# 3. GENERATING PLANT ENGINEERING AND OPERATIONAL DESIGN

## 3.1 PROCESS DESCRIPTION

This section describes the IGCC Power Station (an LEPGP) and its Associated Facilities. The HVTL GO outlet facilities and the natural gas pipeline facilities are described in Section 4 and Section 5, respectively.

### 3.1.1 Technology Selection

ConocoPhillips was selected as the gasification technology licensor for the Project in the spring of 2004. Following its selection announcement, Excelsior began working with ConocoPhillips to explore using different solid fuel feedstocks utilizing ConocoPhillips' E-Gas™ technology. Based upon optimization analyses conducted over a one-year period, Excelsior determined that Mesaba One and Mesaba Two should be designed as "feedstock flexible" facilities capable of utilizing petroleum coke, bituminous coal, sub-bituminous coal, and certain combinations of such feedstocks. Such design will likely minimize long-term energy costs and provide significant life-of-plant benefits to consumers given the IGCC Power Station's capability to utilize different feedstocks and transportation systems.

### 3.1.2 Process and Equipment Descriptions: Introduction

Detailed descriptions of the gasification/power production processes characteristic of an E-Gas™ Technology-based IGCC Power Station are provided in the remainder of this Section. The descriptions provided address the following elements:

- Underlying basis for all computations included in this Joint Application (Section 3.1.3)
- Process chemistry (Section 3.1.4)
- Process subsystems and their operation (Section 3.1.5)
- IGCC Power Station utility systems (Section 3.1.6)
- Major process equipment (Section 3.1.7)
- Operating characteristics (Section 3.1.8)

The major subsystems of the IGCC Power Station that are discussed in detail below include: oxygen supply; feedstock slurry preparation; gasification; slag handling; syngas cooling; particulate matter removal; syngas scrubbing; low temperature heat recovery; acid gas removal; sulfur recovery; tank vent collection; sour water treatment; and the combined cycle power block.

Overall schematic block flow diagrams ("BFD") identifying important equipment and processes related to air pollutant emissions from the Phase I and II Developments are presented in Figures 3.1-1 and 3.1-2, respectively. The only difference in these two figures is the numbers assigned to the emission/control points (the identification numbers that are used in the BFDs correspond to the numbers used in the Application for a Part 70/New Source Review Construction Authorization attached as Appendix 5 to this Joint Application). The emission/control points identified in the BFDs are essentially independent of the development phase and/or the Site.

### 3.1.3 Worst Case Operating Conditions Quantified

During the environmental review and permitting process, the Applicant is required to identify "worst case" operating scenarios that would produce the maximum emissions/discharges associated with construction and operation of the IGCC Power Station. Such scenarios are primarily defined by the operating characteristics of Station equipment and the amounts and characteristics of feedstock to be transported, handled and consumed. Maximum quantities of feedstock consumed and feedstock characteristics are further discussed in Section 3.1.8 and Sections 3.3.1 through 3.3.3 below.

For development of its "worst case" scenario, the Company focused on identifying operating parameters yielding maximum emissions. In general, these scenarios reflect the highest heat input rates and a cautious approach regarding the design optimizations expected to occur (during the FEED process, the preliminary equipment designs used to estimate environmental releases will be refined and uncertainties that now require conservatively high assumptions to be used will be better understood). In employing such an approach, the Applicant is confident that environmental releases and their associated impacts are conservatively analyzed and presented.

Operating conditions producing maximum emissions/discharges from the IGCC Power Station are identified in Table 3.1-1 and Table 3.1-2 in Section 3.1.8. Table 3.1-1 assumes operation of the gasifiers under partial slurry quench ("PSQ") conditions and considers known seasonal influences and the range of potential feedstocks for which the IGCC Power Station will be designed. Table 3.1-2 assumes the same scenarios as Table 3.1-1, but with the gasifier operating in full slurry quench ("FSQ") mode. FSQ is achieved by increasing the coal slurry feed to the second stage of the gasifer to the point where only slurry is used to quench the syngas, thereby eliminating the thermal loss associated with water used to cool the syngas and increasing the overall efficiency of the plant. These efficiency gains will translate into reduced fuel use and, consequently, reduced pollutant emissions/discharges. However, FSQ is an IGCC Power Station design improvement that is subject to further engineering and verification by experience at Wabash River. Therefore, FSQ's expected benefits for the maximum emissions cases are shown in Table 3.1-2, but are not reflected in either the maximum resource requirements or maximum pollutant emissions/discharges quantified in this Application and the ES.

**Figure 3.1-1 Phase I IGCC Power Station Emission Source Block Flow Diagram**

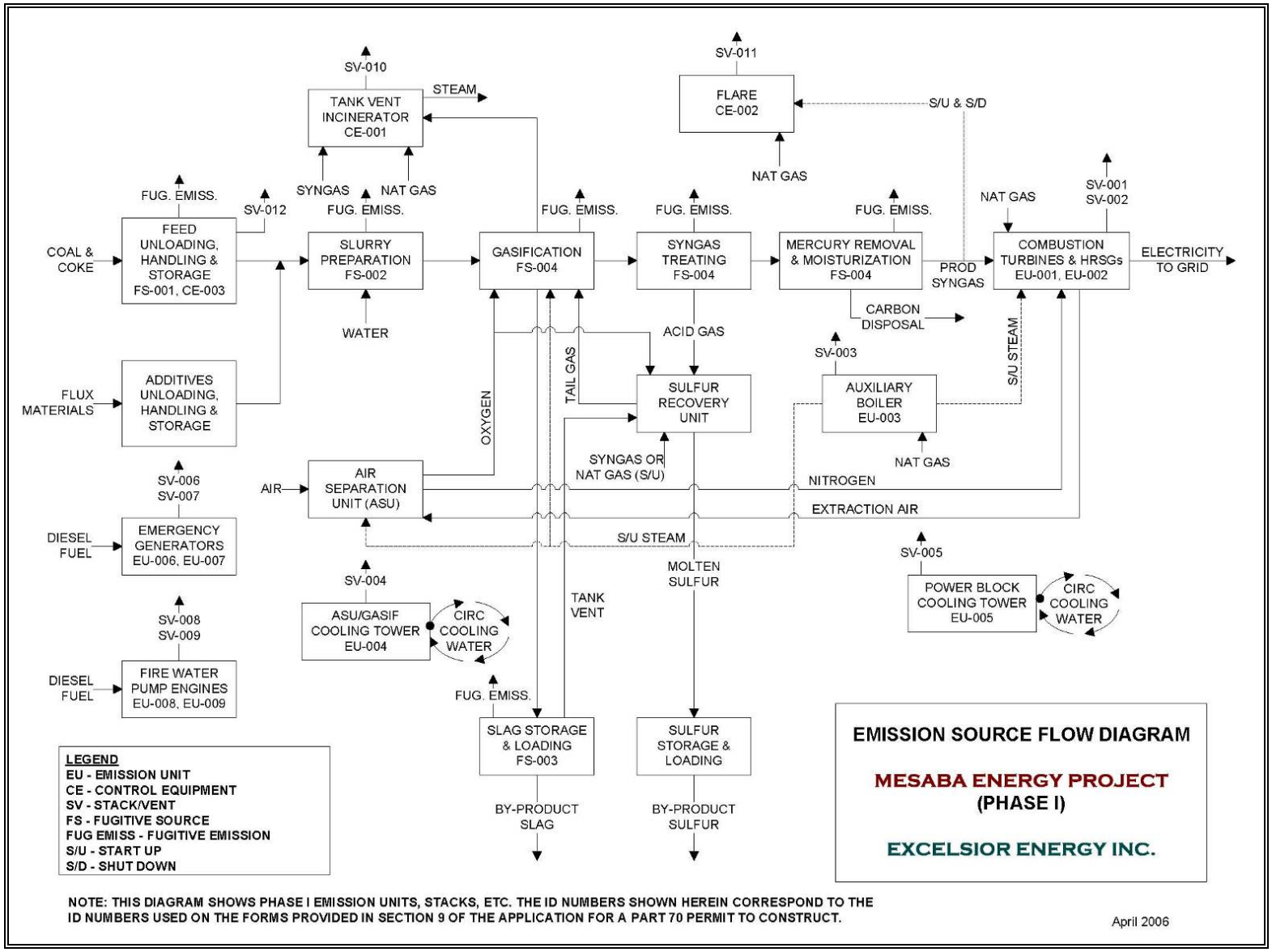
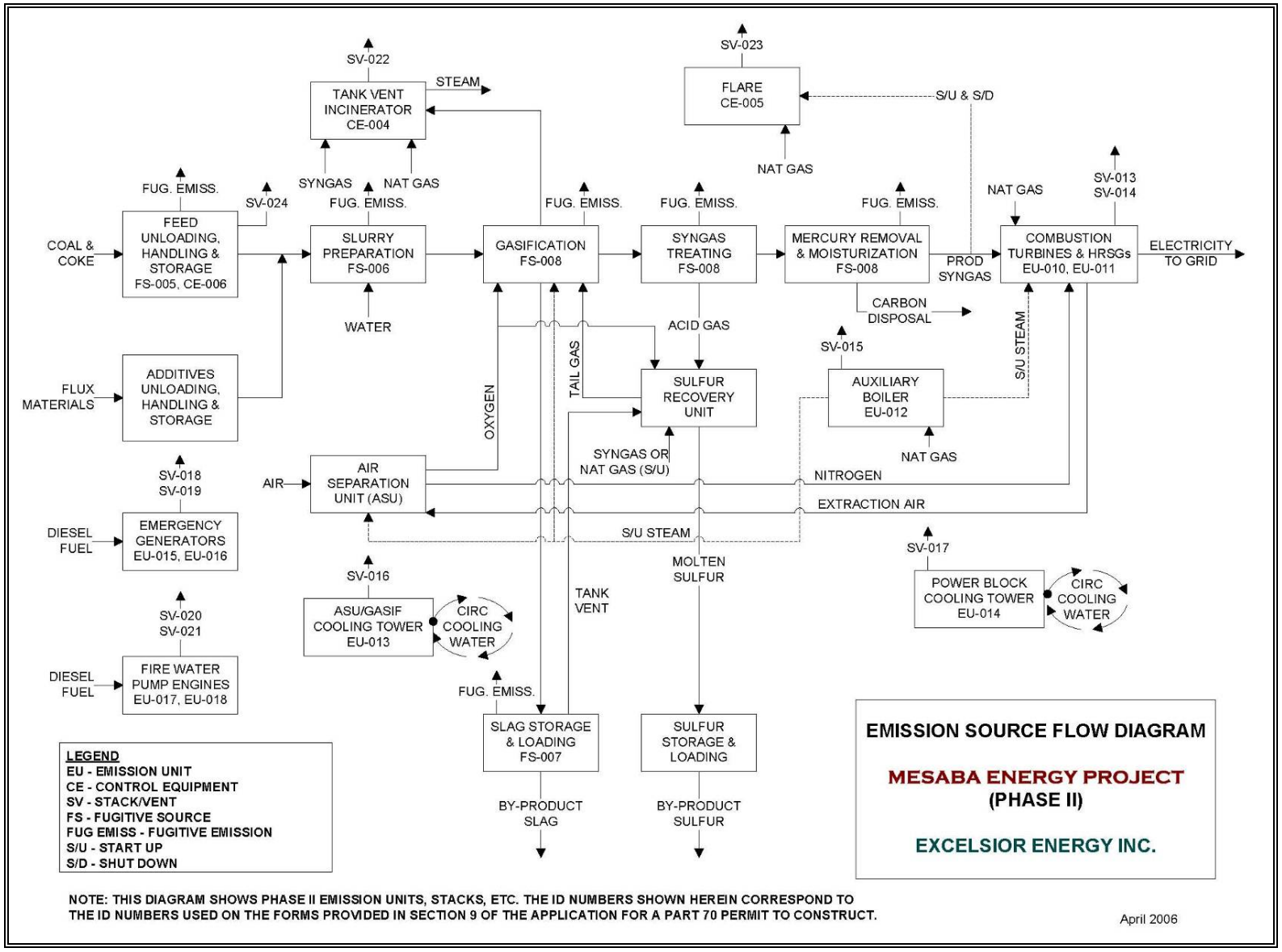


**Figure 3.1-2 Phase II IGCC Power Station Emission Source Block Flow Diagram**



### 3.1.4 Process Chemistry

#### 3.1.4.1 Gasification

Coal and petroleum coke are typically characterized by their heating value, elemental analysis (weight percent carbon, hydrogen, nitrogen and sulfur), mineral matter (also known as ash), and moisture content. Unlike traditional pulverized coal power plants where fuel is actually combusted, in an IGCC power station coal slurry is fed to the gasifier along with oxygen ("$O_2$") and a number of complex chemical reactions occur. A portion of the feedstock is partially oxidized to provide the temperatures necessary for gasification. The gasification temperature is high enough to break essentially all the chemical bonds present in the coal and establish a new mix of smaller molecules based on the following primary reactions:

$C + O_2 = CO_2$ (rapid exothermic, or heat releasing, oxidation reaction)

$C + ½ O_2 = CO$ (rapid exothermic oxidation reaction)

$C + H_2O = CO + H_2$ (slower endothermic, or heat consuming, reaction)

$C + CO_2 = 2CO$ (slower endothermic reaction)

$CO + H_2O = H_2 + CO_2$ ("water gas shift reaction," exothermic and rapid)

$CO + 3H_2 = CH_4 + H_2O$ ("methanation reaction," exothermic)

$C + 2H_2 = CH_4$ (direct methanation, exothermic)

Most of the sulfur in the feedstock is converted to hydrogen sulfide ("$H_2S$") during gasification. A small portion of the sulfur is converted into carbonyl sulfide ("COS"). Most of the nitrogen in the feedstock is converted to ammonia ("$NH_3$"). The syngas composition leaving the gasifier is determined by the gasifier operating temperature and the relative kinetics of the above reactions. Most of the energy in the feedstock is ultimately converted into carbon monoxide ("CO"), hydrogen ("$H_2$"), and a small amount of methane ("$CH_4$"). Low grade coals with lower heating values and higher moisture contents will generate a syngas with more carbon dioxide ("$CO_2$") and $H_2$, the additional $CO_2$ generated from the water gas shift reaction as shown above. Higher quality coals and petroleum coke will result in a syngas that has a much higher CO content.

#### 3.1.4.2 COS Hydrolysis

Because the small fraction of COS formed in the gasifier is difficult to remove in the acid gas removal (AGR) system, the COS is "hydrolyzed" in a catalytic reactor before the syngas is sent to the AGR system. The hydrolysis reaction is shown below:

$COS + H_2O = H_2S + CO_2$

The conversion of COS to $H_2S$ is not 100%, and is limited by the equilibrium conditions at the COS reactor operating temperature.

#### 3.1.4.3 Acid Gas Removal

The acid gas removal ("AGR") system uses methyl diethanolamine ("MDEA"), a weak base, to remove the $H_2S$ from the syngas. $H_2S$ is an acid that forms weak chemical bonds with the cold

lean MDEA solution. Once the MDEA solution absorbs the $H_2S$, it is called a "rich" solution. The rich MDEA solution is regenerated to a lean MDEA solution by reducing the pressure, applying heat, and boiling. The $H_2S$ released from the rich MDEA under such conditions is sent to the sulfur recovery unit ("SRU").

#### 3.1.4.4 Sulfur Removal

The SRU uses standard Claus technology to convert $H_2S$ to elemental sulfur. The Claus reactions are shown below:

$$H_2S + \frac{3}{2}O_2 = SO_2 + H_2O$$

$$SO_2 + 2H_2S = 2S + 2\ H_2O$$

The Claus reactions occur in two steps. In the first step a portion of the $H_2S$ is combusted with $O_2$. The sulfur dioxide ("$SO_2$") that is formed is mixed with additional $H_2S$ and passed over catalyst beds. The Claus reactions are exothermic and reaction heat is recovered, generating low pressure steam. The "tail gas" stream leaving the Claus reactors contains nitrogen ("$N_2$") and other inert gases that entered with the feeds, along with traces of unconverted $H_2S$. The tail gas is recycled to the gasifier.

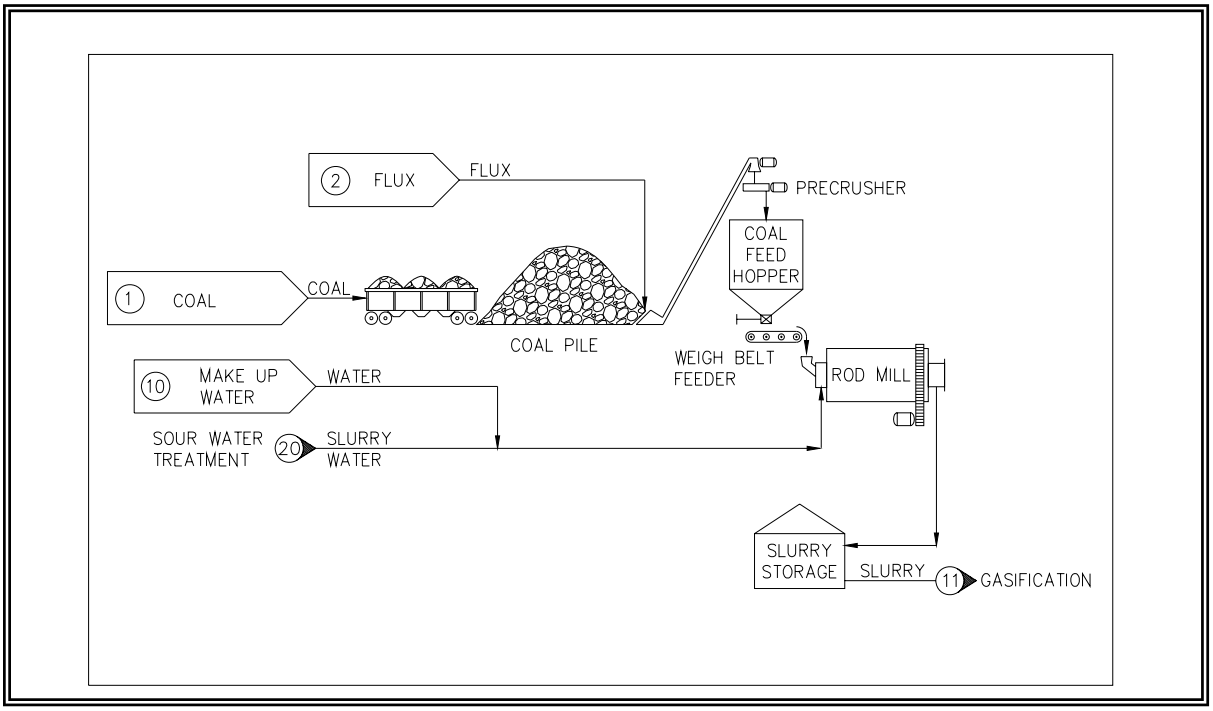
### 3.1.5 Process Operations

#### 3.1.5.1 Slurry Preparation

To produce slurry gasifier feed, the solid fuel is placed on a weigh belt feeder and directed to the rod mill where it is mixed and ground with treated recycled water and slag fines that are recycled from other areas of the gasification plant. The resulting slurry has a paste-like consistency. The use of a wet rod mill reduces potential fugitive particulate matter emissions from the grinding operations and is an efficient method for producing essentially homogeneous slurry. Collection and reuse of water within the gasification plant minimizes water consumption and wastewater discharge.

Slurry feeding allows for consistent and safe introduction of feed into the gasifiers. Prepared slurry will be stored in an agitated tank. The capacity of the slurry storage tank will be sufficiently large to supply the gasifiers' needs without interruption when the rod mill undergoes normal maintenance requirements. The feedstock grinding and slurry preparation area is depicted in Figure 3.1-3.

**Figure 3.1-3 Feedstock Grinding and Slurry Preparation**

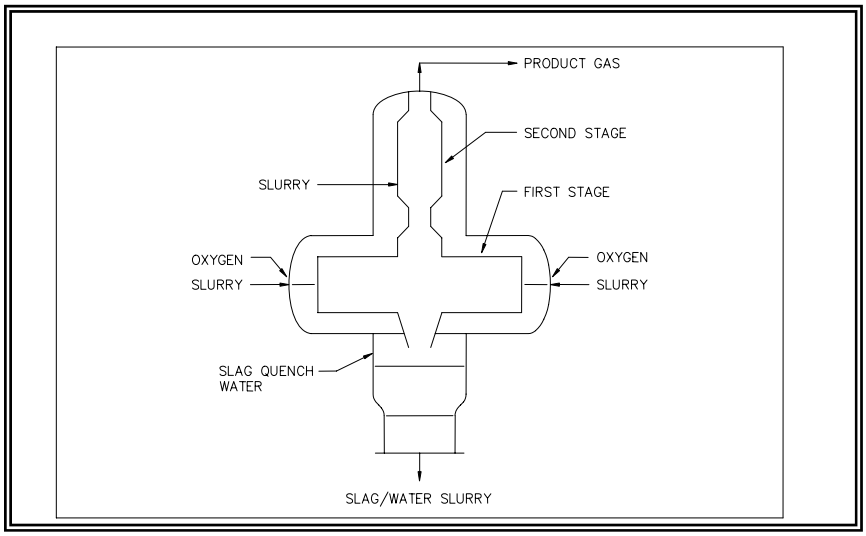



Tanks, drums and other areas of potential atmospheric exposure to the slurry or recycle water will be covered and vented into the tank vent collection system for vapor emission control. The entire feedstock grinding and slurry preparation facility will be paved and curbed to contain spills, leaks, wash down, and storm water runoff. A trench system will carry this water to a sump where it will be pumped into the recycle water storage tank.

### 3.1.5.2 Gasification and Slag Handling

The E-Gas™ gasifier consists of two stages: a slagging first stage, and an entrained flow, non-slagging second stage, as shown in Figure 3.1-4. The first stage is a horizontal refractory-lined vessel in which feedstocks are exposed to sub-stoichiometric quantities of oxygen at an elevated temperature and pressure. Oxygen and preheated slurry are fed to each of two opposing mixing nozzles, one on each end of the horizontal section of the gasifier. The oxygen feed rate to the nozzles will be carefully controlled to maintain the gasification temperature above the ash fusion point to allow good slag removal and high carbon conversion. The feedstock will be almost totally gasified in this environment to form syngas consisting principally of hydrogen, carbon monoxide, carbon dioxide and water.

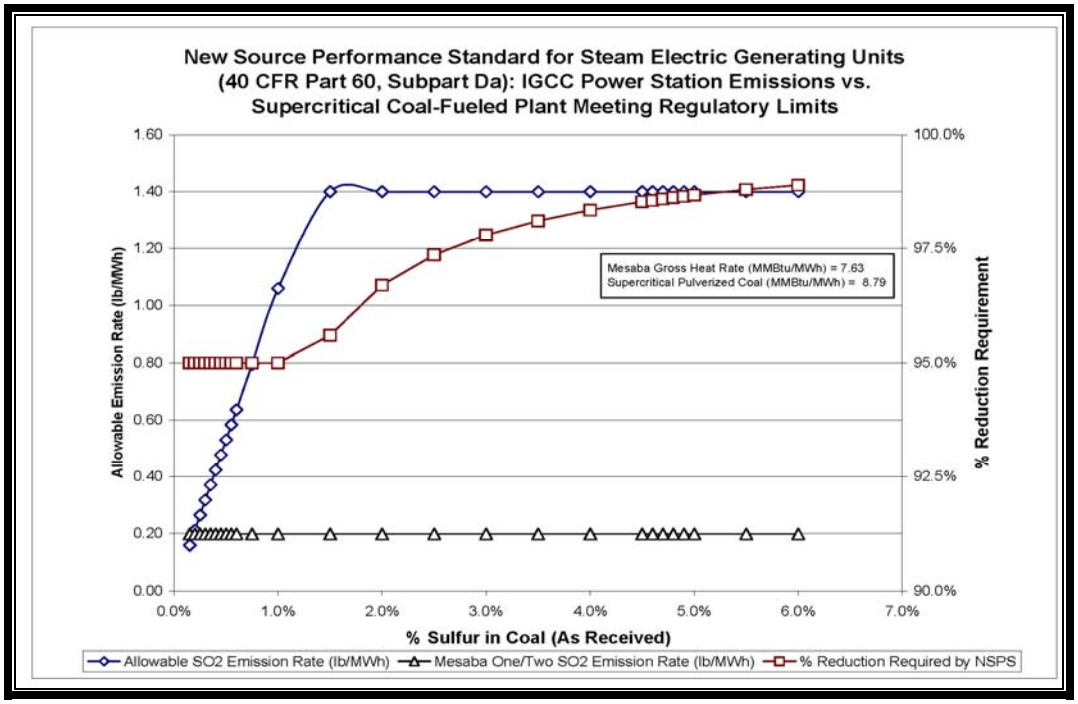
**Figure 3.1-4 E-Gas™ Gasifier**




Sulfur in the fuel will be converted to primarily $H_2S$, with a small portion converted to COS. With the processing provided downstream, over 99% of the sulfur will be removed from high sulfur feedstocks and over 97% of the sulfur will be removed from low-sulfur sub-bituminous coal feedstocks. The removal rate from low sulfur coal nonetheless results in approximately equal sulfur emissions rates as the higher removal rate from higher sulfur coal. In other words, the final $SO_2$ emission rate achieved using E-Gas™ technology is independent of the starting sulfur concentration in the feedstock. Therefore the percentage of $SO_2$ removed from a higher feedstock that exhibits the same $SO_2$ emission rate as a lower sulfur feedstock, would show a higher percentage removal rate.

To illustrate, assume a constant emission rate when using either Coal A or Coal B of 0.025 lbs per million Btu heat input (note that this emission rate is far lower than the New Source Performance Standards emission rate imposed by federal law [the emission limit and percentage reduction requirements imposed on $SO_2$ emissions are illustrated in Figure 3.1-5 along with the $SO_2$ emissions expected from Mesaba One and Mesaba Two] for a new coal-fueled steam electric generating units).

**Figure 3.1-5**
**New Source Performance Standard vs. Mesaba One/Two $SO_2$ Emission Rates**




The percentage of $SO_2$ removed for Coal A and Coal B would be as follows:

**% $SO_2$ removal, Coal A (3.0% S, 11,500 Btu/pound higher heating value):**

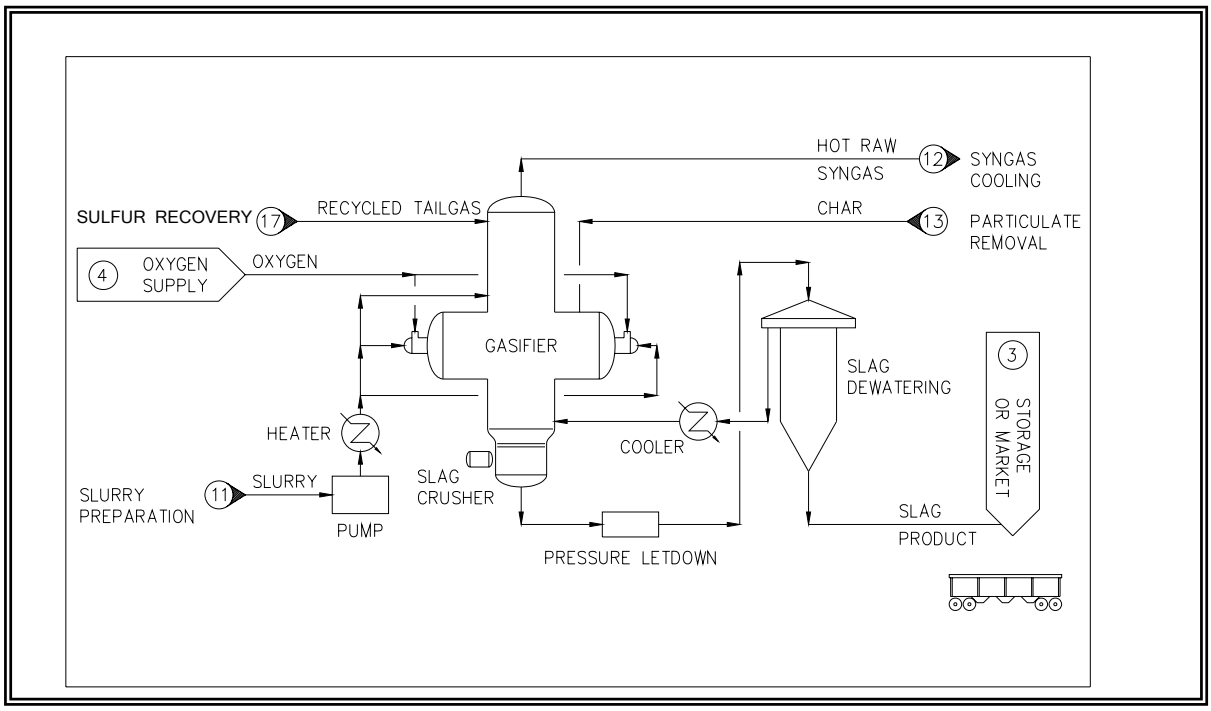
$$\frac{\{[(0.03\text{ lbs S/lb Coal A})*(2\text{ lbs SO2/lb S})*(10^6\text{ Btu/MMBtu})/11{,}500\text{ Btu/lb Coal A}]-0.025\text{ lb/MMBtu}\}}{[(0.03\text{ lbs S/lb Coal A})*(2\text{ lbs SO2/lb S})*(10^6\text{ Btu/MMBtu})/11{,}500\text{ Btu/lb Coal A}]}\times 100\% = 99.5\%$$

**% $SO_2$ removal, Coal B (0.5% S, 8,300 Btu/pound higher heating value):**

$$\frac{\{[(0.005\text{ lbs S/lb Coal B})*(2\text{ lbs SO2/lb S})*(10^6\text{ Btu/MMBtu})/8{,}300\text{ Btu/lb Coal B}]-0.025\text{ lb/MMBtu}\}}{[(0.005\text{ lbs S/lb Coal B})*(2\text{ lbs SO2/lb S})*(10^6\text{ Btu/MMBtu})/8{,}300\text{ Btu/lb Coal B}]}\times 100\% = 97.9\%$$

Mineral matter in the feedstock and any added flux (see Section 3.3.2 for a description of fluxing agents) forms a molten slag which flows continuously through a tap hole in the floor of the gasifier horizontal section into a water quench bath, located below the first stage. The characteristics of the slag produced in the gasifier will vary with the mineral matter content of the feedstock. As depicted in Figure 3.1-6, the solidified slag exits the bottom of the quench section, is crushed, and flows through a continuous pressure-letdown system as a slag/water slurry. This continuous slag removal technique eliminates high maintenance, problem-prone lockhoppers and prevents the escape of raw syngas to the atmosphere during slag removal. The slag/water slurry is then directed to a dewatering and handling area (described later). The raw syngas generated in the gasifier's first stage flows up from the horizontal section into the second stage of the gasifier.

