879	27	15	20	558	16	39	S FCE 1	3	0	S FCE 2	24	14	23.8	13	26	32	2	48	21.8	15	0	120	624	52	9	20
4/11/2012	20.33	548	287	426	835	27	14	21	261	16	32	S FCE 1	3	0	S FCE 2	22	12	20.0	13	26	29	2	40	21.5	13	0	118	1047	48	15	20
4/12/2012	17.32	481	251	356	732	28	14	21	704	16	29	S FCE 1	3	0	S FCE 2	22	14	19.0	13	18	32	2	8	16.9	3	0	95	677	42	9	20
4/13/2012	22.83	664	336	444	1000	29	15	19	520	16	32	S FCE 1	3	0	S FCE 2	29	15	24.0	13	22	26	2	32	21.0	11	0	106	827	56	12	20
4/14/2012	20.63	596	307	419	902	29	15	20	157	16	42	S FCE 1	3	0	S FCE 2	26	11	24.0	13	32	33	2	24	27.9	49	0	140	1029	51	14	20
4/15/2012	23.67	667	327	513	994	28	14	22	652	16	38	S FCE 1	3	0	S FCE 2	25	18	21.9	13	25	34	2	48	26.3	49	19	151	966	55	14	20
4/16/2012	10.57	299	140	225	439	28	13	21	327	16	18	S FCE 1	3	0	S FCE 2	25	18	10.0	13	13	22	2	40	10.4	7	3	62	728	23	10	20
4/17/2012	10.73	176	160	220	336	16	15	20	476	16	22	S FCE 1	3	0	S FCE 2	22	17	10.5	13	15	24	2	24	12.5	20	0	78	441	27	6	20
4/18/2012	9.92	373	166	211	538	38	17	21	461	16	9	S FCE 1	3	0	S FCE 2	23	14	14.8	13	5	19	2	24	4.9	10	0	35	532	28	7	20
4/19/2012	18.55	379	300	415	679	20	16	22	1048	16	30	S FCE 1	3	0	S FCE 2	24	19	18.3	13	19	32	2	48	17.3	49	57	111	347	50	5	20
4/20/2012	16.57	380	255	362	635	23	15	22	414	16	25	S FCE 1	3	0	S FCE 2	27	22	17.7	13	17	35	2	48	16.4	46	60	88	937	42	13	20
4/21/2012	12.92	387	209	283	595	30	16	22	405	16	29	S FCE 1	3	0	S FCE 2	27	22	12.4	13	20	28	2	0	21.0	68	50	102	933	35	13	20
4/22/2012	0.00	0	0	0	0				446	16	5	S FCE 1	3	0	S FCE 2	23	16	0.0	13	4	0	2	0	3.4	16	26	20	329	0	5	20
4/23/2012	7.00	200	110	177	310	29	16	25	0	16	10	S FCE 1	3	0	S FCE 2	21	15	9.1	13	8	0	2	0	6.8	12	26	44	517	18	7	20
4/24/2012	13.56	410	165	289	575	30	12	21	0	16	21	S FCE 1	3	0	S FCE 2	21	11	13.1	13	16	0	2	0	12.2	47	20	79	402	27	6	20
4/25/2012	13.23	407	129	283	536	31	10	21	260	16	7	S FCE 1	3	0	S FCE 2	24	16	8.7	13	3	0	2	0	2.8	13	0	18	303	21	4	20
4/26/2012	20.36	620	329	432	949	30	16	21	910	16	31	S FCE 1	21	14	S FCE 2	21	17	14.3	13	18	23	2	0	18.7	45	41	109	501	55	7	20
4/27/2012	20.50	648	346	391	995	32	17	19	786	16	18	S FCE 1	29	15	S FCE 2	22	15	25.9	13	13	21	2	16	10.1	35	55	59	487	58	7	20
4/28/2012	14.96	461	236	317	697	31	16	21	943	16	23	S FCE 1	25	18	S FCE 2	28	13	18.4	13	12	19	2	8	11.5	120	0	81	499	39	7	20
4/29/2012	18.42	574	286	364	860	31	16	20	877	16	29	S FCE 1	22	19	S FCE 2	27	13	17.6	13	21	18	2	32	18.2	103	0	130	891	48	12	20
4/30/2012	27.87	872	401	503	1273	31	14	18	701	16	42	S FCE 1	23	18	S FCE 2	25	13	14.8	13	27	42	2	56	26.2	70	14	153	750	67	11	20
5/1/2012	25.59	916	390	444	1306	36	15	17	688	16	35	S FCE 1	24	15	S FCE 2	26	15	24.9	13	27	60	2	0	23.6	52	5	149	1126	65	16	20
5/2/2012	20.06	765	330	333	1095	38	16	17	351	16	44	S FCE 1	22	13	S FCE 2	25	15	24.3	13	34	52	2	80	27.0	71	19	173	1196	55	17	20
5/3/2012	25.20	825	389	488	1215	33	15	19	583	16	38	S FCE 1	23	17	S FCE 2	26	14	31.9	13	25	64	2	40	23.2	53	0	145	898	65	13	20
5/4/2012	22.59	730	201	436	931	32	9	19	730	16	36	S FCE 1	22	16	S FCE 2	26	14	24.1	13	26	79	2	56	23.3	50	21	150	1080	33	15	20
5/5/2012	29.09	950	410	642	1359	33	14	22	775	16	40	S FCE 1	22	14	S FCE 2	24	18	34.2	13	29	56	2	64	25.6	68	8	150	1103	68	15	20
5/6/2012	28.42	973	390	617	1363	34	14	22	1143	16	37	S FCE 1	19	10	S FCE 2	25	11	34.7	13	21	75	2	64	19.4	43	0	113	1066	65	15	20
5/7/2012	24.45	847	407	494	1254	35	17	20	1066	16	33	S FCE 1	23	21	S FCE 2	23	14	26.2	13	27	74	2	72	24.6	93	0	143	1118	68	16	20
5/8/2012	25.10	896	436	382	1332	36	17	15	910	16	38	S FCE 1	23	19	S FCE 2	28	14	29.1	13	34	96	2	80	24.5	49	10	164	1258	73	18	20
5/9/2012	16.73	642	281	241	922	38	17	14	395	16	22	S FCE 1	27	20	S FCE 2	27	17	17.6	13	16	71	2	88	14.3	31	0	84	1086	47	15	20
5/10/2012	20.27	707	324	267	1031	35	16	13	1162	16	35	S FCE 1	32	17	S FCE 2	23	19	19.7	13	24	73	2	32	21.6	66	0	137	1071	54	15	20
5/11/2012	16.10	486	259	300	745	30	16	19	831	16	35	S FCE 1	30	14	S FCE 2	22	17	20.5	13	23	51	2	72	20.4	40	0	134	1089	43	15	20
5/12/2012	20.51	626	322	378	948	31	16	18	210	16	38	S FCE 1	20	18	S FCE 2	27	14	21.5	13	24	56	2	48	24.8	49	0	142	1209	54	17	20
5/13/2012	20.45	652	333	422	985	32	16	21	589	16	32	S FCE 1	23	14	S FCE 2	21	17	23.6	13	23	38	2	32	18.9	68	0	116	1206	55	17	20
5/14/2012	21.29	679	341	408	1020	32	16	19	931	16	29	S FCE 1	19	16	S FCE 2	26	14	24.0	13	22	50	2	32	19.8	32	0	112	847	57	12	20
5/15/2012	21.01	707	338	423	1045	34	16	20	555	16	37	S FCE 1	22	21	S FCE 2	21	10	23.1	13	24	58	2	56	21.4	101	0	118	1058	56	15	20
5/16/2012	16.46	558	258	293	816	34	16	18	250	16	24	S FCE 1	20	15	S FCE 2	25	18	19.9	13	18	43	2	64	16.5	39	0	94	819	43	11	20
5/17/2012	20.29	631	329	336	959	31	16	17	620	16	40	S FCE 1	21	21	S FCE 2	19	12	22.0	13	30	69	2	56	25.4	85	0	144	1208	55	17	20
5/18/2012	21.73	723	345	389	1068	33	16	18	511	16	27	S FCE 1	22	16	S FCE 2	20	19	24.3	13	17	69	2	64	17.1	62	0	100	1001	58	14	20
5/19/2012	22.41	721	382	448	1103	32	17	20	519	16	34	S FCE 1	22	16	S FCE 2	20	19	29.0	13	22	56	2	48	21.2	44	0	127	742	64	10	20
5/20/2012	18.89	550	327	358	877	29	17	19	421	16	26	S FCE 1	22	9	S FCE 2	25	13	30.5	13	19	49	2	64	17.6	27	20	105	1039	54	15	20
5/21/2012	14.65	417	298	275	715	28	20	19	439	16	24	S FCE 1	20	7	S FCE 2	26	17	10.3	13	13	38	2	40	12.0	10	6	70	727	50	10	20
5/22/2012	13.10	400	350	236	750	31	27	18	410	16	23	S FCE 1	20	7	S FCE 2	26	17	11.4	13	14	2	2	40	11.1	30	5	71	927	58	13	20
5/23/2012	5.63	178	134	96	313	32	24	17	155	16	17	S FCE 1	20	7	S FCE 2	20	11	4.4	13	12	27	2	8	10.8	150	60	54	729	22	10	20
5/24/2012	14.60	517	206	293	722	35	14	20	530	16	11	S FCE 1	25	19	S FCE 2	25	17	15.6	13	6	56	2	16	5.9	16	52	34	581	34	8	20
5/25/2012	16.21	577	248	334	825	36	15	21	772	16	31	S FCE 1	21	13	S FCE 2	25	17	19.3	13	31	68	2	24	21.5	53	46	123	547	41	8	20
5/26/2012	26.41	887	512	500	1399	34	19	19	912	16	34	S FCE 1	28	14	S FCE 2	28	18	31.4	13	22	84	2	64	22.7	53	36	132	1196	85	17	20
5/27/2012	20.53	672	323	385	995	33	16	19	861	16	27	S FCE 1	34	12	S FCE 2	30	15	25.4	13	22	50	2	64	20.7	55	41	127	863	54	12	20
5/28/2012	16.95	512	270	327	783	30	16	19	338	16	36	S FCE 1	29	8	S FCE 2	25	22	19.3	13	21	5	2	56	21.8	52	37	127	1033	45	14	20
5/29/2012	22.49	717	340	431	1058	32	15	19	651	16	30	S FCE 1	32	15	S FCE 2	26	15	26.4	13	18	46	2	48	18.2	29	19	104	1288	57	18	20
5/30/2012	7.90	227	139	148	366	29	18	19	196	16	25	S FCE 1	24	10	S FCE 2	22	16	9.3	13	22	52	2	32	19.9	15	11	111	1093	23	15	20
5/31/2012	20.14	641	300	356	941	32	15	18	829	16	27	S FCE 1	21	12	S FCE 2	21	16	20.6	13	17	52	2	48	16.1	24	19	83	811	50	11	20
6/1/2012	25.06	874	381	453	1255	35	15	18	857	16	32	S FCE 1	27	20	S FCE 2	27	20	27.2	13	16	60	2	56	15.6	63	81	105	909	64	13	20
6/2/2012	23.18	750	402	443	1152	32	17	19	746	16	37	S FCE 1	24	11	S FCE 2	28	17	36.4	13	30	32	2	48	24.3	60	65	154	732	67	10	20
6/3/2012	22.98	781	373	436	1154	34	16	19	541	16	34	S FCE 1	24	8	S FCE 2	29	16	28.3	13	24	42	2	48	19.0	44	31	108	1302	62	18	20
6/4/2012	19.23	612	294	353	905	32	15	18	1061	16	37	S FCE 1	22	17	S FCE 2	25	14	21.1	13	22	0	2	56	23.0	84	0	135	1036	49	15	20
6/5/2012	20.68	719	315	411	1034	35	15	20	891	16	40	S FCE 1	21	16	S FCE 2	23	8	30.2	13	26	32	2	48	25.5	76	0	160	1139	53	16	20
6/6/2012	13.42	444	195	242	639	33	15	18	280	16	19	S FCE 1	24	20	S FCE 2	22	12	17.2	13	11	28	2	40	10.8	13	9	59	1013	32	14	20
6/7/2012	22.88	756	370	437	1126	33	16	19	1062	16	35	S FCE 1	22	17	S FCE 2	26	12	28.7	13	21	67	2	56	21.1	37	40	126	939	62	13	20
6/8/2012	26.69	931	397	457	1328	35	15	17	635	16	32	S FCE 1	29	18	S FCE 2	24	21	25.4	13	29	45	2	56	23.8	37	-1	138	657	66	9	20
6/9/2012	32.19	1131	494	561	1625	35	15	17	673	16	43	S FCE 1	31	23	S FCE 2	24	14	39.9	13	30	66	2	80	26.4	63	24	155	1283	82	18	20
6/10/2012	22.82	713	362	398	1075	31	16	17	715	16	33	S FCE 1	27	11	S FCE 2	28	17	26.5	13	29	63	2	80	23.0	46	24	128	1459	60	20	20
6/11/2012	19.92	633	303	318	937	32	15	16	742	16	36	S FCE 1	22	10	S FCE 2	26	17	24.0	13	26	17	2	64	22.8	72	29	132	1229	50	17	20
6/12/2012	22.44	691	323	387	1014	31	14	17	589	16	39	S FCE 1	21	16	S FCE 2	22	17	24.0	13	26	9	2	40	23.1	14	16	146	1288	54	18	20
6/13/2012	6.13	186	86	106	272	30	14	17	217	16	11	S FCE 1	20	15	S FCE 2	23	19	9.1	13	7	8	2	32	6.0	7	8	38	1217	14	17	20
6/14/2012	21.35	584	309	361	892	27	14	17	759	16	23	S FCE 1	23	17	S FCE 2	20	11	21.7	13	14	65	2	48	11.7	12	29	74	454	51	6	20
6/15/2012	22.96	686	355	401	1041	30	15	17	683	16	24	S FCE 1	21	11	S FCE 2	25	16	26.3	13	23	57	2	32	15.8	15	20	83	831	59	12	20
6/16/2012	25.74	798	410	436	1207	31	16	17	687	16	40	S FCE 1	22	17	S FCE 2	25	17	23.4	13	40	63	2	64	18.9	20	22	122	754	68	11	20
6/17/2012	24.54	870	292	400	1162	35	12	16	827	16	39	S FCE 1	21	17	S FCE 2	25	15	30.2	13	30	44	2	80	26.1	46	20	146	1262	49	18	20
6/18/2012	20.28	647	312	325	959	32	15	16	647	16	31	S FCE 1	21	9	S FCE 2	23	12	27.7	13	19	0	2	56	20.7	30	32	107	1384	52	19	20
6/19/2012	2.07	80	38	38	119	39	19	18	194	16	8	S FCE 1	21	9	S FCE 2	21	12	6.1	13	11	0	2	8	8.0	10	12	51	1256	6	18	20
6/20/2012	8.05	216	111	128	327	27	14	16	135	16	2	S FCE 1	23	12	S FCE 2	25	21	3.3	13	0	15	2	0	0.0	0	0	0	-1	19	0	20
6/21/2012	18.11	552	279	319	831	30	15	18	614	16	25	S FCE 1	22	17	S FCE 2	22	20	15.6	13	22	34	2	32	18.1	27	14	101	-3	46	0	20
6/22/2012	19.34	579	313	335	892	30	16	17	695	16	28	S FCE 1	21	21	S FCE 2	25	15	26.0	13	18	44	2	40	17.2	34	0	98	1191	52	17	20
6/23/2012	19.57	593	285	329	877	30	15	17	661	16	28	S FCE 1	22	14	S FCE 2	25	19	24.2	13	21	48	2	48	18.9	50	0	102	1163	47	16	20
6/24/2012	19.47	616	268	349	884	32	14	18	520	16	29	S FCE 1	23	16	S FCE 2	22	18	20.2	13	27	57	2	48	19.7	44	0	120	842	45	12	20
6/25/2012	16.65	520	245	281	765	31	15	17	658	16	22	S FCE 1	23	17	S FCE 2	22	17	18.6	13	17	14	2	48	14.8	39	1	82	1014	41	14	20
6/26/2012	20.78	680	314	339	994	33	15	16	579	16	30	S FCE 1	23	11	S FCE 2	22	17	28.9	13	20	41	2	48	16.1	40	0	101	1024	52	14	20
6/27/2012	17.38	541	286	272	827	31	16	16	366	16	23	S FCE 1	22	16	S FCE 2	23	16	19.3	13	14	44	2	40	12.2	24	0	65	979	48	14	20
6/28/2012	13.79	439	219	204	658	32	16	15	283	16	14	S FCE 1	22	12	S FCE 2	23	17	14.0	13	14	9	2	40	14.1	35	0	81	525	37	7	20
6/29/2012	4.59	160	74	80	233	35	16	17	195	16	16	S FCE 1	22	12	S FCE 2	20	8	11.6	13	7	10	2	24	8.1	11	0	46	688	12	10	20
6/30/2012	22.56	702	387	365	1089	31	17	16	845	16	25	S FCE 1	21	9	S FCE 2	26	20	26.4	13	13	47	2	56	14.7	13	7	86	522	65	7	20

TABLE B.2

SMELTER PRODUCTION DATA - CONVERTERS
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Date	*Converter #*	*Charge#*
Apr 6, 2012	3	131
Apr 6, 2012	4	13
Apr 7, 2012	4	14
Apr 7, 2012	6	97
Apr 8, 2012	3	132
Apr 8, 2012	3	133
Apr 8, 2012	6	98
Apr 9, 2012	3	134
Apr 9, 2012	6	99
Apr 10, 2012	3	135
Apr 11, 2012	3	136
Apr 11, 2012	4	17
Apr 11, 2012	5	52
Apr 11, 2012	5	51
Apr 12, 2012	4	18
Apr 13, 2012	4	19
Apr 13, 2012	5	53
Apr 13, 2012	6	102
Apr 14, 2012	3	139
Apr 14, 2012	4	20
Apr 14, 2012	5	54
Apr 14, 2012	6	103
Apr 15, 2012	3	140
Apr 15, 2012	4	21
Apr 15, 2012	6	104
Apr 18, 2012	5	57
Apr 19, 2012	4	24
Apr 20, 2012	5	58
Apr 20, 2012	5	59
Apr 21, 2012	4	27
Apr 26, 2012	4	32
Apr 26, 2012	4	31
Apr 27, 2012	5	63
Apr 28, 2012	5	64

TABLE B.2

SMELTER PRODUCTION DATA - CONVERTERS
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Date	*Converter #*	*Charge#*
May 2, 2012	4	37
May 3, 2012	2	3
May 5, 2012	5	70
May 6, 2012	4	42
May 6, 2012	5	71
May 7, 2012	4	43
May 7, 2012	5	72
May 9, 2012	4	45
May 10, 2012	3	156
May 13, 2012	5	76
May 14, 2012	3	158
May 14, 2012	5	77
May 16, 2012	5	78
May 17, 2012	5	79
May 18, 2012	2	11
May 18, 2012	3	161
May 19, 2012	5	80
May 20, 2012	3	162
May 20, 2012	4	54
May 20, 2012	5	81
May 22, 2012	5	82
May 25, 2012	2	15
May 25, 2012	5	84
May 26, 2012	4	57
May 27, 2012	4	58
May 27, 2012	5	85
May 28, 2012	3	169
May 28, 2012	3	168
May 30, 2012	2	18
May 30, 2012	4	60
May 30, 2012	5	87
May 31, 2012	4	61

TABLE B.2

SMELTER PRODUCTION DATA - CONVERTERS
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

Date	*Converter #*	*Charge#*
Jun 1, 2012	2	19
Jun 1, 2012	5	88
Jun 4, 2012	4	64
Jun 4, 2012	6	02
Jun 6, 2012	2	22
Jun 6, 2012	4	66
Jun 6, 2012	5	93
Jun 7, 2012	4	67
Jun 7, 2012	5	94
Jun 7, 2012	6	04
Jun 8, 2012	2	23
Jun 8, 2012	5	95
Jun 8, 2012	6	5
Jun 9, 2012	2	24
Jun 9, 2012	5	96
Jun 12, 2012	4	71
Jun 12, 2012	5	98
Jun 13, 2012	6	8
Jun 14, 2012	4	72
Jun 14, 2012	5	99
Jun 15, 2012	6	15
Jun 16, 2012	4	73
Jun 17, 2012	4	74
Jun 17, 2012	5	101
Jun 18, 2012	2	28
Jun 18, 2012	4	75
Jun 18, 2012	5	102
Jun 19, 2012	2	11
Jun 19, 2012	2	29
Jun 22, 2012	4	76
Jun 23, 2012	4	77
Jun 24, 2012	5	105
Jun 25, 2012	6	14
Jun 26, 2012	6	15
Jun 27, 2012	4	80

TABLE B.3

SMELTER PRODUCTION DATA
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

	Total Volume (L)				*Total Volume (m3)*				*Percol Addition (L)*	*Underflow Volume (L)*
End Time	*Line 1*	*Line 2*	*Line 3*	*Total*	*Line 1*	*Line 2*	*Line 3*	*Total*	*Total*	*Total*
4/2/2012 7:30	2,372,833	6,736,832	0	9,109,665	2,373	6,737	0	9,110	18,481	1,917,211
4/3/2012 7:30	2,390,766	6,663,156	0	9,053,922	2,391	6,663	0	9,054	18,372	1,944,939
4/4/2012 7:30	2,291,485	6,508,255	0	8,799,740	2,291	6,508	0	8,800	18,219	1,762,363
4/5/2012 7:30	2,270,886	6,429,774	0	8,700,660	2,271	6,430	0	8,701	17,638	1,804,045
4/6/2012 7:30	2,298,240	6,444,084	0	8,742,324	2,298	6,444	0	8,742	18,085	1,629,074
4/7/2012 7:30	2,228,241	6,381,990	0	8,610,230	2,228	6,382	0	8,610	17,923	1,734,408
4/8/2012 7:30	2,364,424	6,338,145	0	8,702,569	2,364	6,338	0	8,703	17,867	1,829,936
4/9/2012 7:30	2,168,934	6,277,724	0	8,446,658	2,169	6,278	0	8,447	18,065	1,841,017
4/10/2012 7:30	2,275,171	6,263,111	0	8,538,283	2,275	6,263	0	8,538	18,234	1,861,612
4/11/2012 7:30	2,344,703	6,249,425	0	8,594,128	2,345	6,249	0	8,594	17,825	1,720,689
4/12/2012 7:30	2,035,420	5,576,192	0	7,611,612	2,035	5,576	0	7,612	18,234	1,703,813
4/13/2012 7:30	2,233,897	6,040,275	0	8,274,172	2,234	6,040	0	8,274	17,617	1,700,890
4/14/2012 7:30	2,115,696	6,188,913	0	8,304,608	2,116	6,189	0	8,305	18,015	1,571,557
4/15/2012 7:30	2,084,653	6,034,827	0	8,119,480	2,085	6,035	0	8,119	17,069	1,440,971
4/16/2012 7:30	2,370,153	6,041,896	0	8,412,049	2,370	6,042	0	8,412	17,307	1,512,870
4/17/2012 7:30	1,936,111	6,042,419	0	7,978,530	1,936	6,042	0	7,979	17,569	1,597,793
4/18/2012 7:30	2,116,343	5,711,465	0	7,827,808	2,116	5,711	0	7,828	17,307	1,749,723
4/19/2012 7:30	2,199,599	5,414,914	0	7,614,513	2,200	5,415	0	7,615	17,311	1,788,437
4/20/2012 7:30	2,462,835	5,975,152	0	8,437,987	2,463	5,975	0	8,438	17,721	1,910,997
4/21/2012 7:30	2,021,895	5,992,787	0	8,014,681	2,022	5,993	0	8,015	17,040	1,799,105
4/22/2012 7:30	2,150,579	5,867,869	0	8,018,449	2,151	5,868	0	8,018	17,841	1,280,780
4/23/2012 7:30	2,253,915	5,847,928	0	8,101,843	2,254	5,848	0	8,102	17,895	1,193,930
4/24/2012 7:30	1,925,861	4,145,129	0	6,070,990	1,926	4,145	0	6,071	17,170	1,487,121
4/25/2012 7:30	1,875,063	4,987,942	0	6,863,005	1,875	4,988	0	6,863	17,830	1,980,091
4/26/2012 7:30	1,874,132	5,379,539	0	7,253,671	1,874	5,380	0	7,254	17,917	1,660,731
4/27/2012 7:30	2,215,149	4,324,456	0	6,539,606	2,215	4,324	0	6,540	17,590	1,733,579
4/28/2012 7:30	2,389,062	6,123,348	0	8,512,410	2,389	6,123	0	8,512	17,641	1,710,970
4/29/2012 7:30	2,462,086	6,800,209	0	9,262,294	2,462	6,800	0	9,262	18,147	1,658,418
4/30/2012 7:30	2,531,192	6,853,950	0	9,385,142	2,531	6,854	0	9,385	18,349	1,410,767

TABLE B.3

SMELTER PRODUCTION DATA
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

	Total Volume (L)				*Total Volume (m3)*				*Percol Addition (L)*	*Underflow Volume (L)*
End Time	*Line 1*	*Line 2*	*Line 3*	*Total*	*Line 1*	*Line 2*	*Line 3*	*Total*	*Total*	*Total*
5/1/2012 7:30	2,362,697	6,821,566	0	9,184,263	2,363	6,822	0	9,184	17,930	1,875,710
5/2/2012 7:30	2,162,929	6,673,260	0	8,836,189	2,163	6,673	0	8,836	18,303	1,885,038
5/3/2012 7:30	2,076,229	6,450,856	0	8,527,084	2,076	6,451	0	8,527	17,577	1,893,827
5/4/2012 7:30	2,376,809	6,541,451	0	8,918,259	2,377	6,541	0	8,918	18,047	1,828,699
5/5/2012 7:30	2,519,497	6,599,949	0	9,119,446	2,519	6,600	0	9,119	17,338	1,792,245
5/6/2012 7:30	2,420,728	6,565,519	0	8,986,247	2,421	6,566	0	8,986	17,484	1,550,370
5/7/2012 7:30	2,504,566	6,599,951	0	9,104,516	2,505	6,600	0	9,105	17,807	1,920,640
5/8/2012 7:30	2,430,928	6,623,099	0	9,054,027	2,431	6,623	0	9,054	17,970	1,939,811
5/9/2012 7:30	2,473,222	6,541,810	0	9,015,032	2,473	6,542	0	9,015	17,552	1,625,953
5/10/2012 7:30	1,976,937	5,882,126	0	7,859,062	1,977	5,882	0	7,859	17,975	1,579,685
5/11/2012 7:30	2,080,296	6,519,617	0	8,599,912	2,080	6,520	0	8,600	18,036	1,625,072
5/12/2012 7:30	378,016	6,523,458	0	6,901,474	378	6,523	0	6,901	18,302	1,901,576
5/13/2012 7:30	302,672	6,516,904	0	6,819,575	303	6,517	0	6,820	17,831	1,735,837
5/14/2012 7:30	375,256	6,510,025	0	6,885,280	375	6,510	0	6,885	17,934	1,783,686
5/15/2012 7:30	2,234,928	6,068,205	0	8,303,133	2,235	6,068	0	8,303	18,412	1,902,992
5/16/2012 7:30	2,436,570	6,514,524	0	8,951,093	2,437	6,515	0	8,951	18,372	1,909,637
5/17/2012 7:30	2,120,897	6,363,604	0	8,484,502	2,121	6,364	0	8,485	17,971	1,825,609
5/18/2012 7:30	2,589,414	6,528,932	0	9,118,347	2,589	6,529	0	9,118	17,495	1,943,964
5/19/2012 7:30	2,388,694	6,517,834	0	8,906,528	2,389	6,518	0	8,907	17,642	1,908,047
5/20/2012 7:30	2,505,539	6,518,254	0	9,023,794	2,506	6,518	0	9,024	17,457	1,946,045
5/21/2012 7:30	2,318,817	6,505,936	0	8,824,753	2,319	6,506	0	8,825	17,638	1,735,314
5/22/2012 7:30	2,227,661	5,900,628	0	8,128,289	2,228	5,901	0	8,128	17,733	1,727,797
5/23/2012 7:30	2,292,388	5,525,197	0	7,817,585	2,292	5,525	0	7,818	17,577	1,738,271
5/24/2012 7:30	1,885,284	4,798,918	0	6,684,202	1,885	4,799	0	6,684	17,041	1,828,645
5/25/2012 7:30	2,587,263	6,503,309	0	9,090,572	2,587	6,503	0	9,091	18,228	1,412,784
5/26/2012 7:30	2,597,604	4,817,840	0	7,415,444	2,598	4,818	0	7,415	18,086	1,681,637
5/27/2012 7:30	2,555,792	6,534,278	0	9,090,070	2,556	6,534	0	9,090	18,332	1,925,085
5/28/2012 7:30	2,678,404	6,565,105	0	9,243,509	2,678	6,565	0	9,244	17,936	1,902,424
5/29/2012 7:30	1,486,553	6,547,197	0	8,033,750	1,487	6,547	0	8,034	17,616	1,706,487
5/30/2012 7:30	2,136,630	6,561,730	0	8,698,360	2,137	6,562	0	8,698	17,793	2,077,259
5/31/2012 7:30	1,861,698	6,524,864	0	8,386,563	1,862	6,525	0	8,387	16,753	1,912,217