**Figure 3.1-6 Gasification and Slag Handling**




Typically, the ash content of coal will be in the range of 5-11%, as received, with ash in petroleum coke expected to average about 0.6%, as received. Slag production at full load will thus vary from about 500 tons per day up to a maximum of about 800 tons per day for each of the two phases of development. The slag will be conveyed from the slag dewatering unit to the slag storage pile using covered conveyors. The storage area will be provided with dust suppression systems. The slag is essentially inert, and will be conveyed from the storage area to rail cars or trucks for transport to market or storage.

The gasifier second stage is a vertical refractory-lined vessel in which additional slurry is reacted with the hot syngas stream exiting the first stage. The feedstock undergoes devolatilization (separation of organic components) and pyrolysis (high temperature decomposition), thereby generating more syngas with higher heat content (less carbon being converted to $CO_2$) since no additional oxygen is introduced into the second stage. This additional slurry lowers the temperature of the syngas exiting the first stage by the endothermic nature of the devolatilization and pyrolysis reactions. In addition to the above reactions, water reacts with a portion of the carbon to produce additional CO, $H_2$ (for subsequent use as syngas fuel for power generation), and $CO_2$. Unreacted solid fuel (char) is carried out of the second stage with the syngas.

Certain other metals present in the feedstocks in trace quantities and volatile at the temperatures typical of the gasifier will also be carried out in their gaseous state as components of the syngas, and removed in the cleanup stage.

The slag/water slurry will flow continuously into the dewatering bin. The bulk of the slag will settle out in the bin while water overflows into a basin in which the remaining slag fines will settle. The clear water from the settler will pass through heat exchangers where it is cooled as

the final step before being returned to the gasifier quench section. Dewatered slag is transferred to the slag storage area to be loaded into trucks or rail cars for transport to market or storage. The slurry of fine slag particles from the bottom of the settler will be recycled to the slurry preparation area to be fed back into the gasifier, ensuring maximum carbon utilization.

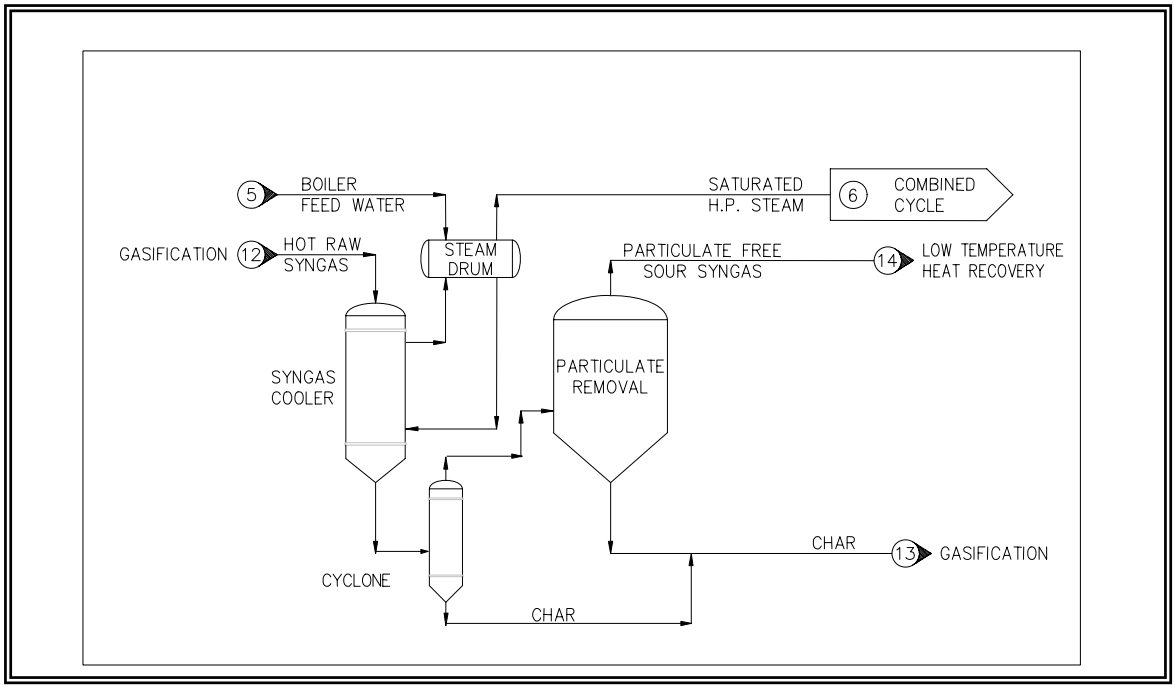
### 3.1.5.3 Syngas Cleanup and Desulfurization

#### 3.1.5.3.1 Syngas Cooling

As shown in Figure 3.1-7, the next two steps in the process are to cool the syngas and then remove the particulate matter from the syngas stream. Captured particulate matter is recycled back to the gasifier.

The hot raw syngas (with entrained particulate matter) exiting the gasifier system is cooled in the syngas cooler, converting a significant portion of the heat from the gasifier to high pressure steam for use in power generation.

**Figure 3.1-7 Particulate Matter Removal**




#### 3.1.5.3.2 Particulate Matter Removal

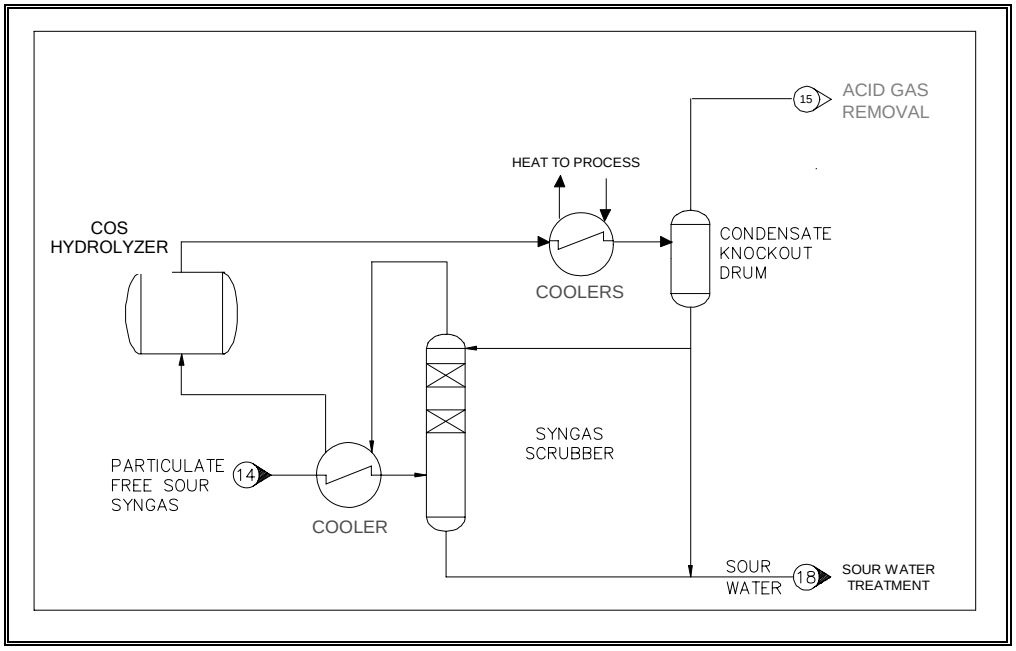
After cooling, the syngas is directed to the particulate matter removal system, as shown in Figure 3.1-6 above. The gas flows first through a hot gas cyclone for removal of relatively large particulate matter and then passes to the particulate matter filter. The filter vessel contains numerous porous filter elements to remove particulate matter. The cleaned syngas exits the unit as a particle free syngas. Particulate matter removal efficiency is expected to be 99.9%. Removed particulate matter from both the hot gas cyclone and the dry filter vessel is recycled to

the first stage of the gasifier to improve carbon conversion efficiency. With particulate matter being recycled to the gasifier from both devices, near complete gasification of the carbon content of the feedstock is obtained. The particle free syngas proceeds to the low temperature heat recovery system.

#### 3.1.5.3.3 Syngas Scrubbing, COS Hydrolysis and Low Temperature Heat Recovery

With particulate matter removed from the syngas, additional gas cleanup (including mercury removal) and cooling steps can more easily be performed. The syngas is scrubbed with recycled sour water (water with dissolved sulfur compounds and other contaminants condensed from the syngas) to remove chlorides and trace metals and to reduce the potential of equipment corrosion and formation of undesirable products in the AGR system. This is shown in 3.1-8.

**Figure 3.1-8 Syngas Scrubbing**

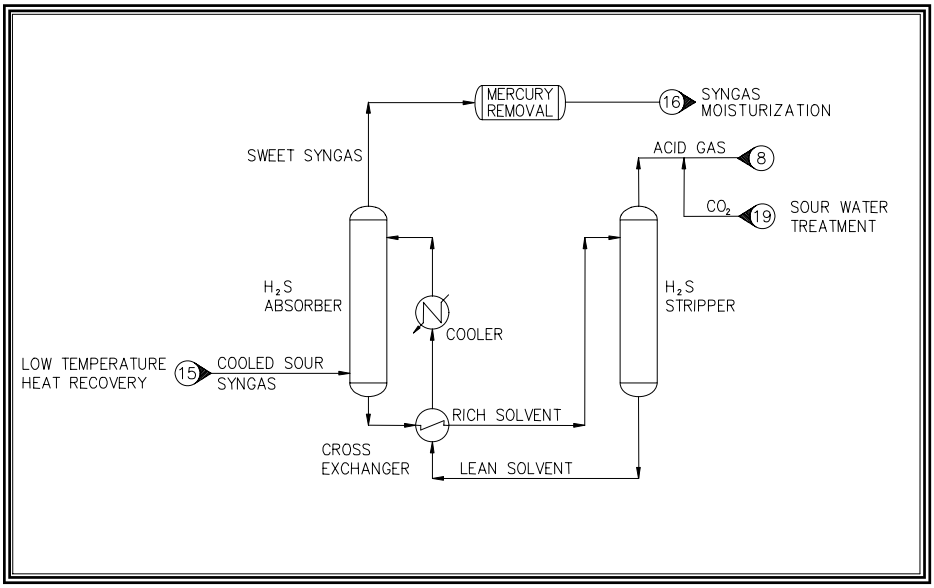



A COS hydrolysis unit is incorporated to achieve a high level of sulfur removal. The purpose of the COS hydrolysis step is to convert the small amount of COS in the syngas to $H_2S$, which can then be efficiently removed in the AGR system. After hydrolysis, the syngas is cooled in process heat exchangers to efficiently utilize the available but relatively low-temperature heat. Most of the ammonia ($NH_3$) and a small portion of the $CO_2$ and $H_2S$ present in the syngas are absorbed in the water condensed by this cooling step. Additionally, some of the trace metals that remained in their gaseous state during the particulate matter removal process will condense. The water is collected and sent to the sour water treatment unit. The cooled sour syngas is fed to the AGR system where sulfur compounds are removed to produce a low sulfur product syngas.

#### 3.1.5.3.4 Acid Gas Removal System

The AGR system (shown in Figure 3.1-9) contacts the cool sour syngas with an aqueous solution of MDEA, an amine absorbent that removes the $H_2S$ to produce a clean product syngas. MDEA chemically bonds with $H_2S$ with a bond that can be easily broken with low level heat in order to regenerate the absorbent. $H_2S$ is absorbed from the syngas by contacting the gas with the MDEA solution within the $H_2S$ absorber column. A portion of the $CO_2$ is also absorbed as well. The $H_2S$-rich MDEA from the bottom of the absorber flows to a cross heat exchanger to recover heat from the hot lean MDEA coming from the stripper. The heated rich MDEA is then directed to the $H_2S$ stripper where the $H_2S$ and $CO_2$ are removed at near atmospheric pressure. A concentrated stream of $H_2S$ and $CO_2$ exits the top of the $H_2S$ stripper and flows either to the carbon-capture system or directly to the SRU. The lean MDEA is pumped from the bottom of the stripper to the heat exchanger. The lean MDEA is further cooled before being stored and then recirculated to the absorber. This unit is a totally enclosed process with no discharges to the atmosphere.

**Figure 3.1-9 Acid Gas Removal**




#### 3.1.5.3.5 Potential Carbon Capture Retrofit

The Applicant believes that some form of state of federal greenhouse gas emissions control will be imposed within the next ten years. To provide the State and consumers with a means to deal with such requirements, the Applicant will design Mesaba One and Mesaba Two to be carbon capture ready. Additionally, the Applicant has contracted with the University of North Dakota Energy and Environmental Research Center ("EERC") to assess $CO_2$ management options for Mesaba One and Mesaba Two. This work is part of the Plains $CO_2$ Reduction Partnership[5],

[5]The Plains $CO_2$ Reduction Partnership is one of seven regional partnerships funded by the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program.

Phase II efforts EERC is conducting for DOE to validate the most promising sequestration technologies and infrastructure concepts identified during Phase I of the Program[6]. Sink-source pairs, specific to the composition of $CO_2$ gas streams that can be removed from the syngas produced by Mesaba One and Mesaba Two, will be identified and ranked according to engineering, economic, and public-acceptance considerations.

The carbon capture system that the Applicant will seek to engineer on a preliminary basis can be added after the IGCC plant is in operation. Based on work to date, such $CO_2$ capture facilities will likely be located within the existing IGCC Power Station Footprint and require an area of approximately 100' X 150' to accommodate necessary equipment. The preferred location for the future $CO_2$ capture equipment would be adjacent to the power block. For PRB coal, the Applicant would attempt to design facilities to capture approximately one third of the carbon (as $CO_2$) present in the solid IGCC feedstock. This capture would likely come at a decrease in capacity and an increase in heat rate of the IGCC plant.[7]

#### 3.1.5.3.6 Mercury Removal and Moisturization

Fixed beds of activated carbon will be provided to remove residual mercury from syngas (see Figure 3.1-9 above). Multiple beds specially impregnated to remove mercury are used to obtain optimized adsorption. The activated carbon capacity for mercury ranges up to 20% by weight of the carbon (Parsons, 2002). The mercury removal system will remove enough mercury from the syngas so that the mercury content of the syngas fuel is no more than 10% of the mercury contained in the solid IGCC feedstock. The mercury removal system will be located immediately upstream or immediately downstream of the AGR. The location will be determined during the next engineering phase of the project by working closely with carbon suppliers to identify the optimum location. After acid gas and mercury removal, the product syngas is moisturized, heated, and diluted with nitrogen for control of nitrogen oxides ("$NO_x$") before being combusted for power generation in the CTGs.

### 3.1.5.4 Sulfur Recovery Unit

The $H_2S$ carried along in the acid-gas from the AGR system is converted to elemental sulfur in the SRU. This technology is based on the industry-standard Claus process involving the conversion of the $H_2S$ to gaseous elemental sulfur and steam. The sulfur is selectively condensed and collected in molten form. See Figure 3.1-10.

The acid gas stream from the AGR units and the $CO_2$ /$H_2S$ stripped from the sour water are fed to the SRU. One-third of the $H_2S$ is combusted with oxygen to produce the proper ratio of $H_2S$ and

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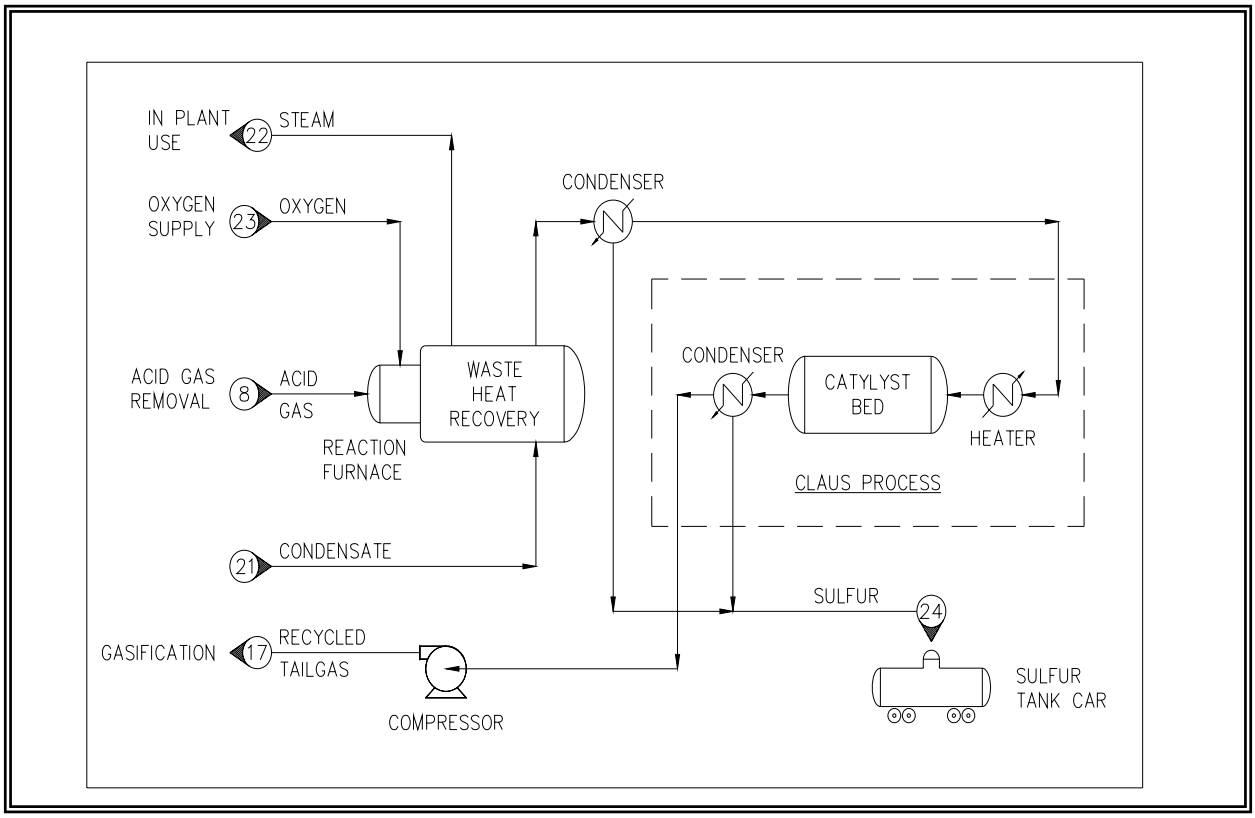
[6] Plains CO2 Reduction (PCOR) Partnership Phase I Final Report/Quarterly Technical Progress Report for the Period July 1-September 30, 2005; DOE Cooperative Agreement No. DE-PS26-03NT41982 EERC Fund Nos. 4251, 4334, 4406, and 9039, January 2006.

[7] These adverse economic and operational impacts associated with carbon capture are expected to be reduced by the research and development initiatives that are presently underway as part of the DOE's Clean Coal Power Initiative and related efforts. Research under these initiatives are attempting to develop the technological path to permit removal of an expected 90% of total $CO_2$.

$SO_2$, which are then reacted together to produce elemental sulfur gas in a reaction furnace. A waste heat boiler is used to recover heat before the furnace off-gas is cooled to condense the first increment of sulfur. Gas exiting the first sulfur condenser is fed to a series of heaters, catalytic reaction stages, and sulfur condensers where the $H_2S$ is incrementally converted to elemental sulfur. The sulfur is recovered and stored in molten form and may be sold as a by-product raw material for fertilizer and other beneficial uses. If not sold, the sulfur will be stored on site and/or transported to a storage facility.

**Figure 3.1-10 Sulfur Recovery Unit**




The tail gas from the SRU is composed primarily of $CO_2$ and nitrogen, with trace amounts of $H_2S$ and $SO_2$, as it exits the last condenser. This SRU tail gas is catalytically hydrogenated to convert the remaining sulfur species to $H_2S$ and then recycled to the gasifier. Recycling the SRU tail gas allows for a very high overall sulfur removal in the IGCC process and eliminates the need for a conventional tail gas treating unit and the associated $SO_2$ and $NO_x$ emissions to the atmosphere.

The sulfur production rate is dependent upon the sulfur content of the feedstock, and will vary from about 30 tons per day up to about 165 tons per day per IGCC unit. The sulfur storage tanks are considered part of the SRU system.

Condensed sulfur from the SRU is collected in the sulfur pit. The liquid sulfur drains into a pit which contains a pump well and sulfur pumps. Sweep nitrogen is introduced into the pit to

prevent the accumulation of an otherwise potentially explosive mixture of $H_2S$ and air, and to control fugitive emissions. The sweep nitrogen inlet and outlet are located at opposite ends of the pit to ensure proper sweep of the vapor space. The sweep nitrogen outlet is collected and recycled to the second stage of the gasifier. Nitrogen is used instead of air as it is readily available and as it is undesirable to return air back to the gasifier's second stage.

The liquid sulfur is pumped from the sulfur pit to a sulfur degassing unit. The sulfur degassing unit strips dissolved $H_2S$ out of the liquid sulfur. The degassed sulfur is pumped from the degassing unit to the sulfur storage tank. The stripped $H_2S$ stream is routed to the tail gas recycle stream to the gasifier.

Sulfur loading involves pumping liquid sulfur from the sulfur storage tanks to trucks or rail cars. The sulfur loading equipment will have vapor recovery systems to control fugitive emissions by returning displaced vapors to the storage tank.

The SRU is a totally enclosed process with no discharges to the atmosphere.

#### 3.1.5.5 Air Separation Unit

The air separation unit provides oxygen for the gasification process, and nitrogen for CTG $NO_x$ control and purging. The ASU contains an air compression system, an air separation cryogenic distillation system ("cold box"), an oxygen pump system and a nitrogen compression system. Two ASU equipment trains will be provided for each phase of the facility.

A multi-stage, electric motor-driven centrifugal compressor compresses filtered atmospheric air that may be combined with additional compressed air extracted from the gas turbines in the power block. The combined air stream is cooled and directed to the molecular sieve absorbers where moisture, carbon dioxide and atmospheric contaminants are removed to prevent them from freezing in the colder sections of the plant. The dry carbon dioxide-free air is separated into oxygen and nitrogen in the cryogenic distillation system. A stream containing mostly oxygen is discharged from the cold box as a liquid and stored in an intermediate oxygen storage tank, from which it is fed to the gasifier.

The remaining portion of the air is mainly nitrogen and leaves the ASU in three separate nitrogen streams. A small portion of the nitrogen is high purity and is used in the gasification plant for purging and inert blanketing of vessels and tanks. The largest, but less pure, portion of the nitrogen is compressed and sent to the combustion turbines for $NO_x$ emission control. A waste/excess nitrogen stream is vented to the atmosphere. There will be no emission of regulated air pollutants from the ASU.

#### 3.1.5.6 Slag Handling, Storage and Loading

The slag/water slurry from the gasifier (see 3.1-6 above) flows continuously into a dewatering bin. The bulk of the slag settles in the bin while water overflows into a settler in which the remaining slag fines are settled and concentrated. The slurry of fine slag particles from the bottom of the settler is recycled to the slurry preparation area, ensuring maximum carbon utilization. The clear water from the settler is passed through heat exchangers where it is cooled as the final step before being returned to the gasifier quench section.

Dewatered slag is transferred by in-plant trucks to the slag storage area from where it will be loaded into on-road trucks or rail cars for transport to market or storage. The dewatered slag is relatively inert. It is also still very moist, and will therefore not be a source of fugitive emissions.

#### 3.1.5.7 Combined Cycle Power Block

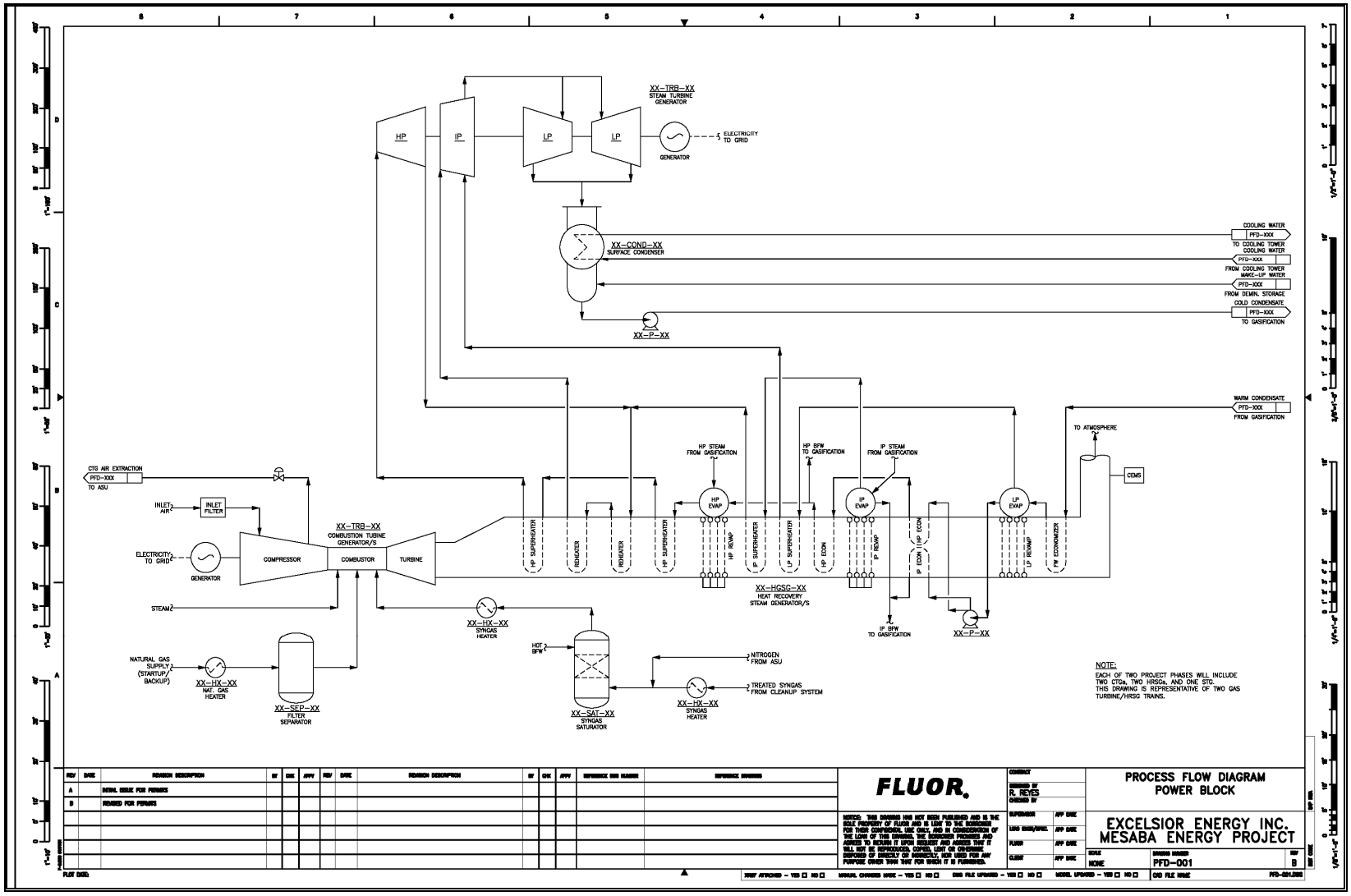
The power generation portion of the IGCC Power Station is similar to a conventional natural gas combined cycle plant. Combined cycle power generation is one of the most efficient commercial electricity generation technologies currently available. Each phase of the Project will include two "F Class" advanced CTGs configured to utilize syngas, two HRSGs, and a single STG. See Figure 3.1-11 below. The CTGs will convert the chemical energy contained in the syngas fuel to electricity both directly through the generators integral to the CTGs, and indirectly through the additional thermal energy contained in the CTG exhaust gas. The exhaust gas is converted to high-energy steam in the HRSGs and subsequently to a significant amount of additional electricity in the STG.

Preheated syngas from the gasification section and compressed air are supplied to the combustor of the combustion turbine and mixed through diffusion (a diffusion flame combustion turbine). Diluent nitrogen added to the syngas fuel reduces the flame temperature in the combustor and thereby reduces production of nitrogen oxides. The hot exhaust gas exiting the combustor flows to the expander turbine, which drives the generator to produce electricity and also turns the air compressor section of the combustion turbine. Hot exhaust gas from the expander is ducted through the HRSG to generate high-energy steam used to produce additional electricity in the steam turbine generator. Following heat recovery, the cooled CTG exhaust gas is discharged to the atmosphere through the HRSG stacks. The HRSG stacks will be provided with emission monitoring instruments as required to verify compliance with applicable emission standards and permit conditions.

The HRSG generates three pressure levels of steam and heats the boiler feed water for the syngas cooler in the gasification section. The HRSG also provides additional energy for superheating steam from the gasification section and cold reheat steam from the STG.

The steam turbine generator is comprised of high pressure ("HP"), intermediate pressure ("IP"), and low pressure ("LP") turbine sections, coupled directly to a generator. The LP turbine section exhausts to the surface condenser. Process heat from the gasification plant is used to preheat the condensate from the steam turbine condenser before it is returned to the HRSG to produce steam. STG exhaust steam is condensed in the surface condenser by indirect cooling with circulating cooling water from the cooling tower. The resulting steam condensate is recycled to the HRSG and other heat recovery equipment to once again produce steam for the STG.

**Figure 3.1-11 Illustration of Combined Cycle Concept**



### 3.1.6 Plant Utility Systems

#### 3.1.6.1 Tank Vent Collection/Boiler System

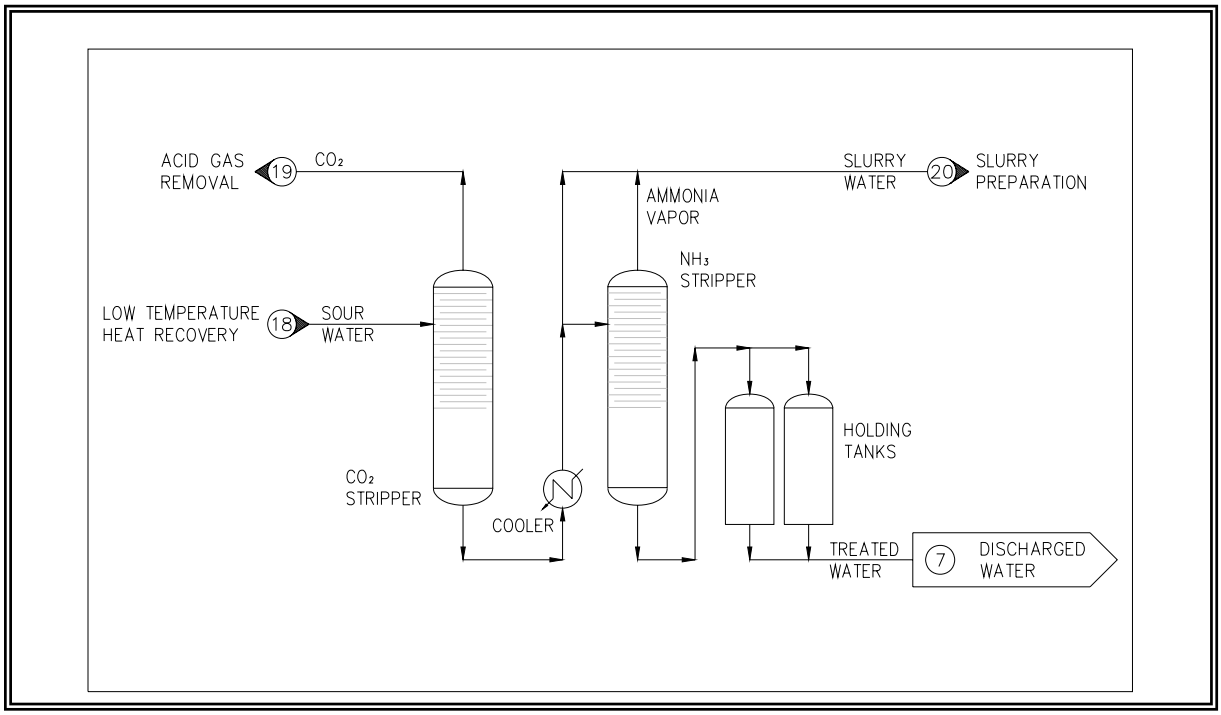
A tank vent collection/boiler system is used to convert each off-gas component in the tank vents to its oxidized form ($SO_2$, $NO_x$, $H_2O$, and $CO_2$) before venting to the atmosphere. The tank vent streams are composed primarily of air purged through various in-process storage tanks, and are routed to the tank vent boiler. This tank purge gas may contain very small amounts of sulfur-bearing components. The high temperature produced in the tank vent boiler thermally converts any $H_2S$ present in the tank vents to $SO_2$. Heat recovery in the form of steam generation is provided for the hot exhaust gas from the tank vent boiler before it is directed to a stack.

The slag handling dewatering system off-gas contains $H_2S$ which would be a source of relatively significant $SO_2$ emissions if vented to the tank vent system. Instead, in this part of the process, $H_2S$ is released from slag water as the pressure is reduced from approximately 400 psig to atmospheric conditions. Rather than vent this "flashed" gas to the tank vent boiler, a blower will combine it with either the tail gas from the SRU for recycle to the gasifier or the SRU feed gas from the AGR, thus eliminating this potential $SO_2$ emission source.

#### 3.1.6.2 Sour Water Treatment

Process water containing dissolved contaminant gases produced within the gasification process must be treated to remove these dissolved gases before being recycled to the coal grinding and slurry preparation area or being blown down to the Zero Liquid Discharge ("ZLD") System. The sour water treatment process is illustrated in Figure 3.1-12. The dissolved gases are driven from the water using steam-stripping. The steam provides heat and a sweeping medium to expel the gases from the water, resulting in a water purification level sufficient for reuse within the plant and/or for blowdown to the ZLD system.

**Figure 3.1-12 Sour Water Treatment**




Water condensed during cooling of the sour syngas contains small amounts of dissolved gases ($CO_2$, $NH_3$, $H_2S$ and other trace contaminants). The gases are stripped from the sour water in a two-step process. First, the $CO_2$ and most of the $H_2S$ are removed in the $CO_2$ stripper column by steam stripping and directed to the SRU. The water exits the bottom of this column, is cooled, and a major portion is recycled to feedstock grinding and slurry preparation. The rest is treated in an ammonia stripper column to remove the ammonia and remaining trace components. The stripped ammonia is combined with the recycled slurry water. A portion of the ammonia stripped water is blown down to the ZLD, with the rest being reused within the plant. Reuse of water within the gasification plant minimizes water consumption and discharge.

This unit is a totally enclosed process with no discharges to the atmosphere.

### 3.1.6.3 Zero Liquid Discharge System

#### 3.1.6.3.1 Gasification Island: West and East Range IGCC Power Station

Water from the bottom of the ammonia stripper is treated in a ZLD unit. The blowdown stream is pumped to a brine concentrator which uses steam or vapor compression to indirectly heat and evaporate water from the wastewater stream. Generated water vapor is compressed and condensed, and the high quality distillate is recycled to the syngas moisturization system or to other water uses in the plant. The concentrated brine is further processed in a heated rotary drum dryer/crystallizer. There the remaining water is vaporized and a solid filter cake material is collected for proper disposal. Use of the ZLD system effectively prevents contaminants in the feedstocks from being discharged with the plant wastewater.

#### 3.1.6.3.2 Elimination of Cooling Tower Blowdown: East Range Site

Stringent conditions applying to discharges of mercury in the Lake Superior Basin watershed make it necessary for the East Range IGCC Power Station to eliminate all direct wastewater discharges to receiving waters (the Station will discharge sanitary wastewaters to the Hoyt Lakes POTW). Elimination of cooling tower blowdown (see Section 3.3.4.2 for a description of this non-contact cooling wastewater stream) – the only process wastewater stream to be generated by the IGCC Power Station – will be accomplished via a second ZLD system serving the power block and gasification island cooling towers. The ZLD treatment system for the Station's cooling tower blowdown would consist of three steps to optimize energy consumption: a clarifier for suspended solids removal, a reverse osmosis ("RO") system to concentrate the dissolved solids, and a brine concentrator/crystallizer to remove water from the dissolved solids.

The cooling tower blowdown water and other non-oily water streams will be processed first via a clarifier to remove suspended solids. The sludge generated will be processed through a dewatering system consisting of a thickener/filter press. The 25% dry cake produced will be trucked offsite for disposal. Trace levels of ferric chloride or ferric sulfate would be added to promote flocculation. The sludge is expected to be non-hazardous and will be tested to confirm such condition.

The overflow from the clarifier will be sent via pressure filters to a reverse osmosis system. The permeate or product water will be recycled to the cooling tower basin to reduce makeup water usage (a 75% recovery is expected). The concentrated reject from the RO will be sent to a ZLD comprised of a mechanical vapor recompression ("MVR") evaporator or similar equipment and crystallizer and the concentrated crystals will be disposed offsite and the recovered distillate will be sent to the boiler feed water mixed bed unit for further polishing and reuse in the HRSGs. The crystallized solids are expected to be non-hazardous. Any excess distillate water can be returned to other water users or the cooling tower basin.

The cycles of concentration ("COC") in the cooling towers will be maintained between 8 and 10 cycles because of the high magnesium and sulfate in makeup water from Mine Pit No. 6 (see Section 3.4.1.1.6).

### 3.1.6.4 Auxiliary Boilers

Two auxiliary boilers, one for each phase of the IGCC Power Station, will provide steam for pre-startup equipment warmup and for other miscellaneous purposes when steam from the gasifiers or HRSGs is not available. These boilers will provide steam in addition to, or in lieu of, the steam that can be generated from the tank vent boilers. Each boiler will produce a maximum of about 100,000 lb/hr of steam and will be fueled by only pipeline natural gas. Annual operation of each boiler will be at or less than 25% of the year at maximum capacity. Boilers will be equipped with low $NO_x$ burners to minimize emissions.

### 3.1.6.5 Flare

The gasification island elevated flare is utilized to burn partially combusted natural gas and scrubbed/desulfurization off-specification syngas during unit startup or on-specification syngas during short-term combustion turbine outages. Syngas sent to the flare during normal planned

flaring events will be filtered, water-scrubbed and further treated in the AGR and mercury removal systems to remove regulated contaminants prior to flaring. Flaring of untreated syngas or other streams within the plant will only occur as an emergency safety measure during unplanned plant upsets or equipment failures. The elevated flare is estimated to be approximately 185 feet in height.

One 2 MW emergency diesel generator will be used for the gasification island and a 350 kW emergency diesel generator will be used for the power block. One or two nominal 300 hp diesel-driven firewater pumps will be provided for each phase (emission estimates are based on having two firewater pumps per phase). These engines will burn very low sulfur distillate oil. Other than plant emergency situations, the engines will be operated less than five hours per month per engine for routine testing, maintenance, and inspection purposes.

### 3.1.7 Major Process Equipment

The major functional process equipment provided for the inside the boundary limit (ISBL) facilities for the IGCC Power Station are identified below. The number of trains and percentage train capacity for each of the functions/components are also identified. Capacities for some of the major components are identified.

#### 3.1.7.1 Air Separation Unit (2x 50%)

- Air Separation Unit (2,507 tons per day/train, based on PRB1 coal operation)
- $N_2$ Booster Compressor for CTG Injection
- Liquid Oxygen and Liquid Nitrogen storage

#### 3.1.7.2 Feedstock (Coal/Petroleum Coke) Handling (1 x 100%)

- Feedstock Active Storage (20 days based on PRB1 coal)/Conveying/Reclaiming (based on 8,550 tons/day, as received)
- Feedstock Inactive Storage (45 days based on PRB1 coal)
- Flux Storage (silos)/Conveying/Reclaiming (250 tons per day based on 50:50 blend of PRB2:PRB3 coals)
- Rotary Railcar Unloading Facilities and Thaw Shed (Feedstock)
- Dust Collectors for enclosed feedstock storage areas
- Truck Unloading Facilities (Flux)

#### 3.1.7.3 Gasification Island (3 x 50%)

- Coal Grinding and Slurry Preparation (2 x 60%)
- Gasification (4,275 tons per day design coal, as received, per gasifier, based on PRB1 coal)
- High Temperature Heat Recovery
- Dry Char Removal
- Slag Grinding (1 x 100%)
- Slag Dewatering (1 x 100%)

- Slag Storage and Loading System (1 x 100%) (800 tons per day [wet basis], based on 50:50 blend of PRB2:PRB3 coals)

#### 3.1.7.4 Syngas Treating (2 x 50%)

- Gas Scrubbing
- Low Temperature Syngas Cooling
- COS Hydrolysis
- Recycle Gas Compression
- Acid Gas Removal
- Acid Gas Enrichment (1 x 100%)
- Mercury Removal
- Syngas Moisturization
- Sour Water System (1 x 100%)

#### 3.1.7.5 Sulfur Recovery and Tail Gas Recycle (2 x 50%)

- Claus Plant Sulfur Recovery ($O_2$-Blown), (Up to 83 tons per day/train, based on high sulfur Illinois #6 operation)
- Molten Sulfur Storage
- Molten Sulfur Truck/Rail Loading Facilities (1 x 100%)
- Tail Gas Recycle (1 x 100%)
- Tank Vent Gas Incineration (1 x 100%)

#### 3.1.7.6 Power Block

- CTG (2 x 50%) (232 MW nominal each, based on Siemens-Westinghouse SGT6-5000F combustion turbine assumed for environmental permitting)
- Heat Recovery Steam Generator and Exhaust Stack (2 x 50%)
- Steam Turbine-Generator (1 x 100%), (Up to 300 MW nominal)
- Surface Condenser (1 x 100%)
- Vacuum, Condensate and Boiler Feedwater Systems (1 x 100%)
- Power Block Circulating Water System
- Raw Water/Demineralizer Water Tankage/Pumps
- Demineralizer System
- Filtered Raw Water, Firewater/Tankage/Pumps
- Wastewater Collection/Wastewater Separation
- Plant and Instrument Air
- Step-up Transformers

#### 3.1.7.7 General Facilities (1 x 100%)

- Gasification/ASU Cooling Water/Tower System
- Zero Liquid Discharge Unit (for Process Condensate Blowdown)
- Process Condensate Blowdown Holding Tank
- Gasification Unit Flare

- Emergency Diesel Generator
- Natural Gas Distribution
- Drains and Blowdowns
- Nitrogen Distribution
- Potable and Utility Water
- Sanitary Sewage System
- Storm Water Collection and Treatment

#### 3.1.7.8 Dominant Structures and Other Buildings Associated With the IGCC Power Station

From visual and air quality modeling perspectives, the dominant structures on site include the following:

- Combustion Turbine Generator Building (230 feet x 180 feet x 75 feet high)
- Steam Turbine Generator Building (170 feet x 140 feet x 90 feet high)
- Air Separation Unit Building (375 feet x 140 feet x 70 feet high)
- Heat Recovery Steam Generator (110 feet x 55 feet x 90 feet high)
- Rod Mill Feed Bins (155 feet x 25 feet x 150 feet high)

These structures and their proximity to the IGCC Power Station's point and fugitive emission sources are identified in Figure 3.1-1 and Figure 3.1-2. The finished grade elevations of the West Range IGCC Power Station Footprint are provided in Figure 3.2-3. The East Range grade elevations are provided in Figure 3.2-5

Other buildings associated with the IGCC Power Station include the control room, administration building, warehouse/maintenance shop, combustion turbine and steam turbine buildings, weather enclosures for the ASU compressors, slurry preparation, water treatment/lab, railcar thaw shed, switchyard control room, several power distribution centers, and a visitor's center.

### 3.1.8 Expected Process Operating Characteristics

The IGCC Power Station will be designed to process a relatively wide variety of feedstocks, including sub-bituminous coal, bituminous coal and petroleum coke. As noted previously in Section 3.1.3, feedstock variability has been considered along with critical components and operating conditions known to influence plant performance (for example, the combustion turbine selected, its operating mode, the operating mode of the gasifier, and ambient conditions) to identify the operating conditions which would provide a reasonable upper limit or "worst case" scenario for potential pollutant emissions/discharges. Table 3.1-1 quantifies such conditions assuming operation of the gasifier in PSQ mode while Table 3.1-2 assumes operation of the gasifier in FSQ mode. Pollutant emissions, discharges, and waste products are quantified assuming the conservative PSQ conditions (see Section 3.4).

**Table 3.1-1**
**Key Performance Indicators Used to Assess Worst Case Environmental Impacts of IGCC Power Station (Phase I, PSQ Mode)**

| Performance Parameter | Estimated Range | Comments |
|---|---|---|
| CTG gross power, MW | 440 | Total for two CTGs |
| STG gross power, MW | 265 - 300 | Varies depending on quantities of steam generated by Gasification Island and HRSGs |
| Net plant generation, MW | 580 - 606 | Output from CTGs plus STG, less internal consumption and losses |
| Coal/coke feed rate, tons/day (as received) | 5,300 -8,550 | Feed rate to gasifiers |
| Coal/coke feed energy, million Btu/hr (HHV) | 5,280 – 5,910 | Energy content of gasifier feedstock |
| Product syngas energy, million Btu/hr (HHV) | 4,190 – 4,368 | Energy content of syngas fuel delivered to CTGs |
| Coal conversion efficiency | 0.71 – 0.80 | Fraction of solid feedstock energy in syngas feed to CTGs |
| Net overall heat rate, Btu/kW-hr (HHV) | 8,900 – 9,500 | Solid feedstock energy used per unit of net electricity to grid |
| Flux feed, tons/day | 0 - 250 | Process additive for gasifier feedstock |
| Slag by-product production, tons/day | 500 - 800 | Varies depending on feedstock composition and flux use |
| Sulfur by-product production, tons/day | 30 – 165 | Varies depending on feedstock composition |

**Table 3.1-2**
**Expected IGCC Power Station Operating Characteristics (Phase I, FSQ Mode)**

| Feedstock: | PRB-1 | PRB-1 | PRB-1 | 50/50 Wt% PRB2/PRB3 | Illinois No. 6 | Sizing Basis |
|---|---|---|---|---|---|---|
| Ambient Temperature: | 38°F | 80°F | -20°F | 38°F | 38°F | |
| Power Generation | | | | | | |
| SW SGT6-5000F CTG (x2) | 440 MW | 440 MW | 440 MW | 440 MW | 440 MW | 440 MW |
| Steam Turbine-Generator | 300 MW | 300 MW | 288 MW | N/A | N/A | 300 MW |
| Gross Power | 740 MW | 741 MW | 728 MW | N/A | N/A | 741 MW |
| Less ASU Auxiliary Load | - 98 MW | -106 MW | - 97 MW | N/A | N/A | N/A |
| Less Internal Consumption | - 37 MW | - 37 MW | - 35 MW | N/A | N/A | N/A |
| Net Power (for Export to Grid) | 606 MW | 598 MW | 596 MW | N/A | N/A | 606 MW |
| Coal Feed (as received), tons/day | 8225 | 8119 | 8136 | 7397 | 5477 | 8225 |

| Feedstock: | PRB-1 | PRB-1 | PRB-1 | 50/50 Wt% PRB2/PRB3 | Illinois No. 6 | Sizing Basis |
|---|---|---|---|---|---|---|
| Coal Feed (dry), tons/day | 5716 | 5643 | 5655 | 5461 | 4957 | 5716 |
| Coal Feed (HHV), MMBtu/hr | 5688 | 5616 | 5627 | 5592 | 5288 | 5688 |
| Plant Heat Rate (HHV), Btu/kWh | 9391 | 9397 | 9439 | 9412 | 9033 | N/A |
| Oxygen Feed (contained), stpd | 5014 | 4950 | 4960 | 5005 | 3894 | 5014 |
| Flux Feed, stpd | 0 | 0 | 0 | 233 | 0 | |
| Design capacity, stpd | | | | | | 233 |
| Slag Produced, stpd | 501 | 495 | 496 | 774 | 772 | |
| Design capacity, stpd | | | | | | 774 |
| Sulfur Produced, stpd | 30 | 29 | 29 | 45 | 162 | |
| Design capacity, stpd | | | | | | 162 |

The composition and properties of the product syngas will vary depending on the solid feedstocks processed and Power Station operating conditions.

Table 3.1-3 shows the expected range of syngas composition and fuel heating value.

**Table 3.1-3**
**Estimated Product Syngas Composition Multiple Feedstock Plant (Phase Independent)**

| Component [1] | Range |
|---|---|
| Hydrogen, vol % | 30 – 40 |
| Carbon monoxide, vol% | 35 – 50 |
| Carbon dioxide, vol% | 13 –26 |
| Methane, vol% | 1 – 5 |
| Nitrogen plus argon, vol% | 2 – 3 |
| Higher heating value, Btu/scf [2] | 240 – 305 |

[1] Parameters shown for dry syngas fuel prior to nitrogen dilution.
[2] Standard conditions defined as 60 $^{o}$F, one atmosphere pressure.

## 3.2 IGCC POWER STATION FOOTPRINT

### 3.2.1 Site Independent Features

The IGCC Power Station Footprint for Mesaba One will encompass about 100 acres. An additional 80 acres of land will be required for a temporary construction laydown area for Mesaba One equipment, and five acres for a concrete batch plant. Current plans call for the Mesaba Two Footprint to be very similar to that for Mesaba One (requiring a IGCC Power Station Footprint of about 200 acres total). As required during construction of Mesaba One,

Mesaba Two would require an additional 80 acres of land for a temporary construction laydown area and five acres for a concrete batch plant.

Figure 3.2-1 illustrates the layout plan for Mesaba One and Mesaba Two. An artist's visualization of the Phase I and II Developments is shown in Figure 3.2-2 (the visualization does not reflect the Site-specific grading plans outlined for the Phase I and II Developments in the following two subsections). The final surfaces proposed for the Phase I and II Developments are shown in Figure 3.2-6 and a drainage plan is provided in Figure 3.2-7.

The final surfaces proposed for the Phase I and II Developments are shown in Figure 3.2-6 and a drainage plan is provided in Figure 3.2-7.

Easements across public and private lands will be required for the IGCC Power Station's Associated Facilities and Additional Lands. The location of such easements is Site specific. The Site-specific plans for such easements are discussed Section 7 and Section 8 for the West Range and East Range Sites, respectively.

### 3.2.2 West Range Site

Figure 3.2-3 provides a preliminary grading plan that shows how the Phase I and II Developments within the IGCC Power Station Footprint will be accommodated. Figure 3.2-4 provides the cross sections of the Phase I and II Developments that are identified on Figure 3.2-3. Additional Lands required to accommodate Associated Facilities outside the IGCC Power Station Footprint are discussed in Section 7. High surficial groundwater levels in soils in the vicinity of the West Range IGCC Power Station may require permanent water table control measures beyond temporary construction dewatering.

### 3.2.3 East Range Site

The grading plan for the East Range IGCC Power Station Footprint is shown in Figure 3.2-5. The East Range plan will not require the same degree of "terracing" as the West Range IGCC Power Station Footprint. The grading plan for the East Range Site will result in about a 10-foot change in elevation from one side of the Station's Footprint to the other (the change in elevation across the West Range IGCC Power Station Footprint varies about 50 feet). Additional accommodations must be made within the Station Footprint for the additional ZLD system not required at the West Range Site, sized to totally eliminate discharges of cooling tower blowdown (See Section 3.6.1.2).