TABLE B.3

SMELTER PRODUCTION DATA
SHUTDOWN PROCEUDRES PLAN
VALE - THOMPSON MINE SITE
THOMPSON, MANITOBA

	Total Volume (L)				*Total Volume (m3)*				*Percol Addition (L)*	*Underflow Volume (L)*
End Time	*Line 1*	*Line 2*	*Line 3*	*Total*	*Line 1*	*Line 2*	*Line 3*	*Total*	*Total*	*Total*
6/1/2012 7:30	2,143,826	6,552,656	0	8,696,482	2,144	6,553	0	8,696	17,681	2,065,438
6/2/2012 7:30	2,519,477	6,538,247	0	9,057,724	2,519	6,538	0	9,058	17,869	1,980,572
6/3/2012 7:30	2,676,142	6,542,165	0	9,218,308	2,676	6,542	0	9,218	18,025	1,964,314
6/4/2012 7:30	2,496,772	6,505,311	0	9,002,083	2,497	6,505	0	9,002	17,558	1,851,874
6/5/2012 7:30	2,543,250	6,479,591	0	9,022,841	2,543	6,480	0	9,023	17,619	1,857,203
6/6/2012 7:30	2,495,501	6,452,282	0	8,947,783	2,496	6,452	0	8,948	18,304	1,980,213
6/7/2012 7:30	2,307,069	6,468,009	0	8,775,078	2,307	6,468	0	8,775	17,436	1,851,207
6/8/2012 7:30	2,429,642	6,479,894	0	8,909,536	2,430	6,480	0	8,910	18,187	1,828,163
6/9/2012 7:30	2,271,803	6,404,513	0	8,676,316	2,272	6,405	0	8,676	17,778	1,706,547
6/10/2012 7:30	2,233,104	6,280,188	0	8,513,292	2,233	6,280	0	8,513	17,853	2,037,557
6/11/2012 7:30	2,407,316	6,177,115	0	8,584,431	2,407	6,177	0	8,584	17,594	2,064,818
6/12/2012 7:30	2,473,506	5,151,295	0	7,624,801	2,474	5,151	0	7,625	17,114	2,070,747
6/13/2012 7:30	2,333,199	6,247,950	0	8,581,149	2,333	6,248	0	8,581	16,187	1,595,440
6/14/2012 7:30	2,099,970	6,237,751	0	8,337,722	2,100	6,238	0	8,338	16,812	1,716,236
6/15/2012 7:30	2,435,130	6,243,197	0	8,678,328	2,435	6,243	0	8,678	17,220	1,765,820
6/16/2012 7:30	2,496,975	6,260,265	0	8,757,240	2,497	6,260	0	8,757	16,874	1,897,191
6/17/2012 7:30	2,179,236	6,227,406	0	8,406,641	2,179	6,227	0	8,407	17,878	1,931,754
6/18/2012 7:30	1,817,445	6,197,161	0	8,014,606	1,817	6,197	0	8,015	18,197	1,890,563
6/19/2012 7:30	2,040,499	6,185,874	0	8,226,373	2,040	6,186	0	8,226	17,648	1,854,350
6/20/2012 7:30	1,990,467	4,738,341	0	6,728,808	1,990	4,738	0	6,729	16,641	1,894,801
6/21/2012 7:30	1,924,921	5,133,574	0	7,058,496	1,925	5,134	0	7,058	16,466	1,805,749
6/22/2012 7:30	2,250,815	6,234,208	0	8,485,022	2,251	6,234	0	8,485	17,206	1,873,459
6/23/2012 7:30	2,382,229	6,262,603	0	8,644,831	2,382	6,263	0	8,645	17,450	1,751,943
6/24/2012 7:30	2,449,319	6,267,442	0	8,716,761	2,449	6,267	0	8,717	17,433	1,831,634
6/25/2012 7:30	2,166,685	6,281,575	0	8,448,260	2,167	6,282	0	8,448	16,836	1,947,608
6/26/2012 7:30	2,237,371	6,295,630	0	8,533,001	2,237	6,296	0	8,533	16,915	1,952,086
6/27/2012 7:30	2,284,333	6,301,761	0	8,586,094	2,284	6,302	0	8,586	16,829	1,913,065
6/28/2012 7:30	2,135,101	6,304,010	0	8,439,111	2,135	6,304	0	8,439	17,085	1,780,581
6/29/2012 7:30	1,986,547	6,268,366	0	8,254,913	1,987	6,268	0	8,255	17,319	1,659,174
6/30/2012 7:30	2,099,338	6,258,395	0	8,357,733	2,099	6,258	0	8,358	16,134	1,539,318

APPENDIX D

2014 SMELTER PRODUCTION FORECAST

2012 Budget Year - 2014 Plan Ver 2

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Totals
Smelter Days	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	16.00		**320.00**
Nickel Conc TPD	756	754	756	781	756	781	731	756	755	756	239		
Ni Conc wtpd to Thickener @ 15% solids	5,042	5,024	5,042	5,210	5,042	5,210	4,874	5,042	5,036	5,042	1,594		
Thickener Overflow (l/min)	2,635	2,626	2,635	2,723	2,635	2,723	2,547	2,635	2,632	2,635	833		
Percol (~20g/ton), kg	17	17	17	18	17	18	17	17	17	17	5		
Thickener Underflow wtpd	1,563	1,557	1,563	1,615	1,563	1,615	1,510	1,563	1,561	1,563	494		
Ni Conc wtpd from filter @ 12% H2O	859	856	859	888	859	888	831	859	858	859	272		
VBN tpd	236	242	177	143	150	135	173	144	172	172	0		
Sand tpd	298	330	298	308	298	308	298	298	308	298	577		
Tons Rstr Feed per Cal Day	992	996	933	924	906	916	904	900	927	928	239		**897**
Rstr Hrs/Cal Day	19.8	19.9	18.7	18.5	18.1	18.3	18.1	18.0	18.5	18.6	2.5		15.5
Filter TPCD	756	754	756	781	756	781	731	756	755	756	128		695
VBN: Ni Conc Tons	31	32	23	18	20	17	24	19	23	23	0		23
Total Feed - Ni	12,920	11,735	11,921	11,070	11,393	11,026	11,374	10,523	11,716	12,127	2,610		**118,415**
Losses - Ni (75% slag losses, 20% thick o/f losses, 5% stack dust)	258	235	238	224	230	223	230	213	237	245	52		**759**
Fce Matte est (38% Ni), tpd	548	551	506	486	484	484	483	447	514	515	215		
Fce Taps/day	33	33	31	29	29	29	29	27	31	31	13		
Converter Charges/day	2.67	2.68	2.46	2.36	2.35	2.35	2.35	2.17	2.50	2.51	1.04		
Quartz tpd	129	129	121	120	118	119	118	117	121	121	31		
Scrap Generated tpd	82	83	76	73	73	73	72	67	77	77	32		
Scrap Consumed tpd	82	83	76	73	73	73	72	67	77	77	32		
Anodes - '000's lb Ni	12,662	11,501	11,682	10,846	11,162	10,803	11,145	10,311	11,480	11,882	2,557		**116,031**
Max LM (3tph)	60	60	56	55	54	55	54	54	56	56	8		**46**
LM TPD	54	54	51	48	50	50	46	46	51	46	19		44
Anodes/Cal Day	933	938	861	826	823	824	821	760	875	874	196	0	787
Limit	942	942	876	828	828	828	828	762	876	876	942	942	866
Total Product - Ni	12,662	11,501	11,682	10,846	11,162	10,803	11,145	10,311	11,480	11,882	2,557		**116,031**
% Recovery - Ni	98.00	98.00	98.00	97.98	97.98	97.98	97.98	97.98	97.98	97.98	98.00		**99.36**
% Cu In Anodes	2.25	2.24	2.35	2.39	2.41	2.44	2.29	2.36	2.36	2.26	3.09		**2.35**
Tonnes SO2	14,066	12,756	13,016	12,642	12,798	12,516	12,816	12,700	12,718	12,944	174		**129,146**

SO2 Yearly
187,500 Limit

Maximum Allowed Throughput: **1350** Tons per smelter day 2 Furn. **1000** Tons per 1 Furn.

Checksum for Losses	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***	***Total***
Tons	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Ni	-	(0)	0	0	(0)	-	0	-	0	0	-	-	**0**
Cu	-	-	-	-	-	-	(0)	-	0	-	-	-	**-**
Co	-	-	-	-	-	-	-	-	-	-	-	-	**-**

Anode Limit	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***	***Total***
Calendar Days	31	28	31	30	31	30	31	31	30	31	30	3	**337**
Anode Limit	942	942	876	828	828	828	828	762	876	876	942	942	**866**
Max Anodes	29,206	26,379	27,166	24,843	25,672	24,843	25,672	23,631	26,289	27,166	28,264	2,826	**291,958**

APPENDIX E

2012 AMEC REMEDIAL ACTION PLAN

VALE CANADA LIMITED

REMEDIAL ACTION PLAN

FOR

REMEDIATION OF IMPACTED SOIL AND GROUNDWATER

AT THE VALE THOMPSON FACILITIES

THOMPSON, MANITOBA

FEBRUARY 2012

AMEC Environment and Infrastructure
440 Dovercourt Drive
Winnipeg, Manitoba R3Y 1N4

Project No. WX16637

INTRODUCTION

Following the completion of a soil and groundwater study at the Vale Canada Limited (Vale) Facilities in Thompson, Manitoba (referred to as the “Plant Site”, the “T-3 Site”, the “Maintenace Shed Site”, and the “Birchtree Site”), AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC), has prepared a remedial action plan to address impacted media at the Site. Vale has announced plans to permanently close its smelting and refining operations located in Thompson at the end of 2014, at which time short and long term remediation actions will be conducted.

AMEC’s RAP references the information in the soil and groundwater study report, which should be referrenced in conjunction with this document, and is subject to the same terms and conditions as the soil and groundwater study report.

BACKGROUND

AMEC’s soil and groundwater study was supported by previous studies; however, the previous studies solely addressed groundwater or a specific area (i.e., the refinery). Based on the results of AMEC’s study, it was determined that the surficial fill and shallow soils in the majority of the south yard of the Plant Site are impacted with metal concentrations above the assessment guidelines (Figure 1). The impacts also extend beneath the slag pile on Site. Nickel impacts have also been detected in the fill, as well as the lower silt and sand deposits immediately adjacent to and below the refinery. In total, the volume of the metals impacted fill and shallow soil in the south yard is approximately 476,300 m^3. The exposed volume (i.e., area not underneath the slag pile or buildings) is approximately 355,700 m^3.

The estimated volume of the impacts in the lower sand and silt deposits below the refinery could not be calculated based on the limited access for sampling and assessment of these soils.

Two areas were present in the south yard in which metal impacts appeared to have extended deeper than the surficial fills and shallow soils. One of the areas consists of the TH11-11 to TH11-14 test hole locations. It has been theorized that buried impacted fill or metals are present in this area which accounts for the deeper detected impacts. The second area consists of the TH11-18 test hole location. The TH11-18 location is adjacent to a former copper storage pond. Impacts in this location also appear to extend to between 2.3 and 3.1 m in depth.

An area of approximately 18,100 m^2 of fill is impacted near the former crusher receiver building. This estimated area is considered to be a minimum value as it appears that the road materials in this area are constructed of impacted fill and may extend into the other portions of the mine facilities. Alternatively, it was reported to AMEC by Vale that impacted soil near the former crusher building may be the result of the haulage and stockpiling of ore at this location over many years.

There are eight distinct areas of PHC impacts in soil at the Plant Site (6), T-3 Site (1), and Birchtree Site (1) (Figures 2 and 3). The source of impact at each of these areas is inferred to include current or former storage tanks, with the exception of the TH11-12 and TH11-13 area on the south portion of the Plant Site south yard. The source of the PHC impacts in this area may be related to the former storage of barrels in this area or potentially buried objects (i.e., drums) similarly associated with the metal impacts in the same area. The total estimated extent of PHC impacts in all areas is estimated to be 33,100 m^3, including an estimated total of 1500 m^3 at a former diesel tank at the Birchtree Mine Site which could not be assessed due to a network of pipes and electrical cables preventing drilling.

There are no applicable risk based guidelines for groundwater at the Site as there are no associated risks to current or future human or ecological receptors. Assessment of groundwater was limited to deriving areas with suitable hydrogeology and sufficiently elevated concentrations of metals to allow for the potential recovery of dissolved metals from the groundwater. Their appears to be three areas in which metals, and specifically nickel, are suitably elevated in groundwater for potential recovery. These include areas in the vicinity of TH11-07, TH11-11, and TH11-16; TH11-18; and TH11-37 and TH11-42. The stratigraphy observed during test hole drilling in the TH11-07, TH11-11, and TH11-16 area and the TH11-18 area both indicate that granular surface fill is limited to between 0.7 and 1.5 m depth. Groundwater elevations for these wells indicate that the groundwater table is below the fill materials, within the silty clay deposits. The TH11-37 and TH11-42 area consists of deeper surficial fill at the refinery periphery (up to 3.4 m depth) and lower sand and silt deposits in the bedrock valley. The measured groundwater elevation for TH11-37 indicates that the groundwater table is within the fill materials. The groundwater elevation for TH11-42 indicates that artesian conditions are present in the lower sand and silt deposits.

Elevated PHC concentrations in groundwater were detected at the locations of determined impacted soil at TH11-11, TH11-25, TH11-39, TH11-76, and TH11-77.

SOIL REMEDIAL ASSESSMENT

AMEC has included and researched three potential remedial options for the impacted soils at the Vale Thompson facilities. For each remedial option, AMEC provided a brief description of the option, assessed potential advantages and disadvantages of each option, and provided a cost per 1000 m^3 of impacted soil remediated. Actual estimated costs of the recommended remedial option program are given in the following section.

Option 1: Remedial Excavation

Description

This option involves a remedial excavation of impacted soil and transport and treatment at the smelter (for metal impacts) or in a landfarm onsite (PHC impacts). Non-impacted soil overlying the impacted soil will be removed and stockpiled on-site for reuse as fill. The excavation would be extended until field soil testing and measurements indicate that soil conditions are indicative of the remedial target guideline parameters. Closure soil sampling would be conducted to demonstrate that soil impact concentrations at the excavation extents are within the remedial target guidelines. The excavation would subsequently be backfilled with the stockpiled soil as well as clean imported fill. Surface conditions would be replicated following backfilling.

Advantages

- Remediation timeframe is short
- Impacts removed from Site subsurface
- No off-site (tipping fee) treatment costs
- Allows assessment of data collected from extents of impacted areas
- No or minimal long term monitoring requirements

Disadvantages

- Most expensive option
- Requires removal of on-site structures to fully remediate Site

Costs

Based on AMEC's research with excavation contractors in Thompson, estimated costs are as follows:

Excavation Contractor (per m^3 of impacted soil)	
Site Preparation	$ 200.00
Impacted soil excavation and hauling on-site	$ 9000.00
Supply and place backfill	$ 7000.00
Total Estimated Contractor Costs	$ 16,200.00

Landfarm treatment of PHC soils costs normally approximately $4000.00 per 1000 m3. Costs to process metal impacted soils through the smelter are not known but are assumed to be minimal taking into account that there is a financial asset in the captured metals. Vale currently has a landfarm on the Site. Should a new landfarm be required or is amiable to be constructed nearer the areas of impact, the estimated cost to construct a licensed landfarm facility is in the order of $300.00 per m^3 of soil capacity.

Consultant costs for remedial excavation programs of this magnitude are typically 10 % of contractor costs, resulting in an estimated consultant costs of \$1620 per 1000 m^3, resulting in a total cost of **\$21,820 per 1000 m^3.**

Option 2: In Situ Enhanced Bioremediation System

Description

This option involves the installation of a gridded series of injection and extraction points within the impacted area. Injection points would involve the drilling of a test hole to the lower depths of the impacted soils, installing a small diameter piezometer screened at the lower end, and sealing the remainder of the test hole with low permeability grout. Extraction points would involve the drilling of a test hole to below the groundwater table, installing a piezometer with a screen that intersects the groundwater table and extends to near surface, and sealing the remainder of the test hole with low permeability grout. Biosparging and bioventing would be achieved through the cultivation of hydrocarbon degrading bacteria by rapid pulses of air injection alternating into individual or small combinations of injection points, followed by low air flow extraction from the extraction points by a sparging/ recovery unit. Nutrient enhancement would be introduced through the extraction points, allowing percolation throughout the impacted area.

The system would be monitored biannually and adjusted accordingly. Once conditions are indicative of being within the remedial guidelines, a closure test hole sampling program would be conducted to investigate the extent of remediation. The timeframe that the system may be required to operate to achieve the remediation guidelines cannot be estimated until the pilot testing is completed, but may extend up to ten years.

Note: this remedial option would only apply to PHC impacted soil. Metal impacts would not be remediated through this bioremedial method.

Advantages

- Does not require extensive intrusive disruption
- Active remediation system with controlled operation
- Remediate soils from below on-site structures without demolition requirement
- Lower capital costs

Disadvantages

- Highest O & M costs
- Will require separate closure assessment

Costs

Pilot Testing per 1000 m^3

Vapour extraction rental and testing, hydraulic conductivity testing	\$ 200.00

Excavation Contractor	$ 500.00
Drilling Contractor	$ 1400.00
Extraction/Injection Materials	$ 400.00
Sparging/Recovery Unit	$ 10000.00
Consultant (includes oversight, project management and reporting)	$ 7600.00
Total Installation Costs	**$ 9900.00**

Consultant (includes monitoring, project management and reporting)	$ 1900.00
Laboratory	$ 900.00
Unit Maintenance (5% of purchase cost)	$ 500.00
Hydro (based on previous experience = $20/month)	$ 240.00
Annual O & M, Monitoring Costs	**$ 3540.00**

Drilling Contractor	$ 190.00
Consultant (includes oversight, project management and reporting)	$ 580.00
Laboratory testing	$ 120.00
Closure Program Costs	**$ 890.00**

Based on the clayey nature of the soil, it is expected that the bioremedial system would most likely have to operate for a minimum of ten years, which would result in a total O & M costs of $35,400.00 per 1000 m^3 of soil, and a total project cost of **$46,190.00 per 1000 m^3 of soil**.

Option 3: Risk Management/Bioenhancement

Description

This remedial option involves the installation of a monitoring well network within and immediately outside the impacted area and the development of a monitoring program to allow on-going assessment on subsurface conditions. As part of the monitoring program, natural attenuation parameters of the groundwater will be examined, optimal concentrations will be calculated, and engineered enhancement of the natural remediation processes would be undertaken. Parameters to be examined would include pH, temperature, reduction/oxidation (redox) potential, dissolved oxygen, nitrate, sulphate, ferric/ferrous iron, and carbon dioxide/alkalinity.

A closure program may be initiated if the monitoring data indicates that natural attenuation has reduced the impacts to the remedial guideline values, however, the expected timeframe is well into the future.

Advantages

- Does not require extensive intrusive disruption
- No mechanical or electrical requirements
- Does not require the removal of on-site structures
- Least expensive option
- Monitoring interval can be adjusted as sufficient data is obtained and warrants

Disadvantages

- Option with longest timeframe
- May require another remedial method to be employed if monitoring data indicates unacceptable risks in the future
- May never completely remediate impacts

Costs

Monitoring Well Network Installation (per 1000 m^3)	
Drilling Contractor	$ 900.00
Consultant (includes oversight, project management and reporting)	$ 610.00
Laboratory testing	$ 130.00
Total Installation Costs	**$ 1640.00**
Consultant (includes monitoring, project management and reporting)	$ 370.00
Laboratory	$ 510.00
Annual Monitoring Costs	**$ 880.00**

Costs for a closure program have not been developed as the timeframe to this activity is considered extensive.

Based on the clayey nature of the soil, it is expected that the monitoring program would most likely have to operate for a minimum of fifty years, which would result in a total monitoring costs of $44,000.00 per 1000 m^3 of soil, and a total project cost of **$45,640.00 per 1000 m^3 of soil (exclusive of the closure program cost)**.

<u>RECOMMENDED REMEDIAL OPTION</u>

AMEC has devised a remedial methodology for the Site to address the soil and groundwater impacts prior to and during the decommissioning of the refinery and smelter. In order to reduce costs for remediating soil and groundwater, and to recognize an economic benefit in recovering metals in both media, AMEC's remedial methodology involves the excavation of soil and incorporates the use of the smelter and refinery to treat metal impacted soil and groundwater.

<u>Groundwater Remediation</u>

The first proposed action for this remedial option involves the removal and treatment of nickel impacted groundwater through processing in the refinery. Groundwater will be removed through the installation and pumping of a series of recovery wells for reprocessing. This action is proposed solely for a "one-time" recapture of metals in the fill and granular deposits below the refinery to remove the bulk of the existing impacts and provide a positive cost recovery from the remedial program. The groundwater capture is not intended to provide a full remediation of groundwater conditions. It is expected that the groundwater below the refinery will eventually become impacted in the future due to the dissolution of metal concentrations in soils. As previously stated, groundwater impacts at the Site do not represent an environmental risk to human and ecological receptors.

Recovery wells, up to 100 mm (4") in diameter and screened within the fill material, are proposed for installation along the eastern portion of the refinery, specifically targeting the sewer outflow trenches immediately adjacent to the refinery, and on the southwestern portion of the refinery in the area of TH11-37 and 97-4B. Additionally, similar recovery wells screened within the lower sand/silt deposit are proposed for installation in the southwestern portion of the refinery in the area of TH11-42 and 97-9A. The proposed wells should be completed with well screens over the respective capture zone (granular fill or lower sand/silt deposit). Submersible pumps will be required for each of the proposed recovery wells.

An estimated 15 to 17 recovery wells in the refinery fill adjacent to the sewer outflow and along the main sewer trenches, spaced 15 to 20 m apart to provide overlapping capture zones, would be required to address the entire sewer line along the eastern side of the refinery and partially downstream. An additional five to seven wells, similarly spaced, are proposed for each of the surficial fill and lower sand/silt units, on the southwest side of the refinery, in the area between and including TH11-37/TH11-42 and 97-9A/97-4B.

AMEC previously calculated that a pumping rate of 7.5 m^3/day (5.2 L/min) would induce a capture zone diameter of approximately 25 m for each single recovery well. Pumping at a higher rate would not likely result in a larger capture zone, as determined by the groundwater model employed to derive the optimum pumping rate. Dillon also calculated that a rate of 5 L/min (~7.5 m^3/day) would be optimal for long term groundwater extraction from the lower sand/silt unit. A capture zone radius was not calculated as wells assessed as part of Dillon's pumping test appeared to be in a detached sand/silt deposit from the pumping well.

The volume of groundwater in the surficial fill below the refinery is estimated to be 10,700 m^3 (10,700,000 L), based on the depth to groundwater, depth of fill, area of the refinery building, and expected porosity of the fill. Assuming 20 to 24 wells were installed within the fill and pumping at a rate of 7.5 m^3/day, the theoretical removal of the groundwater would be completed in 72 to 60 days, respectively. However, it is not expected that pumping will occur consecutively over this full period and recharge of the shallow groundwater will naturally occur. An estimate of 90 nonconsecutive days of pumping is proposed for deriving operating costs.

The volume of groundwater within the lower aquifer cannot be directly determined, however based on Dillon's pump test, it appears that the sand and silt portion below the refinery was at the stage of dewatering at the end of the 30 minute pump test. As such, pumping of the lower aquifer should be conducted in a phased manner. AMEC estimates that pumping should occur for 15 minute intervals followed by a minimum of 1 hour recharge periods. This schedule should prevent the wells from completely purging and damaging the pumps by operating while the well is dry. Recovery well operating efficiencies will require frequent monitoring to determine whether the proposed pumping schedule requires alteration, from time to time, as recharge of the lower deposits decrease with the removal of the groundwater in the fill materials.

It is expected that groundwater will be pumped directly into the refinery for processing, negating the requirement of storage tanks or vessels. The volume of groundwater extracted would require several large volume tanks and would limit the pumping timeframes.

Two additional areas in which metal impacts in groundwater were highlighted (TH11-07, TH11-11, and TH11-16 and TH11-18) are within saturated conditions in the clay deposits below the surficial fill materials. Hydraulic conductivity of the clay deposits at the Site have indicated very low recharge and capture capability. As such, it is not considered time or cost effective to pump groundwater for recapture of the metal impacts in these areas. Should dewatering be necessary during excavation activities (described below) in the area of TH11-12 and TH11-13, the removed groundwater may be processed through the refinery; however, additional assessment of the hydrocarbon concentrations of that water may be required to ensure it would not negatively impact refinery operations.

It is anticipated that the copper arsenate storage pond will be decommissioned with the refinery and smelter. AMEC proposes that the effluent stored in the pond, as well as any former ponds or open water in the south yard, also be transported and processed through the refinery.

Groundwater with elevated petroleum hydrocarbons will not be actively remediated as it is expected to naturally attenuate over time following the removal of PHC impacted soil.

Soil Remediation

The surficial fill in the south yard is impacted with metal concentrations in excess of the assessment guidelines. The impacts appear to extend into the upper portion of the clay deposits below the surficial fill. The main risk exposure pathway for metals is inferred to include direct contact with the impacted soil. Accordingly, remedies to address this exposure pathway were evaluated. The simplest and most robust remedy includes removing the surficial fill and replacing it with clean or treated fill, thus providing a cover between deeper impacts and ground surface. AMEC suggests that the provided cover be a minimum of 1 m thick.

All stored materials, facilities, or debris in the south yard will require removal to another location during the remedial efforts.

The proposed soil remediation strategy involves the excavation and transportation of impacted surficial fill from the south yard to the smelter to be processed and, where possible, the metal impacts removed and captured. In areas were surficial fill is greater than 1 m thick, a decision to remove all the fill or just the upper 1 m will be required. Imported soil, slag, or treated fill can be used to provide the suggested 1 m cover over any remaining impacted material.

AMEC estimates approximately 173,300 m^3 of fill will require removal in the South yard. This volume does not include soil beneath the slag pile (i.e., this soil is already sufficiently covered by slag to mitigate the risks associated with direct exposure), within the area of the former landfill, or beneath the refinery and smelter. The area of the former landfill consists of an elevated former dump area and much deeper granular fill in the roadways surrounding it. It is recommended that slag from the slag pile be transported to this area and a 1 m cover be installed over the elevated dump area and roadways. The estimated volume of slag to incorporate a 1 m cover at the former landfill is 63,700 m^3. It was also noted during the investigation that some garbage and debris was still being placed in the area of the former landfill as the new landfill has not yet been completely constructed. All such garbage and debris should be removed from this area once the new landfill is completed, prior to remedial works.

It is assumed that the excavation and transport of the fill will occur concurrently with or immediately following the treatment of groundwater, enabling the refinery to be decommissioned and the upper 1 m of granular fill, or deeper if required, below the refinery to be similarly treated. The upper 1 m of fill below the refinery includes approximately 29,200 m^3 of soil.

The remaining soil below the smelter cannot be similarly processed as it will not be accessible until the smelter is decommissioned. Further assessment will be required to delineate the volume of impacted soil below the smelter following decommissioning. The current estimate of the volume of soil below the smelter is 17,000 m^3. This soil could be used as fill in the copper arsenate ponds or in the area of any other removed subsurface facilities up to within 1 m of grade. Otherwise, the soil could be disposed in the bottom of the open pit area. Should the refinery not be decommissioned prior to the smelter decommissioning, the fill materials below the refinery could similarly be disposed in the bottom of the open pit area during decommissioning.

The metal exceedances detected in the road materials in the area of the crusher receiving building require additional assessment to determine whether they extend along all the roadways within the mine site and the relevant risk of leaving these materials in place. This area is not included in the Remedial Action Plan.

The area of petroleum hydrocarbon impacts at TH11-12 and TH11-13 should be addressed prior to the south yard excavation. The remaining areas of PHC impacts can be addressed at a later date or at facility closure as the assessment data does not indicate that the impacts are migrating beyond the general source areas. All storage tanks currently not in use or not scheduled for use following decommissioning or closure should be properly dismantled and disposed by a licensed petroleum contractor under the Manitoba Regulation 188/2001 - Storage and Handling of Petroleum Products and Allied Products. Facilities that may remain in operation (which could include the storage tanks north of the mill, east of the refinery, and the T-3 Site and the waste oil storage tank at the Birchtree Site) will require temporary decommissioning and re-commissioning following remediation. Alternatively, these four areas could be remediated following the date when the storage tanks are scheduled to be decommissioned.

AMEC proposes that all PHC impacted soil, estimated to be 33,100 m^3, be excavated and transported to the land farm at the southwest corner of the tailings basin for remediation by bioremediation (land farming). Soil screening and sampling should be conducted during excavation to confirm that all impacts are addressed. Groundwater infiltration during excavation will be collected and disposed in the open pit area. Excavations should be backfilled with imported clean fill.