**Figure 3.2-1 Phase I and II IGCC Power Station Layout**

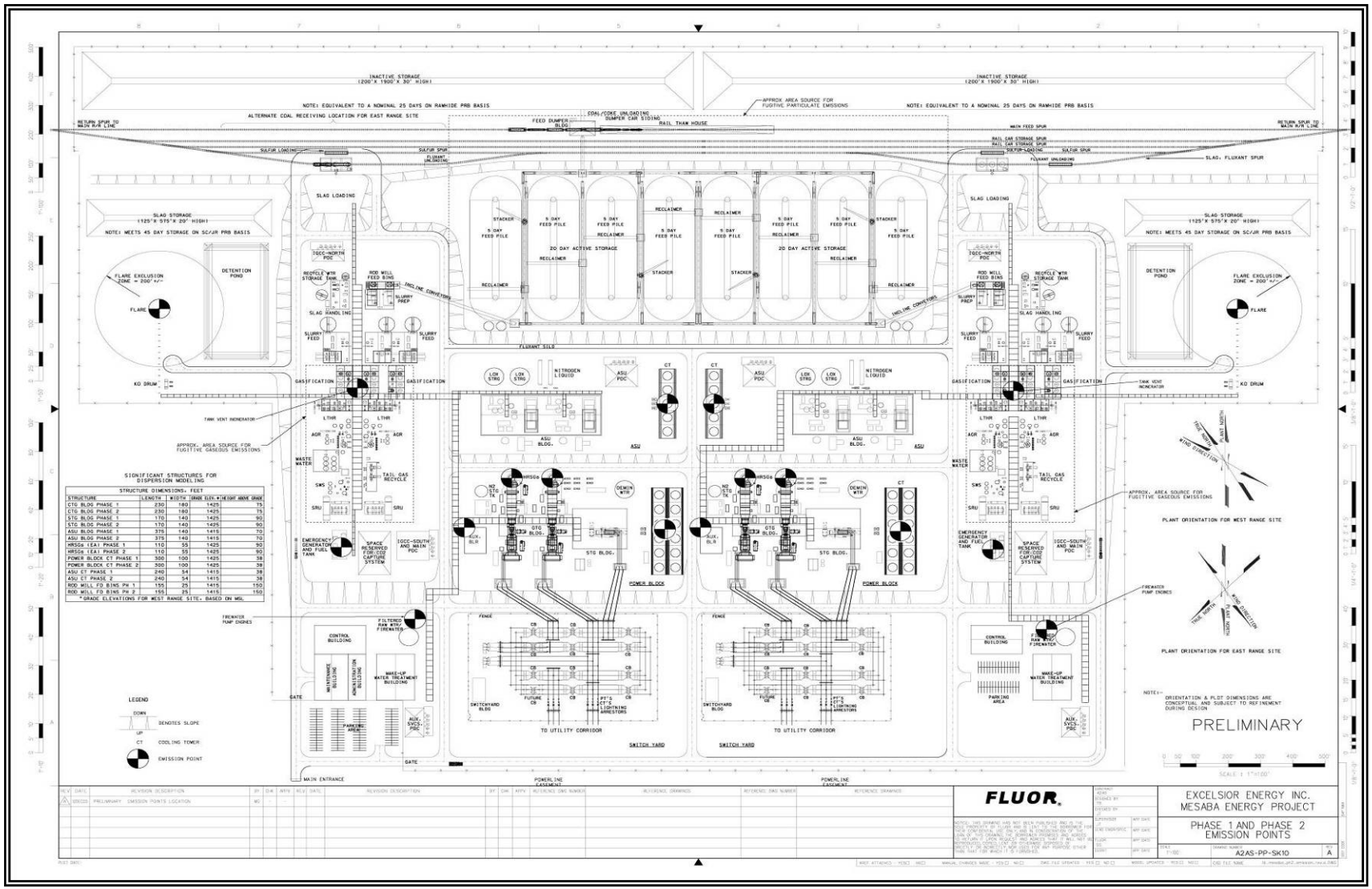


**Figure 3.2-2 Artist's Visualization of Phase I and Phase II IGCC Power Station**

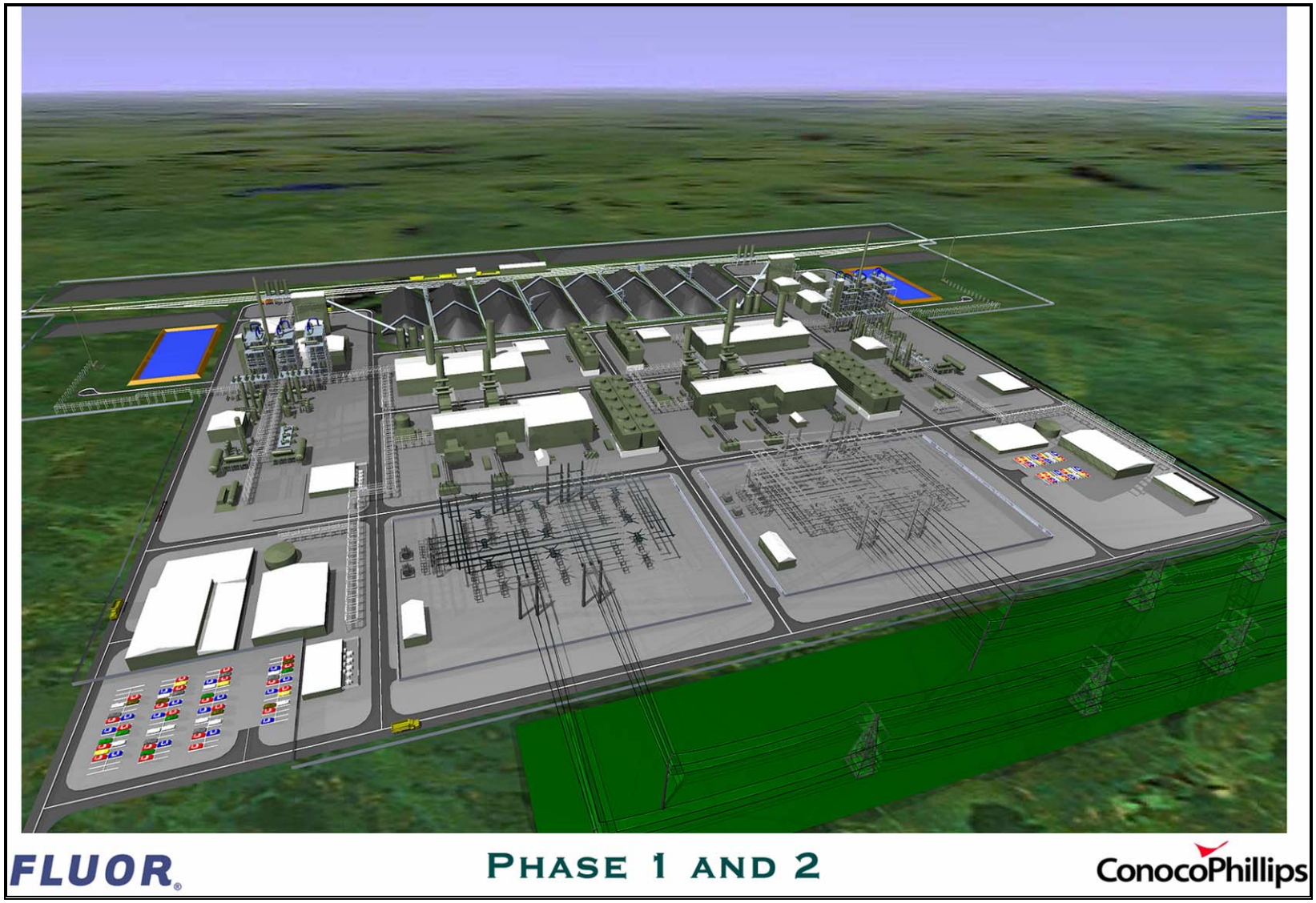


**Figure 3.2-3 Preliminary Grading Plan for Phase I and II IGCC Power Station on West Range Site**

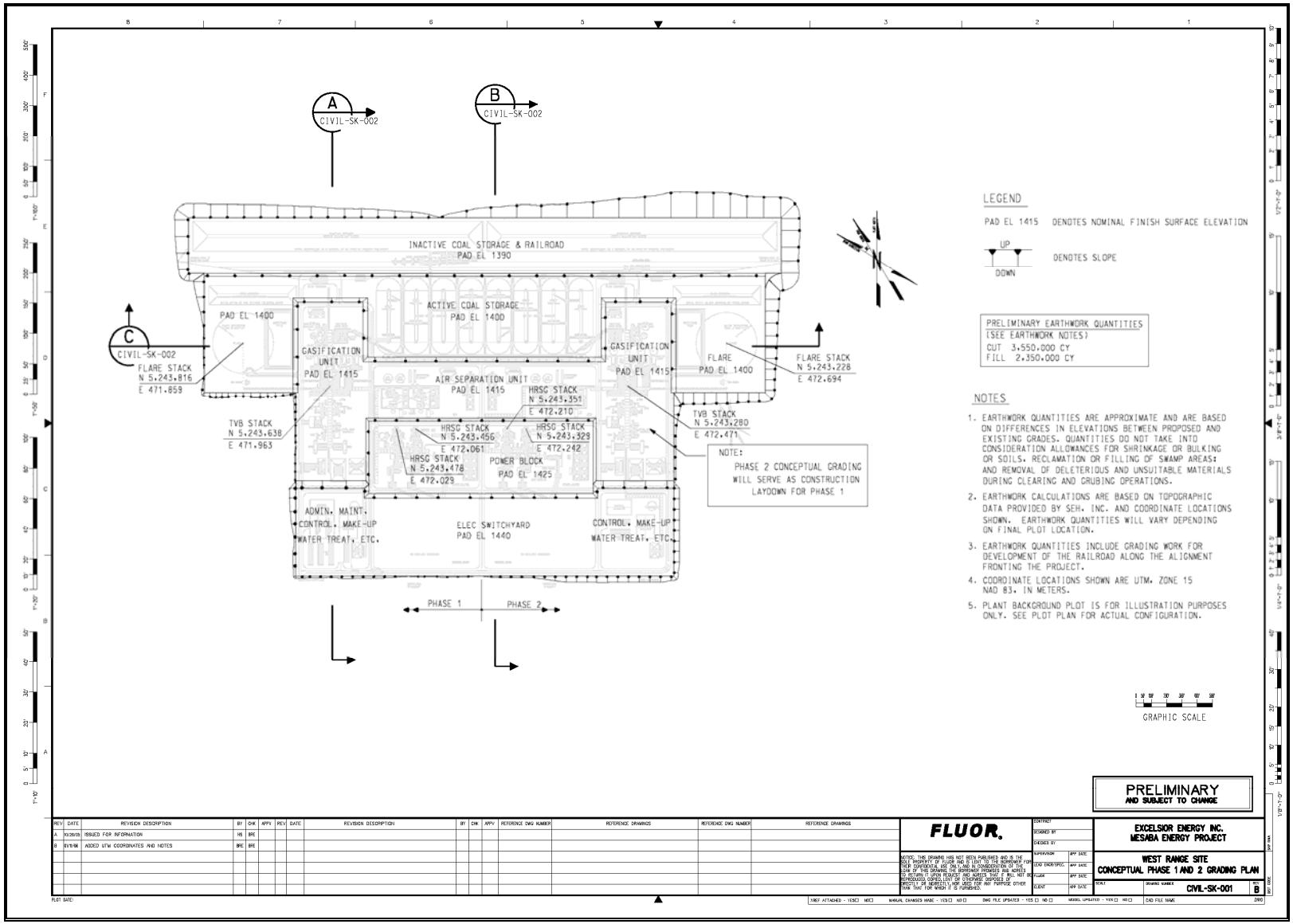


**Figure 3.2-4 Cross Sections of Phase I and II IGCC Power Station on West Range Site**

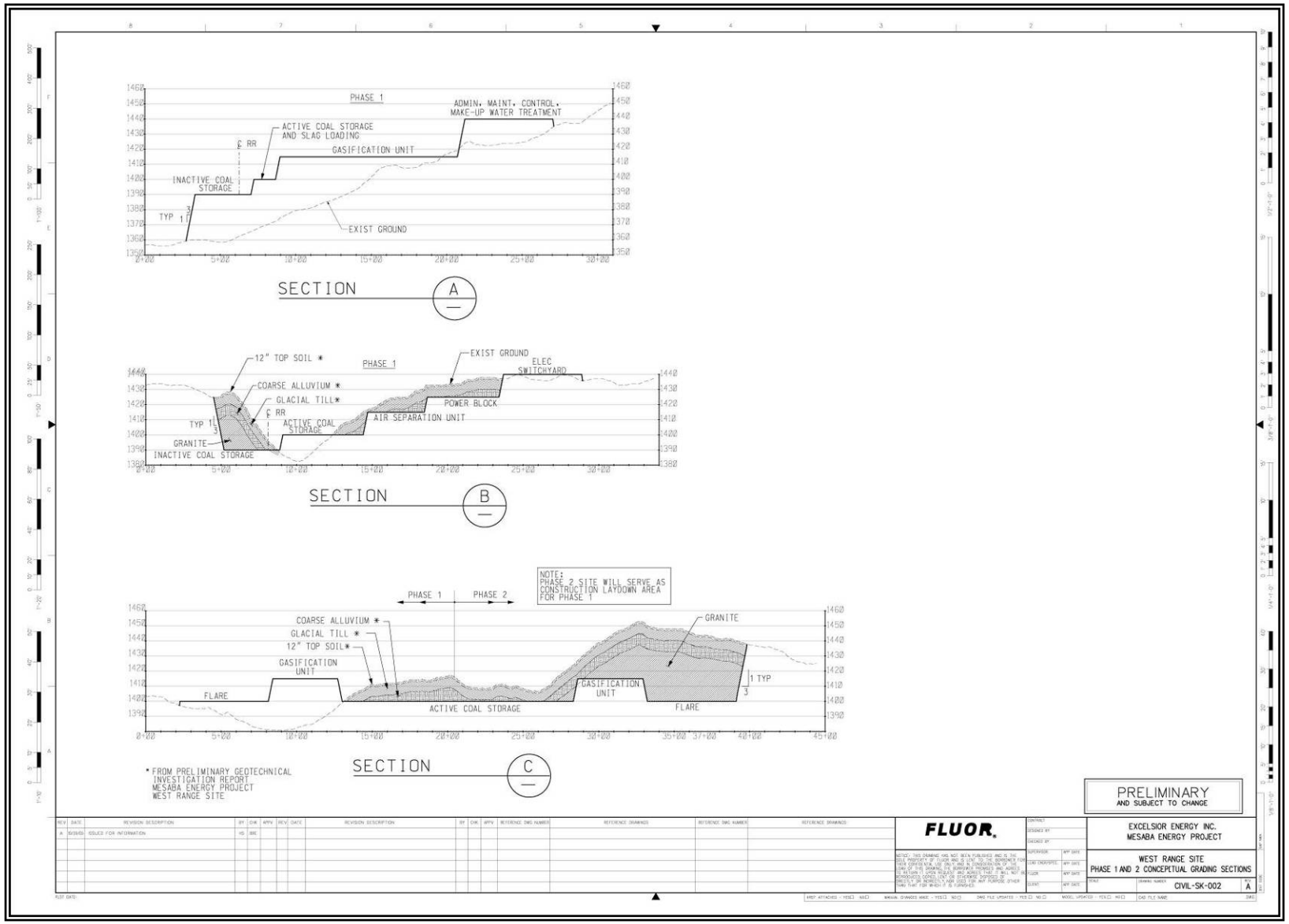


**Figure 3.2-5 East Range Grading Plan**

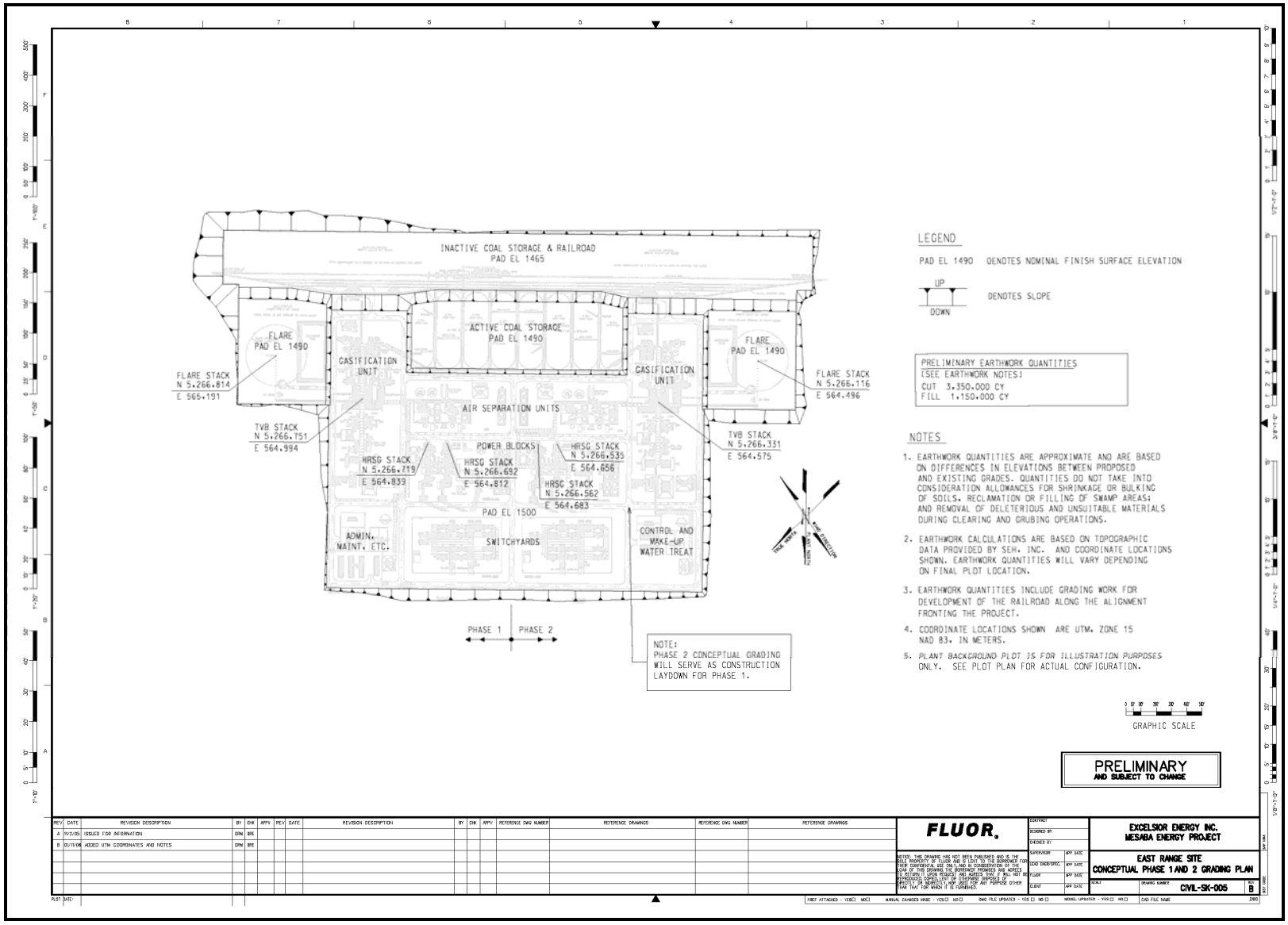


**Figure 3.2-6 Surfacing Plan for Phase I and II Developments**

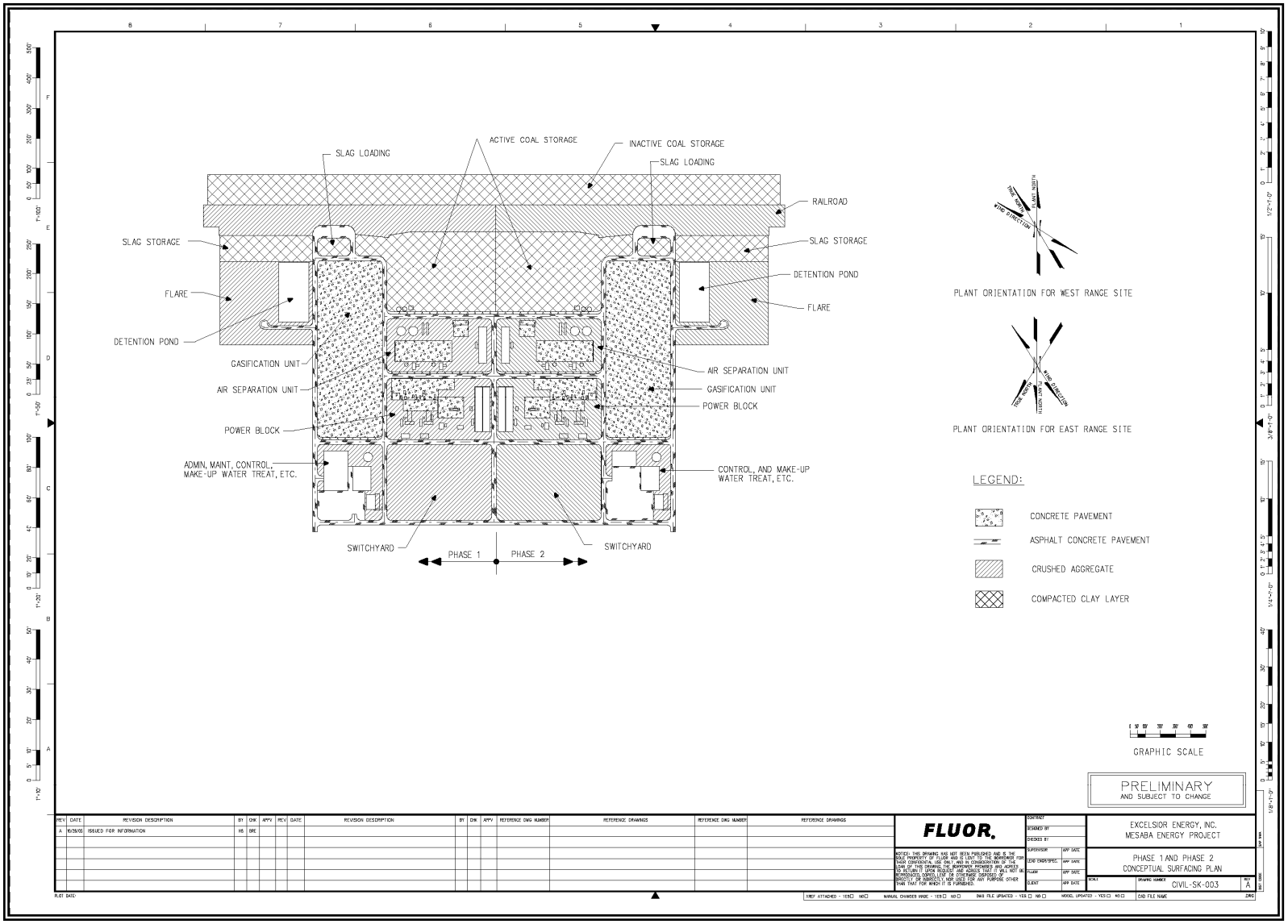
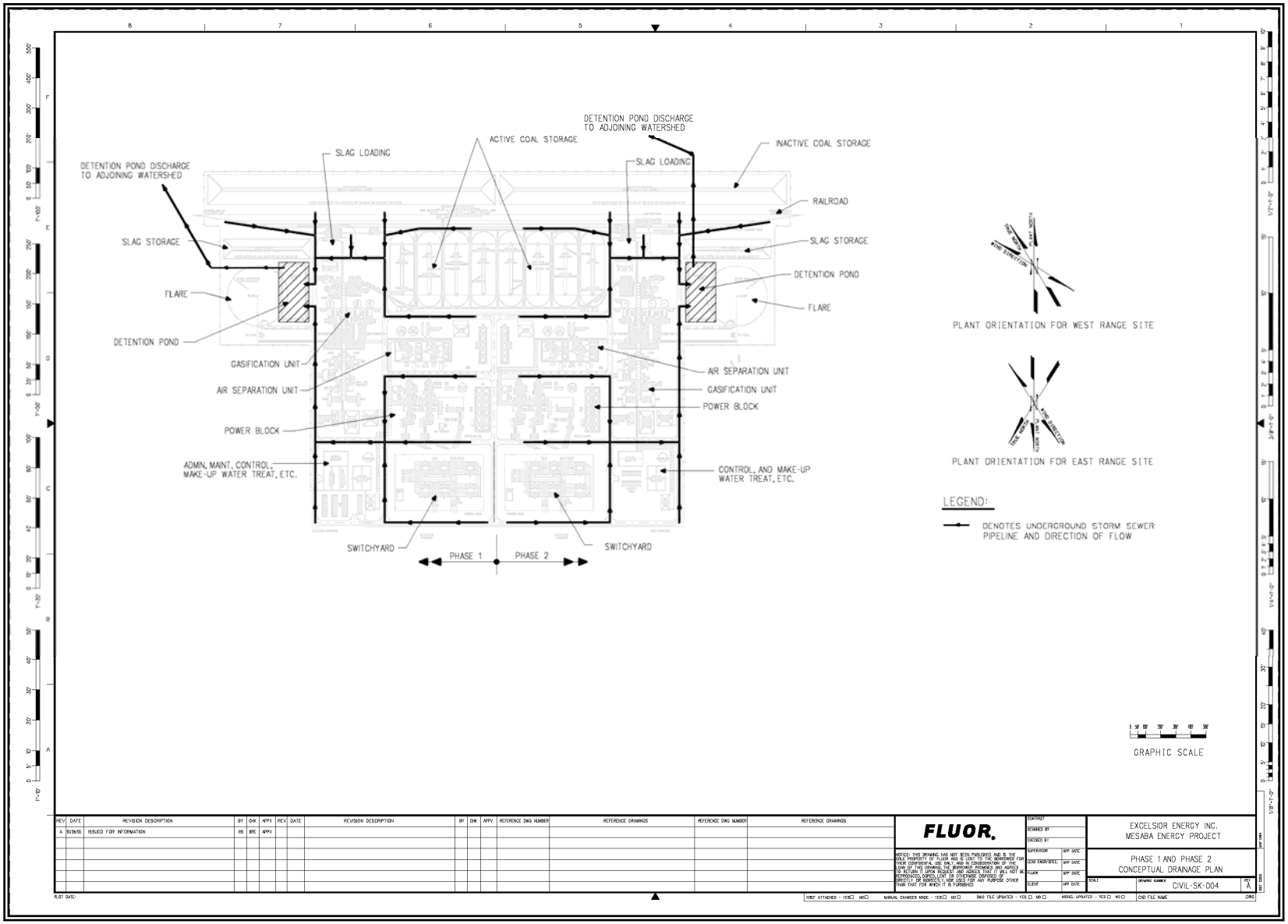


**Figure 3.2-7 Current Drainage Plan for Phase I and II Developments**



## 3.3 RESOURCE INPUTS

### 3.3.1 Feedstocks

#### 3.3.1.1 Delivery

Coal and petroleum coke feedstocks will normally be received by rail in dedicated unit trains from the mine or refinery. Rail access to the West Range IGCC Power Station is from existing BNSF Railway and Canadian National Railroad tracks; rail access to the East Range Site is limited to the Canadian National Railroad. The rail loop at either location will be designed to accommodate unit trains up to 135 cars in length with the average unit train shipment expected to be comprised of 115 cars. Each unit train car will carry on average about 119 tons of feedstock (BNSF, 2005).

Each phase of the IGCC Power Station, under the maximum feedstock input case and assuming gasifier operations in FSQ mode, will require a maximum of 8,230 tons of coal per day on an as received basis. Assuming PSQ operation of the gasifiers, the daily maximum would increase to 8,550 tons on an as-received basis.

One 135 car unit train can deliver about 16,100 tons of coal and each 115 car unit train about 13,700 tons. With Mesaba One and Two operating at full load with the gasifiers in FSQ mode, a maximum 16,460 tons of coal feedstock per day will be consumed, requiring the delivery of about five 115 car unit trains every four days (slightly more than one 115 car unit train per day). With the gasifiers operating in PSQ mode, Mesaba One and Two would require under full load operations a maximum of about 17,100 tons of coal per day, thus not substantively changing the worst case, short term fuel delivery schedule. Approximately four hours time will be required to unload one unit train. Three unit trains per day (midnight to midnight) is the maximum fuel shipment that could be received and unloaded at the plant, but such a schedule would not normally occur.

Mesaba One will utilize approximately 2.7 million tons of feedstock annually assuming operation at a 90 percent capacity factor. Fuel selection throughout the lifetime of the Power Station is expected to be made pursuant to a competitive solicitation process, with selection based upon the terms offered by various suppliers and transportation rate considerations.

The availability of multiple rail transportation modes at a site will enhance the long-term benefits of the fuel-flexible plant design. An important element in the site selection process addressed whether a site could be served by more than one rail provider via its own trackage. This capability introduces the potential for competition into the fuel supply equation and should result in lower fuel costs over the life of the Project relative to what they would be absent such rail competition. The West Range Site offers two major coal transport alternatives, the BNSF and CN, each having direct access to the IGCC Power Station by the construction of short spurs to the Station Footprint. The East Range Site has the CN within immediate vicinity of the Station Footprint, and also has the potential physical capability to receive shipments of fuel via water at Taconite Harbor, with transportation to the site via CE's 70 mile rail line which served the former LTV Mining operations. This alternative is not considered to be cost competitive with the CN rail alternative under current market conditions.

#### 3.3.1.2 Receiving and Storage

The feedstock handling system will include facilities necessary to unload solid feedstock materials, convey them to storage areas, store them until required, reclaim them from storage, blend them as necessary, and convey the blended materials to the slurry preparation system. On-site storage facilities will be provided for two feedstock materials, coal and petroleum coke. Storage facilities will also be provided for flux, a feedstock conditioning material. The feedstock storage facilities will include, for each phase of the facility, approximately 20 days of active storage and approximately 25 days of inactive storage. The storage areas will incorporate dust suppression systems (including covered conveyers and other enclosures, dust suppression sprays, and vent filters) and will be paved, lined, or otherwise controlled to enable collection and treatment of storm water runoff and prevent infiltration to ground water of chemical species leached from feedstock materials and/or flux.

Unloading facilities will include a thawing shed to loosen frozen cargo during the winter season, and a partially enclosed rotary car dumping system. After the locomotive on a unit train positions the first car in the rotary dumper, subsequent cars are placed in the dumping position by an automatic electro-hydraulic positioner. Such rail car positioning systems reduce the run time of the locomotive or switch engine and the emissions that would otherwise occur if engines were required to run during the entire unloading process (the rail car unloading system allows all but one engine to be shut down, that engine being operated at a reduced load to maintain air pressure in the brakes). Feedstock materials fall from the rotated cars into an enclosed pit from which such materials are transferred via a feeder/conveyor system to active storage pile stackers. Four active storage piles for each phase of the facility will provide working feedstock storage. Additional inactive storage will be located on the opposite side of the rail sidings to provide a reserve source of feedstock material in the event normal deliveries of unit trains are interrupted. If needed, feedstock from the inactive pile will be moved by mobile equipment (bulldozers, scrapers, and/or front-end loaders) to the rail unloading pit to access the automated plant feed system. Reclaimers and conveyors will move coal/petcoke from the active piles to the slurry feed preparation area.

The feedstock handling/storage systems and their associated emission controls are further reviewed in Sections 3.4.1.1.5 and 3.4.1.1.6 where annual estimates of fugitive particulate matter emissions attending operation of the IGCC Power Station are provided.

#### 3.3.1.3 Feedstock and Feedstock Characteristics

Mesaba One and Mesaba Two are designed to be "fuel flexible" throughout their economic lifetime. While conventional pulverized coal (PC) fired power plants can sometimes use a limited range of fuels, they must be designed for a specific performance fuel. When using other fuels, the performance and output of these PC plants typically deteriorate. Fuel flexibility will allow the Mesaba One and Mesaba Two to operate at or near maximum capacity using:

- 100% bituminous coal (for example, Illinois No. 6 coal)
- 100% sub-bituminous coal (for example, Power River Basin coal)
- Up to a 50:50 coal/petroleum coke ("pet coke") blend
- Other blends of these fuels

This fuel flexibility, made possible by the use of IGCC technology and the design parameters for the Applicant's IGCC Power Station, will provide ongoing future cost benefits because it allows the Station to adapt its fuel mix over the life of the facility to minimize the cost of power. Fuel flexibility provides Mesaba One and Mesaba Two a hedge against physical dependency upon a single fuel supplier or transportation provider, and in the event of supply disruptions from any mine or carrier. Table 3.3-1 presents the feedstock design specifications being utilized to design the Project's unique feedstock flexibility.

Although the primary fuel source for electric power production will be coal-derived synthesis gas, the Project will also be capable of operating on pipeline natural gas. The power island is a combined-cycle unit, optimized for operation on syngas. This ability to operate on natural gas provides an additional source of available generating capacity (and reliability for periods when the gasification island is unavailable). In addition, it offers the option of installing the combined-cycle power island early in the construction process (that is, ahead of the gasification island), thereby allowing for electricity production from natural gas until the gasification island is installed and the unit begins full base load operation on coal-derived syngas. Although not currently planned for Mesaba One and Mesaba Two, the ability to come online early using natural gas is a very useful resource planning option for subsequent units. The Applicant will propose permits to allow for natural gas firing at capacity factors of 30 percent, 20 percent, 10 percent, and 5 percent for years 1, 2, 3, and thereafter, respectively.

**Table 3.3-1 Feedstock Design Specification Basis**

| Feedstock | Bituminous Illinois No.6 Coal | | Sub-Bituminous PRB Coal | | Petroleum Coke | |
|---|---|---|---|---|---|---|
| | Dry Basis | As Rcvd. | Dry Basis | As Rcvd. | Dry Basis | As Rcvd. |
| HHV, Btu/lb | 12,802 | 11,586 | 11,942 | 8,300 | 15,204 | 13,699 |
| Ultimate Analysis, Wt % | | | | | | |
| Carbon | 70.79 | 64.06 | 69.9 | 48.58 | 87.32 | 78.71 |
| Hydrogen | 4.81 | 4.35 | 4.8 | 3.34 | 3.67 | 3.31 |
| Nitrogen | 1.51 | 1.37 | 0.9 | 0.63 | 1.31 | 1.18 |
| Sulfur | 3.32 | 3.00 | 0.53 | 0.37 | 6.27 | 5.65 |
| Oxygen | 6.92 | 6.26 | 16.77 | 11.66 | 0.72 | 0.65 |
| Chlorine | 0.14 | 0.13 | <0.01 | 0.01 | 0.01 | 0.01 |
| Ash | 12.51 | 11.32 | 7.1 | 4.93 | 0.7 | 0.63 |
| Total | 100.00 | 90.50 | 100.0 | 69.50 | 100.00 | 90.10 |
| Moisture, % | | 9.5 | | 30.5 | | 9.9 |
| Ash Mineral Analysis, Wt% | | | | | | |
| $SiO_2$ | 49.57 | NA | 31.2 | NA | 20.55 | NA |
| $Al_2O_3$ | 19.32 | NA | 13.9 | NA | 9.11 | NA |
| $TiO_2$ | 0.96 | NA | 1.1 | NA | 0.8 | NA |
| $Fe_2O_3$ | 19.32 | NA | 6.3 | NA | 5.44 | NA |
| CaO | 3.81 | NA | 24.3 | NA | 11.77 | NA |

| Feedstock | Bituminous Illinois No.6 Coal | | Sub-Bituminous PRB Coal | | Petroleum Coke | |
|---|---|---|---|---|---|---|
| | Dry Basis | As Rcvd. | Dry Basis | As Rcvd. | Dry Basis | As Rcvd. |
| MgO | 1.01 | NA | 6.1 | NA | 3.64 | NA |
| $Na_2O$ | 0.46 | NA | 1.7 | NA | 1.68 | NA |
| $K_2O$ | 2.40 | NA | 0.2 | NA | 0.66 | NA |
| $P_2O_5$ | 0.35 | NA | 0.5 | NA | 0.52 | NA |
| $SO_3$ | 2.07 | NA | 13.6 | NA | 23.75 | NA |
| NiO | NA | NA | NA | NA | 4.68 | NA |
| $V_20_5$ | NA | NA | NA | NA | 16.11 | NA |
| Other | 0.73 | NA | 1.1 | NA | 1.29 | NA |
| | 100.0 | | 100.0 | | 100.0 | |
| Ash Fusion Temp. (Reducing), $^oF$ | | | | | | |
| Initial Deformation | 2000 | NA | 2170 | NA | 2440 | NA |
| Softening (H=W) | 2150 | NA | 2180 | NA | 2500 | NA |
| Hemispherical (H=1/2w) | 2185 | NA | 2190 | NA | 2550 | NA |
| Fluid | 2370 | NA | 2200 | NA | 2600 | NA |
| Hardgrove Grindability Index | 50-65 | NA | 80 | NA | 53 | NA |

### 3.3.2 Flux Receiving and Storage

The E-Gas™ gasifier will operate at high temperatures. At such temperatures, ash in feedstock material will normally melt and drain to the bottom of the gasifier where it will be removed. The molten ash – known as slag – will be cooled in a water bath outside the gasifier until it solidifies.

Mineral matter in the ash determines the temperature at which ash in the gasifier will melt and slag viscosity at a specific operating temperatures. If the slag is too viscous, it will not easily flow from the gasifier, or could plug the bottom. Flux, typically silica/sand, limestone, iron oxide (or iron ore), or a mixture of these, will be blended with the feed as necessary to control the slag melting point and fluidity. A slag that is too fluid could be excessively erosive to the refractory in the gasifier, so the amount and composition of flux, if used, will be carefully monitored and controlled.

Flux will normally be received by truck (or railcar) and pneumatically conveyed to enclosed storage silos equipped with fabric filters for dust control. Flux from storage silos will be automatically blended with feedstock by a weigh belt feeder system. The required quantity of flux will be a small fraction of the total feed, typically less than 250 tons per day per phase.

### 3.3.3 Natural Gas Supply Pipeline and Metering Station

As noted in Section 1.0, 2.3, and 3.3.1.3, natural gas will be used to start up the facility and as a backup fuel. When operating on natural gas, the Power Station cannot achieve the nominal 606

$MW_{(net)}$ output attainable when operating on syngas. This is due, in part, to the lack of nitrogen that would otherwise be available for nitrogen dilution and power augmentation when operating the ASU to supply oxygen to the gasifiers.

As noted in Section 2.3, Minnesota's Iron Range is served by GLG and NNG. The GLG natural gas pipeline transmission system interconnects with NNG's natural gas pipeline system near Carlton, Minnesota. Figures 2.3.1, and 2.3.2 show the location of the natural gas transmission pipelines north of Carlton and near the West Range Site. NNG's natural gas pipeline to the East Range Site is shown in Figure 2.6.20.

If the West Range Site is approved by the MPUC, natural gas may be supplied through a direct connection with the GLG pipeline located about 12 miles due south of the IGCC Power Station, or from NNG's tapping point located in La Prairie, Minnesota, about 10 miles west southwest of the Station. This access to multiple pipeline infrastructure alternatives is beneficial. The Applicant will contract with either or both entities for natural gas transportation capacity and for quantities and at pressures sufficient to operate the Power Station at its limited capability (see above paragraph) when firing its backup fuel.

As noted in Section 2.6.4, the East Range Site has only one natural gas supply option, the NNG Pipeline. An existing branch pipeline (known as the Erie Branch line) from NNG's main pipeline originating at a tap of the GLG's pipeline in Carlton, Minnesota, directly abuts the eastern boundary of the Buffer Land. Twenty-seven (27) miles of "looped" 16" pipe (that is, new pipeline laid within the ROW of an existing pipeline, in this case the 10" Erie Branch pipeline) and a 2,500 horsepower compressor expansion is required to provide natural gas to the East Range Site in sufficient quantity and pressure to operate the Power Station at its limited capability when firing its backup fuel. Only limited easements are required to access the pipeline ROW. The Applicant would contract with NNG to provide gas transportation and other entities to supply natural gas.

The Applicant will purchase natural gas through a series of contracts with gas suppliers in order to obtain the lowest overall fuel price and best contract conditions for this commodity. Due to the volumes of natural gas required to fuel the IGCC Power Station, the Applicant will install and operate accurate metering equipment to confirm the extent of such purchases. Typical natural gas composition is shown in Table 3.3-2.

**Table 3.3-2 Typical Natural Gas Constituents**

| Constituent | Percent By Volume |
|---|---|
| Methane | 96.9 |
| Ethane | 2.00 |
| Propane | 0.50 |
| n-Butane | 0.10 |
| i-Butane | 0.10 |
| n-Pentane | 0.00 |
| i-Pentane | 0.00 |
| Hexane+ | 0.10 |
| Oxygen | 0.00 |

| Constituent | Percent By Volume |
|---|---|
| Carbon dioxide | 0.00 |
| Nitrogen | 0.30 |
| **TOTAL** | **100.00** |
| Sulfur, ppmv | 14.8 |
| Specific Gravity (air = 1.00) | 0.57-58 |
| Net Heating Value (Btu per scf) | 935 |
| Btu = British thermal units.<br>scf = standard cubic feet. | |

### 3.3.4 Water Supply

Water is needed by Mesaba One and Mesaba Two in significant quantities for the steam cycle, cooling, and introducing fuel into the gasifier. Water supplies for the West Range and East Range Power Stations will come from different sources and be required in slightly different quantities. The sources and quantities of water required at each site are discussed in detail in Section 3.6.1. Section 3.6.1 confirms that the water supply sources for each Site are sufficient to provide the quantities of water required by Mesaba One and Mesaba Two for the specific uses outlined in the subsections below.

#### 3.3.4.1 Steam Cycle

Raw water must be treated to ultra purity standards to be used in the heat recovery steam generators ("HRSG") for steam production. The steam produced in the HRSGs is delivered to the steam turbine and condensed for reuse.

#### 3.3.4.2 Non-Contact Cooling (Cooling Tower Operation)8

Heat must be rejected from the IGCC Power Station's condenser in order to maintain proper steam cycle characteristics. Large volumes of water are required for this purpose (a typical 600 MW pulverized coal-fueled power plant would require about 300,000 gallons of water per minute for a once-through cooling system). The IGCC Power Station will use cooling towers to reduce – relative to a once-through cooling system – the amount of water required to be withdrawn from the Water Resources. In a cooling tower, warmed cooling water from the Power Station's condenser is cooled by the evaporation of a portion of the water as it passes through the cooling tower. In addition to evaporation, a very small amount of entrained water, called drift (water droplets that are entrained in the exhaust air stream carrying heat away from the towers), will also be emitted into the atmosphere. As evaporation continues, salts dissolved in the remaining cooling liquid become more concentrated. When the concentrations of dissolved salts near their solubility limit, scale formation may occur on the condenser tubes and hinder heat transfer. Although addition of certain chemicals can inhibit scale formation, a portion of the cooling water, called blowdown, must be removed from the system and discharged.

[8] Black & Veatch, 1996, "Power Plant Engineering," Page 525-26.

Discharges of cooling tower blowdown will be authorized under terms of an NPDES permit to be issued by the MPCA. The amount of cooling tower blowdown generated, its characteristics, and how its discharge is managed is discussed in Section 3.4.2.

#### 3.3.4.3 Contact Cooling

Water is used in numerous enclosed towers to cool and clean the syngas. This is generally accomplished by routing the syngas through a countercurrent flow of water, with the syngas generally being introduced into the bottom of a tower and water at the top. The water, by virtue of its physical contact with the contaminated syngas, absorbs soluble contaminants, becomes contaminated itself, and thereafter is treated. In Mesaba One and Mesaba Two, such contact process waters will be segregated from cooling tower blowdown and routed through a ZLD system, thereby ensuring that no trace elements carried over from the coal feedstock will be discharged to ambient receiving waters. Systems included in the sour water treatment process will remove mercury from this wastewater stream prior to sending it through the brine concentrator and ZLD system. The ZLD system is discussed in further detail in Sections 3.1.6.3, 3.4.2.1.2, 3.4.3.1.7, 3.4.4.1.3, and 3.6.1.2.

#### 3.3.4.4 Feedstock Slurry and Source of Hydrogen

Water serves a critical role in the IGCC Power Station, both as a slurrying agent for introducing feedstocks into the gasifier and as a source of hydrogen to enhance the reducing atmosphere inside the gasifiers.

## 3.4 PROJECT DISCHARGES AND PRODUCTS

### 3.4.1 Air Pollutants

Discharges of air emissions will meet all required State and Federal standards, with analysis demonstrating that emission levels are largely independent of the specific Site. The block flow diagrams presented in Figure 3.1-1 and Figure 3.1-2 enumerate air emission sources and their associated control equipment. The spatial location of the major air emission points on the IGCC Power Station are identified on the layout plan in Figure 3.2-1. Maximum and average emission quantities from each point have been estimated using:

- Equipment supplier data
- BACT as proposed in the Part 70/New Source Review Construction Authorization permit application
- Test results for similar equipment at other IGCC facilities, especially the existing Wabash River (which also uses E-Gas gasification technology)
- Engineering calculations, experience, and judgment
- Published and accepted average emission factors, such as the U.S. EPA Compilation of Air Pollutant Emission Factors (AP-42)

The following sections describe these estimates and the calculation basis for both criteria and non-criteria pollutants. Detailed calculation descriptions and examples are presented in the West Range IGCC Power Station application for a Part 70/New Source Review Construction Authorization attached as Appendix 5. With the exception of $PM_{10}$ emitted from the cooling

towers, the calculations are independent of the Site and, therefore, can be applied to the East Range IGCC Power Station (PM10 emissions from the cooling towers are increased at the East Range IGCC Power Station due to higher concentrations of total dissolved solids in the mine pit waters).

#### 3.4.1.1 Criteria Pollutants

Table 3.4-1 presents the normal and maximum short-term emission rates for each source. Table 3.4-2 shows the proposed maximum annual criteria pollutant emission rates for each emission source in the facility.

**Table 3.4-1 Short-Term Emission Summary (Phase I plus Phase II)**

| Emission Source | Normal Emission Rate (lb/hr)[1] | | | | | Maximum Emission Rate (lb/hr)[1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NOx | $SO_2$ | CO | PM10[2] | VOC | NOx | $SO_2$ | CO | PM10[2] | VOC |
| Combustion Turbines | 624 | 270 | 380 | 100 | 35 | 792 | 732 | 10,960[3] | 100 | 1,052[3] |
| Tank Vent Boilers | 12 | 7.2 | 3.6 | 0.4 | 0.2 | 39 | 17 | 12 | 1.4 | 0.6 |
| Flares[4] | 0.3 | negl[5] | 2.2 | negl | negl | 478 | 2,080 | 11,400 | 60 | 45 |
| Auxiliary Boilers | 9.4 | 0.8 | 19 | 1.3 | 1 | 9.4 | 0.74 | 19 | 1.3 | 1 |
| Cooling Towers | | | | 9/58 | | | | | 9/58 | |
| Fugitive PM10 | | | | 8.6 | | | | | 8.6 | |
| Fugitive VOC | | | | | 3.8 | | | | | 3.8 |
| Emergency Generators | 158 | 4.2 | 36 | 5.8 | 6.2 | 158 | 4.2 | 36 | 5.8 | 6.2 |
| Emergency Fire Water Pump Engines | 37 | 2.5 | 8.0 | 2.6 | 3.0 | 37 | 2.5 | 8.0 | 2.6 | 3.0 |
| **Total** | **841** | **285** | **449** | **128[6]/177[7]** | **49** | **1,513** | **2,836** | **22,435** | **189[6]/238[7]** | **1,112** |

[1]See following text for description of normal and maximum short-term emissions.
[2]PM10 includes filterable plus condensable fractions.
[3]Peak startup emission rate for four CTGs; normally startup for these engines will not occur simultaneously.
[4]Normal flare emission rates are for natural gas pilots only.
[5] negl = negligible emissions.
[6] West Range IGCC Power Station
[7] East Range IGCC Power Station

**Table 3.4-2 Annual Emission Summary (Phase I and II)**

| Emission Source | Emission Rate (ton/year) | | | | |
|---|---|---|---|---|---|
| | NOx | $SO_2$ | CO | PM10 | VOC |
| Combustion Turbines | 2,772 | 1,332 | 1,928 | 440 | 176 |
| Tank Vent Boilers | 53 | 32 | 16 | 1.8 | 0.8 |
| Flares | 27 | 25 | 572 | 3.4 | 2.6 |
| Auxiliary Boilers | 10 | 0.8 | 21 | 1.4 | 1.1 |
| Cooling Towers | | | | 39[1]/255[2] | |
| Fugitive PM10 | | | | 6.7 | |
| Fugitive VOC | | | | | 17 |
| Emergency Generators | 7.9 | 0.20 | 1.8 | 0.29 | 0.31 |
| Emergency Fire Water Pump Engines | 1.9 | 0.12 | 0.40 | 0.13 | 0.15 |
| **Total** | **2,872** | **1,390** | **2,539** | **493[1]/709[2]** | **197** |

[1]West Range IGCC Power Station
[2]East Range IGCC Power Station
See text in Sections 3.4.1.1.1 through 3.4.1.1.8 for explanation of annual emission basis.

#### 3.4.1.1.1 Combustion Turbine Generators

Emissions from the IGCC Power Station are primarily controlled through the inherently lower polluting IGCC coal gasification technology. Specifically, the production of syngas at relatively high pressure allows efficient and cost-effective syngas cleanup prior to combustion in the CTGs to produce electricity. As discussed in the preceding process description in Section 3.1, the following treatment steps will be applied to the syngas:

- Hot gas particulate matter filtration via cyclone and ceramic filter to achieve more than 99.9% particulate matter removal
- Water scrubbing to remove soluble contaminants, condensable materials, and suspended particulate matter
- Amine treatment combined with COS hydrolysis
- Carbon absorption for removal of mercury and other trace contaminants
- Moisturization (water saturation) for $NO_X$ control and improved power production

In addition to the syngas treatment measures discussed above, the moisturized product syngas fuel is diluted by about 100 percent (one-to-one) with ASU nitrogen for additional $NO_x$ reduction. Steam injection, in lieu of nitrogen dilution and moisturization, will be used for $NO_x$ control when operating on natural gas. Finally, each CTG will be equipped with inlet air filters to minimize particulate matter emissions potentially caused by advection of suspended atmospheric materials contained in the combustion air.

Emissions from the CTGs are based on the following gas concentrations as emitted at the HRSG stack (or, in the case of particulate matter, the stack emission rate):

*Syngas*

- $SO_2$, based on 50 ppmvd, as $H_2S$ in the undiluted syngas, rolling 30-day average and assuming 100% conversion of $H_2S$ to $SO_2$
- NOx, 15 ppmvd (@ 15% $O_2$)
- CO, 15 ppmvd (@ 15% $O_2$)
- PM10, 25 lb/hr/CTG
- VOC, 2.4 ppmvd (@15% $O_2$)

*Natural Gas*

- $SO_2$, pipeline-quality natural gas (assumed 1.0 grain/100 scf total sulfur) and assuming 100% conversion of sulfur to $SO_2$
- NOx, 25 ppmvd (@ 15% $O_2$)
- Other criteria pollutants, equal to or less than syngas emission rates

As is the case with many types of internal combustion engines, CTG emissions of one or more pollutants during startup can exceed the normal operating emission rates for short periods. This temporary higher emission rate is caused by reduced combustion efficiencies during initial operation at low temperatures and low loads, as well as the delay necessary to achieve minimum specified combustor conditions prior to commencement of steam injection for $NO_X$ control.

Table 3.4-3 shows the maximum short-term CTG emission rates for the four major operating conditions. The emission rates shown in this table reflect the maximum values for available commercial CTGs.

**Table 3.4-3 Maximum CTG Short-Term Emission Rates (Phase I and II)**

| Operating Mode | Emission Rate (lb/hr) | | | | |
|---|---|---|---|---|---|
| | $NO_X$ | $SO_2$ | CO | $PM_{10}$ | VOC |
| Normal syngas operation[1] | 624 | 270 | 380 | 100 | 35 |
| Maximum syngas operation[2] | 624 | 732 | 380 | 100 | 35 |
| Maximum natural gas operation | 792 | 24 | 288 | 72 | 26 |
| Worst-case startup[3] | 484 | <24 | 10,960 | 44 | 1052 |

[1]30-day rolling average fuel sulfur.
[2]Peak 1-hour average fuel sulfur.
[3]Worst-case startup for four CTGs; normally all four would not start up simultaneously.

The maximum annual CTG emission rates and basis are summarized in Table 3.4-4 and Table 3.4-5 for the first four years of operation and years 5-30, respectively.

**Table 3.4-4 Maximum CTG Annual Emissions Years 1 – 4 (Phase I and II)**

| | Yr. No. 1 TPY | Yr. No. 2 TPY | Yr. No. 3 TPY | Yr. No. 4 TPY | Basis[1] |
|---|---|---|---|---|---|
| Hrs/Yr | 2630 | 1750 | 880 | 440 | Peak natural gas per year |
| NOx | 2954 | 2880 | 2807 | 2770 | Balance of year on syngas at full load |
| $SO_2$ | 964 | 1088 | 1210 | 1271 | Balance of year on syngas at full load, 50 ppmvd annual average sulfur in fuel |
| CO | 1808 | 1848 | 1888 | 1909 | Plus 50 hr/yr startup/shutdown per CTG, balance of year on syngas at full load |
| PM10 | 401 | 414 | 426 | 432 | Balance of year on syngas at full load |
| VOC | 167 | 171 | 174 | 176 | Plus 50 hr/yr startup/shutdown per CTG, balance of year on syngas at full load |

[1] Indicated hours of natural gas full load operation plus additional operation described for each pollutant.

**Table 3.4-5 Maximum CTG Annual Emissions Years 5 – 30 (Phase I and II)**

| | Tons/Year | Basis |
|---|---|---|
| NOx | 2,772 | 440 hours (approx 5% of the year) on full-load natural gas operation; 8,320 hours on full load syngas operation. |
| $SO_2$ | 1,332 | Full year (8,760 hours) on full-load syngas operation; 50 ppmvd average $H_2S$ in undiluted syngas |
| CO | 1,928 | 50 hours startup/shutdown per CTG, balance of year (8,710 hours per CTG) on full-load syngas operation |
| $PM_{10}$ | 440 | Full year (8,760 hours) on full load syngas operation |
| VOC | 176 | 50 hours startup/shutdown per CTG, balance of year (8, 710 hours per CTG) on full load syngas operation |

#### 3.4.1.1.2 Tank Vent Boilers

The tank vent boilers (TVBs, one for each phase) will be designed to safely and efficiently dispose of recovered process vapors from various process tanks and vessels associated with the gasification process. The TVBs prevent the emission of reduced sulfur compounds and other gaseous constituents to the atmosphere that could cause nuisance odors and other undesirable environmental consequences. The TVBs may also be operated on natural gas to produce steam for the IGCC Power Station during gasifier shutdowns. The estimated maximum short-term and annual emission rates, based on supplier estimates for similar equipment, are shown in Table 3.4-6 and Table 3.4-7.

**Table 3.4-6 Tank Vent Boiler Short-Term Emissions (Phase I and II)**

| Operating Mode | Emission Rate (lb/hr) | | | | |
|---|---|---|---|---|---|
| | NOX | $SO_2$ | CO | PM10 | VOC |
| Normal syngas operation[1] | 9 | 7 | 2.6 | 0.3 | 0.1 |
| Maximum syngas operation[2] | 39 | 17 | 12 | 1.4 | 0.6 |
| Maximum natural gas operation[3] | 24 | 0.2 | 7.2 | 0.8 | 0.3 |

[1]Assumes 30 MMBtu/hour heat input rate.
[2]Assumes 130 MMBtu/hour heat input rate.
[3]Assumes 80 MMBtu/hour heat input rate.

**Table 3.4-7 Maximum Tank Vent Boiler Annual Emissions (Phase I and II)**

| | Tons/Year |
|---|---|
| NOx | 53 |
| $SO_2$ | 32 |
| CO | 16 |
| PM10 | 1.8 |
| VOC | 0.8 |

[1]Based on approximately 280 trillion ($10^{12}$) Btu/yr, syngas plus tank vent vapors, and about 37 trillion Btu/yr natural gas combusted. Assumed sulfur in tank vapors averages 1.5 lb/hr (each phase) on annual basis.

#### 3.4.1.1.3 Flares

The elevated flares for Mesaba One and Mesaba Two will be designed for a minimum 99 percent destruction efficiency for carbon monoxide and hydrogen sulfide. As discussed previously, the flares are normally used only to oxidize treated syngas and natural gas combustion products during gasifier startup operations. The flares will also be available to safely dispose of emergency releases from the IGCC Power Station during unplanned upset events or outages.

The estimated maximum short-term and annual emission rates, based on agency guidance and equipment supplier specifications, are shown in Table 3.4-8.

**Table 3.4-8 Flare Short-Term Emission Rates (Phase I and II)**

| Operating Mode | Emission Rate (Lb/Hr) | | | | |
|---|---|---|---|---|---|
| | $NO_X$ | $SO_2$ | CO | $PM_{10}$ | VOC |
| Normal operation[1] | 0.3 | 0.01 | 2.2 | 0.03 | 0.02 |
| Normal startup operation[2] | 230 | 370 | 5,350 | 28 | 21 |
| Maximum flaring operation[3] | 478 | 2,080 | 11,360 | 60 | 45 |
| | Emission Rate (Tons/Year) | | | | |
| Maximum Annual[4] | 26.8 | 24.6 | 572 | 3.4 | 2.6 |

[1]Natural gas pilot, only.
[2]Startup flaring of syngas for two gasifiers and two flares.
[3]Maximum flaring capacity for two flares, based on flaring syngas production from two gasifiers for each flare and a worst case upset sulfur content of 400 ppmv in syngas.
[4]Maximum annual emission based on combustion of approximately 700 billion Btu of syngas and 136 billion Btu of natural gas during startup, plant upsets, and normal operating conditions.

#### 3.4.1.1.4 Fugitive Equipment Leaks

VOC and HAPs emissions associated with normal equipment leakage have been estimated using proscribed U.S. EPA fugitive emissions factors for valve seals, pump and compressor seals, pressure relief valves, flanges, and similar equipment. For the case of VOC, only the amine handling system is included in the estimate since methyl diethanolamine (MDEA) would be the only VOC handled in significant quantity at the facility. Fugitive emission estimates of HAPs are based on the estimated concentration of each HAP in various syngas streams multiplied by the calculated leakage rates. The estimated fugitive emissions are summarized in Table 3.4-9.

**Table 3.4-9 Fugitive Emission Estimate (Phase I and II)**

| Emission Type | Emission Rate | |
|---|---|---|
| | lb/hr | Ton/Yr |
| Federal HAPs | 0.06 | 0.3 |
| Ammonia | 0.2 | 1.3 |
| Hydrogen sulfide | 4.0 | 17 |
| MDEA | 3.2 | 14 |
| VOC | 3.8 | 16 |
| TRS | 4.0 | 17 |

[1]Volatile organic compounds (VOC) include MDEA, benzene, carbon disulfide, carbonyl sulfide, ethyl benzene, hexane, hydrogen cyanide, naphthalene, toluene, xylenes, and waste oil.
[2]Total reduced sulfur (TRS) includes carbon disulfide, carbonyl sulfide, and hydrogen sulfide.

#### 3.4.1.1.5 Material Handling Systems

Fugitive particulate matter emissions (fugitive dust) will be generated by coal/coke and slag handling, preparation, and storage during the operational phase of the IGCC Power Station. Sources of these emissions include the active and inactive coal/coke storage piles, conveyors/transfer points, slurry preparation area, and the slag storage area. Estimated emissions of total suspended particulate matter (particulate matter with an aerodynamic diameter no greater than 30 microns) and $PM_{10}$ (particulate matter with an aerodynamic diameter no greater than 10 microns) for these sources are summarized in Table 3.4-10 for Phase I operations (fugitive particulate matter emission rates for Phase I plus Phase II would be twice the values shown). Detailed calculations are presented in Appendix 5 (the West Range IGCC Power Station application for a Part 70/New Source Review Construction Authorization Permit); material handling emission calculations are independent of the Site and, therefore, can be applied to the East Range IGCC Power Station.

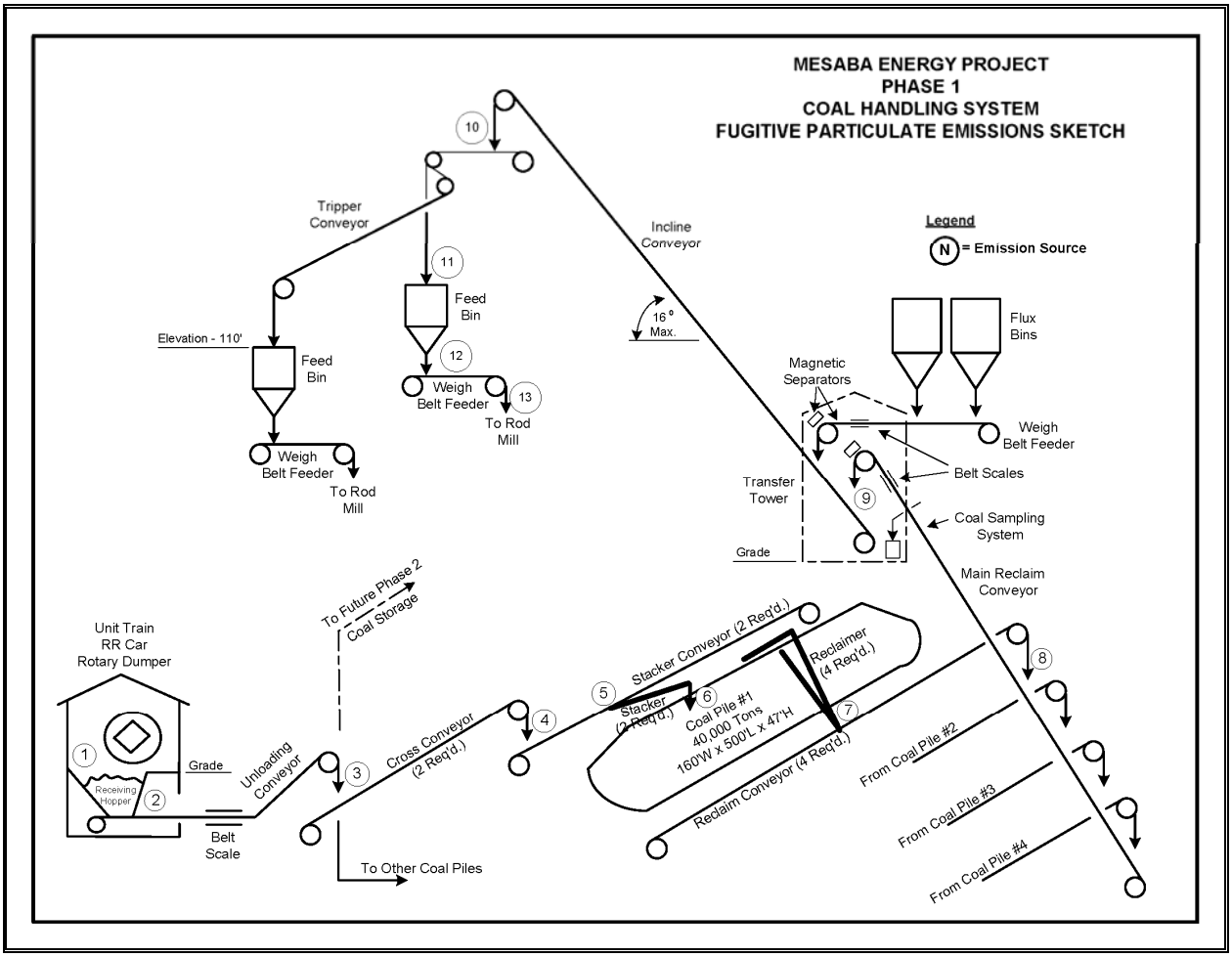
The estimates of particulate matter emission rates (lb/hr, tons/year) are based on methodologies developed by the U.S. EPA and documented in AP-42 ("Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources," 5th Edition). Specific portions of AP-42 utilized in the current analysis include Section 13.2.4 ("Aggregate Handling and Storage Piles"), Section 13.2.5 ("Industrial Wind Erosion"), and Section 13.2.2 ("Unpaved Roads"). These sections were used to estimate emission factors for the various coal/slag handling and moving components, windage losses from the coal and slag piles, and emissions resulting from on-site truck traffic movement of slag from process units to the slag storage pile.

The emission factor for rail car unloading of feedstock was developed from Electric Power Research Institute (EPRI) report CS-3455, published in June 1984. The peak hourly throughput for this system, as well as for conveyors and transfer points up to the storage pile, is based on unloading approximately 36 unit train cars per hour (approximately 4,300 tons/hr). Figure 3.4-1 shows a sketch of the proposed feedstock handling system.

The emission factors (expressed in lb/ton) for aggregate handling systems derived from AP-42 are multiplied by the maximum material throughput to estimate an uncontrolled particulate matter emission rate. Peak values are expressed on an hourly basis and represent the maximum system throughput requirements. For the materials handling facilities upstream of the coal pile, this rate is as described above. For materials handling facilities downstream of the storage pile, the peak rate is based on 120 percent of the average rate required for the nominal plant output. The annual throughput is based on the average material throughput requirement for the plant at full load conditions based on 8,760 hours per year. The AP-42 methodology correlates the aggregate handling particulate matter emission factor inversely with coal moisture content. Because of this, the maximum plant fugitive particulate matter emission rates were found to be higher on operation with Illinois No. 6 coal versus the significantly higher moisture content (and higher as-received throughput rate) for PRB-1 coal. The maximum slag generation and throughput rates are also based on operation with Illinois No. 6 coal. The slightly higher slag generation rate based on operation with a blended coal had an insignificant impact on the emissions from the slag handling systems. However, in practice, PRB coal is known to be dusty. To account for this experience and to derive more conservative "worst case" estimates, the surface moisture content in PRB coal was assumed to be 4% and the fugitive particulate matter

emission rates were recalculated. The fugitive emissions from PRB coal using the revised assumptions are provided in Table 3.4-10.

**Figure 3.4-1 Sketch of Proposed Feedstock Handling System**




Uncontrolled particulate matter emissions estimates were modified as appropriate by a control efficiency multiplier. Control efficiencies used in these estimates include:

| | | |
|---|---|---|
| 1. | No control method | 0% |
| 2. | Railcar/Feedstock storage pile load-in | 50% |
| 3. | Partial enclosure of transfer point | 70% |
| 3a. | Partial enclosure w/dust suppression spray | 75% |
| 4. | Full enclosure of transfer point | 90% |
| 4a. | Full enclosure w/dust suppression spray | 95% |
| 4b. | Full enclosure with baghouse filter | 99% |
| 5. | Roadway w/watering and cleaning | 80% |

The control efficiency for railcar unloading and storage pile load-in using an adjustable stacker are based on engineering judgment for the partial containment systems planned. References to items 3 and 4 above are identified in EPA 450/3-81-005b (Sept. 1982) and Environmental

Progress (Feb. 1984). The control efficiencies for items 3a, 4a, and 4b are based on engineering judgment and preliminary discussions with dust suppression system vendors (to assess enhanced particulate matter suppression and/or capture using the systems identified relative to the control efficiency for an enclosed system alone). The reference for the control efficiency provided for item 5 is found in AP-42 (Section 13.2.2).