REMEDIAL COSTS

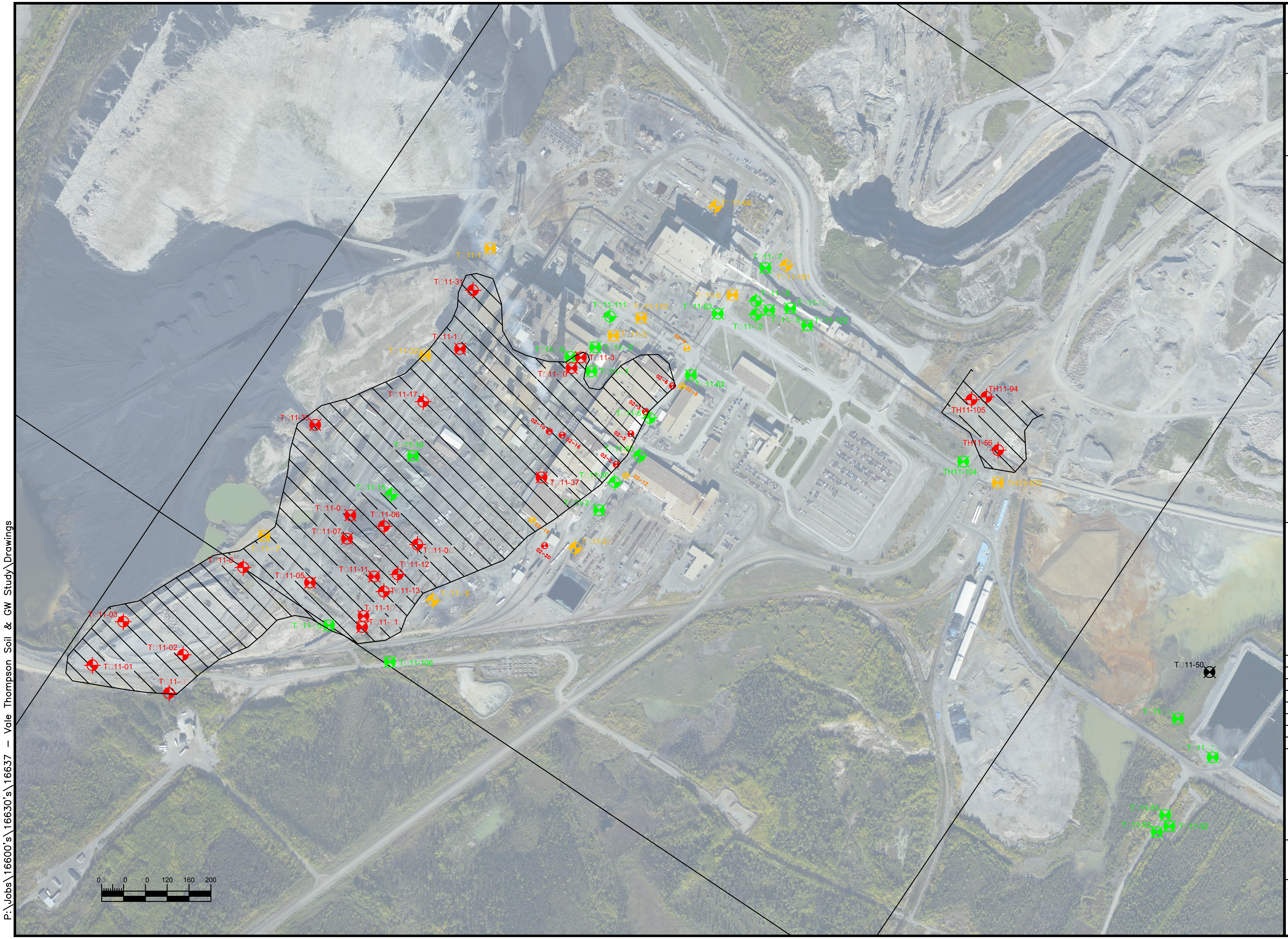
The overall cost of remediating the referenced areas of the Thompson Mine plant site is estimated to be $6,189,100. The cost estimate does not include costs to operate the refinery and smelter in the processing of the impacted groundwater and soil or any of the decommissioning costs associated with the facilities, nor does it include detailed design, oversight, analytical and sampling costs as part of the remedial activities. Additionally, any offset in costs derived from the recovering of metals from this refinery/smelter feed has not been included. Additional activities have been included in the Mine Closure Plan and are not included within these costs, such as rehabilitating the copper arsenate ponds, reshaping the slag piles or removing debris from the south yard.

It is anticipated that the planned remedial work will take place over a one year period immediately prior to the decommissioning of the refinery, smelter, and associated facilities.

A summary of this cost estimate is presented in Table 1.

Table 1 - Thompson Mine Plant Site Summary of Estimated Remediation Cost

Remediation Component	Estimated Cost
GROUNDWATER REMEDIATION	
Installation of 24 shallow and 7 deep recovery wells, including pumps, wiring, and discharge lines to refinery	$106,000
Operation of groundwater pumping for 90 days	$8,600
Transportation of copper arsenate water and former pond / standing water from yard to refinery	$7,000
SUBTOTAL - GROUNDWATER	**$121,600**
SOIL REMEDIATION	
Excavate and transport 202,500 m^3 fill to smelter for processing (includes fill below refinery)	$3,645,000
Transport and place 1 m slag over former landfill (63,700 m^3)	$955,500
Excavate and transport 17,000 m^3 fill below smelter to copper arsenate ponds or open pit	$255,000
Excavate and transport 31,600 m^3 PHC impacted soil to land farm	$496,500
Operate land farm to treat PHC impacted soil (est 3 years)	$75,000
SUBTOTAL - SOIL	**$6,067,500**
TOTAL ESTIMATED COST	**$6,189,100**



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CLIENT□

VALE LIMITED

LEGEND

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MONITORING WELL
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"RED" E□CEEDS G□IDELINES
"GREEN" BELOW G□IDELINES
"ORANGE" □500□g/g DELINEATION CRITERIA
ESTIMATED IMPACT E□TENT

NOTE□SITE FEAT□RE LOCATIONS ARE APPRO□IMATE

NO.	REVISION	DATE	B□

REMEDIAL ACTION PLAN

T□OMPSON FACILITIES
T□OMPSON MINE VALE LIMITED
MANITOBA DIVISION

E□TENT OF SOIL IMPACTS - METALS (PLANT SITE)

SCALE□	AS S□OWN	FIG□RE 1
DATE□	FEBR□AR□ 2012	
DRAWN B□□	MD	
PRO□ECT NO.□	W□16637	

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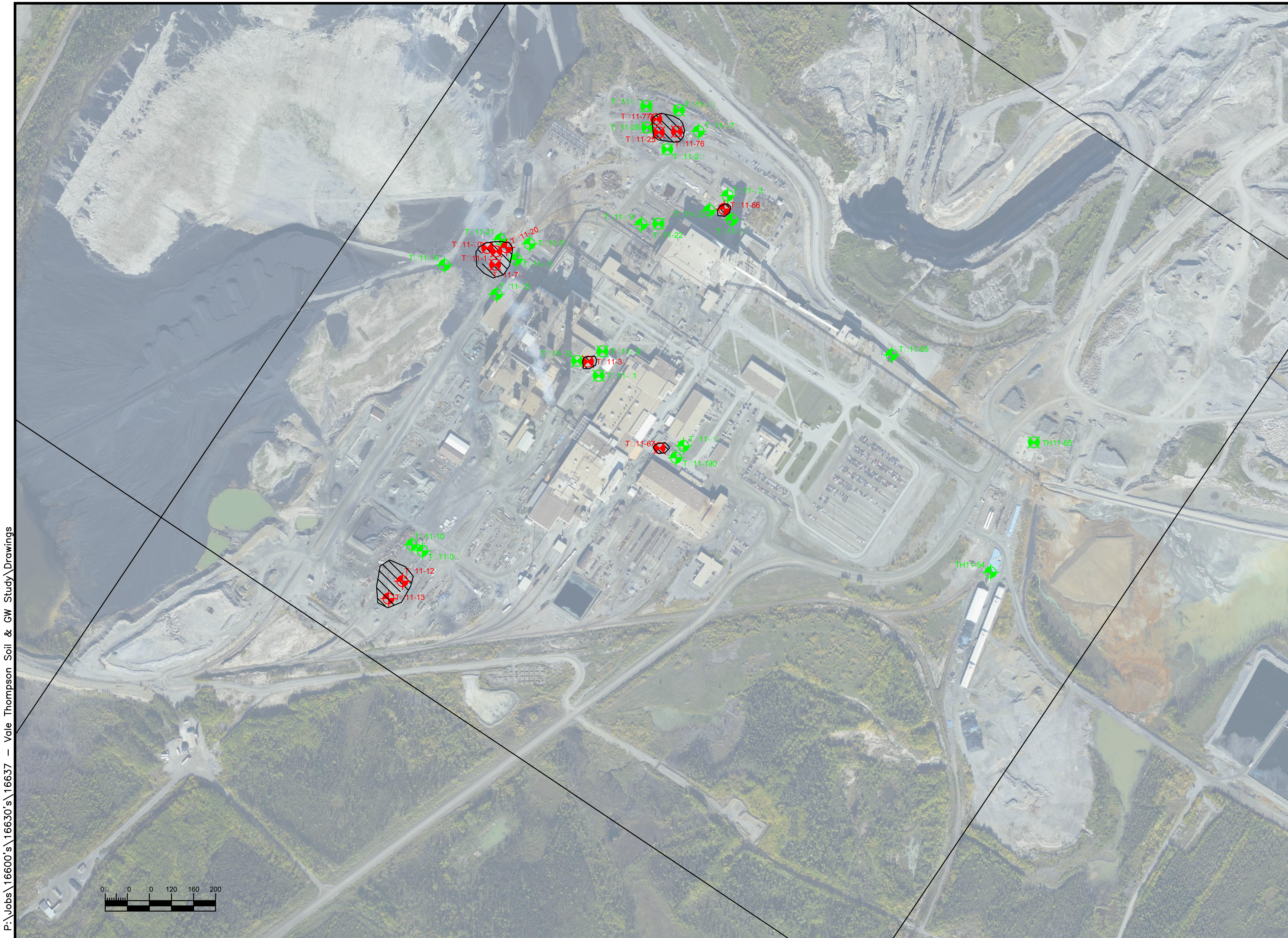

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CLIENT□

VALE LIMITED

LEGEND

TEST □OLE

MONITORING WELL

"RED" E□CEEDS G□IDELINES

"GREEN" BELOW G□IDELINES

ESTIMATED IMPACT E□TENT

NOTE□SITE FEAT□RE LOCATIONS ARE APPRO□IMATE

NO.	REVISION	DATE	B□

REMEDIAL ACTION PLAN

T□OMPSON FACILITIES
T□OMPSON MINE VALE LIMITED
MANITOBA DIVISION

E□TENT OF SOIL IMPACTS - P□C□ (PLANT SITE)

SCALE□	AS S□OWN	FIG□RE 2
DATE□	FEBR□AR□ 2012	
DRAWN B□□	MD	
PRO□ECT NO.□	W□16637	

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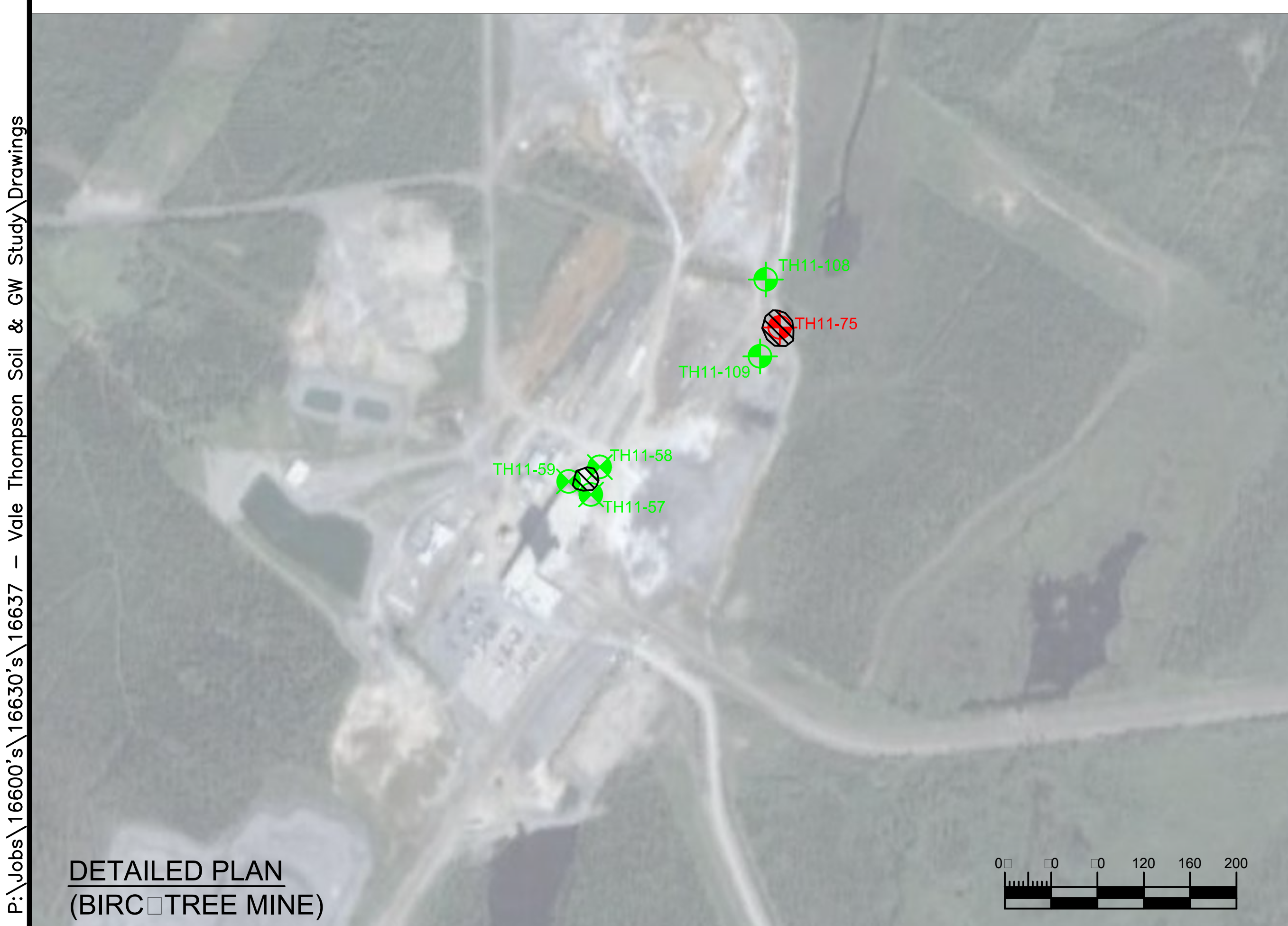
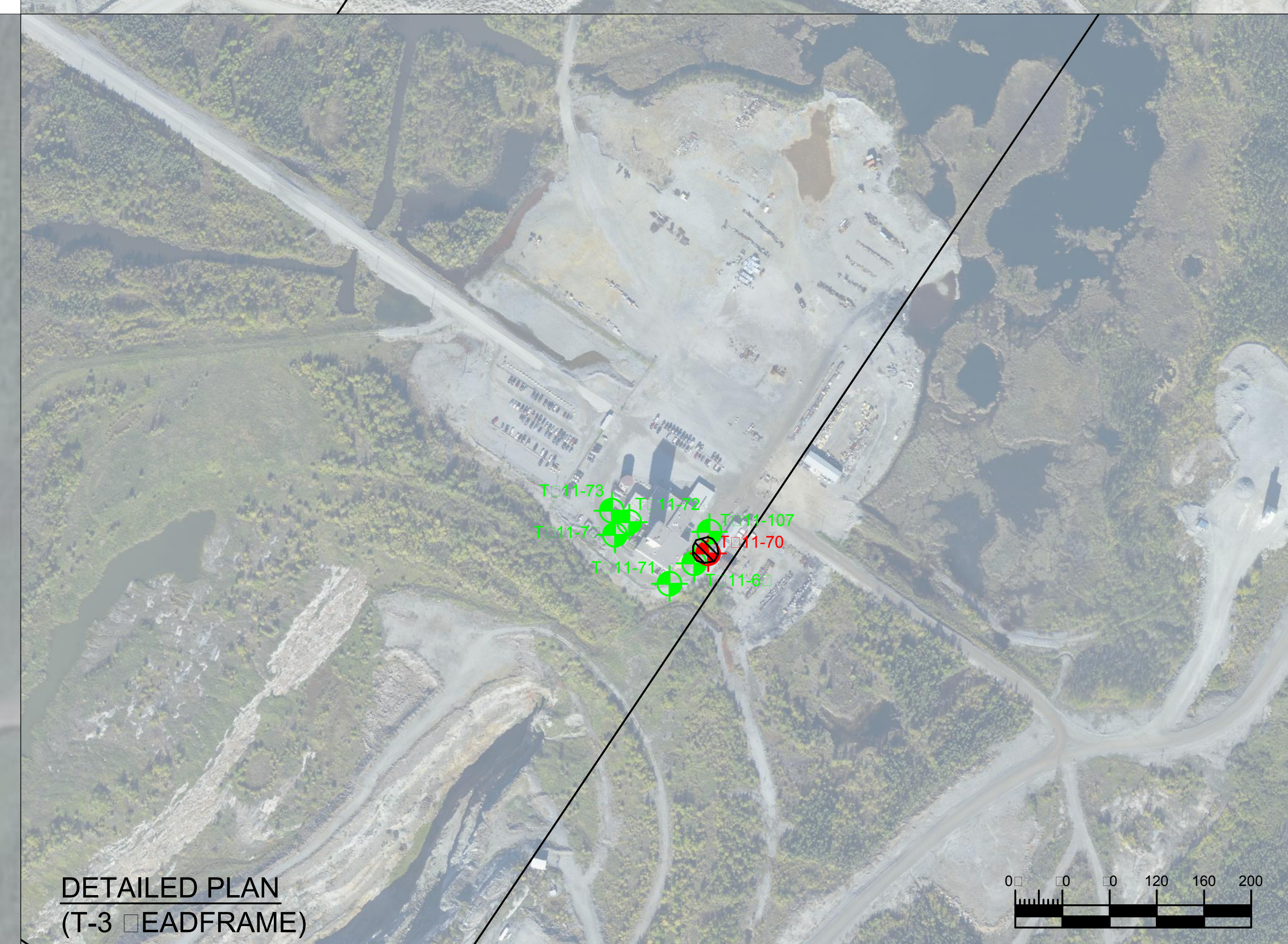
DETAILED PLAN
(MAINTENANCE S□ED AREA)



DETAILED PLAN
(BIRC□TREE MINE)



DETAILED PLAN
(T-3 □EADFRAME)

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CLIENT□

VALE LIMITED

LEGEND

- TEST □OLE
- MONITORING WELL
- "RED" E□CEEDS G□IDELINES
- "GREEN" BELOW G□IDELINES
- ESTIMATED IMPACT E□TENT

NOTE□SITE FEAT□RE LOCATIONS ARE APPRO□IMATE

NO.	REVISION	DATE	B□

REMEDIAL ACTION PLAN

T□OMPSON FACILITIES
T□OMPSON MINE VALE LIMITED
MANITOBA DIVISION

E□TENT OF SOIL IMPACTS - P□C□
(BIRC□TREE MINE□T-3 □EADFRAME□AND MAINTENANCE S□ED AREA)

SCALE□	AS S□OWN	FIG□RE 3
DATE□	FEBR□AR□ 2012	
DRAWN B□□	MD	
PRO□ECT NO.□	W□16637	

APPENDIX F

SMELTER MONTH END INVENTORY

Report Date 30-Jun-12

Sheri.Morris

Smelter Month End Inventory

	Dry Tons	% Co	% Cu	% Ni	% Fe	% S	lb Co	lb Cu	lb Ni	lb Fe	lb S	
1. Concentrates												
Ni concentrate - A2	1067	0.365	0.551	16.200	32.277	27.165	7795	11752	345713	688794	579695	
Cu concentrate	400	0.151	11.836	5.143	27.415	27.454	1208	94691	41145	219317	219633	trapped in #4 dead storage
VBN	570	1.172	0.347	24.310	35.458	31.300	13368	3953	277177	404285	356873	
Agmet	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Kuntz	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Canbra	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
External Conc 1	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
External Conc 2	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Total	**2037**	**0.549**	**2.710**	**16.299**	**32.213**	**28.379**	**22371**	**110396**	**664035**	**1312396**	**1156202**	
2. Refinery Reverts												
Leach Matte	365	0.771	3.167	61.006	0.235	29.883	5628	23122	445340	1713	218141	
Broken Anodes	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
ENR	94	1.166	1.853	75.077	0.408	19.891	2197	3493	141494	769	37487	
Ref Ni Conv	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Dump Ash	162	0.130	1.670	14.170	5.860	0.000	422	5420	45990	19019	0	
L Treat Thick	0	4.532	0.024	12.100	19.834	12.100	0	0	0	0	0	
Cu Residue	806	0.130	31.370	34.431	0.000	0.000	2088	505681	555025	0	0	
SAS	605	0.216	1.075	6.208	0.008	64.736	2607	12998	75089	99	782953	currently in #8 thcickener, to be removed over next year
Refinery Revert 1	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Refinery Revert 2	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Total	**2032**	**0.318**	**13.549**	**31.073**	**0.531**	**25.553**	**12942**	**550714**	**1262938**	**21600**	**1038581**	
3. External Reverts												
Ferro Ni	0	0.001	0.001	45.993	52.937	0.001	0	0	0	0	0	
External Revert 1	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
External Revert 2	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Total	**0**	**0.001**	**0.001**	**45.993**	**52.937**	**0.001**	**0**	**0**	**0**	**0**	**0**	
4. Smelter Products												
Anodes	2088	1.267	2.249	75.677	0.573	19.393	52935	93944	3160562	23936	809915	
Cu Calcine	37	0.300	7.000	8.900	15.320	9.900	222	5180	6586	11337	7326	trapped in calcine silo, needs to be removed
Brick	1423	0.468	0.885	8.091	8.081	16.518	13327	25190	230193	229907	469949	can be shipped to Ontario for sale to Xstrata
Total	**3548**	**0.937**	**1.752**	**47.880**	**3.737**	**18.141**	**66485**	**124315**	**3397341**	**265180**	**1287190**	
5. Smelter In Process												
Roaster Calcine (Ni)	80	0.305	0.449	14.660	31.897	24.800	490	722	23573	51290	39878	actually rotary bin inventory
Roaster Calcine (Cu)	37	0.300	7.000	8.900	15.320	9.900	222	5180	6586	11337	7326	
Flue Dust	500	0.190	0.700	12.100	30.000	14.000	1900	7000	121000	300000	140000	assumed in the flues
Furnace Calcine (Ni)	419	0.319	0.492	14.724	31.685	25.228	2669	4117	123269	265266	211206	
Fce. Matte No. 1	357	1.411	1.221	35.950	29.883	27.886	10078	8717	256682	213364	199107	
Fce. Matte No. 2	527	1.464	1.330	39.064	26.737	28.035	15434	14014	411736	281806	295490	
Fce. Build-up No. 1	641	1.443	1.254	37.107	29.233	27.638	18515	16080	475957	374967	354505	
Fce. Build-up No. 2	476	1.475	1.326	39.229	27.086	27.763	14032	12611	373131	257627	264074	
Fce. Build-up No. 5	434	0.783	12.224	30.504	31.689	23.457	6796	106108	264773	275061	203604	
No. 5 Ferro-Ni Heel	137	0.000	0.000	50.000	50.000	0.000	0	0	137000	137000	0	
Converter Matte (Ni)	275	1.443	1.286	37.818	27.995	27.976	7924	7062	207661	153722	153614	
Converter Build-up	60	0.930	5.560	39.390	35.600	6.580	1116	6672	47268	42720	7896	
Anode Casting	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Anodes in Boxes	289	1.377	2.285	77.572	0.789	17.200	7956	13202	448237	4561	99388	
Broken Anodes	69	1.259	2.248	75.823	0.581	19.353	1746	3120	105203	806	26852	
Converter Aisle Scrap Inside	1541	1.884	0.847	29.319	31.922	11.700	58049	26105	903612	983821	360594	
Converter Aisle Scrap Outside	655	0.900	2.350	30.000	32.040	12.100	11790	30785	393000	419724	158510	
Flue Dust	40	1.000	1.230	30.420	17.540	16.920	800	984	24336	14032	13536	
Other 1	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Other 2	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Brick Adjustment	0						0	0	0.000	0.000	0.000	
Total	**6537**	**1.220**	**2.008**	**33.067**	**28.968**	**19.395**	**159518**	**262478**	**4323023.114**	**3787101.592**	**2535580.028**	
Adjusted Total In Process	6533	1.401	1.713	31.507	30.631	19.866	183088	223765	4116531	4002058	2595595	
6. In Transit												
VBN	3620	1.138	0.349	24.484	34.785	30.980	82391	25291	1772711	2518513	2243005	
Leached Matte	23	0.541	4.139	55.591	0.576	24.814	247	1892	25415	264	11344	
Cu Concentrate / SAS	0	0.326	1.067	6.755	1.681	71.107	0	0	0	0	0	
Brick	1057	0.520	1.030	9.000	9.000	18.400	10995	21778	190297	190298	389055	
Scrap	131	0.900	2.350	30.000	32.040	12.100	2365	6175	78827	84187	31793	
Dust	0	0.000	0.000	0.000	0.000	0.000	0	0	0	0	0	
Total	**4832**	**0.993**	**0.571**	**21.393**	**28.907**	**27.685**	**95998**	**55136**	**2067250**	**2793262**	**2675197**	
7. Summary												
Total	**18985**	**0.941**	**2.905**	**30.852**	**21.542**	**22.893**	**357313**	**1103039**	**11714587**	**8179539**	**8692750**	

APPENDIX G

VALE STANDARD PROCEDURE INSTRUCTIONS

TITLE		Roaster Shutdown (Normal)					IDENT. #	
RST 353		Area	REV. #	1~~0~~	RISK RANK	2	LAST REVIEW	~~January 19, 2005~~Mar. 1/10

Purpose:

- To Safely do a Normal Roaster Shutdown

References:

- So3.0 Roaster Operation
- GEN 001 Smelter PPE and Clothing Requirements

Precautions:

- For winter months, empty feed from rotary bins before shutting down roasters.

Prerequisites:

- Authorized Personnel Only.

Procedure:

1. Follow normal shut down procedures;Reference so3.0 Roaster Operation. ensure main air is closed, wind box open.

2. **Note:** Check and ensure windbox opening is not plugged.

3. In extreme cold weather, close feed plow and leave turn-table turning. In winter months, bin level should be left at not more than 25% to prevent freeze up of the bin. Turning the bin once every ½ hour will help prevent the turntable from freezing.

4. Clean out K. K. Box, feed hopper, and transition section.

5. Shut off air supply to K. K. (NOTE: During winter months Kipp Kelly gates are left running).

6. Shut off 6 lb. air and K. K. vent air.

REASON FOR REVISION IF APPLICABLE			REFERENCED LP SHEETS		
INCIDENT	SCHEDULED				
PROCESS CHANGE	EQUIPMENT CHANGE				
OTHER: New Training Organization					
WRITTEN BY	Training Department			DATE	Mar. 1/2010
REVISED BY				DATE	

DEPARTMENT SIGNATURES		
REVIEWED BY	TITLE	DATE
APPROVAL SIGNATURES		
APPROVED BY	TITLE	DATE

	Rev	Date
RST 355 Roaster Shutdown Major		

<u>Purpose:</u> To safely shutdown a Roaster for a major repair.

<u>References:</u> SO-3.0 Roaster Operation

<u>Precautions:</u> Lock and tag practice to be followed.

<u>Tools And Equipment:</u>

<u>Personal Protective Equipment:</u>

- Standard Smelter Personal Protective Equipment
GEN 001 Smelter PPE and clothing requirements
-

<u>Prerequisites:</u>

- Authorized Personnel Only.

Procedure:

Ensure feeding conveyor belt is stopped and tagged.

Empty rotary bin and blow out cone. Process supervisor should start dumping bed slowly while emptying rotary bin.

Clean off any feed build up in feed hopper and K. K. area.

Dump the remaining bed, fluff occasionally using roaster air.

Leave approximately 6 - 12" of bed in roaster to protect tuyeres from getting damped.

Lock out roaster K. K. air supply.

Open inspection port to check bed level in roaster.

If bed low enough, (below manway door) open door on 4th. Floor.

Remove bricks from doorway, visually inspect inside roaster for feed build up, loose bricks, etc.

Maintenance removes cyclone and uptake covers and install hanging platform in roaster uptake.

Using air lance, clean out horizonal section.

Ensure cyclone is clear of dust remove bell or expansion joint on cyclone discharge pipe. Blank off pipe below to prevent debris from falling in.

Open dust hopper door and clean out hopper.

Disconnect dust hopper discharge pipe above drag and blank off.

After maintenance are finished with repairs, muck out bed and check tuyere heads for plugged holes or B. O. tuyeres. (require welding)

End of Procedure

TITLE	Adjusting Furnace Tie Rods						
SMT 270	Furnace Side	REV. #	1	RISK RANK	7	LAST REVIEW	4/12/2010

Purpose:

Too safely and efficiently Measure/apply/Maintain Constant Pressure on Fce Refractory via Whalers, Buck stays + Billet Plates.

- Normal operation = once a week.
- Shutdown/Start-up = once daily (24 hrs)

References:

- **GEN 001 Smelter PPE and clothing requirements**
- See Component - Definition/Description. (Attached)
- See Diagrams.
- SMT 313

Precautions:

- Applying/Jacking in excess of 300 tons constant pressure.
- Never adjust a tie rod more than ¼' at a time.
- Do not exceed piston on "Jack". (Yellow indicator line)
- Do not exceed tonnage capabilities, (Red Line @ Gauge/Manifold)

Tools and Equipment:

- Hydra - Tight Jack, 1.5" Stroke, Mandrel, various size Saddles, accommodating "Alternative/Old method of Adjustment!
- Enerpac hydraulic .5 hp Pump + Gauge.
- Appropriate "Manifold", accommodating, Two (2) 5"x4.75" = 2.25" stroke, Enerpac Jacks, Model 50 ton capacity Jacks - single action, two (2) needle valves, Two (2) 10,000 psi high pressure hoses/couplings, Two (2) manually operated check valves.
- Appropriate "Manifold", accommodating, Two (2) 5.5 x 4.9 = 2" stroke, Enerpac Jacks, Model 60 ton capacity Jacks - single action, two (2) needle valves, Two (2) 10,000 psi high

pressure hoses/couplings, Two (2) manually operated check valves.