The wet spray dust suppression systems require that water be supplied to the various injection points. This water may be blended with glycol for freeze point suppression, and/or surfactants (wetting agents) or chemical binding or encrusting agents. Because of such chemical additions, any free water draining from the solids will be captured and treated as required before re-use on-site or off-site disposal.

Determination of particulate matter emissions resulting from wind erosion of the storage piles requires information on pile geometry and wind velocities at the plant site. As shown on the IGCC Power Station plot plan and visual renderings (see Figure 3.2-1 and Figure 3.2-2), oval storage piles have been assumed. Lengths, widths, angles of repose and heights have been determined to provide the required storage volumes in one or more piles. These values were used to estimate the pile surface areas exposed to winds, as required by the AP-42 procedure. Historical wind velocity profiles (speed and annual frequency of occurrence) were obtained from University of Minnesota Technical Bulletin AD-TB1955 for the local Hibbing, Minnesota area. The reported wind velocities are relatively low, and only infrequently exceed the threshold friction velocity needed to generate quantifiable emissions as defined by the AP-42 procedure. Hence, at these conditions, the piles were not significant contributors to overall plant particulate matter emissions.

In-plant trucks will be used to transport dewatered, by-product slag from the gasifier slag handling area to the slag storage pile or bins to await shipment by rail or truck to offsite locations. A truck traffic emission factor from AP-42 is used to estimate fugitive road dust from this internal slag transfer operation. A control efficiency of 80 percent has been applied to this emission source based on watering of the roadway near the pile to suppress dust and periodic removal/cleanup of dust-producing material.

## Table 3.4-10 Fugitive Particulate Matter Emission Estimate ( Phase I Operation)

| Emission Source Description | | Notes | PM30 Emission Factor (lb/ton) | PM10 Emission Factor (lb/ton) | Maximum Hourly Throughput (ton/hr) | Maximum Annual Throughput (ton/yr) | Control Method | Control Efficiency (%) | Controlled PM30 Maximum Hourly Emission Rate (lb/hr) | ControlledPM30 Maximum Annual Emission Rate (ton/yr) | Controlled PM10 Maximum Hourly Emission Rate (lb/hr) | Controlled PM10 Maximum Annual Emission Rate (ton/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COAL HANDLING AND STORAGE** | | | | | | | | | | | | |
| 1 | Railcar Unloading | 1,9 | 0.00174 | 0.00087 | 4,300 | 3,100,000 | Partially Enclosed Shed with dust suppression sprays | 75 | 1.871 | 0.674 | 0.935 | 0.337 |
| 2 | Unloading hopper to Unloading Conveyor | 2,9 | 0.0020 | 0.0010 | 4,300 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.432 | 0.156 | 0.204 | 0.074 |
| 3 | Unloading conveyor to Cross-Conveyor | 2,9 | 0.0020 | 0.0010 | 4,300 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.432 | 0.156 | 0.204 | 0.074 |
| 4 | Cross-Conveyor to Stacker Conveyor | 2,9 | 0.0020 | 0.0010 | 4,300 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.432 | 0.156 | 0.204 | 0.074 |
| 5 | Stacker Conveyor to Stacker | 2,9 | 0.0020 | 0.0010 | 4,300 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.432 | 0.156 | 0.204 | 0.074 |
| 6 | Stacker to Coal Pile | 2,9 | 0.0020 | 0.0010 | 4,300 | 3,100,000 | Ring-type dust suppression sprays at discharge point; Adjustable height stacker | 50 | 4.323 | 1.558 | 2.044 | 0.737 |
| 7 | Reclaimer to Reclaim Conveyor | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Partially Enclosed transfer point with dust suppression sprays | 75 | 0.216 | 0.779 | 0.102 | 0.368 |
| 8 | Reclaim Conveyor to Main Conveyor | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.043 | 0.156 | 0.020 | 0.074 |
| 9 | Main Conveyor to Incline Conveyor | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays inside building | 95 | 0.043 | 0.156 | 0.020 | 0.074 |
| 10 | Incline Conveyor to Tripper Conveyor | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.043 | 0.156 | 0.020 | 0.074 |

| Emission Source Description | | Notes | PM30 Emission Factor (lb/ton) | PM10 Emission Factor (lb/ton) | Maximum Hourly Throughput (ton/hr) | Maximum Annual Throughput (ton/yr) | Control Method | Control Efficiency (%) | Controlled PM30 Maximum Hourly Emission Rate (lb/hr) | ControlledPM30 Maximum Annual Emission Rate (ton/yr) | Controlled PM10 Maximum Hourly Emission Rate (lb/hr) | Controlled PM10 Maximum Annual Emission Rate (ton/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | Tripper Conveyor to Feed Bin | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Fully enclosed transfer point with baghouse dust collector | 99 | 0.009 | 0.031 | 0.004 | 0.015 |
| | Windage from Coal Storage | 3,5 | -- | -- | -- | -- | None | 0 | -- | 0.104 | -- | 0.052 |
| | **SUBTOTAL** | | | | | | | | **8.28** | **4.24** | **3.97** | **2.02** |
| **COAL SLURRY FACILITY SOURCES** | | | | | | | | | | | | |
| 12 | Feed Bin to Weigh Belt Feeder | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.043 | 0.156 | 0.020 | 0.074 |
| 13 | Weigh Belt Feeder to Rod Mill Feed Chute | 2,8 | 0.0020 | 0.0010 | 430 | 3,100,000 | Fully enclosed transfer point with dust suppression sprays | 95 | 0.043 | 0.156 | 0.020 | 0.074 |
| | **SUBTOTAL** | | | | | | | | **0.09** | **0.31** | **0.04** | **0.15** |
| **SLAG TRANSPORT AND STORAGE** | | | | | | | | | | | | |
| | Slag Disposal Truck Traffic | 4 | 8.5 | 2.26 | 0.40 | 3,500 | Apply dust suppressant | 80 | 0.680 | 2.975 | 0.181 | 0.791 |
| | Slag Storage Load-in | | Nil | Nil | | | Wet slag | 100 | 0.000 | 0.000 | 0.000 | 0.000 |
| | Windage from Slag Storage | 3,6 | -- | -- | -- | -- | None | 0 | -- | 0.027 | -- | 0.013 |
| | Slag Storage Load-out | 7 | 0.0053 | 0.0025 | 39 | 281,780 | None | 0 | 0.207 | 0.748 | 0.098 | 0.354 |
| | **SUBTOTAL** | | | | | | | | **0.89** | **3.75** | **0.28** | **1.16** |
| | **TOTAL** | | | | | | | | **9.25** | **8.30** | **4.28** | **3.33** |

1. Emission Factor from EPRI CS-3455 (6/84).
2. Coal emission factors for transfer points from AP-42 Section 13.2.4); U=9.3 mph, M=4%; Emission factor E = k*0.0032*{(U/5)^1.3/(M/2)^1.4}; k=0.74 for PM and = 0.35 for PM10.
3. Windage emissions from AP-42 (Section 13.2.5); wind speeds from AD-TB1955 University of Minnesota "Climate of Minnesota".
4. Emission factor for onsite truck traffic (slag transfer) from AP-42 (Section 13.2.2) in lb/VMT (vehicle miles traveled); Hourly throughput units are VMT per hour; assumed 0.2 mile/round trip between process units and slag pile; approximately 2 truck/hr required (20 ton truck); Approx 0.4 VMT/hr.
5. Coal active storage pile based on 4 oval piles, providing 20 day capacity ( ~ 160,000 tons for PRB-1).
6. Slag storage pile based on 1 oval pile, providing ~ 50 day capacity ( ~ 37,000 tons for bituminous coal or PRB2 – PRB3 blend).
7. Slag emission factors for transfer points from AP-42 Section 13.2.4); U=9.3 mph, M=2%; = k*0.0032*{(U/5)^1.3/(M/2)^1.4};k=0.74 (PM)/ = 0..35 (PM10).
8. Facilities between coal pile and slurry prep based on hourly throughput rate of 120% of average capacity at full plant output.
9. Maximum hourly feed rate based on unloading of thirty-six cars (119 tons per car) of unit train per hour; enables unloading of full unit train in about 3.2 hours.

#### 3.4.1.1.6 Particulate Matter and Mercury Releases from Cooling Tower Drift

The high concentration of total dissolved solids (TDS) found in East Range pit waters is the source of increased PM10 emissions from the East Range cooling towers relative to such emissions from the West Range Site. TDS in pit waters on the East Range have been shown to be present at concentrations up to 1,800 mg/L, whereas peak concentrations of TDS in the West Range pits are on the order of 340 mg/L. The peak number of cycles of concentration expected at the West Range Site is eight, while East Range cooling towers are expected to operate up to a maximum of ten cycles of concentration.

Table 3.4-11 shows the expected maximum particulate matter emissions from the cooling towers as a result of drift. Alternate feedstock cases have shown slightly different conditions for the two cooling towers, which would affect the emissions rates somewhat. The emission estimates presented below are based on 100 percent PRB-1 coal feed to the plant, and the Siemens-Westinghouse turbine power block (606 MW net nominal plant output at the IGCC Power Station switchyard), and are indicative of the maximum combined particulate matter release. The drift rate is based on 0.001% of the tower recirculation rate as provided by equipment suppliers and reflects the use of high efficiency drift eliminators. The total dissolved solids (TDS) content of the drift is the maximum value estimated from water quality measurement data for the makeup water (the water quality data from which such maxima were derived are provided in the West Range NPDES Permit Application attached as Appendix 6 and in Appendix 7). Table 3.4-11 shows emissions from a single phase. The emissions for the combined Phase I and II operations would be double those shown.

**Table 3.4-11**
**Particulate Matter (PM10) Emissions from Cooling Tower Drift (Per Phase)**

| | West Range | | East Range | |
|---|---|---|---|---|
| | Power Block Cooling Tower | Gasification/ ASU Cooling Tower | Power Block Cooling Tower | Gasification/ ASU Cooling Tower |
| Duty (MMBtu/hr) | 1,740 | 690 | 1,740 | 690 |
| Recirculation Rate ($10^6$ lb/hr) | 116 | 46 | 116 | 46 |
| Drift (lb/hr) | 1,160 | 460 | 1,160 | 460 |
| TDS (ppmw) | 2,720 | 2,720 | 18,000 | 18,000 |
| PM10 Emission (lb/hr/tower) | 3.2 | 1.3 | 21 | 8.3 |
| PM10 Emission (lb/hr/cell) | 0.3 | 0.3 | 1.7 | 1.7 |
| PM10 Emission (TPY) | 14 | 5.5 | 91 | 36 |

The Power Block cooling tower is currently configured with 12 cells, and the smaller Gasification/ASU cooling tower with 5 cells. Key performance data related to the cooling tower cells are presented in Table 3.4-12.

**Table 3.4-12 Cooling Tower Characteristics (per cell)**

| Characteristic | Value |
|---|---|
| Exhaust Flow, $10^6$ acfm (wet) | 1.37 |
| Exhaust Temperature, $^oF$ | 104 |
| Outlet Elevation (above grade), ft | 48 |
| Outlet Diameter, ft | 33 |

The cycles of concentration in a cooling tower relate how much the dissolved solids are allowed to concentrate in the cooling water system. Assuming i) the Power Station is operating on eight cycles of concentration; ii) the total amount of water recirculated in the power block and gasification/ASU cooling towers is approximately 320,000 gallons per minute; iii) drift constitutes approximately 0.001% of the water being recirculated; iv) the plant operates at a 92% capacity factor year around; and v) the concentration of mercury in the raw make-up water is 0.9 nanograms per liter, releases of mercury via drift could be expected to be on the order of 0.04 grams per year per phase of the Project. At ten cycles of concentration, the amount of mercury released via drift would be 0.05 grams per year. Annual releases on this order are not considered to be environmentally consequential.

#### 3.4.1.1.7 Auxiliary Boilers

The auxiliary boilers will normally operate only when no steam is available from the gasifiers or HRSGs. The annual capacity factor for these boilers will be 25% or less. The auxiliary boilers will be provided with low NOx burners for emission control. Emission rates based on supplier guarantees for similar equipment are shown in Table 3.4-13.

**Table 3.4-13**
**Maximum Auxiliary Boiler Short-Term and Annual Emission Rates**
**(Phase I and II)**

| | lb/hr | Ton/Year* | Basis |
|---|---|---|---|
| NOx | 9.4 | 10 | Low NOx burner, 30 ppmvd (@ 3% O2) |
| SO2 | 0.74 | 0.82 | 1 grain/100 scf in pipeline gas |
| CO | 19 | 21 | 100 ppmvd (@ 3% O2) |
| PM10 | 1.3 | 1.4 | 0.005 lb/million Btu, HHV |
| VOC | 1.0 | 1.1 | 10 ppmvd (@ 3% O2) |

*Annual emission based on 25% maximum annual capacity factor.

#### 3.4.1.1.8 Emergency Diesel Engines

Other than the emergency uses for which they are intended, the diesel engines driving the emergency generators and fire protection pumps will be operated no more than 100 hours per year. Emissions for each engine are estimated using accepted agency-published factors (AP-42)

and low sulfur diesel fuel. Table 3.4-14 shows the maximum short term and annual non-emergency emissions for each engine.

**Table 3.4-14**
**Emergency Diesel Engines Emissions (Phase I and II)**

| Diesel Engine | Approx Capacity, Each | Total No. Of Engines - Phases I and II | Short-Term Emission (Lb/Hr) | | | | | Annual Emission (Ton/Yr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $NO_X$ | $SO_2$ | CO | $PM_{10}$ | VOC | $NO_X$ | $SO_2$ | CO | $PM_{10}$ | VOC |
| Emergency generators – gasification island | 2 MW | 2 | 129 | 2 | 30 | 4 | 4 | 6.4 | 0.1 | 1.5 | 0.2 | 0.2 |
| Emergency generators – power block | 350 kW | 2 | 29 | 2 | 6 | 2 | 2 | 1.5 | 0.1 | 0.3 | 0.1 | 0.1 |
| Fire pumps | 300 hp | 4 | 37 | 2.5 | 8.0 | 2.6 | 3.0 | 1.9 | 0.1 | 0.4 | 0.1 | 0.1 |

### 3.4.1.2 Non-Criteria Pollutant Emissions and Lead

#### 3.4.1.2.1 Lead Emissions

Plant emission rates for trace amounts of lead were estimated from published information for a similar IGCC facility.[9] These estimates are shown on Table 3.4-15 included in the hazardous air pollutants emission discussion below.

#### 3.4.1.2.2 Sulfuric Acid Emissions

Sulfur trioxide ($SO_3$) emissions, expressed as sulfuric acid ($H_2SO_4$), for the CTGs and other plant emission sources were estimated based on supplier information and measurements at the Wabash River. These estimates are also shown on Table 3.4-15 in the hazardous air pollutants emission discussion below.

### 3.4.1.3 Hazardous Air Pollutant Emissions

Emission rates for hazardous air pollutants (HAPs), as identified by the Minnesota Pollution Control Agency, have been estimated for the Project using the following sources (listed in order of significance):

- Results of regulatory test programs at Wabash River - adjusted, as appropriate, for the expected worst-case feeds to the Mesaba Energy Project.
- Equipment supplier information.

[9]NETL - National Energy Technology Laboratory, U.S. Dept of Energy, *Major Environmental Aspects of Gasification-based Power Generation Technologies, Final Report*, December 2002.

- Published emission factors and reports applicable to IGCC facilities.
- Engineering calculations and judgment.
- U.S. EPA emission factors (AP-42) for coal combustion.

HAP emissions at the IGCC Power Station will be reduced by the inherently low polluting IGCC technology and many of the same process features that control criteria emissions. A large portion of the heavy metals and other undesirable constituents of the feed will be immobilized in the non-hazardous vitreous slag by-product and thereby prevented from causing adverse environmental effects. Gaseous and particle-bound HAPs that may be contained in the raw syngas exiting the gasifiers will be totally or partially removed in the syngas particulate matter removal system, water scrubber, and AGR systems described above. In addition, the mercury removal carbon absorption beds will ensure that mercury emissions from the IGCC Power Station will be 10 percent or less of the mercury present in the feedstock as received.

Table 3.4-15 presents a summary of estimated HAPs emissions for the Phase I and Phase II IGCC Power Station. The West Range Site application for a Part 70/New Source Review Construction Authorization is attached as Appendix 5 and contains in an appendix the methodology used to estimate HAP emissions, shows example calculations, and identifies the sources of HAPs data used.

**Table 3.4-15**
**Annual Hazardous Air Pollutant Emissions (Phase I and II)**

| CAS # or MPCA # | Compound | Annual Average HAP Emission (ton/yr) | | | | Total Phase I | Phase I & Phase II |
|---|---|---|---|---|---|---|---|
| | | CTGs | TVB | Flare | Fugitive | | |
| 75-07-0 | Acetaldehyde | 0.044 | 1.6E-04 | 3.9E-04 | | 0.045 | 0.089 |
| 98-86-2 | Acetophenone | 0.022 | 7.9E-05 | 2.0E-04 | | 0.022 | 0.045 |
| 107-02-8 | Acrolein | 0.43 | 1.5E-03 | 3.8E-03 | | 0.43 | 0.87 |
| 7440-36-0 | Antimony | 0.027 | 2.8E-04 | 7.0E-04 | | 0.028 | 0.056 |
| 7440-38-2 | Arsenic | 0.059 | 1.5E-03 | 3.7E-03 | | 0.064 | 0.128 |
| 71-43-2 | Benzene | 0.061 | 0.028 | 0.071 | 0.0063 | 0.167 | 0.333 |
| 100-44-7 | Benzyl chloride | 1.03 | 3.7E-03 | 9.2E-03 | | 1.0 | 2.1 |
| 7440-41-7 | Beryllium | 0.0064 | 7.9E-06 | 2.0E-05 | | 0.0064 | 0.0128 |
| 92-52-4 | Biphenyl | 0.0025 | 9.0E-06 | 2.2E-05 | | 0.0025 | 0.0051 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate (DEHP) | 0.11 | 3.9E-04 | 9.6E-04 | | 0.109 | 0.218 |
| 75-25-2 | Bromoform | 0.06 | 2.0E-04 | 5.0E-04 | | 0.057 | 0.114 |
| 7440-43-9 | Cadmium | 0.24 | 5.7E-05 | 1.4E-04 | | 0.24 | 0.47 |
| 75-15-0 | Carbon disulfide | 1.13 | 4.0E-03 | 1.0E-02 | 0.034 | 1.18 | 2.35 |
| 463581 | Carbonyl sulfide | | | | 0.058 | 0.058 | 0.116 |
| 532-27-4 | Chloroacetophenone, 2- | 0.0103 | 3.7E-05 | 9.2E-05 | | 0.0104 | 0.0208 |
| 108-90-7 | Chlorobenzene | 0.032 | 1.1E-04 | 2.8E-04 | | 0.032 | 0.065 |
| 67-66-3 | Chloroform | 0.088 | 3.2E-04 | 7.9E-04 | | 0.089 | 0.179 |
| 0-00-5 | Chromium, total (1) | 0.013 | 1.1E-03 | 2.6E-03 | | 0.016 | 0.033 |
| 18540-29-9 | Chromium, (hexavalent) | 0.0038 | 3.2E-04 | 7.9E-04 | | 0.0049 | 0.0099 |
| 7440-48-4 | Cobalt (1) | 0.0064 | 1.2E-03 | 3.0E-03 | | 0.011 | 0.021 |

| CAS # or MPCA # | Compound | Annual Average HAP Emission (ton/yr) | | | | Total Phase I | Phase I & Phase II |
|---|---|---|---|---|---|---|---|
| | | CTGs | TVB | Flare | Fugitive | | |
| 98-82-8 | Cumene | 0.0078 | 2.6E-05 | 6.6E-05 | | 0.0079 | 0.0159 |
| 57-12-5 | Cyanide (Cyanide ion, Inorganic cyanides, Isocyanide) | 0.140 | 4.6E-03 | 1.2E-02 | 0.0088 | 0.16 | 0.33 |
| 77-78-1 | Dimethyl sulfate | 0.071 | 2.5E-04 | 6.3E-04 | | 0.072 | 0.144 |
| 121-14-2 | Dinitrotoluene, 2,4- | 4.2E-04 | 1.5E-06 | 3.7E-06 | | 4.2E-04 | 8.4E-04 |
| 100-41-4 | Ethyl benzene | 0.14 | 0.032 | 0.079 | 5.4E-06 | 0.25 | 0.50 |
| 75-00-3 | Ethyl chloride (Chloroethane) | 0.061 | 2.2E-04 | 5.5E-04 | | 0.062 | 0.124 |
| 106-93-4 | Ethylene dibromide (Dibromoethane) | 0.0018 | 6.3E-06 | 1.6E-05 | | 0.0018 | 0.0036 |
| 107-06-2 | Ethylene dichloride (1,2-Dichloroethane) | 0.059 | 2.1E-04 | 5.3E-04 | | 0.060 | 0.119 |
| 50-00-0 | Formaldehyde | 0.42 | 1.5E-03 | 3.7E-03 | 1.1E-06 | 0.42 | 0.84 |
| 110-54-3 | Hexane | 0.10 | 3.5E-04 | 8.8E-04 | 1.5E-06 | 0.10 | 0.20 |
| 7647-01-0 | Hydrochloric acid | 0.096 | 3.0E-04 | 7.4E-04 | 0.034 | 0.13 | 0.26 |
| 7664-39-3 | Hydrogen fluoride (Hydrofluoric acid) | 1.2 | 5.3E-05 | 1.3E-04 | | 1.2 | 2.5 |
| 78-59-1 | Isophorone | 0.86 | 3.1E-03 | 7.6E-03 | | 0.87 | 1.73 |
| 7439-92-1 | Lead | 0.014 | 6.3E-05 | 1.6E-04 | | 0.014 | 0.028 |
| 7439-96-5 | Manganese | 0.025 | 2.4E-03 | 5.9E-03 | | 0.034 | 0.068 |
| 7439-97-6 | Mercury | 0.012 | 6.6E-04 | 1.6E-03 | | 0.015 | 0.029 |
| 74-83-9 | Methyl bromide (Bromomethane) | 1.23 | 0.011 | 0.029 | | 1.3 | 2.5 |
| 74-87-3 | Methyl chloride (Chloromethane) | 0.78 | 6.0E-03 | 1.5E-02 | | 0.80 | 1.61 |
| 71-55-6 | Methyl chloroform (1,1,1 - Trichloroethane) (4) | 0.029 | 1.1E-04 | 2.6E-04 | | 0.030 | 0.060 |
| 78-93-3 | Methyl ethyl ketone (2-Butanone) | 0.58 | 2.1E-03 | 5.1E-03 | | 0.58 | 1.17 |
| 60-34-4 | Methyl hydrazine | 0.25 | 9.0E-04 | 2.2E-03 | | 0.25 | 0.51 |
| 80-62-6 | Methyl methacrylate | 0.029 | 1.1E-04 | 2.6E-04 | | 0.030 | 0.060 |
| 1634-04-4 | Methyl tert butyl ether | 0.051 | 1.8E-04 | 4.6E-04 | | 0.052 | 0.104 |
| 75-09-2 | Methylene chloride (Dichloromethane) | 0.056 | 5.5E-04 | 1.4E-03 | | 0.058 | 0.117 |
| 91-20-3 | Naphthalene | 0.064 | 8.1E-04 | 2.0E-03 | 2.6E-05 | 0.067 | 0.133 |
| 7440-02-0 | Nickel | 0.0096 | 4.2E-03 | 1.0E-02 | | 0.024 | 0.048 |
| 108-95-2 | Phenol | 0.95 | 1.2E-02 | 3.0E-02 | 7.8E-08 | 0.99 | 1.98 |
| 123-38-6 | Proprionaldehyde | 0.561 | 2.0E-03 | 5.0E-03 | | 0.568 | 1.136 |
| 7784-49-2 | Selenium | 0.014 | 2.4E-04 | 5.9E-04 | | 0.015 | 0.029 |
| 100-42-5 | Styrene | 0.037 | 1.3E-04 | 3.3E-04 | | 0.037 | 0.075 |
| 127-18-4 | Tetrachloroethylene (Perchloroethylene) | 0.063 | 2.3E-04 | 5.7E-04 | | 0.064 | 0.129 |

| CAS # or MPCA # | Compound | Annual Average HAP Emission (ton/yr) | | | | Total Phase I | Phase I & Phase II |
|---|---|---|---|---|---|---|---|
| | | CTGs | TVB | Flare | Fugitive | | |
| 108-88-3 | Toluene | 0.00081 | 0.0112 | 0.0280 | 6.6E-04 | 0.041 | 0.081 |
| 108-05-4 | Vinyl acetate | 0.011 | 4.0E-05 | 1.0E-04 | | 0.011 | 0.023 |
| 1330-20-7 | Xylenes | 0.055 | 0.013 | 0.032 | 1.0E-05 | 0.10 | 0.20 |
| | ***Total federal HAPs*** | ***11.4*** | ***0.2*** | ***0.4*** | ***0.1*** | ***12.0*** | ***24.1*** |
| | | | | | | | |
| | ***Other Emissions*** | | | | | | |
| 56-55-3 | Benz[a]anthracene | 5.6E-05 | 2.0E-07 | 5.0E-07 | | 5.7E-05 | 1.1E-04 |
| 207-08-9 | Benzo(k)fluoranthene | 1.6E-04 | 5.8E-07 | 1.4E-06 | | 1.6E-04 | 3.3E-04 |
| 50-32-8 | Benzo[a]pyrene | 5.6E-05 | 2.0E-07 | 5.0E-07 | | 5.7E-05 | 1.1E-04 |
| 218-01-9 | Chrysene (Benzo(a)phenanthrene) | 1.5E-04 | 5.3E-07 | 1.3E-06 | | 1.5E-04 | 3.0E-04 |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | 9.1E-05 | 3.2E-07 | 8.1E-07 | | 9.2E-05 | 1.8E-04 |
| 3697-24-3 | Methylchrysene, 5- | 3.2E-05 | 1.1E-07 | 2.8E-07 | | 3.2E-05 | 6.5E-05 |
| 7664-93-9 14808-79-8 | Sulfuric acid and sulfates | 62.0 | 0.2 | 0.6 | | 62.8 | 125.6 |
| | Other VOC | | | | 8.3 | 8.3 | 16.6 |
| | Hydrogen sulfide | | | | 8.6 | 8.6 | 17.2 |
| | Total Volatile Organic Compounds (VOC) | 9.6 | 0.1 | 0.4 | 8.4 | 18.6 | 37.1 |
| | Total Reduced Sulfur (TRS) Compounds | 1.1 | 0.004 | 0.010 | 8.7 | 9.8 | 19.7 |

#### 3.4.1.3.1 Mercury

The volume of pre-combustion syngas present at the time of its clean-up in the E-Gas™ process is about one hundred times less than the volume of the post-combustion gas handled in a typical conventional pulverized coal-fired boiler. An inherent advantage that IGCC technology has over such conventional systems is that gas clean up equipment can be much smaller in size and the residence time for allowing contact between a chemical (like mercury) and an absorbent (like activated carbon) can be increased, thereby providing for greater pollutant removal efficiency. This pre-combustion gas clean-up process allows for highly effective mercury removal rates, which in the case of Mesaba One and Mesaba Two will be at least 90 percent of the as-received combustion concentration present in its incoming fuel. For Mesaba One and Two, this translates to maximum annual mercury emissions of only 54 pounds on a twelve month rolling average. Figure 3.4-2 shows how mercury is expected to partition throughout the IGCC Power Station.

### 3.4.1.4 Carbon Dioxide

Carbon dioxide emissions from the IGCC Power Station are a function of the feedstock consumed and the Station's net heat rate (a measure of the overall efficiency under which the energy in the feedstock is converted to electricity). The characteristics of the feedstock that dictate the rate at which $CO_2$ is emitted are its carbon content and higher heating value. Figure 3.4-3 illustrates the rates at which $CO_2$ will be produced by Mesaba One and Mesaba Two

when using 100% bituminous coal and 100% subbituminous coal as a feedstock. The $CO_2$ emission rates shown in Figure 3.4-3 do not account for any $CO_2$ removal that would occur as a result of the equipment additions described in Section 3.1.5.3.5. For purposes of comparison, the $CO_2$ generation rate of Sherco 3 (a pulverized coal-fired electric generating unit using western subbituminous coal) is also shown in Figure 3.4-3.

Emissions of $CO_2$ from other large coal-fired electric generating units in Minnesota are shown in comparison with Mesaba One and Mesaba Two in Figure 3.4-4. For those units shown in Figure 3.4-4 that use wet limestone scrubbers (for example Boswell Energy Center and Sherburne County Unites 1 and 2) $CO_2$ emissions will be underestimated as $CO_2$ is produced as a consequence of removing $SO_2$ from the combustion gases. For those units that use lime spray dryers to remove $SO_2$ from their combustion gases (for example, Sherburne County Unit 3), $CO_2$ is produced as a consequence of producing lime (CaO) from limestone ($CaCO_3$), some $SO_2$ will be removed by soluble oxides present in coal ash, thereby lowering the quantity of $CO_2$ produced as a result of reacting $SO_2$ and limestone slurry added for such reason.