- Appropriate “Manifold”, accommodating, Three (3) 6.5 x 5.5= 2.25” stroke Enerpac Jacks, Model 100 ton capacity jacks - single action, two (2) needle valves, Three (3) 10,000 psi high pressure hoses/couplings, Three (3) manually operated check valves.
- Tie Rod Wrench, light lube oil, Wire Brush, Two Wheel Dolly, Extension Cords.

Prerequisites:

- (2) Two Authorized Furnace Personnel.

Procedure 1 **“Normal Measurement /Adjustment”**

Note: Establishing what pressure is on an Individual Tie Rod assembly is based on a linear Measurement between the inner and outer Faceplates The greater the distance or less Compression = the less pressure is applied.

The Pressure Indicator is a “Gauge’” installed on each Spring Assembly That allows a quick/efficient visual Assessment of “Pressure applied” on Assembly.

The exact pressure required is referred to as “SPEC” or “ON SPEC”; If the “Gauge Point” …is anywhere on the ½” Indicator Bar, which Represents the allowable “Operational Range” of required pressure + Or – ¼” of “On Spec”; is Considered within the “SPEC” of required pressure + Does Not Require Adjustment.

Adjustment Not Required. (See diagram)

Note: Adjustment MUST BE done in ¼" increments to avoid any abrupt or acute pressure deviation on any one tie rod, which could result in failure of the tie rod or the adjacent tie rod assembly, culminating in;

- Danger to crew.
- Damage to Jacking Equipment/Tie Rod components.

There is no "TIME FRAME FACTOR" between increments!

Note: Although the size of the Furnace Components & Equipment varies, the principle of applying Controlled Compression of these Springs between the Face Plates, results in the desired Pressure transferred to Whalers, Buck stays, Billet Plates on the Fce Refractory.
See Diagrams / Tie Rod sheets

Note: Some Tie Rod Assemblies; @ # 2 Furnace
1,2,7,8, @ Bottom Longitude and
33,34,39,40 @ Top Longitude
Require simultaneously adjustment as their Buck stay is designed & fabricated to accommodate dual Tie Rods.

1. Place Enerpac Jacks in "Jack Holders – Pedestals".
   "Jack Base" placed against "retaining plate"

2. Adjust position of the "Jacking/Retaining Plate", using the "Retaining Nut", until the space between Plates; "Retaining Plate & Outer Face Plate" which accommodates the "Jack cylinder" of 4". (Retracted)

3. Ensure Retaining Nut & Security Rod Nuts are positioned accommodating the function required. (**Loosening or tightening assembly**)

Note: At this point each crewmember should be delegated to one of the two functions. A member operates/monitors the pump & gauges while the other monitors "Spring/Faceplate Position" compression, Jacking assembly, Indicator.

4. Activate "Enerpac Pump";
    - Plunger lever (down)
    - Switch - depress

5. Monitor closely the position of "Outer Face Plate" relative to "Pressure Indicator".

6. Align edge of Outer Face Plate to Centre Line of the "Pressure Indicator Bar"----
    - "On Spec" = Precise alignment between centre line of Bar and edge of "Outer Face Plate"

7. Stop Pump Function.

8. Snug up Retaining Nut to "Outer Face Plate".

9. Release Jacks by gently/slowly reversing Plunger lever (up).

Note: Ensure the releasing of plunger lever is done gradually as an acute release could result in damage to tie rod components or jacking equipment or may subsequently injure personnel.

10. Remove Jacks from Pedestals.

Procedure 2 "Adjusting at Unsprung End"

Note: This is an alternative method of adjusting allowing or accommodating;

- Pulling thru Tie Rods.
- Releasing pressure on B/O Rod Section.

1. The appropriate Saddle [length] is placed on the Unsprung (Matte) end of the Tie Rod squarely positioned against Butt Plate!

Note: The Saddle size is relative to the Length of Threaded Rod protruding! The minimum length is 13”, allowing the smallest 6’ saddle and the “Hydra tight Jack”

2. The hydraulic Jack is placed on the Tie Rod,
(Base in) and slid up to the Face of Saddle.
(Piston/stroke out)

3. The Ring Nut (Tie Rod Nut) is then threaded along the Tie Rod , positioning depends on the adjustment requirement, (loosen/Tighten) ensure the
“Jack – Saddle – Ring Nut” are positioned squarely, tighten by hand!

4. A) Connect “Hydraulic pump hose harness to Jack, ensure the fittings (Male/Female) are clean and tightened firmly.

Note: It is not required to dis-assemble/re-assemble Pump/Harness/Jack assembly for subsequent Tie Rods.

4. B) Engage Pump, “Plunger/Lever”

5. Activate Pump (Toggle switch / Button), apply sufficient pressure to accommodate the required Function; Tightening/Loosening spring assembly.

Note: Do not exceed “Piston Stroke Limit” (1inch), which is indicated by a yellow Line on the circumference of piston. **(Seal)**

6. Tighten or loosen “Tie Rod Nut” according to requirements, utilize wrench if required to snug up Nut to Butt Plate.

7. Once Nut is In place, Slowly disengage Pump/Plunger Lever releasing pressure with a minimum amount of Shock to assembly/equipment!

Procedure 3 **"Tie Rod Removal / Replacement"**

This procedure Takes Place as a result of the Following Conditions;
A) Structural changes/Rebuild of the Furnace, that may need modification to Component capabilities such as "Springs" or pulling through/lengthening Tie Rod.

or

B) The integrity of one or more of the components of a Tie Rod assembly has been Compromised by either;

1) - Direct contact with molten Material that has physically deformed/destroyed components.

2) – Indirect contact with molten material, which could alter the "Temper" of components. [Radiant heat]

Note: In the above cases consideration **MUST BE** given to the adjacent Tie Rod Assemblies.

Case A) "Complete Furnace Rebuild" requires a Total relaxation or decompression of the "Spring Assemblies", releasing all pressure on all Tie Rods as uniformly as Possible.

Phase 1

This must be done in ¼" increments as per previous indicated "Normal Operating Procedure"; to ensure **Uniform** relaxation of Pressure on Furnace the suggested sequence is as Follows;

1. # 1 Furnace, starting on bottom Longitudes @ North side of the Slag End at # 1 Tie Rod, working south towards # 14 and continuing on the south side at # 15 to # 33. apply normal adjustment procedure as described.

It is acceptable to make three or four adjustments (Passes-Increments) on the bottom Tie Rods. There is no “TIME FRAME FACTOR” between increments!
At this point all Bottom Tie Rods should have been relaxed by approximately 1”, with Spring Inner Face Plate measurement roughly 14”

Any further reduction in pressure releasing without considering the Top Tie Rods could jeopardize the integrity of the Furnace Roof.

Ensure uniformity, relaxing of Top Tie Rods is essential.

2. Move Crew/Equipment to Roof Area.

3. Starting at # 37 North adjust/release Longitude Tie Rod as previously indicated procedure, ¼” Increments at one time. Progressing South to # 44 + continuing Back + Forth making 3/4 passes releasing a max. 1”.

4. Move crew/equipment to and release the 3 top latitude Tie Rods, applying the same technique
¼” increments x 3 or 4 passes, maximum 1”.

The status of pressure on the # 1Furnace Tie Rod assemblies at this point should be as follows;
Top Latitude (3) Side wall
“Specs” @ 17 7/16” = 48.3 tons, add 1” for Adjustment/relaxing of “Spring Assembly” would result in a measurement of 18 7/16 at the Faceplates or equaling to approximately 21 tons pressure!
Top Longitude (8) End wall
“Specs” @ 17 9/16” = 48. tons, add 1” for Adjustment/relaxing of “Spring Assembly” would result in a measurement of 18 9/16 at the Faceplates or equaling to approximately 21 tons pressure!

Bottom Longitude (14) "Specs" @ 17 ¾ " = 65.5 tons, add 1" adjustment/relaxing of Spring Assembly would result in a measurement of 18 ¾ " at the Faceplates or equaling to approximately 28 tons pressure!

Bottom Latitude (2) @ Corners

"Specs" @ 17 7/8 " = 60 tons, add 1" adjustment/relaxing of Spring Assembly would result in a measurement of 18 7/8 " at the Faceplates or equaling to approximately 25 tons pressure!

Bottom Latitude (19) @ Side wall

"Specs" @ 17 11/16 " = 62.5 tons adjustment/relaxing of Spring Assembly would result in a measurement of 18 7/8 " at the Faceplates or equaling to approximately 28 tons pressure!

PHASE 2

It is acceptable + convenient to start the final releasing pressure on the top Tie Rods where phase 1 ended.

Following the same methods previously described, ¼" increments adjust/relax Tie Rods;

- Starting at # 37 North adjust/release Longitude Tie Rod as previously indicated procedure, ¼" Increments at one time. Progressing South to # 44 and continuing Back and Forth making 3 or 4 passes will result in 0 - Tons

1 Furnace, Complete decompression of Spring Assemblies occurs at approximately 19 **½** - 20 inches ".
 # 2 Furnace, Complete decompression varies on each Individual Spring assemblies, see Diagram/Spec sheet.

Note: In the Case of a complete "Furnace Rebuild" consideration must be given to the "Roof" if any or all panels are to be replaced, then the pressure on the relative Tie Rods and subsequent Skews, Buck stays can be released! Any panels that are to remain must be left with appropriate tonnage as per S.O.P. requirements. If relative Buck Stays to B/O Panel are to be replaced, a proper "staggering/rotation" of removal and replacement will take place to ensure that specific Panel is not jeopardized. (Refer to SMT 313)

Note: After a complete rebuild, (New Furnace); A "Staggered Jacking Sequence", on both Top and bottom assemblies will be applied. (See Diagram**)**

Procedure 3

"Removal of Spring Assembly"

Note: Spring Assembly must be totally relaxed or decompressed.

Note: This may require the use of 2-24" pipe wrenches, one to secure or counter lock the "Tie Rod" the other to loosen the "Nuts". In extreme cases a "Die" may have to be run over B/O threads to accommodate "Nut" removal. (See Protective Sleeve)

1. Loosen off + remove "Retaining Nut".

2. Loosen off + Remove all Four (4) – 11/8" "Retaining Bolt Nuts".

3. Dislodge "Retaining Plate" and retract or push retaining bolts back thru sleeves in retaining Plate, allowing the hook up of a 3/8" sling choke at one of the sleeves.

4. Using adjacent Tie Rod Assembly/Apron, or whaler beam, hook come-a-long, to “Retaining Plate” via 3/8” sling, lift, slide + lower Plate. **[Monitor/Control “swing”]**

5. Complete Lowering/removing sling + store Face Plate if not damaged. [**When handling Faceplate, use 2 crewmembers**]

6. Loosen off + remove “Outer Faceplate Nut”.

7. Using adjacent Tie Rod Assembly, Apron or Whaler, hook come-a-long, to “Outer Face plate” via 3/8”, sling, lift, slide + lower Plate. **[Monitor/Control “swing”]**

8. Remove “Springs” from “Inner Faceplate Guides and Tie Rod”, store if undamaged or reusable.

Procedure 4

“Removal of Tie Rod Sections”

Structural Changes, Rebuild of the Furnace that may require modification component capabilities such as “Springs”, pulling through or lengthening Tie Rods or removal of B/O sections due to exposure to molten material or radiant heat, or Burred/Damaged threads

1. Locate the relative coupling on the furnace from the “Spring Assembly”.
(See Tie Rod layout Sheets Top + Bottom)

2. Heat (torch) Relative Corners of Lock Washers and straighten or cut off completely;
   - At/over “Locknut”
   - At/over “Coupling or Turnbuckle”

3. Apply a “Pipe Wrench” to coupling/turnbuckle creating a “Counter Lock” by wedging at “Fce Underbelly” or at “Pillar”.

4. Apply another pipe wrench to adjacent locknut and back or loosen of the nut by at least one (1) full turn.

* **Ensure "Lock Washer" function/seating is broken!**

** **The location of the "Coupling/Turnbuckle" relative to the "Furnace pillar" impacts on the number of crew capable of safely rotating wrenches/equipment!**

5. Leaving "Counter Lock Pipe Wrench" at the Coupling/ Turnbuckle" in place, situate (1) one "Pipe Wrench" on Tie Rod 6 to 12 inches from the "Turnbuckle" and another pipe wrench situated outside the furnace at relative area of "Spring Assembly", NOT on Threads! The crew then in unison loosens or backs off entire Tie Rod Section.

*** The number of crewmembers and wrenches depends on the length of "Section and the degree of difficulty.**
**** Check/ensure "J Hooks or Chain Supports" are in place along "Tie Rod Section" in question? If "J Hooks or chain supports" are not on location, the use of Ropes or Wooden Blocks can accommodate by;**

- **Preventing "Binding" of the Rod.**
- **Prevents sudden drop as separation occurs at the "Tie Rod Section/Turnbuckle" [safety + Threads]**

<u>Component – Definition/Description</u>

The Function of the Furnace Tie Rod is to apply a Consistent/uniform amount of Pressure on Furnace Refractory via Whalers, Buck Stays, and Billet Plates.

The Amount of Pressure applied/required varies Depending on;

- Furnace Size – (Structural Steel Components)
- Location of Tie Rod Assembly on the Furnace

 # 1 Furnace

* 15 sets @ Two Spring Assemblies - 40 ton each
* <u>31 sets</u> @ Three Spring Assemblies - 40 Ton each
46 sets Total

 # 2 Furnace

* 2 sets @ Two   Spring Assemblies   - 30 Ton each
*14 sets @ Three Spring Assemblies   - 30 Ton each
* 2 sets @ Four   Spring Assemblies   - 30 Ton each
*10 sets @ Four   Spring Assemblies   - 20 Ton each
*10 sets @ Five   Spring Assemblies   - 20 Ton each
* 2 sets @ Ten   Spring Assemblies   - 30 Ton each
40 sets Total

<u>Description</u>

Each tie Rod Assembly consists of;

*** Two - Compression Face Plates; (Inner/Outer)**
Face Plates accommodate alignment/containment of Springs allowing sufficient support for pressure (Tons) Applied on the Tie Rod.

*** One - centred 2 ¾" Tie Rod "Port";** each Face Plate. Maintains alignment of Tie Rod relative to Springs + other Face Plate.

*** Two - centred Tie Rod "Guide Ports";** over/under each Tie Rod Port. (4-Inch Diameter)

*** Two Face Plate "Guides";** cylindrical shaped, 4-inch Diameter by 16-20 inches long. One end is inset in the lower/upper guide "Port" of the inner Face Plate. The other end accommodates the "Ports" in the outer "Face Plate". The two "Guides" together [over-under] the Tie rod ensure an even/aligned compression + releasing of the spring assembly! **(Prevents Binding)**

"**Coil Springs**"**;** at least two, but may be as many as ten depending on Requirements, Dimensions and Capabilities vary. Controlled compression of these springs [**Between the Face Plates**] results in the desired pressure (**tons**) applied via the Whalers, Buck stays, and Billet Plates on the Furnace refractory.

* **One - Retaining “Plate”** **Large Fces only**
*** Four- Retaining “Bars”** **Large Fces only**
* **One - Retaining “Nut”** **Large Fces only**

All retaining components prevent injury and damage by ensuring the pressure applied within the tie rod assembly, if and when inadvertently released is limited and a restrained to short distance, usually the distance between Outer Plate and Retaining late, 6 to 8 inches.

“Coupling/ Turnbuckle”; Rectangular shaped Block 4 ¼” x 4 ¼” x 8” long with threaded ports its entire length accommodating the threaded Tie Rod ends.

“Tie Rod Nut”; Secures Tie Rod at Coupling, Faceplate Or Retaining Plate.

“Tie Rod ”; Length Varies from 2 to 24 feet.

“Lock Washers”; 5” squared mild steel, corners are bent on opposite ends + directions, locks the connection or joint of;
“Tie Rod - Nut - Coupling - Nut - Tie Rod” **(see diagram)**

These components make up the appropriate length along and across (longitude/latitude) the Furnace. Together they create a solid instrument allowing the transference of applied pressure (tons) at the Face Plate Spring Assembly to Whalers, Buck stays, Billets.

Note: “Arch Plates”; although these are not part of “Tie Rod Components Assemblies”, there is a direct/ critical correlation between these + “Top Longitude Tie Rods”, contact must be maintained @ “Buckstay/Archplate” to “End Wall” for appropriate pressure (4 – 7 Tons) and control to be applied @ Roof Panels [East/West Integrity}! See Diagram/Procedure, attached to SMT 313

End of Procedure

<table>
<tr><td colspan="2">REASON FOR REVISION
IF APPLICABLE</td><td colspan="2">REFERENCED LP SHEETS</td></tr>
<tr><td>INCIDENT</td><td>SCHEDULED</td><td></td><td></td></tr>
<tr><td>PROCESS CHANGE</td><td>EQUIPMENT CHANGE</td><td></td><td></td></tr>
<tr><td colspan="2">OTHER: New Training Organization</td><td></td><td></td></tr>
</table>

<table>
<tr><td>WRITTEN BY</td><td>Smelter Training</td><td>DATE</td><td>April 12/2010</td></tr>
<tr><td>REVISED BY</td><td>Training Department</td><td>DATE</td><td>April 12/2010</td></tr>
<tr><td colspan="4">DEPARTMENT SIGNATURES</td></tr>
</table>

REVIEWED BY	TITLE	DATE
Florence Colbourne	**Training department**	April 12/2010

APPROVAL SIGNATURES

APPROVED BY	TITLE	DATE

TITLE	Furnace Operation During (Shutdown- Drain)						M/D/Y
SMT 271	Furnace Side	REV. #	1	RISK RANK	10	LAST REVIEW	4/12/10

Purpose: **To apply Established procedures that will prepare for and Counter the Negative aspects of a "Shutdown" on the Furnaces, which enhances a Safe/Efficient "Start-up".**

References:

- See SMT #'s 304, 338, 261,
- See Attached Relative Drawings/Diagrams.
- Previous Shutdown "History"
- Tech/services Data.
- GEN 001 Smelter PPE and Clothing Requirements

Precautions:

- Losing Control of Furnace Refractory Expansion/Contraction via Improper Shutdown/Start-up

Tools And Equipment:

- All Relative Furnace Equipment.

Prerequisites:

- Authorized Furnace Personnel only.

Procedure:

Furnace ~~ShutdownPreparation~~Shutdown Preparation	1. Scrap: addition will cease at least (1) one week prior to the date of "takedown or drain". Considering: a) Build up. {Hearth + Side walls} b) Condition of Fce/refractory. c) Reason. "Shutdown or Rebuild-drain"? Scrap hoppers to remain full of scrap on landings until "converter wash" phase. (**Sand will be maintained in Hoppers**)
"Scrap"	
"Silica"	2. Silica: In furnaces at time of "converter wash" phase ~~should~~Should be 38%. This will offset the return of low silica (25%) converter slag. To attain higher silica, consultation/co-operation with the Process Supervisor (**control room**) will be required. Inching up silica via roaster should be initiated at least one week prior to shutdown (subject to process). The higher the silica, the fewer number of hoppers of sand will be needed to remain within our operational window (32% to 38%,during shutdown) as the precise ratio (Formula) indicates below. 3. Minimum / maximum operational window during shutdown is as follows: **Minimum** target silica % in Furnaces = 32% **Maximum** target silica % in Furnaces = 38%
	4. To maintain the % of silica at the target: Current slag =

“Silica”

Silica %	Ladles of slag	Hoppers of sand
32%	1	1
34%	2	1
36%	3	1
38%	4	1

5. In order to raise furnace slag silica by 2% ,calculate;

Inches of slag (**#1,fce**) = 61 + slag level - matte level

Inches of slag (**#2,fce**) = 60 + slag level - matte level

Inches of slag (**#5,fce**) = 43 + slag level - matte level
(# 5 N/A off line, cold standby- sept/00)
Hoppers / sand required; for every 10" of slag, add 1 Hopper of sand

Example: #1 furnace; 61" represents distance between Tap/Skim hole!

Matte level = 30", slag level = 10"

Inches of slag = 61 + 10 - 30 = 41"
Hoppers of sand required = 4
<u>or</u>
Take a manual (7/8 bar) matte measure and include total slag on bar and divide by 10”...

41" divided by 10 = 4 hoppers sand!

Note: To maintain the furnace slag sio2 at the current level, without roaster operation, one hopper of sand must be added per ladle of Converter Slag.

Liquid levels

Liquid levels" as applies to :

a) **Normal/Vacation Shutdown-** which requires us to **Takedown** Liquid Levels, yet retaining enough in furnace to apply sufficient power, allows us to maintain furnace at "hot standby"!

b) **Drain For Rebuild,** requires us to remove all liquid from furnace, allowing a minor/major rebuild.

Shutdown Takedown

Preparation

a) Shutdown -**Takedown**, liquids levels in furnace, should be allowed to increase to;
Matte - minimum - 35"
Maximum - 40"
See SMT 338, "Skimming Furnace Process" .

b) Slag Level will depend on condition of furnace walls, the roaster will go down upon reaching desired matte level, and shortly thereafter skimming the furnace should begin, depending on calcine level {amount} in Furnace.

Note: Depending on calcine levels, it may be necessary to Tap one or two ladles if Matte Levels exceeds our guide lines re: (**High Matte - Skim Operation/ see "Safety Factor"**)
Monitoring both calcine level and matte level is essential. Once skimming phase is complete, tap furnace down to 15" - 20" of matte (Target).
"Do Not, if possible, Tap to Slag".

Takedown

“Drain”

Note: Every attempt should be made to equally distribute matte taps to converters and subsequent Return Slag to Furnaces, as this should attain some continuity of metallurgy in converters and more importantly the Furnaces (power - b/u etc). Also Note, if for a variety of reasons, circumstances (slag level) dictates, it may become necessary to skim a particular furnace after converter wash to reach our “Desired Levels” ;

Matte	15" - 20"
Slag	20" - 40"

Total Liquid = 45" to 60",

"Using Old Matte Measurement Method"
(All liquid on 7/8 bar)

Note: Do not remove skim chutes to accommodate breast removal until final skim campaign is complete.

Drain Preparation for “Rebuild”

"Liquid levels" as applies to:

Draining Furnace - “Rebuild"

The initial task in an efficient "Furnace Drain" is to reduce the magnetite build up on the hearth and solidified calcine impregnated slag along side/end walls at or just above the normal "slag line level".

To effectively accomplish this, drain procedures should Begin at least two (2) weeks beforehand, (depending on Amount and location of build up to be removed) with Controlled, gradual adjustments to power, tap settings, “Furnace inputs”, roaster calcines/flue dust+ converter return slag. These would coincide with equally controlled "Furnace outputs", {skimming/tapping}.

The build up on the hearth at the skim end is historically Greater so the "Taps" could initially be lowered (moderately on 1st phase {1+2 electrodes}) which slowly reduces and changes said build up to the molten state. This, "lowering taps", could also coincide with a slight increase in furnace power, although it’s not essential if ample time is allowed. It should also be done intermittently, as constantly Lowering taps could create a "cold top", that is not desired during the last 2 to 3 weeks of operation.

Magnetite Build-up Removal

The application of other supplementary methods of Magnetite build-up removal include;

- Reducing the flue dust addition.
- Reducing the frequency of "taps" taken out, and skim hours, allowing liquid bath (clean/warm) to rise above the side wall build up.
- Coke addition via Fce/drags.
- Cast iron {scrap}

Drain Preparation

The chronological steps of this "process procedure" of "Preparation - drain" of a furnace are as follows;

1. A complete inspection and subsequent recommendations as to required maintenance work in addition to the major rebuild must be done well in advance of "final drain".

2. At initial stages of Preparation, {2 to 3 weeks} - measure magnetite, at specific intervals { once every 24 hrs } at;

- Electrodes
- Side Roof Ports {if applicable}
- Vent Port
- If possible at "Emergency Sand Port", 3rd floor

Note: The last two locations should become attainable (**meas.**) during the last stages of preparation, (**2 to 3 days**), and are **Critical** re: accurate matte level build-up relative to Skim/tap hole elevations and may indicate actual "Matte Level" at back of Furnace. Therefore they must be taken **Before** final skim campaign.

3. Begin (**2 to 3 weeks before final drain**) applying Magnetite removal techniques, such as;

- Intermittently adjusting taps according to degree and Locations of Magnetite build up.

4. To attack bottom build-up; intermittently lower taps, on all or individual phases depending on location of bottom build-up, add scrap iron where required and allowed, maintain lower matte & slag levels. May also require increase in power depending on;

- Length of preparation time allocated
- Current matte/slag levels & temps. {shift to shift)

Drain Preparation

5. To attack side wall build-up;

- Apply max. Available "Power" @ max."Taps"-33.

This should attain maximum power radius, to Fce/walls.

- ***Maintain a higher matte/slag level;**
  : Matte - 32" to 40"
  : Slag - 20" to 30"

Forcing the hottest part of Fce/bath "Matte/Slag Interface" up into sidewall build-up, by **Controlled**, Skimming, Tapping, and Roaster Operating Hours.

- Curtail or reduce flue dust input.

- Add " coarse coke ", in a "hotter top".

* **Deviating from "Normal Operational Guidelines"**

6. Check + Ensure electrode paste levels and casing are sufficient allowing constant power control during drain.
{**1 or 2 days before drain** }

7. Stop adding flue dust, (**2 to 3 days before drain**); this will reduce the oxide in the furnace, thereby increasing the amount of sulphide, resulting in enhancing the rate of build-up **Removal**, and creating a "hot top".

Note: Reducing Fce/Air flow via "Damper" will also assist in Maintaining a "hot top", subject to our current process requirements {**monitor/adjust accordingly**}.

Drain Preparation

8. When sufficient build-up has been removed, begin preparation for "final shutdown/drain procedure";
a) Begin building/raising matte level to appropriate level, the extent of said level will be higher than our normal operational "High Matte Level;

35" - 40” Large Furnaces

25" - 30” Small Furnaces

However, must not exceed the ***Safety Factor** which varies Fce to Fce of the "Skim Block and Hole", we must consider;

- Current Tap/Slag Hole Elevations.
- Bottom Build-up Measurement.

The aggregate measurements of [**matte level + build-up**] must not come within 15" (**safety factor**) of centre of skim hole elevation.
To establish our "drain matte level";
{**Applying current elevations # 1 fce/ 00-01**} (**See diagram**)
: Matte tap hole centre line to centre of skim hole = 61”
: Minus ***15"** {o/c skim hole to bottom of Cu Blk} - 15 ”
= **46”**

The degree or depth of matte allowed to build in the furnace is a management decision, considering;
- Furnace/Conditions
- Crew input

By raising matte level, we allow;
a) Maximum amount of slag to be skimmed "off" via Granulator, which is a more efficient method than "Tapping - Transferring slag”.

b) Should enhance a final attack on "side wall build-up", resulting in an appropriate cleaning of the furnace, therefore reducing demolition work.

Drain Preparation

9. Shut down roaster, empty rotary bin.

10. Air lance, fettling pipes, o/f pipes, side walls {via doors}

11. After as much dust/Calcines have been cleared from pipes and side walls are allowed to settle {**1/2-1hr**}, open Furnace damper fully, venting Fce/freeboard.
{**15-30 min <u>only</u>**}
(**Reduces dust contaminants during demolition**)

12. Set damper 5% open or less {manual} this setting will assist in maintaining "hot top".

13. Set and maintain **<u>Initial</u>** appropriate "power/taps";
: 2 to 4 Mgws at 24 to 33 taps

Drain Preparation

14. Take Matte Measurements;

(2) Two methods of checking Matte Level;

[Applying #1 Fce elevations, see diagram]

<u>Method 1):</u> Matte Measurement {normal}

- o/c tap holes to o/c skim hole = 61"

Minus

- ***"Safety factor-skim block " = <u>15"</u>

Absolute maximum matte level = 46"

<u>46" at normal matte measuring location</u> (**SMT304**)

<u>method 2):</u> take; Mag./Meas. at # 1 electrode {west}

- B/U at #1 electrode (west) e.g. = 10"

- Matte Meas. At Fce/vent {south} e.g. = 48"

Calculate;

- Build/up at # 1 electrode {west} e.g. = 10"

Plus

- Liquid Matte at Fce/vent {south} e.g. = 48"

If the aggregate of the above two factors 58<u>"</u> is less than the skim hole elevation @;

o/c Hearth to o/c Skim Hole = 76"

Minus

Build-up @ <u>10"</u> + Liquid matte @ 48" = <u>58"</u>

18

<u>18"</u> minus 15" = 3" "Skimmer Safety Clearance"

<u>"Final skim process can safely begin"</u>

***** Represents, the bottom of Skim Block which is roughly 15" down from centre of Skim Hole, Matte must never infringe at this elevation. (see diagram/drawing)

Drain Preparation

Note: If both methods of calculations do not establish safe levels; "Tap" appropriate ladles of matte ensuring "safety guidelines/clearance for Skimmer, {minimum 15"}

Shutdown Drain

15. Open slag hole , {lance slightly upward} and skim Furnace as per normal operation/process!

16. Monitor and apply appropriate power/taps to sustain a clean/hot "last skim campaign.

"Vacation" + "Rebuild"

Note: Monitor last skim process closely. Watch for matte contamination of slag with;
Visual indications/symptoms at bowl/slag hole.

- Colour + temperature change
- Sparks
- Buttons Samples (Coloured)

If the above symptoms develop it may become necessary to tap one or two ladles of matte. (**Skim slowly!**)

17. When "maximum" amount of slag has been safely Skimmed off, Bud-up Fce.

18. Begin "Tapping furnace".

19. Monitor and maintain appropriate power/taps during final "draining/tapping". Cease Drain/Tapping when appropriate levels have been reached.
(See Liquid Levels For "Vacation Shutdown)

Note: Slipping electrodes may be required as the Furnace bath is lowered in order to maintain constant power.

Shutdown Drain For "Rebuild" Only

20. Drain as much matte and remaining slag as possible, Consideration should be given to;

- Centre hearth tapping, if/where applicable
- Continuous tapping, "tapping on the fly"

Ladles of slag to be equally distributed to the other Operating furnaces.

21. When furnace drain is completed, raise electrodes out of bath, cut power and appropriately tag at "transformer + control~~orl~~ Room". Inform the sub-station.

22. Ensure electrodes are blocked appropriately (rams) before personnel enter furnace.

23. Open furnace doors, damper, and return slag chute gate fully allowing quicker cooling.

Shutdown Operation

Tie Rods: Should be "dead on" spec, this will allow for movement plus or minus within acceptable guidelines;

: ½" on Ni Furnaces {Large}

: ¼" on Cu Furnace {Small}

(Considering for spring variance, especially on # 5 Fce)

Our current tension requirements on tie-rods vary;

Large Units = Ni Fces as per "specs" on current sheet

Top: "indicator specs", {**see diagram**}
2 spring assembly set @ 7 7/16 @ centre exerts 48.3 tons pressure

Bottom: "indicator specs", {**see diagram**}
3 spring assembly set @ 17 11/16" @ centre exerts 62.5 tons pressure

Small Unit = # 5 as per "specs" on current sheet.

Top: "indicator specs", (see diagram)
2 spring assembly set @ centre exerts 28 T pressure.

Bottom:
Longitude: "indicator spec" (see diagram)
2 spring assembly set @ centre exerts 46 T pressure.

Latitude: "indicator spec" (see diagram)
2 spring assembly set @ centre exerts 35 T pressure.

All related tie-rod equipment should be checked and repaired or replaced if needed. {Tool crib operator}

Shutdown Operation "Power"

The necessary power for Furnace Process during Shutdown is regulated and controlled via the "Shift office Terminal", according to our operating parameters and the Instructions of the Furnace Operator or Supervisor.

Furnace Power Requirements + Application

- 1.0 to 2.0 m.w. Per phase = 3.0 - 6.0 m.w. Per hour
- 8 hours x 3.0 = 24 m.w. Per shift
- 8 hours x 6.0 = 48 m.w. Per shift
- 24 hours = 3 x 24 = 72 m.w. Per day
- 24 hours = 3 x 48 = 144 m.w. Per day

The power consumption per shift can be read on the VAX screen fcerpo'. The screen includes amount of power consumed this shift in MW's plus the amount consumed over the last 3 shifts.

The amounts are totalled and updated at 3:00 p.m., 11:00 p.m. and 07:00 a.m.

Note: In event of a disruption in power application (loss of Power) a slight increase in power setting should be applied when power's re-established, to make up Requirements. The increase should be calculated on extended time frame (long term), do not try to regain desired conditions (Furnace) in short period of time, use 24 to 48 hours.

Shutdown Operation "Power"

Power Setting: 1.0 to 2.0 m.w.

1 to 33 taps depending on variances of numerous factors.

Hearth temperatures" the normal operating temperatures of the furnace shutdown report will be based on data accumulated 4 to 6 weeks prior to shutdown. Our daily temperature reading should be recorded at the beginning of each shift.

This will establish continuity and minimize variance trends. Our target for hearth electrodes is to remain within 100 degrees of normal operating temperatures to attain and maintain this goal we must control and monitor;

Power (**as per recommendation**), our ability to remain within this constant range greatly depends on % silica of the furnace bath, which should not drop below 32%. **(See shutdown preparation).**
If this happens power becomes unstable, causing Fluctuating and spiking which reduces control, resulting in Either too hot or too cold conditions. a temporary counter measure is to adjust tap settings downward, this may stabilize power, short term (**1 - 4 hours**), however our most effective and lasting measure is to add sand at the electrodes.

Shutdown Operation

Note: Sand addition at electrodes requires removal of Furnace Power,[**Apply SMT 261**] and Collars which result in substantial loss of heat. Once the decision to add sand is made, a slight increase in power & taps, 1 to 2 hours prior, will enhance both application and the required immediate % silica increase (**warm top**). This also applies to the procedure for build-up measurement. **Visual inspection** of furnace is imperative as it allows another method of power assessment requirements. The optimum conditions should be, 6" - 12" of liquid around each electrode with a reddish brown top,(**not glowing**). On the other hand, a black crusty top, with little or no liquid at the electrodes is not desirable. If this coincides with dropping hearth temperature, then a power increase could be applied. However conditions could warrant a variety of responses;
E.g.: A normal or warm hearth temperatures plus a cold, black, crusty, top (**resulting from sand addition @ collar and power removal**), this could be corrected with raising taps (**only**).

Note: Closing furnace damper (**slightly**) will also enhance the warming procedure, this will raise the freeboard and your wall & vent temperature will also rise as a result (**monitor closely**).

Note: Often being more creative with Tap Setting will fulfil our Fce/requirements rather than increasing power. (**Consider all factors**)

Shutdown Operation

Bottom Cooling Fan must be shut-off at square "d" and a status tag must be applied to it. The fan should only be turned on if hearth electrode temperatures rise above normal operating readings, (**the fan being turned on would also**) coincide with a power reduction on either, the whole furnace, or an individual phase. An increase in hearth – electrode temperatures may also indicate build-up erosion, which should be monitored and compared to normal operating averages on each unit.

Liquid Levels also impact our ability to "effectively" control power, the more mass or volume, the more power is required to attain and maintain desired furnace conditions. Excessive liquid levels also slows or Impedes the responsiveness of our adjustments; power / taps, cooling fan, damper etc. too little liquid could create a potential hazard if inappropriately excessive amount of power is applied. The build-up becomes vulnerable to erosion, as low matte level reduces insulation between build-up and matte/slag interface.
An extreme of this scenario (low levels) coupled with low on ram (electrode) will cause loss of contact (bath) resulting in loss of power.
For these reasons we recommend 15" to 20" of matte, 20" to 30" of slag, total overall liquid level 45" to 60”

Furnace Draft - “Damper”: will be set at -6, roughly 50% of normal operation set point.

Adjusting furnace damper will impact on freeboard, wall, vent, stack & breech temperatures. It can also be utilized (in part) to control furnace top conditions.

Shutdown Operation

Vent normal operating temperatures will be noted on furnace shutdown report, keeping to lower end of window, (within 50 to 75) should give us desired conditions.
Stack and breech temperatures should be checked on the display screen “fluect”
These temperatures should stay above 50 - 60 °c.
If not, open dampers slightly to see if the temperatures improve.

Miscellaneous
"Electrode collars": must remain in place, the frequency of sand addition will impact greatly on furnace temperatures & conditions (**crust**) immediately, replacement upon completion is essential (**heat loss**).

Furnace Drags and Return Slag Chutes: should be blocked off, capped and/or sealed with insulation or whatever applies or is practical.

Controlling furnace draft appropriately with effectively applied above measures helps minimize power required and makes efficient use of that requirement.

Shutdown Operation

Magnetite Measurements allows us to evaluate condition of Furnace bottom, averages based on the last 4 to 6 weeks of normal operation will be recorded on "Furnace Shutdown Report".

Measurements to be taken every "3 days" as follows;

#1 furnace - 12 x 8 shift
#2 furnace - 4 x 12 shift
#5 furnace - N/A (cold standby)

By remaining at target hearth temperatures **(-100 °c of Normal operation)** adding to present build-up is all but Unavoidable.

We can, however, minimize that addition of build-up or Suspend it in a semi-molten state allowing for a safe and efficient start-up. (Tapping – skimming – roaster).
After initial cooling; (1st week), build-up should increase (20" to 30") then stabilize or level off.
Any further increase could be countered with warming methods, as per Power / Tap adjustments.

Taking Slag Samples (via 7/8 bar at electrodes) will coincide with build-up Measurements, as above (3 days). Samples will be Bagged and tagged, (date – furnace) with 12 x 8 shift Placing all 2 furnaces sample bags in larger sample bag, Dated and left in G.F. office. These samples will help Establish and Enhance procedures for future shut-downs, also arrangements have been made to have samples Analyzed, giving us our current silica % assays which Should enhance, (**awareness, power spikes - silica**)
Power Control.

If conditions re-establish themselves as per previous Shutdowns re: (chrome silica slag) creating an impenetrable interface, we will cease attempting to take Build-up Measurements.

Shutdown Operation

Tie-Rod Measurement and Adjustment

Assuming all tie-rods are on "spec" at start of shut-down and temperatures (refractory) remain on target, this in turn would indicate little or no contraction, resulting in minimum number of tie-rods requiring adjustment (frequency).

The schedule for measurement and adjustment if required is;

- #1 furnace = 12 x 8 shift
- #2 furnace = 4 x 12 shift
- #5 furnace = N/A cold standby

Note:
Appropriate furnace operation during shut-down directly affects, time and effort required to remain within "spec", Subsequently greatly enhancing furnace refractory (Minimum shock) and our start-up. Optimum target would be required to adjust no (0) Tie-Rods.

Shutdown Operation

Furnace Electrode Cooling:
The glycol electrode cooling system will be left on for the Shutdown. This will enable us to have electrode cooling available if we have problems with stability.

The system is set up so that a **leak** greater than {4} four Gallons will be detected. The glycol system will then shutdown and the power will trip on the furnace. In order to detect small **leaks** the glycol electrode cooling system should be inspected at least three times a shift. The glycol system will trip Furnace Power, **(*Electrodes remain in bath)**
If there is no glycol flow or the differential flow is too high or the level in the coolant tank drops too quickly or too low.
Check the system thoroughly before restarting to ensure that there are no leaks. Repair all leaks before restarting the glycol electrode cooling system and powering up the furnace.
If there is a communication problem between the glycol Electrode cooling system (**plc**) and the safe (**computer**) the system will shutdown and power down the furnace (**Remove 3 electrodes from the bath**). The most likely cause will be a power failure to the system. Have this checked by electrical/instrumentation. Ensure communications are re-established before restarting the cooling system + powering up the furnace.

***** Installed (**plc**) to reduce the risk of liquid (glycol) coming in contact with molten material via void created by electrodes being removed from furnace bath. (**safety-critical**)

Shutdown Operation

Furnace Block Removal : Our target is to remove and Replace five Tap Blocks North and South, on all Operating Furnaces.

- # 2 Fce, South Cu module will be removed/inspected, the remaining modules will be assessed as block/breast removal takes place.

During Block removal phase Furnace Crews **Must Ensure;**

(a) Bud up capabilities of Mudgun, including availability of nozzle extenders.
(b) Scrap Hoppers are full and on landings.
(c) Monitor relative furnace conditions closely;
- Relative Furnace T/C 's
- Visual Furnace Inspection.
- Block + Breast face.

(d) Appropriate Furnace Power application, adjust or remove according to conditions.
- Consider differences regarding ambient temperature during winter vs. summer shutdown, it's logical to assume we would require less power to achieve targets, during summer.

- Ensure "lockout furnace power"- {roof entry} procedure, SMT 261 are applied for build up measurement and sand addition.

Skim Breast Removal:
All furnaces will sustain skim breast removal and Replacement during shutdown, consultation, input & regard between Fce/operator, Operations Superintendent, & Mason Foreman will decide extent of removal.
Consider liquid levels and temperatures at start & during removal. (**See Shutdown Procedure**)

Shutdown Operation

Visual Inspection of Furnace:
Shall occur a minimum of twice per shift, depending On furnace conditions and our current, shift function or Requirement. Consider;

- Power applied (spiking and or arching) could be a result of electrode casing damage or paste requirement, which would be difficult to detect without visual inspection.
- General furnace top condition, impacting on; application of power, sand addition, and draft.

Drag Repair will involve of a Thorough Inspection and Replacement **(if Required)** of all components on all Operating Furnace Drags. The inspection consists of;

1. Removing six to eight drag covers and inspecting the condition of, Chain (**may include tightening**), Liners, Bolts and Idlers + Bearings.
2. Removing inspection doors at "B" to "C+D" drop points and inspecting condition of liners, chain, bolts Idlers + Bearings.
3. Removing covers at cyclone discharge and drop point on "B" drag and inspecting condition of liners, bolts, Idlers + Bearings.
4. Replace any B/O components found and re-seal drag Covers and inspection doors with fibre – flax.

Note: Every attempt should be made to accomplish drag Insp./Repairs as soon as Roaster Beds are dumped and Furnaces drained.
This will allow maximum utilization of manpower just prior to shutdown as the last operating days full crews will be available.

End of Procedure

Modifications to “Shutdown Procedures”

The following is list concerns/items that if adopted would make (in my opinion) shutdown more efficient, safe. It does not refer to or consider the political ramifications (union).

: All Furnace crews working on “off” shift should have and utilize “Radios”

: Furnace crews that **work should carry/hold a “Stencilled furnace bid”**

- The employees that “Parachute in” to furnaces for shutdowns, have little or no experience with ;
  - Glycol system, alarms, resets
  - Block Removal
  - Electrode/Hydraulics
  - Drag Repairs

Even if they have knowledge of the above the fact that most of them don’t have the opportunity to acquaint themselves (practically) as they only work enough shifts during the operational year to allow/qualify them to work the shutdown or Stat Holidays .This practise is unfair to the crews they work with as the Stencilled people tend to carry the load and are relied on more by the foreman. Safety both to personnel and equipment could be compromised under these circumstances.

Consider; Adding to Miscellaneous Items

Tool Crib Operators shutdown Responsibilities”;

Check and replace if required all components of "Rosebud assemblies/chute cooling feed + discharge lines"
: Quick Connects – check/oil or replace.
: Fittings - check and/or replace.
: Hoses – check and/or replace.
: Heat resistant Protective "sleeves"

"Respite Station" – can be any designated location within the smelter were extraordinary event/circumstances are taking place i.e.; "mucking out roaster"

End of Procedure

"FURNACE OPERATION/PROCEDURES DURING SHUTDOWN"

OUR OBJECTIVE IS TO ESTABLISH APPROPRIATE TARGETS/GOALS AND DEVELOP/APPLY

PROCEDURES THAT WILL COUNTER OR OFFSET THE NEGATIVE ASPECTS OF A SHUTDOWN ON THE FURNACES, WHICH WOULD ENHANCE A SAFE/EFFICIENT START UP.

THE FOLLOWING IS A RESULT OF A ACCUMULATION OF INPUT - DATA, BASED ON EXPERIENCE OF CREWS THROUGH NUMEROUS STANDARDIZATION MEETINGS AND SUBSEQUENT SUB-COMMITTEE, TECHNICAL SERVICES AND REQUIREMENTS OF THE PROCESS.

{applied as guidelines,'96 shutdown}

IT IS BY NO MEANS A PRECISE OR COMPLETE SET OF PROCEDURES, AS THERE WILL NO DOUBT BE ADDITIONS OR REFINEMENT OF SOME SEGMENTS AND DELETION OF OTHERS. IT SHOULD BE AN EFFECTIVE START TO A CULMINATION OF PROCEDURES IN ATTAINING OUR ULTIMATE OBJECTIVE.

NOTE; IT SHOULD BE UNDERSTOOD, EACH ASPECT OR SEGMENT OF THE FOLLOWING WILL BE INDIVIDUALLY ANALYZED AND REDEVELOPED IN DUE COURSE AND ACCORDING TO OUR FORMAT FOR STANDARDIZATION OF FURNACE PROCEDURES, ie; TIE-ROD MEASURE/ADJUSTMENT OR BUILD/UP MEASUREMENTS.

SHUT DOWN PREPARATION

SCRAP : ADDITION WILL CEASE (1) ONE WEEK PRIOR TO THE DATE OF **"TAKEDOWN".** SCRAP HOPPERS TO REMAIN FULL OF SCRAP ON LANDINGS UNTIL **"CONVERTER WASH"** PHASE !

SILICA: IN FURNACES AT TIME OF "CONVERTER WASH" PHASE SHOULD BE 38%. THIS WILL OFFSET THE RETURN OF LOW SILICA (25%) CONVERTER SLAG. TO ATTAIN HIGHER SILICA, CONSULTATION/CO-OPERATION WITH PROCESS SUPERVISOR (CONTROL ROOM) WILL BE REQUIRED. INCHING UP SILICA VIA ROASTER SHOULD BE INITIATED AT LEAST ONE WEEK PRIOR

TO SHUTDOWN (SUBJECT TO PROCESS). THE HIGHER THE SILICA, THE FEWER NUMBER OF HOPPERS OF SAND WILL BE NEEDED TO REMAIN WITHIN OUR OPERATIONAL WINDOW **(32% TO 38%)**, AS PRECISE RATIO (FORMULA) INDICATES BELOW.

MINIMUM TARGET SILICA % IN FURNACES = 32 %

TO MAINTAIN THE % SILICA AT THE TARGET:

CURRENT FURNACE SLAG SILICA	LADLES OF SLAG / HOPPER OF SAND
32	1 = 1
34	2 = 1
36	3 = 1
38	4 = 1

IN ORDER TO RAISE FURNACE SLAG SILICA BY 2% ,CALCULATE;

INCHES OF SLAG (#1,#2) = 63 + SLAG LEVEL - MATTE LEVEL

INCHES OF SLAG (#5) = 42 + SLAG LEVEL - MATTE LEVEL

HOPPERS OF SAND REQUIRED = INCHES OF SLAG / 10

EXAMPLE: MATTE LEVEL = 30", SLAG LEVEL = 10"

INCHES OF SLAG = 63 + 10 - 30 = 43

HOPPERS OF SAND = 4

TO MAINTAIN THE FURNACE SLAG SIO2 AT THE CURRENT LEVEL, WITHOUT ROASTER OPERATION. ONE HOPPER OF SAND MUST BE ADDED PER LADLE OF CONVERTER SLAG.

SHUT DOWN PREPARATION

LIQUID LEVELS: IN FURNACE, JUST PRIOR TO "TAKE DOWN" SHOULD BE ALLOWED TO INCREASE TO; (MATTE) MINIMUM 35", (SLAG) WILL DEPEND ON CONDITION OF FURNACE (WALLS), THE ROASTER WILL GO DOWN UPON REACHING DESIRED MATTE LEVEL, AND SKIMMING THE FURNACE SHOULD BEGIN NOTE: DEPENDING ON CALCINE LEVELS, IT MAY BECOME NECESSARY TO TAP ONE OR TWO LADLES IF MATTE LEVELS EXCEEDS OUR GUIDE LINES RE:(HIGH MATTE - SKIM OPERATION). MONITORING BOTH CALCINE LEVEL AND MATTE LEVEL IS ESSENTIAL. ONCE SKIMMING PHASE IS COMPLETE, TAP FURNACE DOWN TO 15" - 20" OF MATTE (TARGET) "DO NOT IF POSSIBLE TAP TO

SLAG". NOTE: EVERY ATTEMPT SHOULD BE MADE TO EQUALLY DISTRIBUTE MATTE TAPS TO CONVERTERS AND SUBSEQUENT RETURN SLAG TO FURNACE, AS THIS SHOULD ATTAIN SOME CONTINUITY OF METALLURGY IN CONVERTERS AND MORE IMPORTANTLY OUR FURNACES (POWER - B/U, ETC). ALSO NOTE, IF FOR A VARIETY OF REASONS, CIRCUMSTANCES (SLAG LEVEL) DICTATE, IT MAY BECOME NECESSARY TO SKIM TO SKIM A PARTICULAR FURNACE AFTER CONVERTER WASH TO REACH OUR DESIRED LEVELS MATTE 15" - 20", SLAG 20" - 30", TOTAL = 45" - 55", "USING OLD MATTE MEASUREMENT METHOD".

*REMOVING SKIM CHUTES TO ACCOMMODATE BREAST REMOVAL SHOULD NOT OCCUR UNTIL FINAL SKIM IS COMPLETE.

SHUT DOWN PREPARATION

TIE-RODS: SHOULD BE "DEAD ON" SPEC, THIS ALLOWS FOR MOVEMENT PLUS OR MINUS WITHIN ACCEPTABLE GUIDELINES, ALSO WILL HELP ACCOUNT FOR SPRING VARIANCE (PRESSURE).

OUR CURRENT TENSION REQUIREMENTS ON TIE-RODS VARY (LARGE UNIT - SMALL UNIT).

LARGE = 3 SPRINGS

LARGE FURNACES	#1 FCE	TOP	= 13 1/2" EXERTS 28 TONS PRESSURE.
		BOTTOM	= 13" EXERTS 52 TONS PRESSURE.
	# 2 FCE	AS PER "SPECS" ON CURRENT SHEET	

SMALL = 2 SPRINGS

SMALL FURNACE #5 TOP = 13 3/4 EXERTS 28 TONS PRESSURE.

BOTTOM:

LONGITUDE = 12 1/2 EXERTS 51 TONS PRESSURE.

LATITUDE = 12 3/4 EXERTS 46 TONS PRESSURE.

TIE-RODS SHEETS FOR # 5 FCE WILL BE REVISED ACCORDING TO; REQUIRED

TONS, "SPEC" MEASUREMENTS FOR EACH INDIVIDUAL TIE ROD AND EQUIPMENT MODIFICATION,**{PRESSURE/ADJUSTMENT INDICATORS}**,WITH RELATIVE INFO

AND CIRCULATED AFTER REBUILD !

ALL RELATED TIE-ROD EQUIPMENT SHOULD BE CHECKED AND REPAIRED OR REPLACED IF NEEDED.

POWER REQUIREMENTS

- 1.5 TO 2.0 M.W. PER PHASE = 4.5 - 6.0 M.W. PER HOUR
- 8 HOURS x 4.5 = 36 M.W. PER SHIFT
- 8 HOURS x 6.0 = 48 M.W. PER SHIFT
- 24 HOURS = 3 x 36 = 108 M.W. PER DAY
- 24 HOURS = 3 x 48 = 144 M.W. PER DAY

THE POWER CONSUMPTION PER SHIFT CAN BE READ ON THE VAX SCREEN `FCERPO'. THE SCREEN INCLUDES AMOUNT OF POWER CONSUMED THIS SHIFT IN M.W. PLUS THE AMOUNT CONSUMED OVER THE LAST 3 SHIFTS. THE AMOUNTS ARE TOTALIZED AND UPDATED AT 3:00 P.M., 11:00 P.M. AND 07:00 A.M.

NOTE: IN EVENT OF A DISRUPTION IN POWER APPLICATION (LOSS OF POWER) A SLIGHT INCREASE IN POWER SETTING SHOULD BE APPLIED WHEN POWER RE-ESTABLISHED, TO MAKE UP REQUIREMENTS. THE INCREASE SHOULD BE CALCULATED ON EXTENDED TIME FRAME (LONG TERM), DO NOT TRY TO REGAIN DESIRED CONDITIONS (FURNACE) IN SHORT PERIOD OF TIME, USE 24 TO 48 HOURS.

POWER SETTING

POWER SETTING: 1.5 TO 2.0 M.W.

4 TO 18 TAPS

DEPENDING ON VARIANCES OF NUMEROUS FACTORS.

HEART TEMPERATURES" THE NORMAL OPERATING TEMPERATURES OF THE FURNACE SHUTDOWN REPORT WILL BE BASED ON DATA ACCUMULATED 4 TO 6 WEEKS PRIOR TO SHUTDOWN. OUR DAILY TEMPERATURE READING SHOULD

BE RECORDED AT THE BEGINNING OF EACH SHIFT THIS WILL ESTABLISH CONTINUITY AND MINIMIZE VARIANCE TRENDS. OUR TARGET FOR HEARTH - ELECTRODES IS TO REMAIN WITHIN 100 DEGREES OF NORMAL OPERATING TEMPERATURES TO ATTAIN AND MAINTAIN THIS GOAL WE MUST CONTROL AND MONITOR; (1). POWER (AS PER RECOMMENDATION), OUR ABILITY TO REMAIN WITHIN THIS CONSTANT RANGE GREATLY DEPENDS ON % SILICA OF THE FURNACE BATH, WHICH SHOULD NOT DROP BELOW 32% (SEE SHUTDOWN PREPARATION). IF THIS HAPPENS POWER BECOMES UNSTABLE, CAUSING FLUCTUATING AND SPIKING WHICH ELIMINATES CONTROL, RESULTING IN EITHER TOO HOT OR TOO COLD CONDITIONS. A TEMPORARY COUNTER MEASURE IS TO ADJUST & TAP SETTINGS DOWNWARD, THIS MAY STABILIZE POWER, SHORT TERM (1 - 4 HOURS), HOWEVER OUR MOST EFFECTIVE AND LASTING MEASURE IS TO ADD SAND AT THE ELECTRODES.

NOTE; SAND ADDITION AT ELECTRODES REQUIRES REMOVAL OF POWER AND COLLARS WHICH RESULT IN SUBSTANTIAL LOSS OF HEAT. ONCE THE DECISION TO ADD SAND IS MADE, A SLIGHT INCREASE IN POWER & TAPS, 1 TO 2 HOURS PRIOR, WILL ENHANCE BOTH APPLICATION AND THE REQUIRED IMMEDIATE **%** SILICA INCREASE (WARM TOP). THIS ALSO APPLIES TO THE PROCEDURE FOR BUILD-UP MEASUREMENT. VISUAL INSPECTION OF FURNACE IS IMPERATIVE AS IT ALLOWS ANOTHER METHOD OF POWER ASSESSMENT REQUIREMENTS. THE OPTIMUM CONDITIONS SHOULD BE, 6" - 12" OF LIQUID AROUND EACH ELECTRODE WITH A REDDISH BROWN TOP, (NOT GLOWING). ON THE OTHER HAND, A BLACK CRUSTY TOP, WITH LITTLE OR NO LIQUID AT THE ELECTRODES IS NOT DESIRABLE. IF THIS COINCIDES WITH DROPPING HEARTH TEMPERATURE, THEN A POWER INCREASE COULD BE APPLIED. HOWEVER CONDITIONS COULD WARRANT A VARIETY OF RESPONSES; (1) A NORMAL OR WARM HEARTH TEMPERATURES PLUS A COLD, BLACK, CRUSTY, TOP (RESULTING FROM SAND ADDITION COLLAR AND POWER REMOVAL), THIS COULD

BE CORRECTED WITH RAISING TAPS (ONLY). **NOTE:** CLOSING FURNACE DAMPER (SLIGHTLY) WILL ALSO ENHANCE THE WARMING PROCEDURE, THIS WILL RAISE THE FREEBOARD AND YOUR WALL & VENT TEMPERATURE WILL ALSO RISE AS A RESULT (MONITOR).

BOTTOM COOLING FAN

MUST BE SHUT-OFF AT SQUARE "D" AND A STATUS TAG APPLIED TO IT. THE FAN SHOULD ONLY BE TURNED ON IF HEARTH ELECTRODE TEMPERATURES RISE ABOVE NORMAL OPERATING READINGS, (THE FAN BEING TURNED ON WOULD ALSO) COINCIDE WITH APOWER REDUCTION ON EITHER, THE WHOLE FURNACE OR AN INDIVIDUAL PHASE. A INCREASE IN HEARTH - ELECTRODE TEMPERATURES MAY ALSO INDICATE BUILD-UP EROSION WHICH SHOULD BE MONITORED AND COMPARED TO NORMAL OPERATING AVERAGES ON EACH UNIT.

LIQUID LEVELS

ALSO IMPACT OUR ABILITY TO "EFFECTIVELY" CONTROL POWER, THE MORE MASS OR VOLUME, THE MORE POWER IS REQUIRED TO ATTAIN AND MAINTAIN DESIRED FURNACE CONDITIONS. EXCESSIVE LIQUID LEVELS ALSO SLOWS OR IMPEDES THE RESPONSIVENESS OF OUR ADJUSTMENTS; POWER / TAPS, COOLING FAN, DAMPER ETC. TOO LITTLE LIQUID COULD CREATE A POTENTIAL HAZARD IF INAPPROPRIATELY EXCESSIVE AMOUNT OF POWER IS APPLIED. THE BUILD-UP BECOMES VULNERABLE TO EROSION, AS LOW MATTE LEVEL REDUCES INSULATION BETWEEN BUILD-UP AND MATTE/SLAG INTERFACE. ALSO AN EXTREME OF THIS SCENARIO (LOW LEVELS) COUPLED WITH LOW ON RAM (ELECTRODE) WILL CAUSE LOSS OF CONTACT (BATH) RESULTING IN LOSS OF POWER.

FOR THESE REASONS WE RECOMMEND 15" - 20" OF MATTE, 20" - 30" OF SLAG, TOTAL OVERALL LIQUID LEVEL 45" (55" MAX).

FURNACE DRAFT

DAMPER: WILL BE SET AT -6, ROUGHLY 50% OF NORMAL OPERATION SET POINT. **NOTE** ADJUSTING FURNACE DAMPER WILL IMPACT UNDER FREEBOARD WALL, VENT, STACK & BREECH TEMPERATURES. IT CAN ALSO BE UTILIZED (INPART) TO CONTROL FURNACE TOP CONDITIONS.

"VENT" NORMAL OPERATING TEMPERATURES WILL BE NOTED ON FURNACE SHUTDOWN REPORT, KEEPING TO LOWER END OF WINDOW, (WITHIN 50 TO 75) SHOULD GIVE US DESIRED CONDITIONS.

STACK AND BREECH TEMPERATURES SHOULD BE CHECKED ON THE SCREEN **`FLUECT`**. THESE TEMPERATURES SHOULD STAY ABOVE 50 - 60 °C.

IF NOT OPEN DAMPERS SLIGHTLY TO SEE IF THE TEMPERATURES IMPROVE.