**Figure 3.4-2 Expected Mercury Partitioning in the IGCC Power Station (Mesaba One and Mesaba Two)**

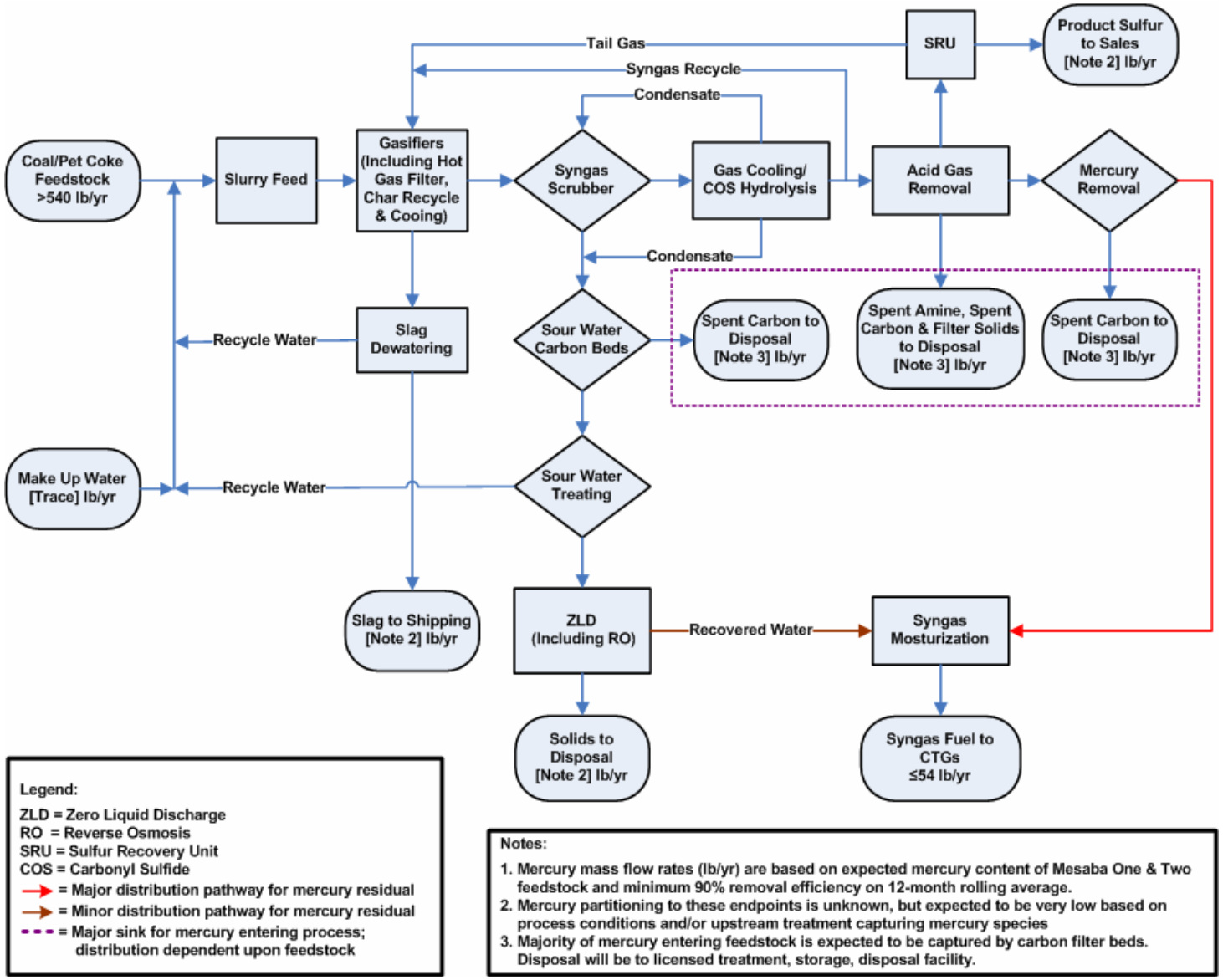


**Figure 3.4-3 Carbon Dioxide Emissions From Mesaba Energy Project vs. Sherco Unit 3**

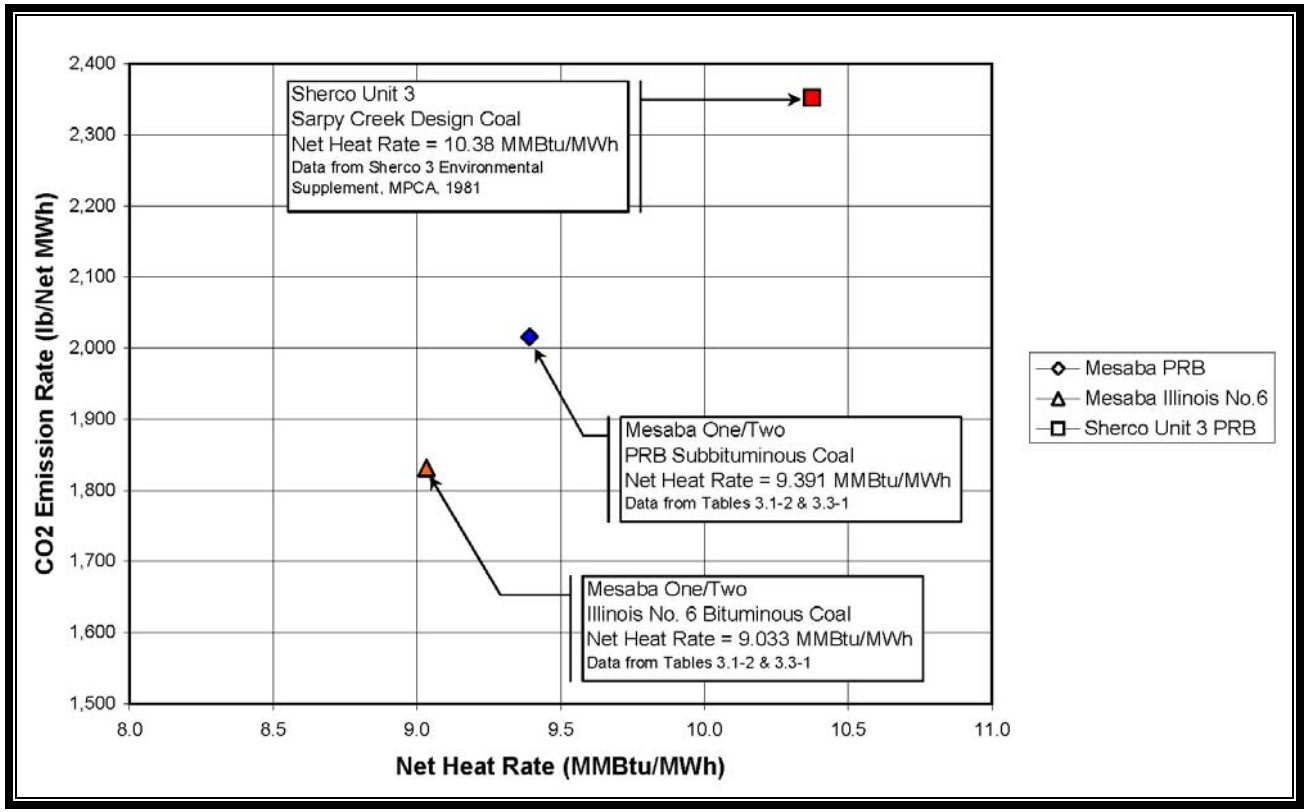
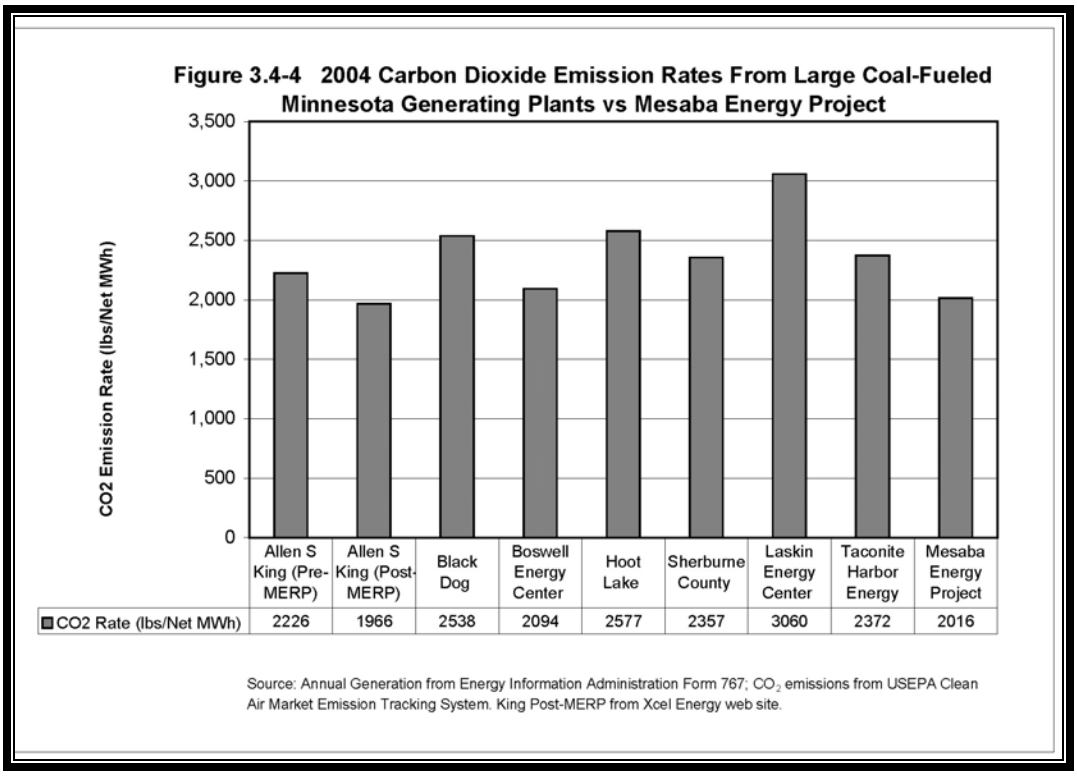


**Figure 3.4-4 2004 Carbon Dioxide Emission Rates From Large Coal-Fueled Minnesota Generating Plants vs. Mesaba Energy Project**




### 3.4.2 Water Effluents

The allowable quantity and concentration of chemical species in wastewater discharges from the IGCC Power Station are dependent in large part on the characteristics of potential receiving waters in the Project's vicinity. In the case of the West Range and East Range Sites, the receiving waters are located in different watershed basins that have greatly different water quality criteria.

Importantly with respect to wastewater discharges, the East Range Site is located within the Lake Superior Basin watershed, and the standards that apply to discharges of bioaccumulative chemicals of concern ("BCCs") in that basin effectively preclude discharges of cooling tower blowdown from Mesaba One and Mesaba Two. The reason for such discharge prohibitions is that mercury – a BCC – is found in the source waters for the East Range Site at concentrations nearly equal to the water quality criteria standard applied to end-of-the-pipe discharges.

Water quality criteria applied to waters located within the Lake Superior Basin are defined at Minn. R. 7052.0211, subp. 3 ("Mixing zones for bioaccumulative chemicals of concern [BCC]"):

> After March 9, 1998, acute and chronic mixing zones shall not be allowed for new and expanded discharges of bioaccumulative chemicals of concern (BCC) to the Lake Superior Basin.

Paragraph K of Minn. R. 7052.0350 confirms mercury as a BCC. The water quality criterion for mercury in all waters within the Lake Superior Basin watershed is 1.3 nanograms per liter. The combination of this criterion and the elimination of a mixing zone for BCCs are of great concern to facilities that would otherwise try to operate cooling towers within the Lake Superior Basin watershed. The reason for the concern arises because the median concentration of mercury in water recently sampled in two of the main pits from which water supplies for the IGCC Power Station would be appropriated is on the order of 0.75 nanograms per liter. This means that the cycles of concentration at which the cooling towers could operate would be reduced so severely as to result in extreme pumping costs and provide practically no margin of error to comply with the Lake Superior Basin's water quality criterion for mercury.

The most effective solution for eliminating uncertainties on the East Range Site tied to permitting discharges of cooling tower blowdown containing mercury is to totally eliminate the discharge of cooling tower blowdown. This can be done by enlarging the zero liquid discharge system to handle all of the IGCC Power Station's non-domestic wastewater streams. In this configuration, the IGCC Power Station would be designed to evaporate whatever water cannot be reused in the plant processes, and leave only a solid stream of salts for disposal at a licensed non-hazardous treatment/disposal facility. This scheme would significantly increase the cost of the IGCC Power Station but would allow for the utilization of the East Range Site and/or any other location within the Lake Superior Basin.

#### 3.4.2.1 Site Independent Features of IGCC Power Station

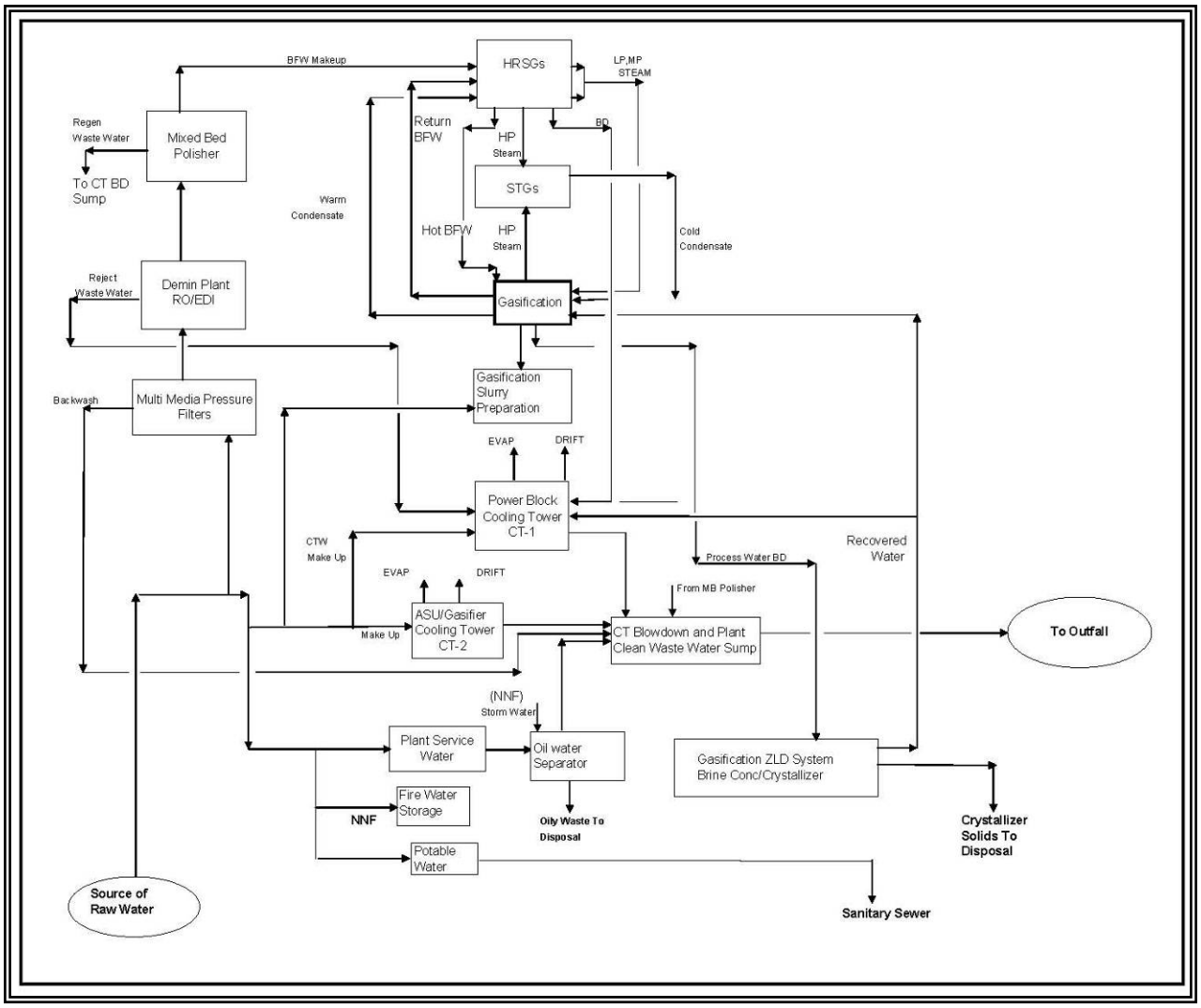
##### 3.4.2.1.1 Commonalities: Introduction

Although differences in the amounts of water appropriated, consumed, and discharged will vary between the West and East Range Sites, the general requirements for water will be the same as those specified in Section 3.3.4. A generalized water balance diagram that applies to each the Phase I and Phase II Developments at either Site is shown in Figure 3.4-5.

##### 3.4.2.1.2 Zero Liquid Discharge System: Gasification Island

The gasification island will incorporate a significant environmental feature to protect the quality of local streams and lakes. That is, wastewater (generated from gasification and slag processing operations) containing certain levels of heavy metals and other contaminants from the feedstocks will be treated in a state-of-the-art ZLD system. This system will recover distilled water for reuse in the power plant, reducing fresh water consumption, and, more importantly, concentrate heavy metals and other contaminants of concern into a solid waste stream (see Section 3.4.4). This solid waste will be effectively disposed of in approved waste management facilities. Therefore, no wastewater streams from the ZLD system serving the gasification island will require disposal at either site (see Figure 3.4-5).

**Figure 3.4-5 Water Balance Diagram Showing Integration of ZLD System into Gasification Island in Mesaba One and Two Design***




NNF = normally no flow.

*In the case of the East Range Site, cooling tower blowdown is routed to a second ZLD system to avoid discharges to surface waters in the Lake Superior Basin watershed (see Figure 3.6-1).

#### 3.4.2.1.3 Storm Water Management

##### *3.4.2.1.3A Pre-Construction*

Environmentally sensitive areas outside the Station Footprint (and other developed areas) will be identified prior to the start of construction. These locations will be clearly delineated and will not be disturbed during site preparation activities. Best Management Practices ("BMPs") for storm water runoff will be identified, adopted and implemented during this time period.

#### *3.4.2.1.3B Construction*

Initial site preparation activities will include building access roads, clearing brush and trees, leveling and grading the area encompassing the Station Footprint and temporary construction-support features, bringing in necessary utilities, and undertaking dewatering activities that may be required. Trucks will be required to bring in fill material for roadways and the Power Station Footprint, remove harvested timber, remove debris from the site, and stockpile fill material. Gravel and road base will be utilized for the temporary roads, material storage, and parking areas as noted in Figure 3.2-8.

In accordance with 40 C.F.R. part 122.26(b)(14)(x), the Applicant will develop and submit to the MPCA prior to undertaking any construction activities a Storm Water Pollution Prevention Plan (SWPPP) that identifies erosion prevention and sediment BMPs. The plan will include specific identification of foreseeable conditions and proposed practices to properly address all such identified conditions during the various stages of construction and post construction. The plan will include a description of the nature of the construction activity and address and contain the following:

- Potential for discharging sediment and/or other potential pollutants from the Power Station Footprint and Buffer Land.
- Location and type of all temporary and permanent erosion prevention and sediment control BMPs, along with procedures to be used to establish additional temporary BMPs as necessary for the construction site.
- Construction site maps with existing and final grades, including dividing lines and direction of flow for all pre and post-construction storm water runoff drainage areas located within the Project limits. The construction site maps will also include impervious surfaces and soil types.
- Locations of areas not to be disturbed.
- Location of areas where construction will be phased to minimize duration of exposed soil areas.
- All surface waters and existing wetlands, which can be identified on maps such as United States Geological Survey 7.5 minute quadrangle maps or equivalent maps within one-half mile from the Project boundaries, which will receive storm water runoff from the construction site, during or after construction.
- Methods to be used for final stabilization of all exposed soil areas.

**Operation**

Storm water generated during operation of the IGCC Power Station will be managed in three ways. Storm water with potential to become contaminated with process solids/liquids will be segregated from process equipment by curbs, elevated drain funnels and other means and returned as make-up to the feedstock slurrying system or for other process water use.

Storm water that could become contaminated with oil (such as water runoff from parking lots) will be routed through an oil/water separator and then to the cooling tower blow down sump prior to discharge off-site.

Storm water from other areas not associated with industrial activity will be routed to the storm water detention pond where settling can occur and initial rainfall ("first flush") can be contained, checked, and released in a controlled manner to a permitted outfall.

#### 3.4.2.1.4 Sanitary Discharges

The sanitary wastewater produced during operation of the IGCC Power Station will be relatively small (about 30 gallons per person per day) and will be discharged to nearby Publicly Owned Treatment Works ("POTW"). In the case of the West Range Site, the closest POTW is the regional system located in Bovey. The Bovey POTW would be accessed via the City of Taconite sanitary sewer system. In the case of the East Range Site, the closest POTW is the Hoyt Lakes wastewater treatment plant. The Hoyt Lakes POTW would be accessed via a new pipeline constructed by the City. As an alternative, sanitary wastewaters from plant activities could be treated in an on-site septic system.

### 3.4.2.2 West Range (Preferred Site)

In the case of the West Range IGCC Power Station, the chemistry of the water effluent streams is inextricably linked to the chemistry of the Station's source waters. The reason for this strong link is that the only discharge to West Range receiving waters will be cooling tower blowdown (see Section 3.4.2.2.2).

#### 3.4.2.2.1 Introduction: Water Requirements, Water Use Flow Diagram and Receiving Waters

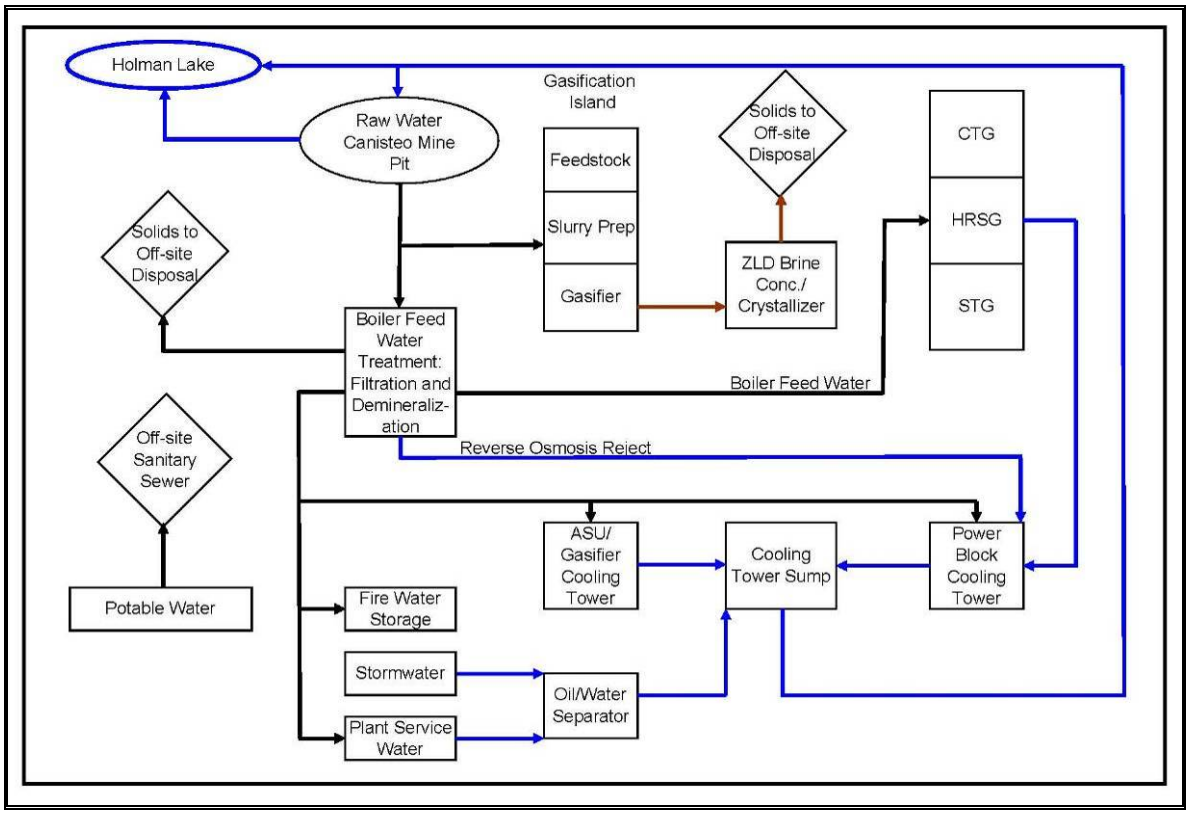
Information regarding water requirements for the IGCC Power Station and a generalized water use block flow diagram for the West Range Site are presented in Table 3.4-16 and Figure 3.4-6, respectively.

**Table 3.4-16**
**West Range Water Appropriation Requirements**

| Phase | Average Annual Appropriation (GPM) | Peak Appropriation (GPM) |
|---|---|---|
| I | 4,000[a]-4,400[b] | 6,500 |
| I and II | 8,800[b]-10,300[c] | 15,200 |

[a]Based on 8 COC in the gasification island and the power block cooling towers
[b]Based on 5 COC in the gasification island and the power block cooling towers
[c]Based on 3 COC in the gasification island and the power block cooling towers

**Figure 3.4-6 IGCC Power Station Water Use Flow Diagram—Phases I and II**




As shown in Figures 3.4-6 and 3.4-7, the receiving waters for the West Range Site will be the Canisteo Mine Pit ("CMP") and Holman Lake. The location of these waters relative to the IGCC Power Station is shown in Figure 3.4-8.

Figures 3.4-6 and 3.4-7 show that the CMP would also serve as the source of water for the IGCC Power Station. The Applicant's water management plan calls for other sources of water to be pumped into the CMP to provide sufficient water supplies and to maintain water levels and appropriate water chemistry. A general introduction to the water management plan is provided in Section 3.4.2.2.4. A detailed discussion of the water management plan is provided in Section 3.6.

**Figure 3.4-7 Water Supply and Wastewater Discharge System Schematic**

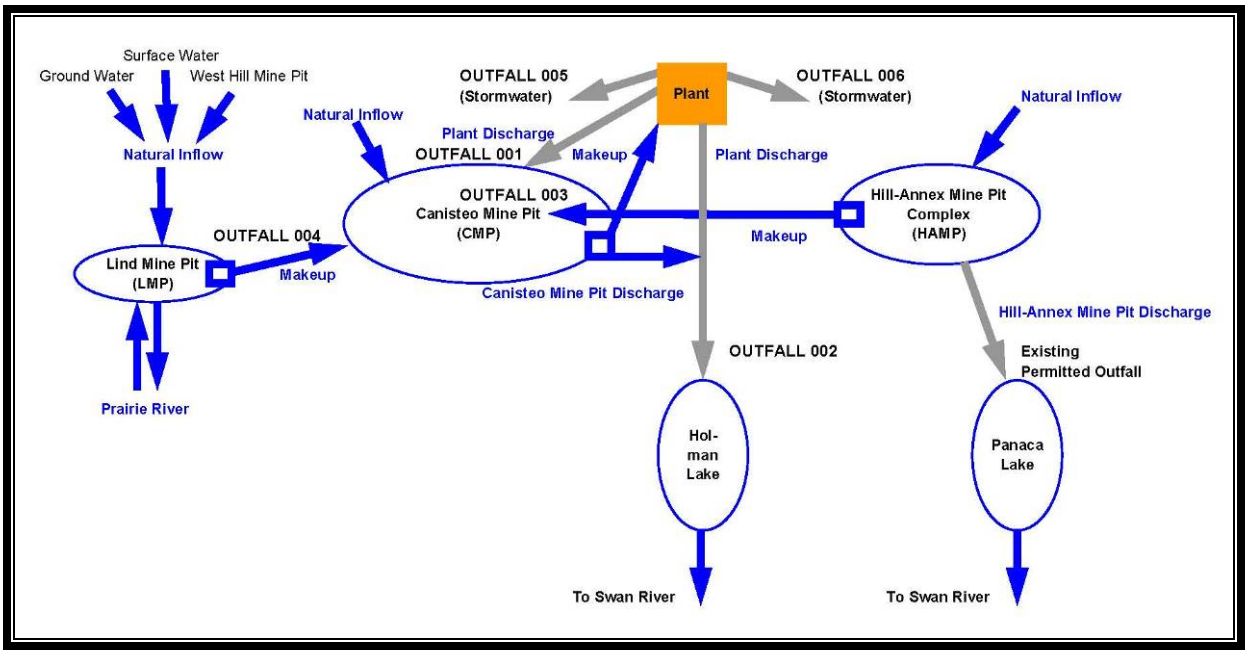
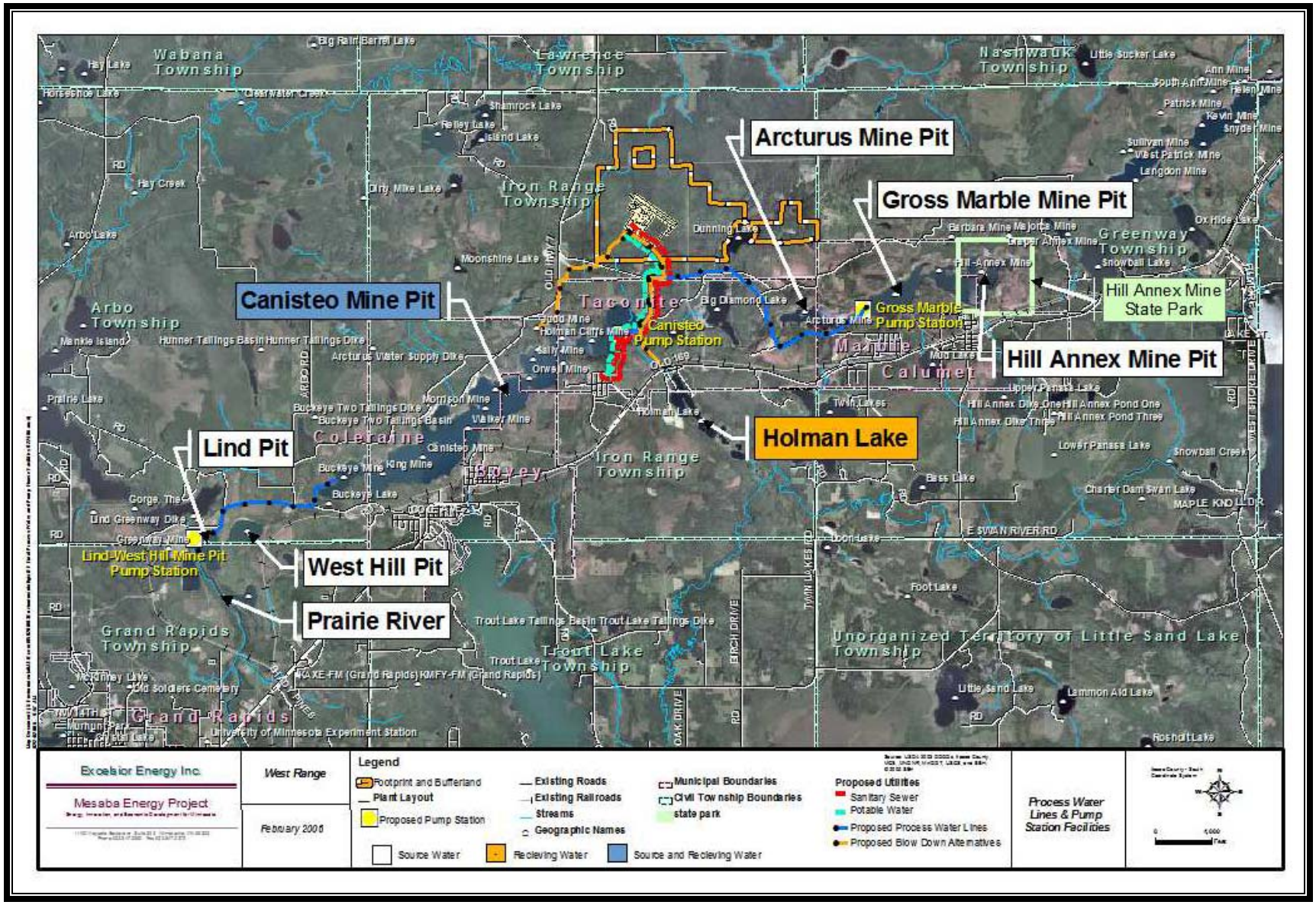


**Figure 3.4-8 West Range Site Receiving Waters**



#### 3.4.2.2.2 Cooling Tower Blowdown

Because almost all of the wastewater discharged from the IGCC Power Station operations is due to the need to remove a portion of the condenser cooling water for control of dissolved solids (as noted previously in Section 3.3.4.2, this wastewater stream is referred to as "cooling tower blowdown"), the constituents in the discharge are essentially the same materials present in the water supply to the plant, but more concentrated. Based on the IGCC Power Station equipment operating requirements and source water quality, the plant cooling towers are expected to be limited to between approximately three to eight COC. Therefore, the contaminants in the cooling water blowdown could be concentrated (due to evaporation in the cooling tower) by about three to eight times the concentration in the water supply.