"MICCELLANEOUS"

ELECTRODE COLLARS MUST REMAIN IN PLACE, THE FREQUENCY OF SAND ADDITION WILL IMPACT GREATLY ON FURNACE TEMPERATURES & CONDITIONS (CRUST) IMMEDIATELY, REPLACEMENT UPON COMPLETION IS ESSENTIAL (HEAT LOSS).

FURNACE DRAGS AND RETURN SLAG CHUTES SHOULD BE BLOCKED OFF, CAPPED AND/OR SEALED WITH INSULATION OR WHATEVER APPLIES OR IS PRACTIABLE.

CONTROLLING FURNACE DRAFT APPROPRIATELY WITH EFFECTIVELY APPLIED ABOVE MEASURES, HELPS MINIMIZE POWER REQUIRED AND MAKES EFFICIENT USE OF THAT REQUIREMENT.

MAGNETITE OR BUILD-UP MEASUREMENTS

ALLOWS US TO EVALUATE CONDITION OF FURNACE BOTTOM, AVERAGES BASED

ON THE LAST 4 TO 6 WEEKS OF NORMAL OPERATION WILL BE NOTED ON

FURNACE SHUT-DOWN REPORT. MEASUREMENTS TO BE TAKEN EVERY "3 DAYS" AS FOLLOWS;

#1 FURNACE - 8 X 4 SHIFT

#2 FURNACE - 4 X 12 SHIFT

#5 FURNACE - 12 X 8 SHIFT

BY REMAINING AT TARGET HEARTH TEMPERATURES (-100 °C OF NORMAL

OPERATION) ADDING TO PRESENT BUILD-UP IS ALL BUT UNAVOIDABLE.

WE CAN HOWEVER MINIMIZE THAT ADDITION OF BUILD-UP OR SUSPEND IT

IN A SEMI-MOLTEN STATE ALLOWING FOR A SAFE AND EFFICIENT START-UP

(TAPPING - SKIMMING - ROASTER). AFTER INITIAL COOLING; (1st. week),

BUILD-UP SHOULD INCREASE (20" - 30") THEN STABILIZE OR LEVEL OFF.

ANY FURTHER INCREASE SHOULD BE COUNTERED WITH **WARMING** METHODS

(POWER).

TAKING SLAG SAMPLES WILL COINCIDE WITH BUILD-UP MEASUREMENTS, AS

ABOVE (3 DAYS). SAMPLES WILL BE BAGGED AND TAGGED, (DATE - FURNACE)

WITH 12 X 8 SHIFT PLACING ALL 3 FURNACES SAMPLE BAGS IN LARGER

SAMPLE BAG, DATED AND LEFT IN G.F. OFFICE. THESE SAMPLES WILL HELP

ESTABLISH AND ENHANCE PROCEDURES FOR FUTURE SHUT-DOWNS, ALSO

ARRANGEMENTS HAVE BEEN MADE TO HAVE SAMPLES ANALYZED, GIVING US OUR CURRENT SILICA % ASSAYS WHICH SHOULD ENHANCE, (AWARENESS, POWER

SPIKES - SILICA) CONTROL POWER.

IF CONDITIONS RE-ESTABLISH THEMSELVES AS PER LAST SHUT-DOWN RE:

(CHROME SILICA SLAG) CREATING AN IMPENETRABLE INTERFACE, WE WILL

CEASE ATTEMPTING TO TAKE BUILD-UP MEASUREMENTS, CONTINUING TO DO SO WOULD BE COUNTER PRODUCTIVE.

TIE-ROD MEASUREMENT AND ADJUSTMENT

ASSUMING ALL TIE-RODS ARE ON "SPEC" AT START OF SHUT-DOWN AND

TEMPERATURES (REFRACTORY) REMAIN ON TARGET, THIS IN TURN WOULD

INDICATE LITTLE OR NO CONTRACTION, RESULTING IN MINIMUM NUMBER OF

TIE-RODS REQUIRING ADJUSTMENT (FREQUENCY).

THE SCHEDULE FOR MEASUREMENT AND ADJUSTMENT IF REQUIRED IS;

#1 FURNACE = 8 X 4 SHIFT

#2 FURNACE = 8 X 12 SHIFT

#5 FURNACE = 12 X 8 SHIFT

NOTE: THE MEASUREMENT/ADJUSTMENT OF TIE RODS ON # 5 FCE IS THE ONLY OPERATIONAL FUNCTION TO BE CARRIED OUT ,FROM JULY 1 TO JULY 15. AS PER DECISION/AGREEMENT PLEASE STAY WITHIN PRE-SHUTDOWN "SPEC RANGE", { CURRENT TIE ROD SHEETS-JUNE/96 } ! A NEW "SHEET" WILL BE DEVELOPED/CIRCULATED BASED ON INDIVIDUAL TIE ROD SPRING ASSEMBLIES CAPABILITIES TO ATTAIN/MAINTAIN THE "POST-SHUTDOWN" PRESSURE REQUIREMENT. THIS WILL INCLUDE A "PRESSURE/ADJUSTMENT INDICATOR" WHICH WILL REPLACE OUR NEED TO PHYSICALLY MEASURE EACH TIE ROD ! **(AS PER # 2 FCE) {SEE ATTACHED DIAGRAM)**

APPROPRIATE FURNACE OPERATION DURING SHUT-DOWN DIRECTLY AFFECTS, TIME AND EFFORT REQUIRED TO REMAIN ON "SPEC", SUBSEQUENTLY GREATLY ENHANCING FURNACE REFECTORY (MINIMUM SHOCK) AND OUR START-UP. OPTIMUM TARGET WOULD BE REQUIRED TO ADJUST NO (0) TIE-RODS.

FURNACE ELECTRODE COOLING

THE GLYCOL ELECTRODE COOLING SYSTEM WILL BE LEFT ON FOR THE SHUT-DOWN. THIS WILL ENABLE US TO HAVE ELECTRODE COOLING AVAILABLE IF WE HAVE PROMBLEMS WITH STABILITY.

THE SYSTEM IS SET UP SO THAT A LEAK GREATER THAN {4 TO 7} GALLONS

WILL BE DETECTED.

THE GLYCOL SYSTEM WILL THEN SHUTDOWN AND THE POWER WILL TRIP ON THE FURNACE. IN ORDER TO DETECT SMALL LEAKS THE GLYCOL ELECTRODE

COOLING SYSTEM SHOULD BE INSPECTED AT LEAST THREE TIMES A SHIFT.

THE GLYCOL SYSTEM WILL TRIP FURNACE POWER (ELECTRODES REMAIN IN

BATH) IF THERE IS NO GLYCOL FLOW OR THE DIFFERENTIAL FLOW IS TOO

HIGH OR THE LEVEL IN THE COOLANT TANK DROPS TOO QUICKLY OR TO LOW.

CHECK THE SYSTEM THOROUGHLY BEFORE RESTARTING TO ENSURE THAT THERE

ARE NO LEAKS. REPAIR ALL LEAKS BEFORE RESTARTING THE GLYCOL

ELECTRODE COOLING SYSTEM AND POWERING UP THE FURNACE.

IF THERE IS A COMMUNICATION PROBLEM BETWEEN THE GLYCOL ELECTRODE

COOLING SYSTEM (PLC) AND THE **SAFE** (COMPUTER) THE SYSTEM WILL

SHUTDOWN AND POWER DOWN THE FURNACE (REMOVE 3 ELECTRODES FROM THE

BATH). THE MOST LIKELY CAUSE WILL BE A POWER FAILURE TO THE SYSTEM. HAVE THIS CHECKED BY AN ELECTRICIAN / OR INSTRUMENTATION MAKE SURE

COMMUNICATIONS ARE RE-ESTABLISHED BEFORE TRYING TO RESTART THE

COOLING SYSTEM AND POWER THE FURNACE.

MISCELLANEOUS

FURNACE BLOCK REMOVAL: OUR TARGET IS TO REMOVE AND REPLACE FIVE

TAP BLOCKS NORTH AND SOUTH, ON ; # 1 FURNACE AND FOUR TAP BLOCKS

#"s 2 AND 5 FURNACES. WHEN CARRY OUT REMOVAL OF BLOCKS

CONSIDERATION SHOULD BE GIVEN TO;

(A) MAINTAINING BUD UP CAPABILITIES OF MUDGUN, INCLUDING AVAILABILITY OF NOZZLE EXTENDERS.

(B) WATER ON COOLING MODULES ON #1 FURNACE, UNTIL BLOCKS

OUT.

(C) MONITOR RELATIVE FURNACE CONDITIONS CLOSELY;

: RELATIVE T/C's

: VISUAL FURNACE INSPECTION

:BLOCK/BREAST FACE

(D) FCE/POWER ADJUST OR REMOVE ACCORDING TO **FCE/BLK** CONDITIONS. **SPECIAL CONSIDERATION TO 3rd PHASE ON # 1 FCE THIS YEAR !!{EXTENDED BRST/BLK REMOVAL}**

-CONSIDER DIFFERENCES REGARDING AMBIENT TEMPERATURE DURING WINTER VS SUMMER SHUTDOWN, ITS LOGICAL TO ASSUME WE WOULD REQUIRE LESS POWER TO ACHIEVE TARGETS, DURING SUMMER.

-PRESENT "ROOF ENTRY PROCEDURE" APPLIES FOR BUILD UP MEASUREMENT AND SAND ADDITION.

SKIM BREAST REMOVAL: ALL Ni FURNACES WILL SUSTAIN SKIM BREAST REMOVAL AND REPLACEMENT DURING SHUTDOWN, CONSULTATION, INPUT & REGARD BETWEEN FURNACE OPERATOR, OPERATIONS G.F., & MASON FOREMAN WILL DECIDE EXTENT OF REMOVAL. **CONSIDER:** LIQUID LEVELS AND TEMPERATURES AT START & DURING REMOVAL. (SEE SHUTDOWN PROC.)

VISUAL INSPECTION OF FURNACE: WE RECOMMEND A MINIMUM OF TWICE PER

SHIFT, DEPENDING ON FURNACE CONDITIONS AND YOUR FUNCTION **(BLK-R/R)**

CONSIDER: POWER APPLIED (SPIKING AND OR ARCHING) COULD BE A RESULT

OF ELECTRODE CASING DAMAGE OR PASTE REQUIREMENT WHICH WOULD BE

DIFFICULT TO DETECT WITHOUT VISUAL INSPECTION.

: GENERAL FURNACE TOP CONDITION, IMPACTING ON; APPLICATION OF

POWER, SAND ADDITION, DRAFT.

Only documents on the Smelter Intranet Site are controlled. Printed/posted copies are not controlled documents – reference online documents to ensure continued validity. Date printed 14/01/2013 12:36 PM.							
TITLE	Furnace Shutdown SMT's						
SMT 632		REV. #	0	RISK RANK	1	LAST REVIEW	**02-22-2011**

Purpose:

The following is a list of Smelter SMT's to be used as a guide line for Fce Employees' working the shutdown

References:

- See SMT's – 259,261,270,271,273,281,282,284,288,302,304,308,311,313,328, 338,630,631
- See Relative Drawings/Diagrams (smt-271)
- Previous Shutdown "History"
- Tech/services Data.
- GEN 001 Smelter PPE and Clothing Requirements

Precautions:

- Losing Control of Furnace Refractory Expansion/Contraction via Improper Shutdown/Start-up

Tools and Equipment:

- All Relative Furnace Equipment

Prerequisites:

- Authorized Furnace Personnel only

Procedure:

SMT – 271 is to be used as the initial guide-line for the proper shutdown and start up of the Nickel Fce's going into and coming out of the Shutdown process. The other listed SMT's are to be used as additional tools to insure a safe and productive shutdown is maintained. All SMT's are found on the Smelter website, and employees are encouraged to familiarize themselves with the appropriate procedures to ensure all aspects are covered safely / properly during the Shutdown and Startup phases.

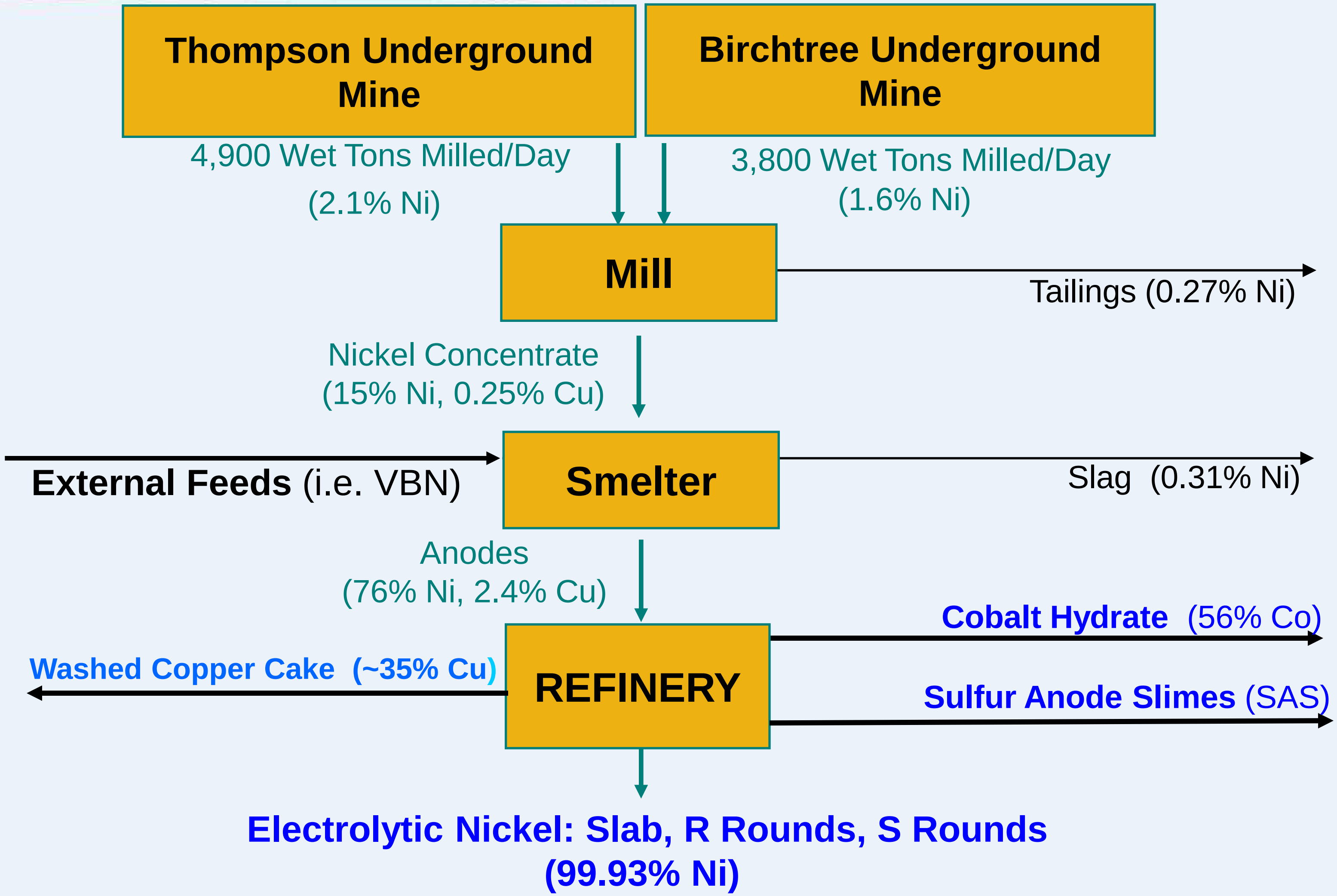
End of Procedure

REASON FOR REVISION IF APPLICABLE			REFERENCED LP SHEETS		
INCIDENT	SCHEDULED				
PROCESS CHANGE	EQUIPMENT CHANGE				
OTHER: New Training Organization					
WRITTEN BY	Tony Ricketts			DATE	Feb. 22/2011
REVISED BY				DATE	
DEPARTMENT SIGNATURES					
REVIEWED BY		TITLE		DATE	
Florence Colbourne		**Supervisor**		Feb. 23/2011	
APPROVAL SIGNATURES					
APPROVED BY		TITLE		DATE	

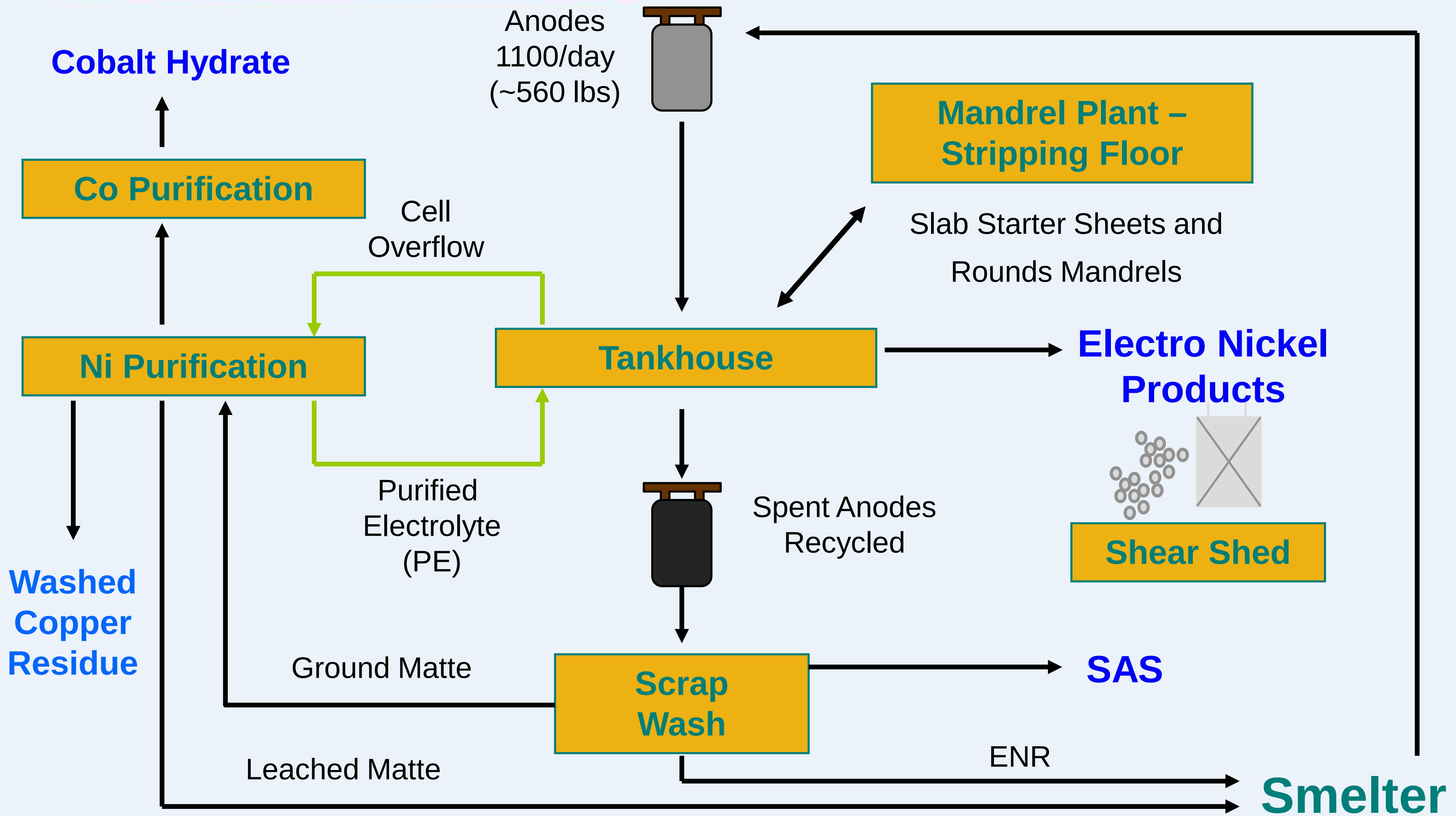
APPENDIX H

SIMPLIFIED REFINERY PROCESS FLOW DIAGRAM

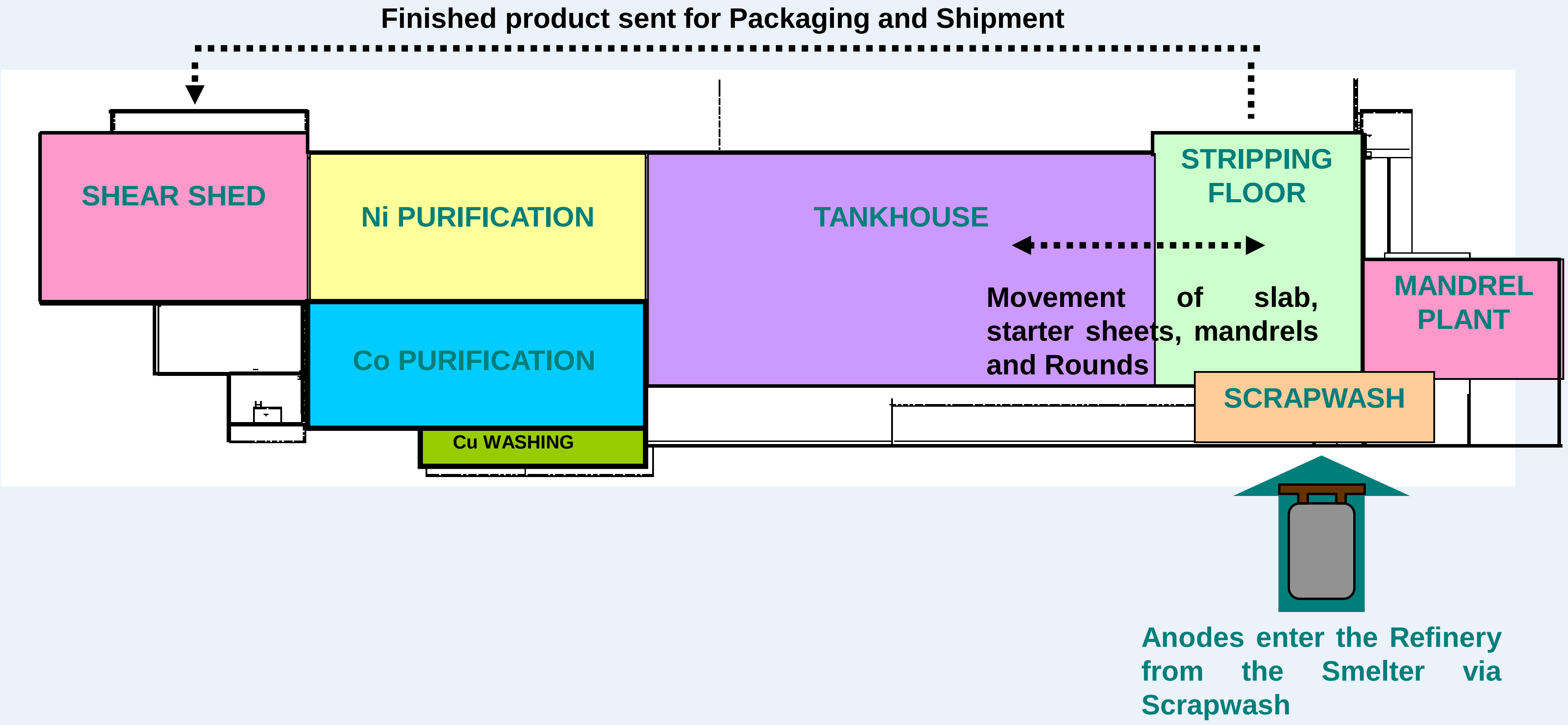
Overview of the Manitoba Operations



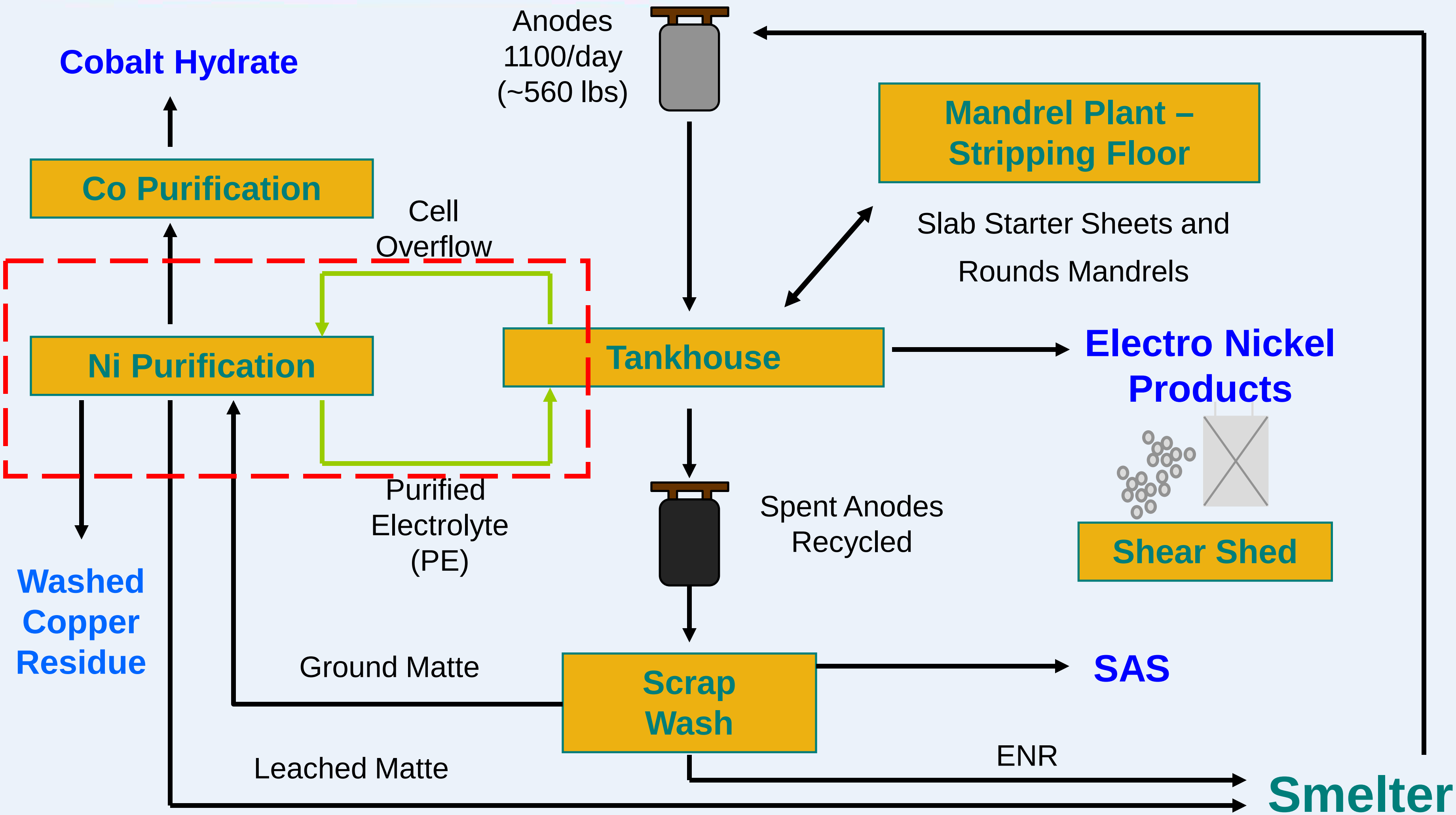
Refinery Overview (Simplified)



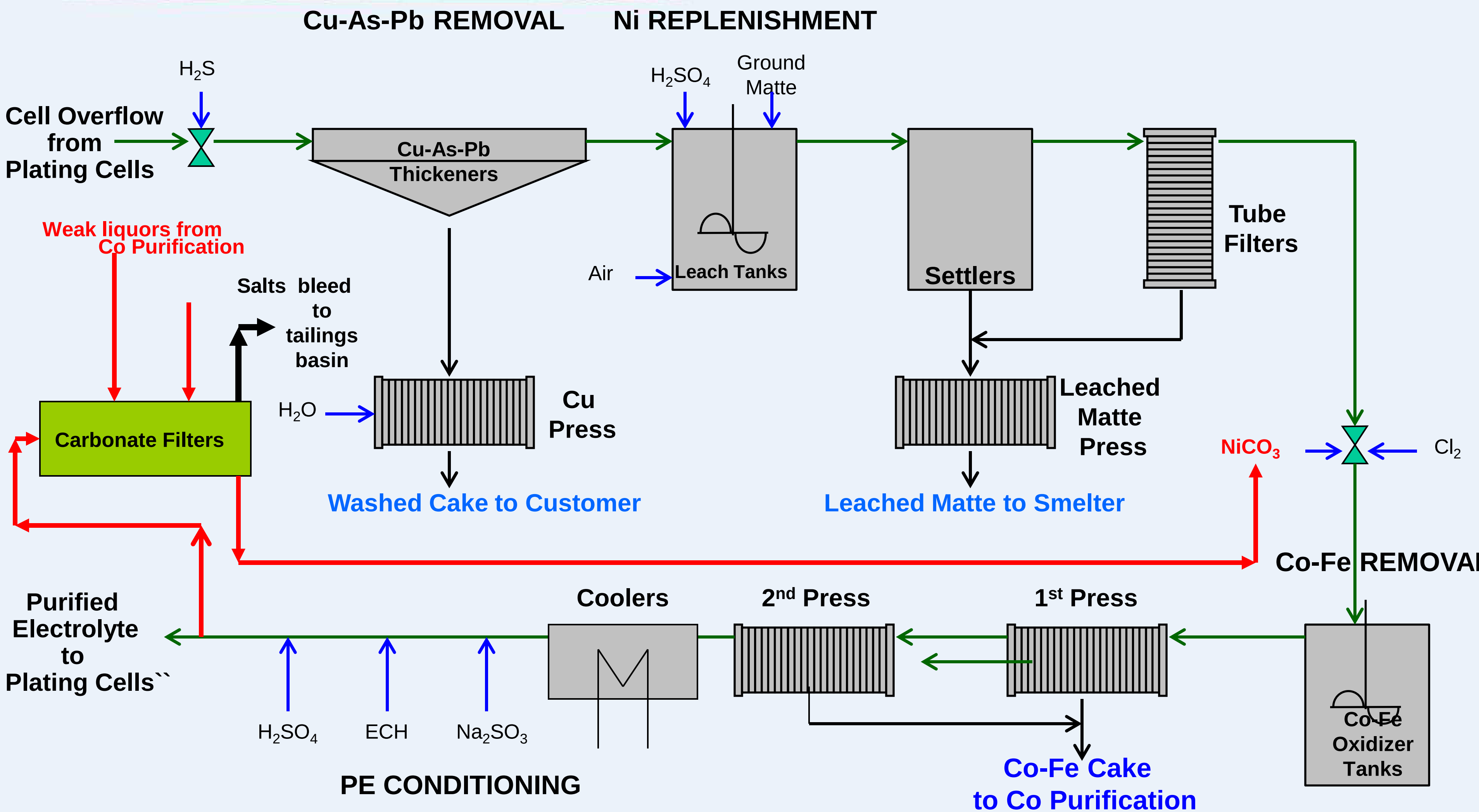
SIMPLIFIED REFINERY FOOTPRINT TODAY



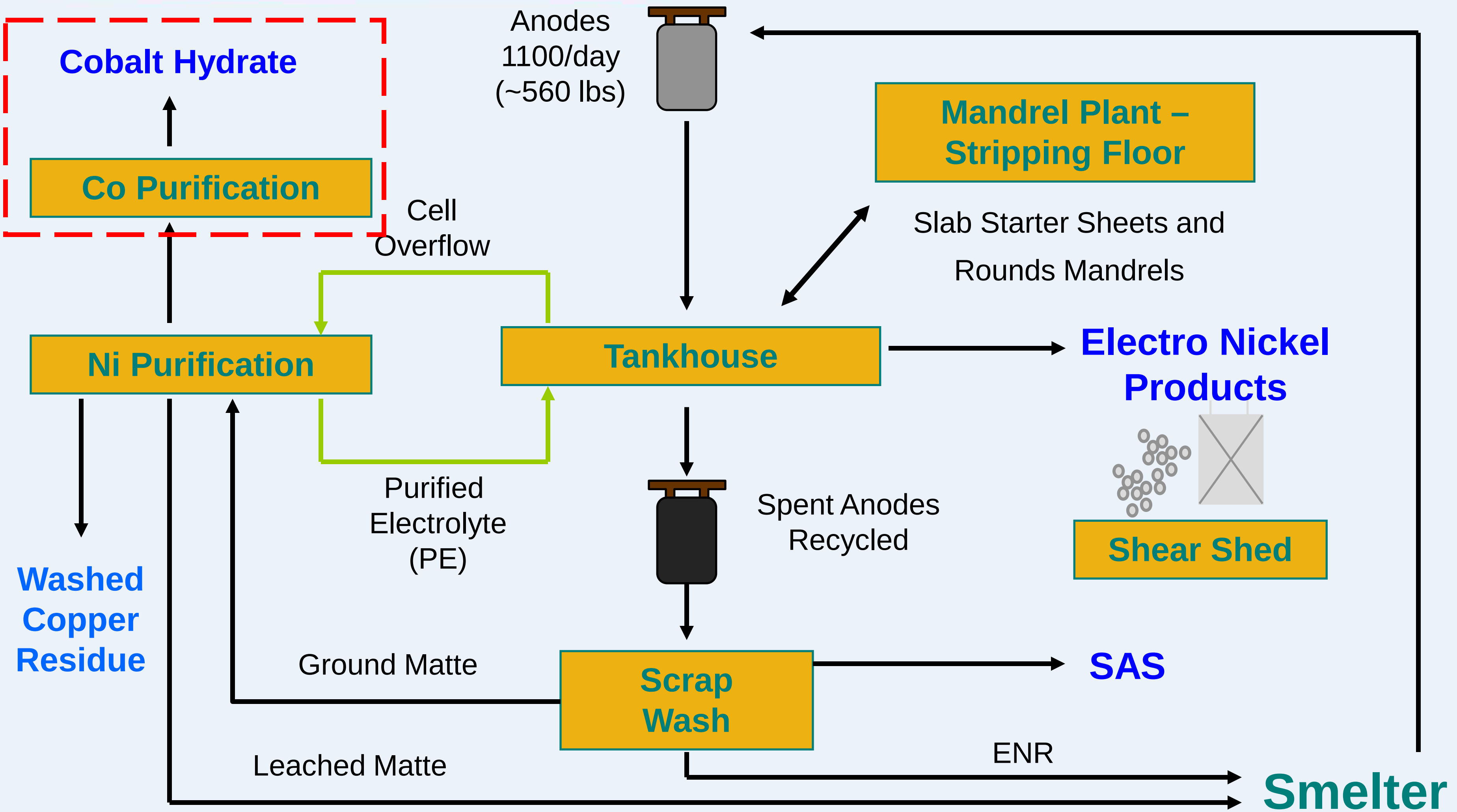
Refinery Overview (Simplified)



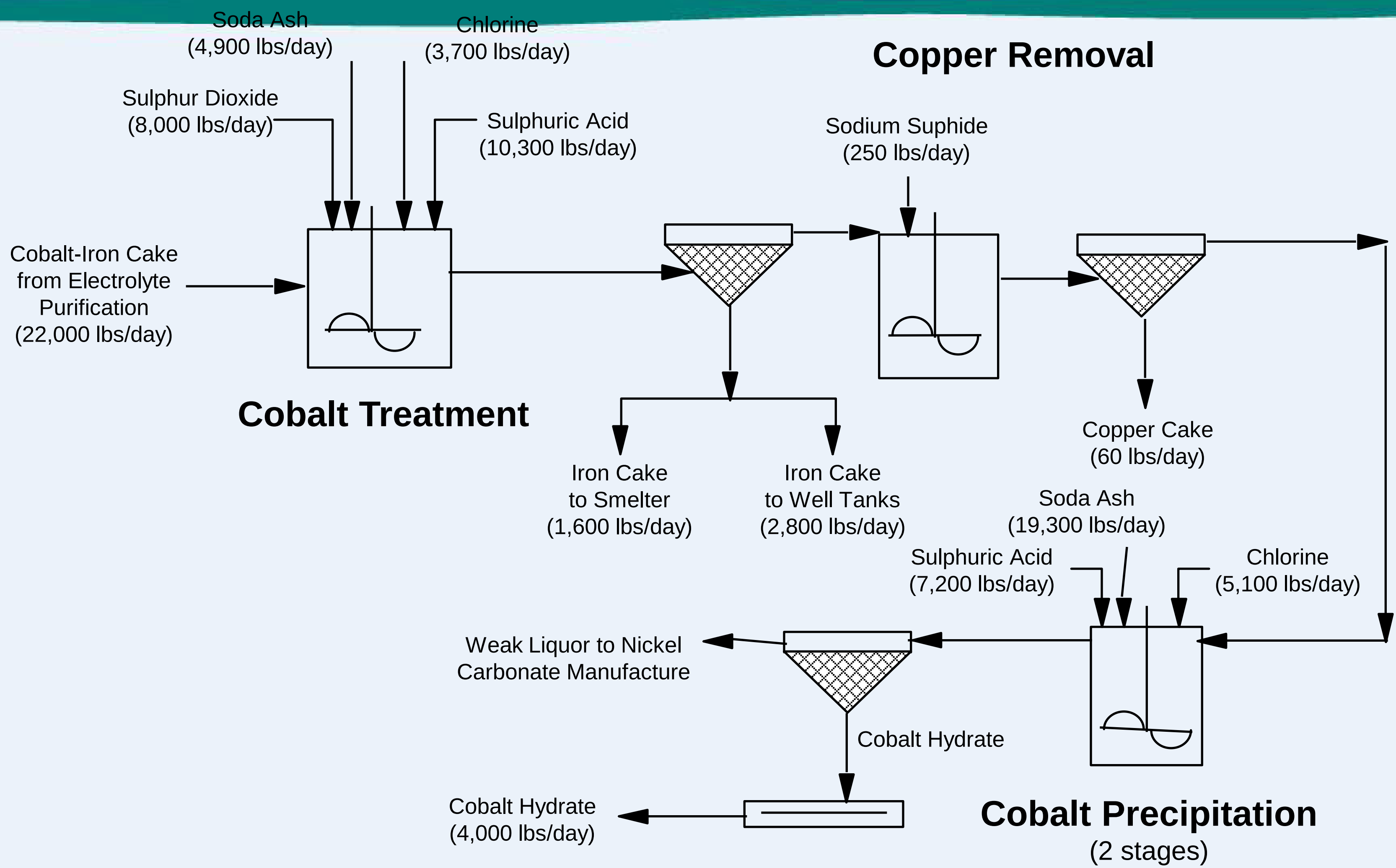
Ni Purification (simplified)



Refinery Overview (Simplified)



Co Purification (simplified)



APPENDIX I

VALE'S DETAILED SUMMER SHUT DOWN PROCEDURES

REFINERY

SHUTDOWN/

START UP

MANUAL

2011

REFINERY SHUTDOWN:

GENERAL SHUTDOWN:

Initial Preparation

- **All Supervisors:**
  - Stock up on supplies (gloves, respirator cartridges, flashlights, etc.).

- **Tankhouse:**
  - Count jumper cables & clamps and repair as required.
  - Ensure that there is adequate cut out bars to accommodate 20 Mother cells. Order enough poly to cover all nickel.
  - Print off anode and production ages before turning power off on database. Ensure extra copies are made for start up.
  - Make sure loco diesel tank is full.
  - Ensure adequate supply of cleaned/dipped masking stick for start up (13 long/7 short bins)
  - Ensure new masking sticks are ordered in advance.
  - Order plating cell materials (i.e.: nipples, circulation hoses, PTM tools, steel wool, weir material etc.)
  - Ensure that there are adequate anode bags available for the start up
  - Ensure there is enough tank top furniture for start-up.
  - **Prior to the Shutdown, ensure all production racks are repaired and ready for use at the final pull**

- **Mandrel Plant:**
  - Acid truck is empty.
  - Acid Tank is empty.
  - Prior to Shut down, arrangements are to be made through the Warehouse to cease ink orders until the Print room start up date of August 15th. There should be ink available to use on August 15th, already on site. Batches should resume arriving on the week of August 15th.
  - H2SO4 tanks (2) are dropped and changed out the week prior to shut down (arrangements to be made with the Mill.)
  - All mandrel storage racks are to be brought into the building for storing stripped mandrels. Additional storage areas to be identified and prepped as required (Order 2x4s to stack mandrels safely)
  - Order reagents/ Supplies:
    - Copper sulphate
    - Boric acid
    - Salt
    - HCL
    - Grit for Pang born bar Cleaner
    - Grit for Printroom blaster

- Ensure adequate print screens for R-Rounds and S-Rounds are available
- Ink arrives for printing Operation to commence the week of August 15, 2011
- Printroom supplies are stocked prior to shut down date
- Ensure adequate amount of “poly clean” to clean printer is on hand

- **<u>Shear Shed:</u>**
  - Orders placed to lower R & S Rounds Levels.
  - Orders placed to ship out slab.
  - Orders placed to reduce Cobalt Hydrate inventory.
  - Make sure there is adequate Propane supply for fork lift operations.
  - Ensure there is adequate Nitric acid available at Start up to fill Nitric tank

- **<u>Purification:</u>**
  - Order reagents:
    - Nitrogen
    - Sulphite (can’t be more than 3 months old)
    - Argon
    - Borax
    - HCL
    - Sodium Sulphide
  - Ensure there are spare electrodes (ORP & pH) beside the Control Room (In-Bin).
  - Test heat exchangers
    - Check for leaks
    - Check automatic valves
  - Test carbonate to leach train line to make sure it is not plugged.
  - Make sure there is an adequate supply of breathing air.

- **<u>RTS:</u>**
  - Order sample bottles.
  - Notify Operations of Shutdown sewer sampling schedule.

- **<u>MAINTENANCE:</u>**

Areas require cleaning

1. West side of the refinery south of Dr 7 we need the boxes, racks and buggies moved so several semi trailers can be parked there. The new scrapwash drum needs to be moved to the south yard.
2. West side of the refinery south of Dr 11 all the matte boxes and materials need to be removed as we will be storing materials and we will also be hoisting material up to the top floor of purification.
3. Shear shed Cold storage we will require a lay-down area for all the Bertsch shear parts.
4. Outside Dr 17 we will be placing a 1300 CFM compressor and connecting it to

the main compressed airline.

5. South end of tankhouse basement, we will be working on the well tanks as well as the tankhouse launders, feed lines and timbers.
6. Tankhouse basement needs to be cleaned in it's entirety of all debris and overhead salts.

- **<u>Key event work orders</u>**

  - Impact crusher replacement work order 902053 to start July 21st. This needs to be completed by July 24th so the ENR bay work can start.

  - Heat exchanger piping change-over work order 1019992 to start Aug 3th.

- **<u>Utilities Shutdowns</u>**

There will be electrical outages through-out the entire shutdown as utilities services all there main breakers. A formal schedule is to be drafted and distributed to all buildings.

Process water	July 30th to Aug 2nd.
Vacuum	July 25th to Aug 8th.
Compressed Air	July 25th to July 26th.July 31th to aug 2nd
Steam	July 31th to July 29th.

<u>2011 Pre-Shutdown Work</u>:

During the 2011 scheduled shutdown, we will be replacing 4 sets of plating cells, and 4 haunches.

The following cells are scheduled to be removed the first week of Shutdown;

0-west	Tank 117-118	Haunch replacement
0-west	Tank 125-126	Haunch replacement
1-East	Tank 11-12	Haunch replacement
1-West	Tank 87-88	Haunch replacement
4-West	Tank 113-114	Tank Replacement
4- West	Tank 115-116	Tank Replacement
4- West	Tank 117-118	Tank Replacement
4- West	Tank 119-120	Tank Replacement

In order to ensure that the tank and haunch replacements are completed within the allotted time frame, these tanks will need to be cut, emptied and dismantled. As we get closer to the Shutdown, these cells identified for removal, are to be cut based on the anode age (spend out the anodes) and remove all materials. Tank Repair will require 2 days on each set to prep them for removal.
This must be scheduled accordingly to allow the entire Shutdown for removal/replacements.

The post tension cable system on #3 Cu Thickener will be replaced with a carbon fibre banding system. Starting July 11th, minimize washing and ensure PE storage tanks are at empty. #3 Cu Thickener must be taken offline by July 18th. We will operate with three contactors and two thickeners for the remainder of the week. #3 Cu Thickener will be drained down to the rake level so that stress on the thickener walls is reduced to minimum. Floor area under #3 Cu Thickener must be cleaned for scaffolding installation.

The Carbonate Storage tops must be cleaned prior to July 25th.

No. 19 and No. 25 Acid Tanks will be replaced during the 2011 Shut Down. Prior to these replacements, operations are required to empty it and rinse it with water.

All plates and bladders have to be removed from the Cobalt Hydrate press prior to July 25th.

Tankhouse Shutdown:

1. **<u>In order to maximize bridge time, Tankhouse crews start times will be altered on July 23rd and July 24th. Day shift will begin at 6:30am to 6:00pm on the above dates and afternoon shift will begin as per normal.</u>**
2. Organize stripping floor. Obtain all available racks including yellow and red mandrel racks (in South yard). Need 10 empty anode racks for production bars. All racks need to be cleaned before being used.
3. The night before the power goes off drop all Bonding and HCL Tanks. Contact Control Room before dropping tanks.
4. All Production rinse tanks are to be emptied, cleaned and refilled on the afternoon shift of July 21st.
5. Ensure all unit ages in the database are printed for all units as well as pre-shutdown ECH addition rates.
6. The power will shut off July 23rd at 6:00 am. Notify Utilities prior to power shutdown.
7. Knife switches on **<u>all rectifiers</u>** are to be opened to create an open circuit. This is especially important to prevent S Rounds from turning black.
8. Pull cathodes in the order of heavy to light. This will ensure we have enough racks. 8, 9, & 10 day old material will be processed as final product.
9. All nickel in racks needs to be tagged properly (When a rack has more than one day of product, the different products should be separated with tags) and arranged on the stripping floor for expedited bonding needs at start up.
10. All nickel needs to be hot water dipped.
11. Pull hoses back so they are just sitting in the boxes.
12. On Thursday, July 21st, all Mother cell tanks will be cut at 1:00pm. All cathodes to be stripped once they are pulled. Once stripped and re-masked all racks are to be neatly placed on the Stripping floors and covered with poly.
13. For R and S rounds, follow pull ahead schedule to ensure we only produce 3, 4, and 5 day nickel. This is to begin on **Saturday**, **July 18th, reference schedule.**

14. Install slats on all boxes, (Obtain boxes from the South yard to the Box Floor on July 22nd).

15. Once all nickel is removed, Tankhouse Supervision is to inform Control Room of completion.

SCHEDULE FOR PULLING AHEAD FOR SHUT DOWN
ALL PLANS SET UP AS BEING AT FULL POWER FOR THE LAST 2 WEEKS OF JULY.

- **Rounds Units**

All rounds units will begin pulling ahead on July 18th. Pulls will be as follows;

July 18th	24 tanks
July 19th	26 tanks
July 20th	26 tanks (6 sheets out of each cell)

There will not be any more production pulls after July 20tht, until power is shut off on the morning of July 22nd. This will ensure all plated rounds material is of marketable size. On July 21st, the Rounds units will pull additional anodes to get to a 16 day old cycle. No anodes will be pulled on July 22nd.

1East will pull as follows

Starting

July 17	10 tanks
July 18	16 tanks
July 19	16 tanks
July 20	16 tanks

Slab will not pull ahead on production but will pull ahead on anodes to get to a 16 day anode

Purification Shutdown:

Note: If we are shutting off the steam to the soda ash tanks, close the manual steam valves so that soda ash doesn’t back up into steam lines

1. Reduce solids level in sumps, matte settlers, tube filters, and thickeners to minimum level.

2. Set up electrolyte heaters (mother cell and alpha laval) and prepare pumping loop.

3. Schedule Carbonate storage tanks to be empty when flow is shut off.

4. Schedule Mill soda ash tank empty at shutdown. Coordinate with Mill operations. They expect last batch on Thursday, July 22 **(verify with Mill)** night shift (approx. 2:00 am). Fill Mill Soda Ash Tank once more with hot water and make last transfer. Pump Iron to Mill Thursday, July 22 **(verify with Mill)**, leave enough Iron for the process.

5. Copper Building will operate until tanks are empty.

6. Nickel concentration to be over 85 grams/litre and Borax concentration to be over 8.5 grams/litre.

7. Arrange to have bulk Nitrogen tanks left in proper state for shutdown. (Reagent Supervisor)

8. Leave plastic acid tanks at approximately 20% full other than No. 19 and No. 25 tank which are to be replaced. Tank connection valves are to be closed, locked, and discharge lines drained.

9. Head Tanks are to be left full for shutdown.

10. Cobalt settler tanks are to be left empty to provide room for the pumping of floods during the shutdown.

11. Leave instrument air dryers operating. (Electrical/Instrumentation Supervisor)

12. Do not shut liquor flow off until all Nickel is out of the tanks.

13. Turn off all pump gland water once pump is not being used (pinch off with hose clamps, tie wraps).

14. Close all suction and discharge valves on pumps that are shutdown.

15. Process sewer will be monitored on I.A. during shutdown. Our shift people will pick up samples and deliver them to the Main Lab**. Sewer pH's to be logged twice per shift in the Control Room log.** Colin Greenidge will be responsible for the training on where and how to pick up the samples.

16. All process tanks are to be kept filled whenever possible (No truck loads of liquor are to be removed from the building unless all process tanks are full). ICP check required before filling tanks.

17. Clean first pass presses per normal, until impurities are removed to shutdown specifications. *No presses are to be left completely full. All presses are to have some cake in them to serve as a filter medium. This also applies to second pass presses.*

18. Carbonate addition has to be in place for leach trains.

19. One of each: Second press and S-Ni press to be off and cleaned and flushed for start up. Emulsifiers completely washed out. Two each: First pass presses clean and off for start up.

20. All electrodes to be stored in distilled H_2O and checked weekly (water evaporation), and also spare electrodes near Control Room.

    a. Ensure that all electrodes in the following table are checked.

Check when complete	ELECTRODE	Check When complete	ELECTRODE
	Slab pH		#1 contactor ORP
	R-rounds pH		#2 contactor ORP
	1^{st} pass pH		#3 contactor ORP
	North Leach Train 1^{st} tank pH		pH adjustment tank pH's (2)
	North Leach Train 2nd tank pH		Secondary NiCO3 press pump tank pH's (2)
	North Leach Train ORP		Carbonate recovery tank pH's (2)

	South Leach Train 1st tank pH		#1 Treatment tank ph
	South Leach Train 2nd tank pH		#1 Treatment tank ORP
	South Leach Train ORP		#2 Treatment tank ph
	Matte Filter Feed tank pH		#2 Treatment tank ORP
	Sni equalizer pH		DeCu tank ORP
	Sni equalizer ORP		1st precip feed tank pH
	Sni head tank ORP		#1 1st precip tank pH's (2)
	Mother cell pH		#2 1st precip tank pH's (2)
	Ni Chlorine scrubber A&B pH's (2)		#3 1st precip tank pH's (2)
	Cobalt Chlorine scrubber A&B PH's (2)		#1 Hypo mixer A&B pH's (2)
	#1 cobalt oxidizer pH		#2 Hypo mixer A&B pH's (2)
	#2 cobalt oxidizer pH		
	#3 cobalt oxidizer pH		
	#4 cobalt oxidizer pH		

1. Shut down the Matte Filter Feed Tank vent air assist.

2. Shut off all unnecessary water flow (demisters, contractor construction area, Tankhouse hoses, etc.).

3. The I/A and UCM's will be left "powered up":
   - o All loops including the following will be left on: Cl_2, H_2S, N_2 pressures, H_2S storage, process sewer pH and acid tank levels.
   - o Instrumentation to remove H_2S line pressure interlock to contactor block valves on.
   - o When line purging is completed, Process Supervisors are to reactivate the interlock.

4. ICP unit will operate until all flow is shut down in Purification and will be available throughout shut down.

5. Acid line to matte filter feed tank to be drained and valve locked.

6. Acid Distribution Pumps are to be isolated and status tagged when no more acid transfers are required.

H_2S, SO_2, and Chlorine Buildings:

1. Shut off H_2S at tanks, lock valves, and purge all lines, once gas goes off. H_2S system to be isolated from header lines and diverted to the stack. Both header lines to be pressurized with nitrogen. (Reagent Supervisor)

2. Leave nitrogen pressure at 300 P.S.I. on lines to H_2S building (bulk nitrogen). (Reagent Supervisor)

3. Close all H_2S, SO_2, and Chlorine Building doors. (Foreman)

4. The flare stack igniting system is to be checked. (Reagent Foreman)

5. Bulk nitrogen storage tanks may have to be blown down periodically. If bulk storage tank at H_2S building rises to 375 P.S.I., blow down to 300 P.S.I.

    a. If bulk storage tank at Cl_2 building rises to 250 P.S.I., blow down to 200 P.S.I.

6. Chlorine is to be purged all the way from the car right through to the oxidizers and cobalt purification. Disconnect Chlorine cars. Pressurize with nitrogen from Chlorine building to isolation valves entering vapourizer room.

7. SO_2 is to be purged all the way from the car right through to treatment tanks. Disconnect SO_2 cars. Pressurize with nitrogen from SO_2 building to Cobalt Purification.

<u>MATTE LEACH TRAIN (North Side): Thursday July 21st</u>

- 7:00 a.m.
    - Cut matte in half from Scrapwash

- Noon
    - Revert hose for the North leach train to be moved to South leach train.
    - Adjust ph with carbonate (2.8-3.0). **<u>This will ensure copper cementation.</u>**

- 3:00 p.m.
    - Store excess liquor in storage tanks

- 7:00 p.m.
    - Solids level in North train should be less than 1%. (if not flush longer).
    - Take north Leach train off line, by-pass flow.
    - Drop (via hose to sumps) approximately 3-4 feet of level from #41 and #43 leach tanks with air and agitators on. After 3-4 feet of level are dropped, shut off agitators and drop rest of tank.
    - Pump #44 Pre-settler empty (use air if solids are hung up) to south leach train.
    - Clean out overflow boxes on #41 and #43 leach tanks, also clean out #44 Pre-settler, including overflow ring and inspect the well. The well will have to be removed to be cleaned.

- Remove air spargers, clean, and replace. **<u>Check air lines</u> <u>to spargers and ensure they are not partially plugged.</u>** Tanks have to be clean enough so spargers will not plug up again. Wash leach tanks out with liquor if required.
- Fill North leach train with thickener overflow and use as a launder.

Note: Log any spargers with oversized holes and any agitator problems. Do not put on line if holes are too big – blank if required **<u>and store at the welders booth at Dr.29.</u>**

Do not operate leach train agitators when the tank is below ½ full. This can damage the agitator.

<u>Matte Leach Train (South Side): Saturday, July 23rd</u>

Note: Friday July 22nd, evening shift: Run matte sparingly between 2-5% solids.

- Saturday July 23rd, Start at 7:00 am

  - Adjust leach train pH with carbonate to 3.0, no matte, agitators on.

  - Leave the **<u>south</u>** leach train on line (matte off) while dropping #34 pre-settler to #3 pachuca, until solids are flushed to less than one percent.

  - Solids level in South leach train should be less than 1% (if not flush longer).

  - Drain No. 25 Acid Tank to leach train and Matte Filter Feed Tank, flush tank with water and drain discharge lines.

  - Drop approximately 3-4 feet of level from #32 and #33 leach tanks with air and agitators on. After 3-4 feet of level is dropped, shut off agitators and drop rest of tank.

  - Clean out overflow boxes on #32 and #33 leach tanks, also clean out #34 Pre-settler, including overflow ring and inspect the well.

  - Clean all electrodes and screens in leach tanks (both North and South sides). Store electrodes in distilled water.

  - Remove air spargers, clean, and replace. **<u>Check air lines</u> <u>to spargers and ensure they are not partially plugged.</u>** Tanks have to be cleaned enough so spargers will not plug up again. Wash leach tanks out with liquor if required.

- Refill the leach train with thickener overflow.

- Shut matte addition off in Scrapwash and flush both matte slurry lines.
- Clean out matte slurry mix tank.

  - **NOTE:**
    - Log any agitator problems.

    - Log any spargers with oversized holes and any agitator problems. Do not put on line if holes are too big – blank if required **<u>and store at the welders booth at Dr.29.</u>**

    - **Do not operate leach train agitator when tank is below ½ full. This can damage the agitator.**

- Leave flow on to the plating cells until the pull is complete. As pulls are complete each individual corresponding equalizer can be shut off.

- When shutting off equalizers close manual valves from head tank.

- Gas alarms and ICP numbers will have to be monitored closely until all flow is shut off.

- When flow is off, leave all process tanks full so that flow can be easily established at start up. This is to include the Head Tanks. Exception to this rule is the Settler tanks. These are to be left empty to allow room for the pumping of floods during shutdown if required.

<u>PURIFICATION INSTRUCTIONS FOR POWER OFF:</u>

- Shut off heat exchangers on Regular and Sulphur-Nickel.

- Lower equalizer levels to 60%.

- Adjust Slab and R Rounds P.E pH to 2.5.

- Shut off SO3 to Sulphur Nickel 30 minutes prior to power off. This must be coordinated with the electrician to avoid error. This is done to prevent S-Rounds from turning black.

- Empty Sodium Sulphite tanks and wash out pumps (store in test bench) to prevent salt build up. Replace lines for startup.
- Shut off ECH to Slab, S and R rounds nickel.
- Measure cell overflow on ICP once power goes off

COPPER ARSENIC REMOVAL:

1. Following the “power off” continue normal copper arsenic removal. (Note that with the power off in the Tankhouse the return flow has increasingly less copper and arsenic to remove). Measure contactor feed electrolyte temperature hourly to monitor drop. (Sample point at well tanks and thermo couple). Can add H_2S to anolyte until temperature gets to 112 °F. Below this temperature gassing will occur. Make sure gas is purged before flow is turned off.

2. Shut down seeding to thickeners once power is off.

3. Make sure we measure thickeners and all are good levels before shutting down copper filters and the flow is shut off.

4. Continue to remove copper until the anolyte feeding the contactors has a concentration in .0015 range or anoltye Temperature reaches 112°F. All Leach Train and all sump liquor is to be processed. When this target has been met, shut off H_2S gas at the H_2S building and suck the H_2S lines empty. Fill header lines with N_2 to approx. 200 psi. When the flow is completely off, put all the electrodes in distilled H_2O.

5. Leave Thickener rakes to remain turning for duration of shutdown.

6. After two hours check vent gas content for H_2S at the west wall and, if clear, shut down H_2S vent fans.

COBALT REMOVAL:

1. This area becomes a mandatory respirator area once power is off.

2. Following the "Power Off" in the Tankhouse continue to remove Cobalt at the Oxidizers until the temperature in the tube filter filtrate drops below 125 °F or .050-.060 g/l Cobalt, what ever comes first. Put Cl_2 in manual control when Cobalt at the Tube Filters reached 0.10 g/l. Run heating circuit to get to .050-.060 g/l cobalt if required. Notify Utilities before starting the heating circuit. **NOTE:** Do not shut off liquor flow until all nickel is out of the tanks. When all flow is shut down be sure that the electrodes are stored in distilled H_2O. Purge all the CL_2 out of the lines from the Chlorine Building to the oxidizers with Nitrogen. Close valve on car and disconnect all cars. Leave these lines filled with Nitrogen to 70 P.S.I up to the Chlorine Vaporizers.

3. Iron to be shut approximately 5 hours before CL2 gas is shut off.

4. Shut all Gland water,(if valve is leaking crimp hose) pump suction and discharge valves including: Tube Filter filtrate pumps. Shut off Tube Filter vacuum, back wash valves and air supply to these valves. Shut off water sprays to vacuum scrubber.

5. Keep overhead tanks full, shut manual discharge valves.

6. Clean up all oil spills to reduce fire hazard at Racine unit.

7. Shut off and Lock Acid Tank supply for P.E. Drain lines to slab, R rounds, S rounds and Mother cell. Place P.E. pH electrodes in distilled H_2O.

8. Shut off all manual valves to equalizers.

9. Shutdown chlorine scrubber once chlorine gas is off, lines have been purged and #19 Acid Tank has been drained.

NICKEL CARBONATE AREA:

1. Carbonate is required until cobalt in P.E. meets specifications.

2. Empty the carbonate storage tanks for start up. Pump remaining carbonate to Thickener O/F Tanks during the final stages of PE purification. Flush $NiCO_3$ lines to oxidizers and Thickener O/F Tank with liquor when completely shutdown. Leave empty. Wash all filter drums clean of carbonate. Fill boots with water.

3. When the filters are finally washed and shut down, turn the steam off to the carbonate recovery press pump tank.

4. Mill tank should be empty. Fill Mill SA Tank one more time with hot water and flush to Mill. Coordinate this with Mill. Blow line clear with air.

5. Dilute the Saturated Soda Ash Tank to approximately 100 g/L and shut off recirculation pumps on the Saturated and Dilute Tanks. These tanks to be as empty as possible prior to shutdown.

6. Ensure No.12 Acid Tank is at 20% level and flush No. 22 Tank with water, empty acid lines used for acid washing. Leave the drain valves for this line open. Failure to do so can result in damaged filter cloths and damaged filter strings.

7. Blow out all saturated Soda Ash lines to process tanks with steam. This includes:
   - Main Storage Tanks to Saturated SA Tanks.

8. a) Shut down all agitators in the carbonate storage tanks once empty.
   b) Unplug overflow lines between carbonate storage tanks as required.
   c) Inspect and clean if necessary all vacuum filtrate lines.

9. Shut off the main vacuum valve feeding the filters and water valves to scrubber and demister.

10. Shut tank connection valve #1, #2, Soda Ash Storage Tanks. Remove screen box covers, drain discharge lines through screen boxes, flush with water or steam. Leave steam and air on tanks. Turn water off after completion.

MATTE FILTRATION:

1. Ensure the Matte Filter Feed Tank is empty of solids. Leave tank half full of liquor and keep agitator running.

2. Ensure matte press is empty.

3. Ensure matte truck is empty.

4. Drain the acid line to the Matte Filter Feed Tank.

5. Put electrodes in distilled water.

6. Shut off tank recirculating pump.

7. Ensure all gland water is off, all pump suction and discharge valves are closed. Clamp off all gland water lines.

8. Shut down the Matte Filter Feed Tank vent air assist once all acid has been drained and flushed.

<u>COPPER FILTRATION:</u>

1. Ensure copper press and truck are empty

2. Wash drums and fill the boots with water after which pumps can be shutdown.

3. Leave the. 16 ft., 14 ft., and dissolution tanks empty.

4. Shut off all air and steam to all tanks (16, 14 and dissolution)

5. Close all pump suction and discharge valves, ensure gland water is off and hoses clamped

COBALT PURIFICATION:

1. Target all tanks to be empty for 8:00 pm on July 23rd.

2. Make up a heated dilute soda ash charge to wash chlorine scrubber and lines.

3. Ensure that the liquid SO2 line is sucked empty and the valves are closed at the car. Line is to be purged with Nitrogen and left pressurized. (This is to be done when the last treatment charge is being processed.)

4. No. 19 acid tank is to be drained and flushed with water. All acid lines from tank are to be drained empty and the tank valve closed.

5. Presses should be left with some material in them to prevent cloth from drying out.

6. Shutdown all agitators, pumps (close gland water, suction, discharge valves) and put all electrodes in Distilled water.

7. Surge tank to be left no more than half full.

8. Leached treatment press emulsifier tank left half full for start up. The reactor tank is to be half full. Check with the Mill for scheduling pumping of iron prior to their shutting down.

9. Carbonate may have to operate to ensure there is room for weak liquor while Cobalt side is operation.

PURIFICATION FINAL INSTRUCTIONS:

1. Close manual valves on the discharges of the acid storage tanks.

2. Close suction and discharge valves on the acid pumps. Drain pumps to relieve pressure from casing.

3. Ensure Purification is not shutdown until all gas systems are purged.

MANDREL PLANT SHUTDOWN PROCEDURE:

1. Steam to be shut off ink stripping line.
2. Nitric tank to be emptied and washed out. Follow standard procedure when draining tank.
3. Ensure all ink trays are emptied.
4. Remove and discard printing screens.
5. Cover printer with poly.
6. Shut off ovens.

SHEAR SHED SHUTDOWN PROCEDURE:

1. Process all nickel ahead of the shear.
2. Shut off and empty dip tanks steam and water last working day.
3. Nitric tank is to be drained, and washed. (Do not refill as maintenance will occur) Schedule to refill tank immediately at Start up.
4. RTS to sample and assay all Cobalt bags going out for shipment at the beginning of Shutdown.
5. Ship all nickel and cobalt during the week before the shutdown.

SCRAPWASH SHUTDOWN PROCEDURE:

1. Ensure 400 ton of ENR is available on the pad for start up.
2. Process all scrap anodes and clean Tyler sumps, screens etc. Make sure all belts are run empty.
3. Be sure that the matte storage bins No. 1 and No. 2 bin are left empty.
4. Leave matte feed bin empty.

5. Grind out Ball Mill to ensure it is empty. This will make it easier for ball replacement and other repairs.

6. Drain SAS line, grit line and blow clean (to Mill).

7. Shut down all pumps. Close suction and discharge valves. Ensure gland water is shut off.

8. Empty 1-A, 1-B, 2-A, and 2-B tanks. Make sure water from 1369 sump is diverted to the sewer.

<u>PURIFICATION CREW INSTRUCTIONS ON RETURN TO WORK:</u>

1. Beware of muscle strains and blisters

2. Personal hygiene

3. Wear proper equipment in good condition;
    a. Press Cleaners
    b. Operators working with acid: rubber clothing

4. Respirators clean and in good condition.

5. Respirators required for press cleaning and washing with electrolyte.

6. Beware of acid leaks;

7. Process problems; Filter washing, filter clarity, especially black nipples on presses make extra work.

8. Volume control is important; Sumps to be pumped out on a regular basis.

9. Quality control; Oil spills, leaks, Operators keep own areas clean.

10. Respirator and hearing protection required areas.

11. Electrolyte heater

12. Relieving on the job and team work on and between shifts.

13. Switch tagging

14. Opening and closing presses

15. Water control

REFINERY START UP – PURIFICATION:

1. Initiate Electrolyte Flow: August 17th.

A) Fill process tanks, initiate and balance flows through the Purification circuit, using a minimum of process tanks initially:

- One leach train
- One thickener
- Two tube filter leg tanks.
- One cobalt oxidizer train
- One first pass press pump tank
- Use a minimum of first and second presses

Initiate flow through presses slowly, as cold electrolyte filters poorly and we risk liner plate gasket failures.

B) Feed electrolyte to No. 4 circuit (No. 21 and No. 22 equalizers)

C) Adjust pH to 2.3

D) Initiate liquor flow through the mother cell equalizer to the mother tanks.

E) Mill is expecting to require Mill Soda Ash on August 17th

2. Operate the Heating Circuits:

A) Contact the Compressor Building and communicate clearly, the intention to put the three heat exchangers into service.

B) Perform routine checks to ensure appropriate cell sliders are opened and there are no major leaks

The plan for ramping up production is to feed heated P.E. to all circuits simultaneously. With the two new heaters and the existing Alpha Laval, it is expected there will be ample heat to accomplish this. This aggressive plan leaves little room for error with respect to heating parameters. By using the following criteria, inefficiencies will be minimized.

Proceed as follows:

a) Initiate flow through the slab heater to all slab cells. When flow is stabilized, start steam flow through the heater.

b) Initiate flow through the R-Rounds heater to No. 41 and No. 42 equalizers. When the flow is stabilized, start steam flow through the heater (all R-Rounds cells are being flushed).

c) Initiate flow through the Alpha Laval and have it discharge to the well tanks. When flow is stabilized, start steam addition to the heater.

d) Initiate flow through the heat exchanger to the mother cells. Open the steam valve and ensure condensate drains are opened. Do not adjust the pH at this time.

e) When tube filter temperatures reach 120 °F, start flow through more process tanks. Use your best judgement as you put thickeners, leach tanks, cobalt oxidizers, and tube filter tanks on line. If temperatures are dropping off, you are going too fast.

f) Continue to flush all circuits until they are overflowing with a minimum temperature of 120 °F. **Ensure that the feed lines to each unit are flushed as flow is established to them to flush out any solids that may have settled over the shutdown.**

g) **Note:** Do not exceed 150 °F. on any of the heat exchangers discharges or we risk damage to the FRP flanges that join the piping. Be prepared to ramp down steam additions as we proceed with the heating up phase.

h) Operate the heating circuits to maintain temperature as follows:

i. Tube filter filtrate greater than 120 °F.

ii. Contactor feed greater than 115 °F.

iii. Slab cell overflow greater than 120 °F.

iv. S-Rounds greater than 105 °F.

v. R-Rounds greater than 110 °F.

vi. Mother cell greater that 135 °F.

i) **Note:** The temperatures specified are within the range to prevent stress in plating and the risk of "splits" as the new deposit plates on cathode surfaces. In general, all heating circuits must be on line to achieve these temperatures. The largest heat loss is across the Tankhouse due to open cell design and miles of circulation hoses. In winter months, electrolyte heater discharge temperature will have to be set at 140 °F to achieve 120 °F on cell overflows. During the heating phase, shut ventilation fans off to conserve heat.

3. Reagent Addition:

A) Start producing carbonate. Have storage tanks full. Ensure Soda Ash storage tanks are re-circulating.

B) Copper, cobalt, arsenic and lead content (New ICP unit can now do this) of all tanks to be collected and put on Master List. To be done by Operations prior to start up.

C) Pressurize H2S lines to Refinery, and also the Nitrogen lines to the H2S system.

D) Pressurize chlorine lines to the Refinery.

E) Check scrubbers and ensure they are ready for service.

F) Change and check all pH and potential electrodes as required.

G) Check Reactor tank pH. Adjust with concentrated HCL to 2.5 pH. Do not add anolyte to the Reactor tank as it lacks acidity with the power off.

H) Start H2S vent fans and check drafts at all locations to ensure no H2S escapes to atmosphere during start up.

I) Check ALL pump packings to ensure minimum water passes through packing to volute.

J) Unless otherwise directed ensure settler press filtrate is sent to weak liquor tanks. Do not send to Tube filter filtrate as temperature will be affected and volume may be unwanted.

K) Any solids spills to sumps must be identified to prevent copper, arsenic, and iron from dissolving and contaminating the main flow.

L) Operators to do copper, cobalt, arsenic, lead and iron analysis and temperatures:

1. Thickener overflow (filtered)
2. Leach Train overflow (filtered)
3. Tube Filter Filtrate
4. First Press Filtrate
5. Purified electrolyte

EXTREME CARE must be taken to prevent aeration of electrolyte after the Leach Train to prevent copper dissolution. ALL PUMP TANKS must be kept full (to prevent free falling electrolyte) and no pumps are to suck air.

M) Add H_2S only after copper in feed to contactors is above 0.0015 g/l. Maintain a potential of -70. Target for .0007 - .0015 g/l. If potential is below -70 MV, too much nickel will precipitate, causing a drop in nickel concentration. Dependent on impurity levels; plan to put the gas on.

N) H_2S flow can be established once feed temp. is 115 ^oF; ensure H_2S fans are on. Nitrogen in the H_2S lines will slow the initial response on potential, so over addition at start up must be watched.

O) Matte in Leach Train will cement Copper at pH 2.7 - 3.0. If pH drops below 2.5 Copper will not cement, resulting in off-specification product. Do not allow Matte Settler pump tanks, Tube Filter tanks or pump tanks to aerate. **Note: Sodium Sulphide may be used sparingly to control coppers in PE during, and immediately after start up. If sodium sulphide is used, ensure that iron is <0.0001 gpl in PE before putting power on. This is to be added to the Tube Filter Filtrate tanks. Do not add any Sodium Sulphide in the 2nd press pump tanks.**

P) Start adding fresh ground matte to the leach train when the temperature at the Well Tanks reaches 105°F (5000 lbs./hour minimum). Maintain pH at 2.7 to cement copper.

Q) Maintain oxidizer pH at 3.3 – 3.5 to eliminate chlorine evolution if there are raw slimes in tanks and launders. Also, this will precipitate iron.

R) Prior to chlorine addition, start chlorine scrubber. When oxidizer feed is at 124 °F. and pH is 4.6 – 4.8, start chlorine addition.

S) Start taking regular samples during start up.

T) **All electrodes in Purification process to be buffed in once the heating circuit is on and flow has been established.**

U) Start Iron addition when Fe:As ratios are nearing 8 to 1. Remember, due to retention time Fe is 5 hours away. Once started, maintain Fe:As ratio of 10 to 1.

V) Make up a new Sodium Sulphite tank prior to start-up; schedule so as to allow enough time for proper agitation. Make sure solution is well mixed and clear.

W) Refinery Technical Services will monitor pH and temperature at the request of the Purification Superintendent.

X) Carbonate is needed to stabilize Leach Train pH's when Bonding tanks are being dropped.

REFINERY START UP - COBALT AREA:

A) *Air lines for instrument and process air must be drained

B) Pressurization of the SO_2 lines can proceed. Water lines are to be flushed to sewer, including dilute soda ash makeup water. Check drop leg at north end. Air line and water line filters MUST be changed prior to start up of precipitation.

REFINERY ELECTROLYTE SYSTEM START-UP PROCEDURE:

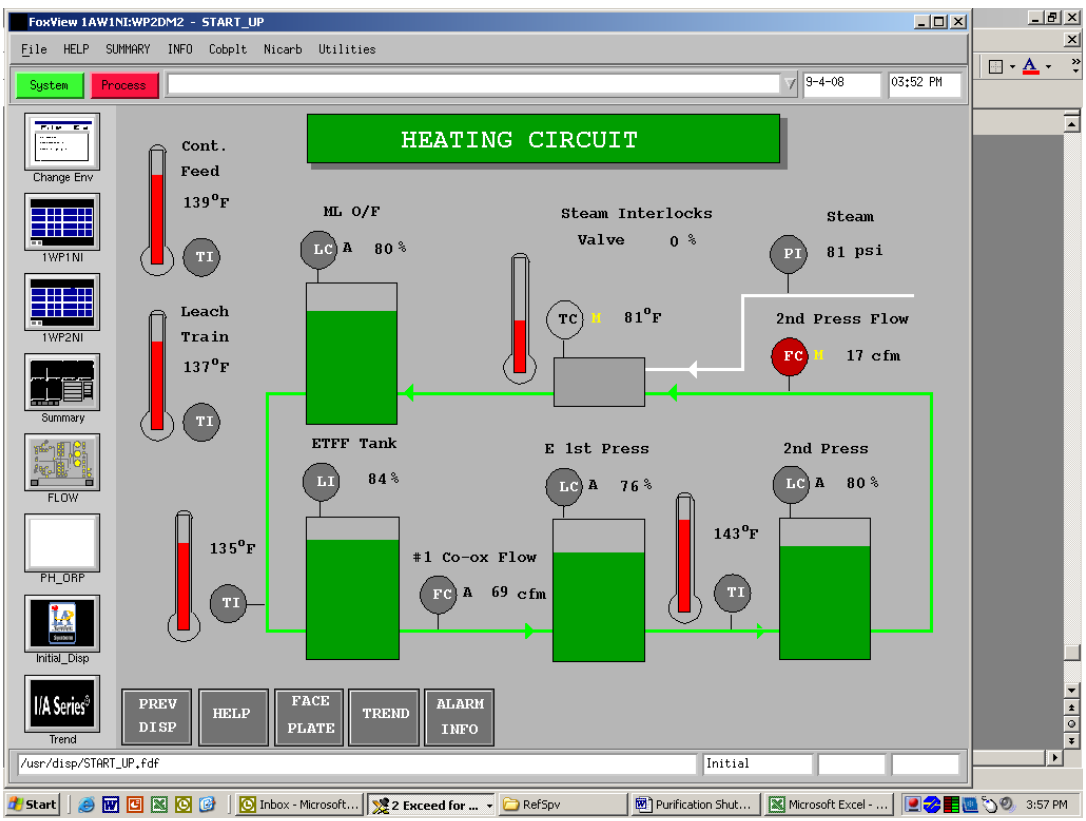
Work to be performed in the Compressor Building:

1. Have Utilities put three additional electric boilers into service, each having 10,000 lbs/hour steam generating capacity, for a total output of 30,000 lbs./hour steam.

Heat Exchanger Start-up:

Prior to Start Up

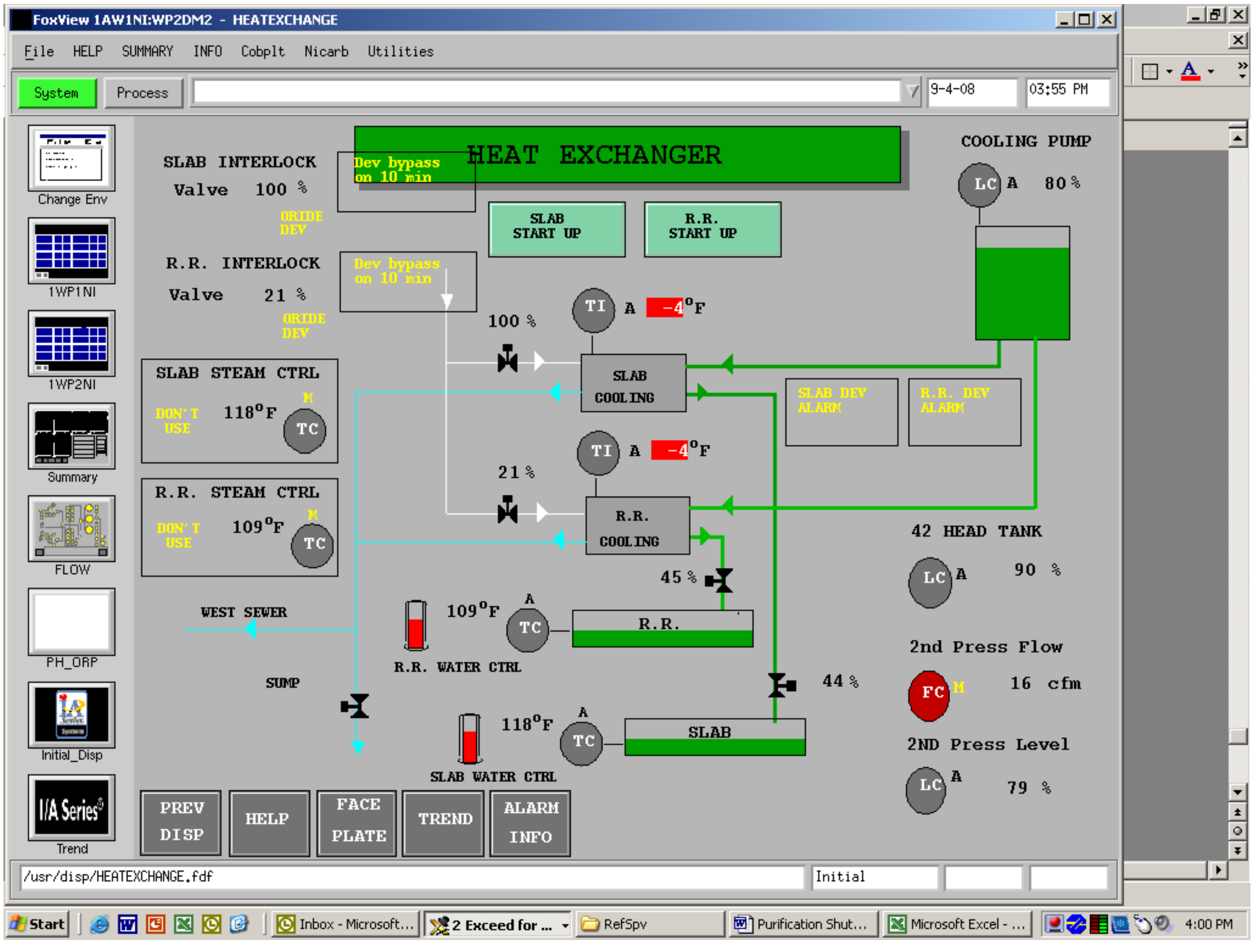
1. Start up plate and frame heating circuit with 50-70 cfm through Alpha heater. Put heated flow to the matte leach overflow tank.



2. pH adjust the flow through the leach train immediately to 3.0 because there will be high pH liquor from cleaning the chlorine scrubber.

3. Start flow to mother cells, with steam on through the Mother cell heat exchanger.

4. Initiate flow through the R-Rounds and Slab heat exchangers to head tanks, plating cells, and well tanks. Steam is initiated (regulated at 20 p.s.i.).



5. Operations to check all equipment and pumps.

Note: Interlocks that will shutdown the two heater circuits are identified on the heating circuit display on I.A. under “Help for Steam Interlocks”.

TANKHOUSE STARTUP:

<u>TANKHOUSE CREW INSTRUCTIONS ON RETURN TO WORK:</u>

1. Personal safety equipment
2. Eyeglasses
3. Gloves
4. Strains and sprains
5. Bending and lifting
6. Handling nickel
7. Crane and equipment checks
8. Procedure and policy (hooks, aluminum, respirators, etc.)
9. Housekeeping
10. Bonding Procedures/ Placement of electrodes in solution

<u>PRE STARTUP:</u>

Note: For Shutdown and Start up purposes, all available Refinery personnel is to be provided to the Tankhouse to assist in pulling/threading bars

1. **<u>In order to maximize bridge time, Tankhouse crews start times will be altered on August 22nd thru August 26th. Day shift will begin at 6:30am to 6:00pm on the above dates and afternoon shift will begin at 4:00pm to 3:30am. Ensure overtime is offered to man up to full complement for all bridges</u>**

2. All Tankhouse crews are to ensure that their tanks are ready, adequate sheets are made, leaks are repaired, copper buss bars are shone, and required tank top furniture changed.

3. All hoses are to be pulled back so they are just sitting in the boxes. This is to ensure proper dispersion of ECH when power goes on.

4. Install cables on tank 44 on the East side and on tank 120 on the West side of circuits 3, 4, 5, and 6. Installing 2 cables between the East and West side will be adequate as we will be at reduced power.

5. Unplug orifices and check tank overflows

6. Exercise all East and West Wall fans to blow out to clean off any dust accumulated from shut down.

7. During the flushing phase, any tanks that have "thermal blocks" must be taken care of immediately by initiating circulation with a steam hose. This will prevent split nickel when the power goes on.

8. All new mandrels are to be blended; any racks containing unblended sheets to be sent back to the Stripping Floor for proper blending.

9. Mother cell blanks to be dipped in hot water before they are put in tanks.

10. RTS to monitor/advise bonding tanks during startup for the entire start up process

11. Bonding and HCL tanks are to be made up as per recipe the shift prior to tanks going on line (afternoon or night shift of August 22nd)

12. A crew of 3 PTMs is to be arranged for a 4:00am start on the morning on August 22nd to perform bonding. Note: All members require a 'welcome back' line up meeting involving bonding procedures.

13. Tankhouse supervisor to inspect the R-Rounds sample point. Ensure air and electrical power is turned on at the sampling arm. Make sure the arm is moving into the path on the rounds conveyor discharge point above the storage bin.

IMMEDIATELY PRIOR TO POWER ON:

1. Utilities must be contacted one-half hour before power is established on any circuits. This is to be performed by the Tankhouse Superintendent.

2. Before power is established on any of the circuits, all tanks must be washed down. It is to ensure that all contacts (center, side, lugs) are wet – this is very important.

3. Tankhouse Supervisor to contact Control Room to turn on sulphite ½ hour before power goes on to #2 and #6 circuits.

START UP:

Set points (Adjustments to be controlled and documented by the area Superintendent through the On Line Order Book for front line supervision at the time of start up.):

Ensure that adequate mechanical and electrical coverage is available throughout the start up process (24 hour coverage)

- Tanks Online:

1. The tanks to go on first will be determined by Refinery management.
2. When loading nickel into the south half (tanks south of jumper cables) of circuits 3, 4, 5, and 6, a tank (south of the jumper cables) must be left open. This is to allow for release of any current once the cables are removed. Once cables are removed, the tank must have 6 cut out bars installed before power is restored to the circuit. This tank can be filled after power is established. Note: For circuits 3, 4, and 5 a mother cell can be used to accomplish this.
3. Cut out mother cells with cut out bars before jumper cables are pulled.
4. Mother cells to go online after full power is established.

- **Power up on all circuits:**

1. 4000 amps to start (as low as possible power).
2. After all circuits loaded, 5000 amps for 4 hours.
3. Increase 1000 amps/hour until 8000 amps is achieved.
4. Management to make decision when to go to 9100 amps.
5. Schedule manpower for fire watch when at full power.

- **R Rounds:**

1. Set PE pH at 2.5 as requested by Superintendent before power on.
2. Set PE pH to 3.0 once at full power.
3. Set ECH rate based on number of tanks on line X 1.30 shutdown rate. (**FORMULA:** Shutdown rate/ Tanks on line at Shutdown, x 1.3 [to build background] x Tanks online at start up***) Note: This is based on when full power is achieved.***

4. ECH addition levels to be monitored daily based on one-day production observation.
5. Tank overflows temperature not to be less than 110°F for power on.
6. PE temperature to be regulated to no higher than 120°F.

- **S Rounds:**

1. Set PE pH at 3.0 before power on.
2. Set Sulfite at .013 g/l one half hour before putting power on #2-circuit.
3. When at full power, set ECH rate to be determined by the area Superintendent.
4. ECH addition levels to be monitored daily based on one-day production observation.
5. Daily S Round assays to be done until we are at full power.
6. When at full power increase sulfite rate as per Superintendent.
7. Cell-overflow temperature not to be less than 95°F for power on.
8. PE temperature to be regulated to no higher than 100°F.

- **Slab:**

1. Set PE pH at 2.3 as requested by Superintendent before power on.
2. Set PE pH at 3.0 once at full power.
3. When at full power, set ECH rate based on number of tanks on line times 1.30 shutdown rates. (**FORMULA:** Shutdown rate/ Tanks on line at Shutdown, x 1.3 [to build background] x Tanks online at start up). ***Note: This is based on when full power is achieved.***
4. ECH addition levels to be monitored daily based on one-day production observation.
5. Cell-overflow temperature not to be less than 115°F for power on.
6. PE temperature to be regulated at 120F (Temperatures up to 130°F may be required dependent on what stage of heating PE is at).

- **Mother Cell:**

1. Cut out mother cells with cut out bars.

2. Mother cells will be put on line when at full power.

SHEAR SHED START-UP

1. Safety indoctrination topics to be addressed:
   - Personal safety equipment
   - Bending/lifting
   - Beware strains, sprain, etc.
   - Work self back into shape
   - Handling nickel (sharp edges, etc.)
   - Review YTD shear incidents - Beware of hazards
2. Examine all equipment requiring repairs and initiate work orders for mechanical personnel.
3. Conduct a manual walk through, check of the entire shearing cell
4. Fill production dip tanks and turn on steam
5. Check all stored nickel for oil drips from crane exercising.
6. Clean all nickel handling surfaces of oil.
7. Drain water from air lines.
8. Fill Nitric tank.

SCRAPWASH START-UP:

1. Safety indoctrination topics to be addressed:
   - Personal safety equipment
   - Bending/lifting

- o Beware strains, sprain, etc.
- o Work self back into shape
- o Equipment checks
- o Housekeeping
- o Review Scrapwash YTD incidents - Beware of hazards

2. Examine repairs required to equipment and initiate work orders required for mechanical personnel.

3. Drain water from all air lines and check auto bleed-off on main air line to Refinery behind 2-B storage tank.

4. Ensure that a Ball Mill Operator is arranged to grind ENR, beginning on **August 16th.** We need to add fresh ground matte to the leach train when H_2S addition is started (5000 lbs./hour minimum). *Failure to deliver ground matte will result in off spec product.*

Schedules for Tanks on line:

❑ **Rounds Units:**

All sheets going into the Plating cell for Rounds units will be new (non-plated). Sheets will go into the cells on August 22nd. First pulls will occur on August 26th. The first cycle will be heavy pulls of 26, 24, & 26 cells per day. On the second cycle will be where the units get back into their regular pulling schedules. (See excel File "Start Up Pulls")

❑ **Slab Units**

All sheets going in will be from 7-day old to new. See excel File "Start Up Pulls")
All sheets will go into the cells on August 22nd, with the first pull occurring on August 25th. This schedule will ensure that the nickel plates will not be pulled heavy. Keep in mind as start up times may change, the weights may be light. Scaling for weights of the plates must occur prior to pulling. Management will determine if nickel needs to be dropped for another day.
Note: the first pull cycle will be heavy to ensure that all nickel is pulled by 10-day old. Regular pull schedules will occur on the second pull cycle.