In general, the amount of cooling tower blowdown requiring discharge to receiving waters is calculated as follows:[10]

$$\text{Blowdown} = \frac{\text{Evaporation}}{\text{Cycles - 1}} - \text{Drift}$$

As determined by this formula, wastewater discharge rates to the CMP and/or Holman Lake will be inversely proportional to the cycles of concentration at which the cooling towers are operated. The number of cycles of concentration in the IGCC Power Station will be determined in large part by the concentration of mercury in the CMP waters, the water quality criteria standards for mercury, TDS and hardness, and the total mass of mercury discharged to Holman and Panasa Lakes as allowed under conditions of an NPDES permit issued to Mesaba One and Two.

The following outlines the Applicant's methodology for operating Mesaba One and Two (the methodology is fully discussed in Section 5.2.2.1 and Appendix D, both contained in the NPDES Permit application attached as Appendix 6). The IGCC Power Station will operate at five cycles of concentration during Phase I and at three cycles of concentration for Phase I and II. A portion of the IGCC Power Station effluent will be discharged to the CMP and a portion will be discharged to Holman Lake. The volume of water discharged directly to Holman Lake from the IGCC Power Station will be controlled such that the total mass of mercury discharged to the Swan River watershed (the sum of any future discharge from the Hill-Annex Mine Pit to Panasa Lake and the IGCC Power Station discharge directly to Holman Lake) will be no greater than the mass currently permitted to be discharged to the watershed from the Hill-Annex Mine Pit Complex ("HAMP Complex") . Importantly, the outcome of this operating scenario is no net increase in the mass of mercury permitted to be discharged to the Swan River watershed under the existing NPDES Permit (No. MN0030198) currently held by the Minnesota Department of Natural Resources ("MDNR"). The volume of water discharged directly to Holman Lake will be adjusted about every five years, or as needed during Phase I and II operation, to limit the mass of mercury discharged. The expected peak and annual average wastewater discharge rates for the IGCC Power Station are summarized in Table 3.4-17.

[10] Black & Veatch, 1996, "Power Plant Engineering," Page 525-26.

**Table 3.4-17**
**Estimated Wastewater Discharge Rates To West Range Site Receiving Waters**

| | Cycles of Concentration | Peak Discharge (GPM) | Average Annual Discharge (GPM) |
|---|---|---|---|
| I | 5 | 1,300 | 550-900 |
| I and II | 3 | 5,140 | 2,200-3,500 |

The estimated average annual consumptive and non-consumptive uses and flows contributing discharge to the CMP during operation of a single phase, based on five cycles of concentration in the gasification island and the power block cooling towers, are shown in Figure 3.4-9. The flows for combined Phase I and II operation and three cycles of concentration in the cooling towers are shown in Figure 3.4-10. Specific water uses related to the gasification island and the power block are described below.

**Figure 3.4-9 Mesaba One: Water Uses Contributing to IGCC Power Station Discharge**

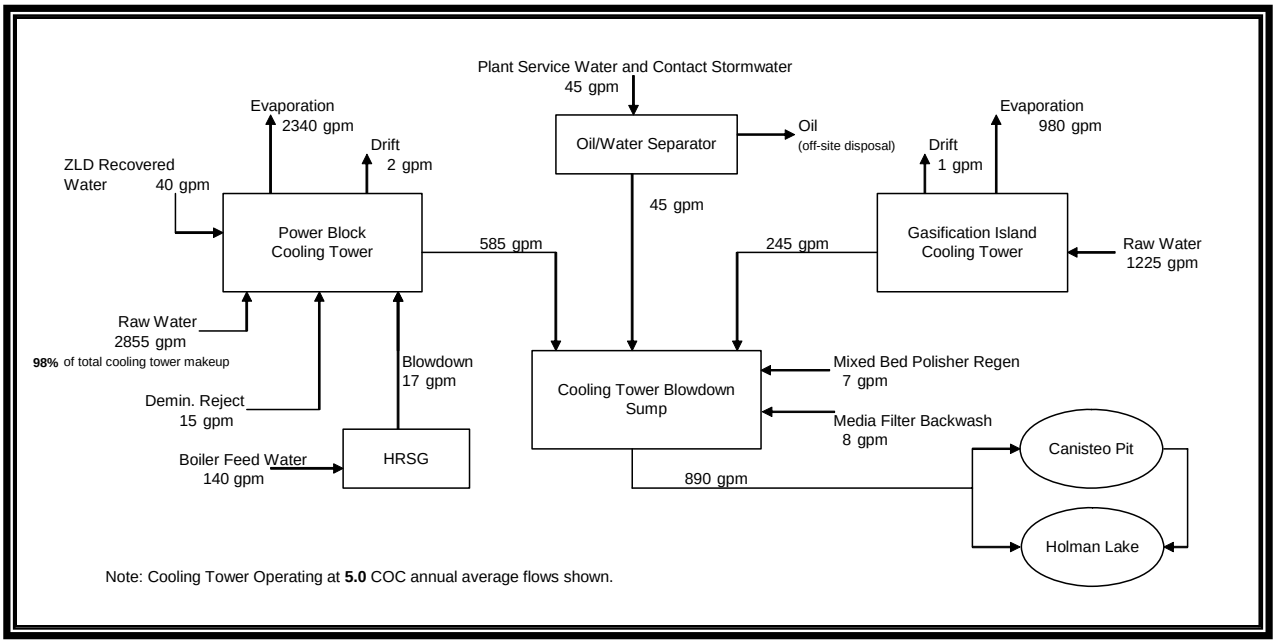
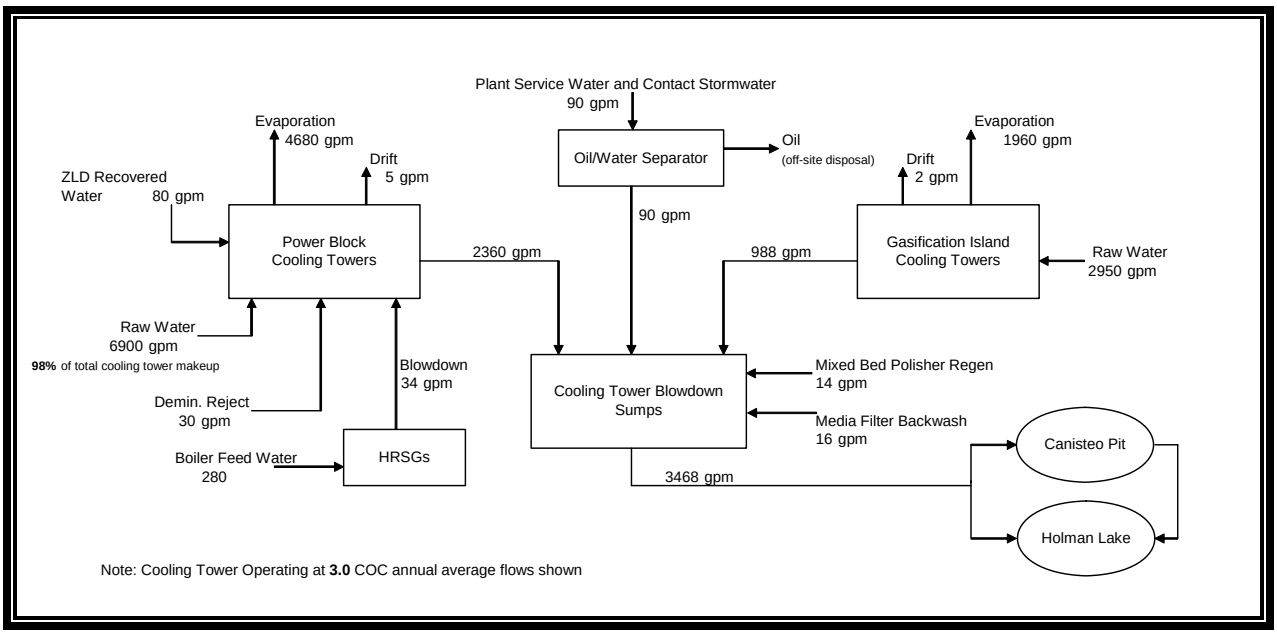



**Figure 3.4-10 Mesaba One and Mesaba Two - Water Uses Contributing to IGCC Power Station Discharge**




As shown in Table 3.4-18, the wastewater from the IGCC Power Station will consist mostly of cooling tower blowdown, blended with relatively low amounts of additional wastewater streams from other plant systems, including HRSG blowdown, reject water from the boiler feed water demineralizers, and treated storm water (processed through an oil/water separator) from plant drains isolated from contamination by process solids/liquids (see Figure 3.4-3).

**Table 3.4-18 Wastewater Discharge Rate From Systems In The Phase I IGCC Power Station**

| Wastewater Component | Cycles of Conc. | Expected Discharge (GPM) | |
|---|---|---|---|
| | | Ann. Avg. | Peak |
| Power Block Cooling Tower Blowdown | 8 | 335 | 498 |
| HRSG Demineralizer /RO Reject Water* | 8 | 15 | 15 |
| HRSG Blowdown* | 8 | 17 | 17 |
| Gasifier/ASU Cooling Tower Blowdown | 8 | 140 | 209 |
| Plant Service Water | 8 | 45 | 45 |
| Mixed Bed Polisher Regen./Backwash | 8 | 15 | 15 |
| [redacted] | | | |
| Power Block Cooling Tower Blowdown | 5 | 585 | 873 |
| HRSG Demineralizer /RO Reject Water* | 5 | 15 | 15 |
| HRSG Blowdown* | 5 | 17 | 17 |
| Gasifier/ASU Cooling Tower Blowdown | 5 | 245 | 366 |
| Plant Service Water | 5 | 45 | 45 |
| Mixed Bed Polisher Regen./Backwash | 5 | 15 | 15 |
| [redacted] | | | |
| Power Block Cooling Tower Blowdown | 3 | 1,180 | 1,750 |
| HRSG Demineralizer /RO Reject Water* | 3 | 15 | 15 |
| HRSG Blowdown* | 3 | 17 | 17 |
| Gasifier/ASU Cooling Tower Blowdown | 3 | 494 | 732 |
| Plant Service Water | 3 | 45 | 45 |
| Mixed Bed Polisher Regen./Backwash | 3 | 15 | 15 |

*The HRSG Demineralizer/RO Reject Water stream and HRSG Blowdown stream both discharge directly to the Power Block Cooling Tower and, therefore, would be reflected in the discharge from the Power Block Cooling Tower. For example, the average annual discharge from the IGCC Power Station assuming 8 cycles of concentration would be 535 gpm (335+140+45+15), not 567 (335+15+17+140+45+15).

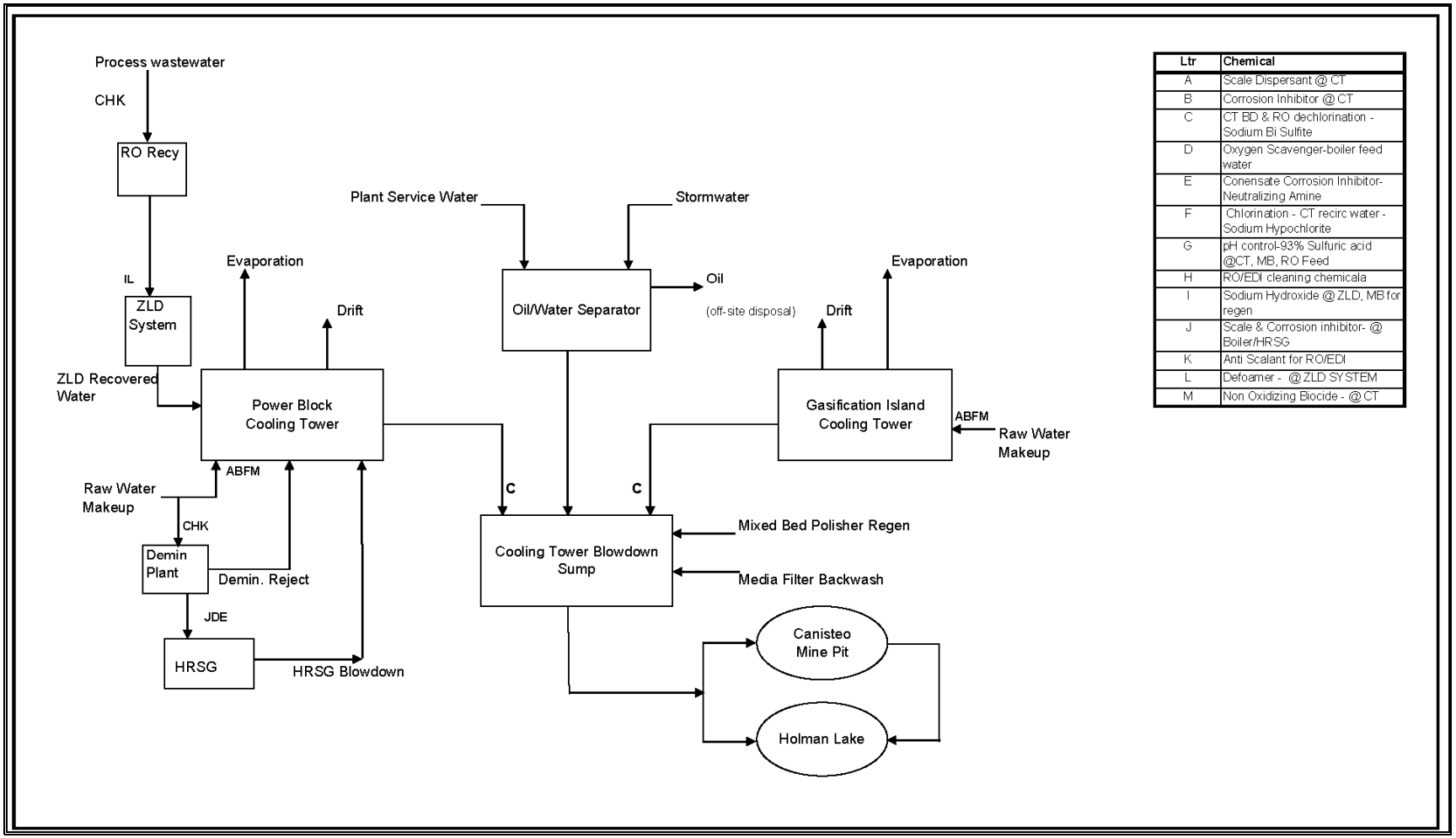
The chemicals that are expected to be added to the circulating water system and the residual amounts that ultimately would be discharged from Mesaba One and Mesaba Two to receiving waters are identified and listed in Table 3.4-19. The Applicant has screened the chemicals identified in this table for phosphorous containing compounds and will establish in the design basis for the IGCC Power Station that use of such chemicals is to be avoided. These chemicals are primarily needed to control cooling water corrosion and fouling, and to neutralize certain undesirable constituents in the plant discharge stream. The point of introduction for each of the chemicals is indicated in the table and in Figure 3.4-11. Material Safety Data Sheets (MSDS) representative of the chemical additives are provided in Appendix C of the NPDES Permit Application attached as Appendix 6. The estimated combined chemical usage for Mesaba One and Mesaba Two is also listed (half the indicated amount would be used for Mesaba One). However, the majority of the chemicals would be consumed in the plant processes and only residual amounts would be present in the water ultimately discharged to the CMP and/or Holman Lake. These quantities are preliminary estimates only and are subject to revision when the

specific water chemistry program for the facility is developed for submission to appropriate regulatory agencies for review and approval.

**Table 3.4-19 Chemical Additives Used Per Year (Phase I and II)**

| Chemical | Point(s) Of Introduction | Estimated Usage (lbs/Year) | Estimated Residual In Discharge | Basis, % In Discharge |
|---|---|---|---|---|
| Scale Dispersant | Cooling Towers | 75,000 | 750 | 1% |
| Corrosion Inhibitor | Cooling Towers | 300,000 | 3000 | 1% |
| Dechlorination – Sodium bisulfite | Cooling Tower<br>Blowdown Sump,<br>Reverse Osmosis System | 15,000<br>7500 | 150<br>75 | 1% |
| Oxygen Scavenger | Boiler Feed Water | 6600 | 66 | 1% |
| Condensate Corrosion Inhibitor-Neutralizing Amine | Boiler Feed Water | 2200 | 22 | 1% |
| Chlorination - Sodium Hypochlorite | Cooling Towers | 300,000 | 1500 | 0.5% |
| pH control-93% Sulfuric acid | Cooling Towers,<br>Reverse Osmosis,<br>Mixed Bed | 18,000<br>3000<br>11,000 | 36<br>6<br>22 | 0.2% |
| Sodium Hydroxide | Mixed Bed regeneration | 11,000 | 0 | (totally neutralized) |
| Scale and Corrosion inhibitor | Boiler/HRSG | 13,000 | 130 | 1% |
| Anti-Scalant | Reverse Osmosis,<br>Deionizer | 150<br>200 | 2<br>2 | 1% |
| Non-Oxidizing Biocide | Cooling Towers | 11,000 | 22 | 0.2% |

**Figure 3.4-11 Points of Chemical Addition in IGCC Power Station Circulating Water System**




| Ltr | Chemical |
|---|---|
| A | Scale Dispersant @ CT |
| B | Corrosion Inhibitor @ CT |
| C | CT BD & RO dechlorination - Sodium Bi Sulfite |
| D | Oxygen Scavenger-boiler feed water |
| E | Conensate Corrosion Inhibitor-Neutralizing Amine |
| F | Chlorination - CT recirc water - Sodium Hypochlorite |
| G | pH control-93% Sulfuric acid @CT, MB, RO Feed |
| H | RO/EDI cleaning chemicala |
| I | Sodium Hydroxide @ ZLD, MB for regen |
| J | Scale & Corrosion inhibitor- @ Boiler/HRSG |
| K | Anti Scalant for RO/EDI |
| L | Defoamer - @ ZLD SYSTEM |
| M | Non Oxidizing Biocide - @ CT |

#### 3.4.2.2.3 Source Water Quality

The water needs of the IGCC Power Station at the West Range Site will be met by appropriating water out of the following nearby abandoned mine pits; the CMP, the HAMP Complex, and the Lind Mine Pit ("LMP"). The Prairie River will also serve as a Water Resource, the use of which is described in the Applicant's overall water management plan. These Water Resources are shown in Figure 3.4-8 The current quality of each water source is summarized in Table 3.4-20. In general, the current concentration of each constituent is based on the median concentration of available qualified water quality analyses. Water quality data is provided in an appendix to the NPDES Permit Application provided in Appendix 6.

**Table 3.4-20**
**Current Source Water Quality**

| Constituent | Water Source | | | | |
|---|---|---|---|---|---|
| | Units | CMP | HAMP Complex | LMP | Prairie River |
| Hardness | mg/l | 308 | 229 | --[b] | --[b] |
| Alkalinity | mg/l | 180 | 163 | 178 | 76 |
| Calcium | mg/l | 55.3 | 58.6 | 73.2 | 50 |
| Magnesium | mg/l | 40.8 | 20.5 | -- | 22 |
| Iron | mg/l | <0.05 | <0.05 | -- | -- |
| Manganese | mg/l | <0.02 | <0.02 | -- | -- |
| Chloride | mg/l | 5.15 | 5.2 | 4.9 | 1.3 |
| Sulfate | mg/l | 103.5 | 59.5 | -- | <5 |
| TDS | mg/l | 337 | 254 | 402 | -- |
| pH | mg/l | 8.4 | 8.3 | 7.7 | 7.4 |
| Aluminum | ug/l | <25 | <25 | -- | 91 |
| Barium | ug/l | 28.6 | 29.7 | -- | -- |
| Cadmium | ug/l | <10 | <10 | -- | -- |
| Chromium (6+) | ug/l | <5 | <5 | -- | -- |
| Copper | ug/l | <10 | <10 | -- | -- |
| Fluoride | mg/l | -- | -- | -- | -- |
| Mercury | ng/l | 0.9 | 0.9 | 0.8[a] | 0.59 |
| Nickel | ug/l | <5 | <5 | -- | -- |
| Selenium | ug/l | <2 | <2 | -- | -- |
| Sodium | mg/l | 6.6 | 6.2 | 5.0 | 2.5 |
| Specific Conductivity | umhos/cm | 476 | 418 | -- | 171 |
| Zinc (3) | ug/l | <10 | <10 | -- | -- |
| BOD | mg/l | <2 | <2 | -- | -- |
| COD | mg/l | <2 | <2 | -- | -- |
| TOC | mg/l | 1.9 | 1.9 | -- | -- |
| TSS | mg/l | 1.5 | 1.5 | -- | -- |
| Ammonia (as N) | mg/l | <0.1 | <0.1 | 0.1 | 0.018 |
| Phosphorus | mg/l | <0.1 | <0.1 | 0.01 | 0.029 |

[a] For the mass balance computations presented in Section 5, it was conservatively assumed that the mercury concentration in the LMP is identical to that in the HAMP Complex and the CMP.
[b] --Indicates that no data was collected.

#### 3.4.2.2.4 West Range Outfalls, Discharge Rates, and Receiving Water Quality

For the West Range Site, the direct receiving waterbodies for discharges of cooling tower blowdown from the IGCC Power Station will be the CMP and Holman Lake.

Holman Lake will receive discharges from the CMP for purposes of water level control in the CMP and/or to maintain water quality within that Pit (to keep the concentration of solids from building up).

Figure 3.4-12 and Figure 3.4-13 show the expected discharge outfalls for Mesaba One and Mesaba One and Two, respectively. The combination of surface flow/infiltration of water to the CMP, the input of excess water from the HAMP Complex, and the discharge of water from the CMP (or directly from the Power Station) to Holman Lake would act to reduce the concentration of mineral constituents in the CMP. The locations of the discharge outfalls are shown on Figure 3.4-14.

**Figure 3.4-12 Phase I Water Operations Flow Rates: West Range Site**

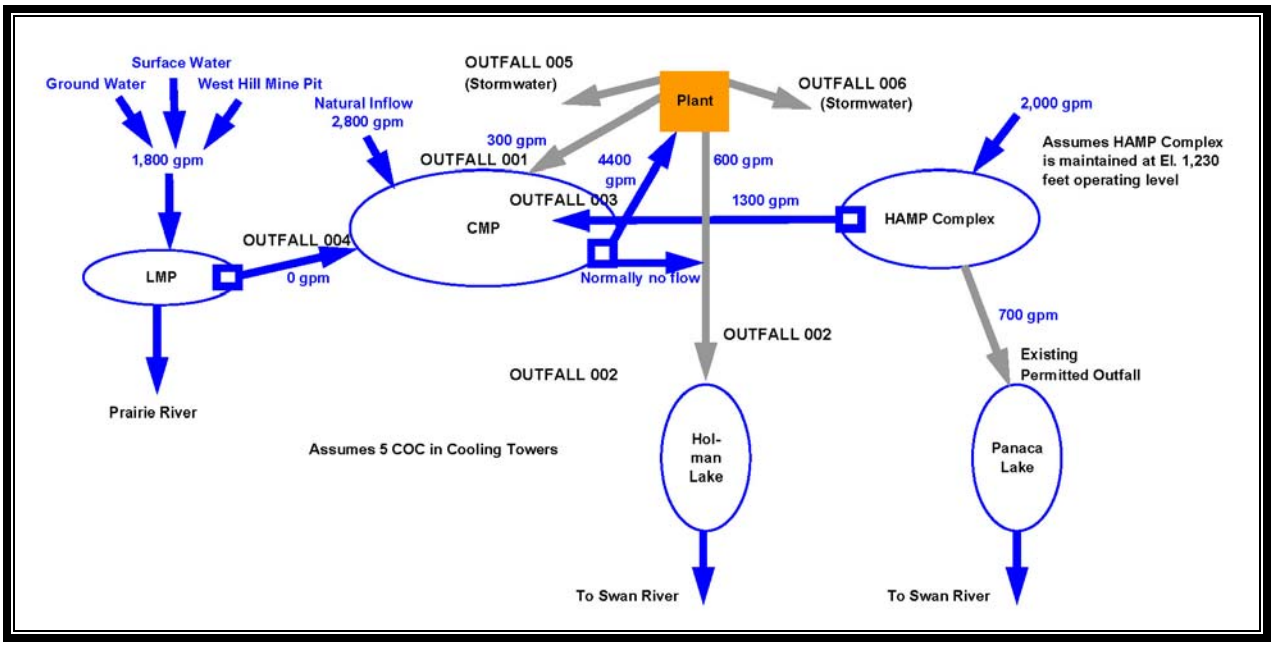



**Figure 3.4-13 Phase I and II Water Operations Flow Rates: West Range Site**

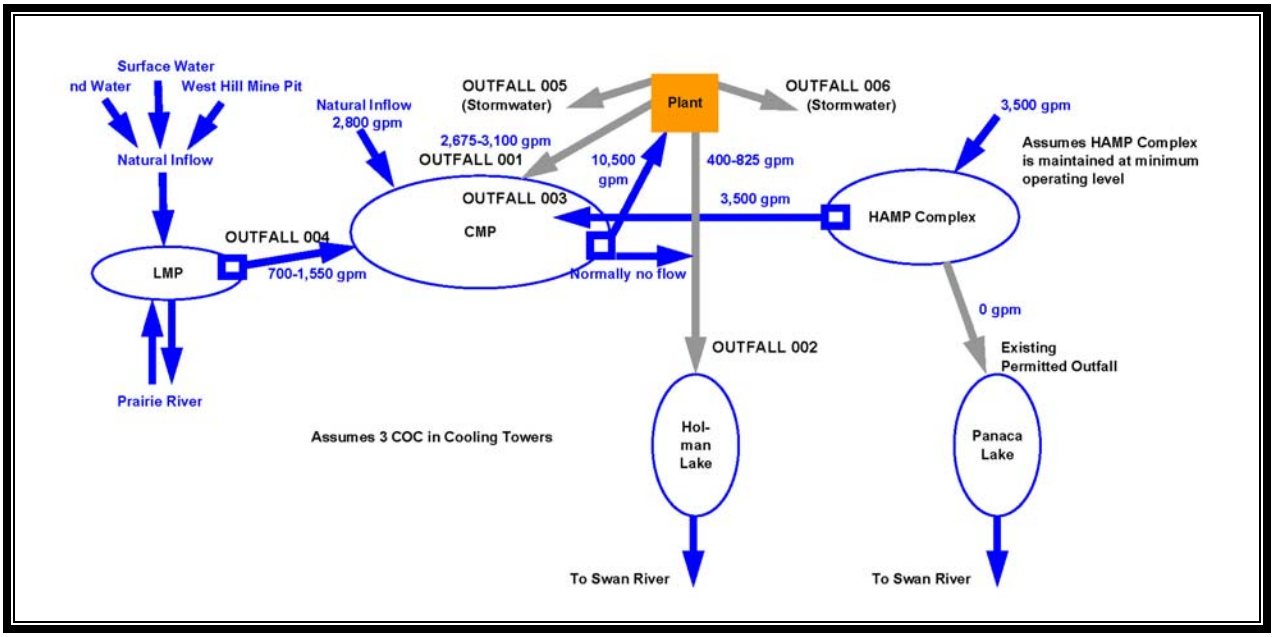
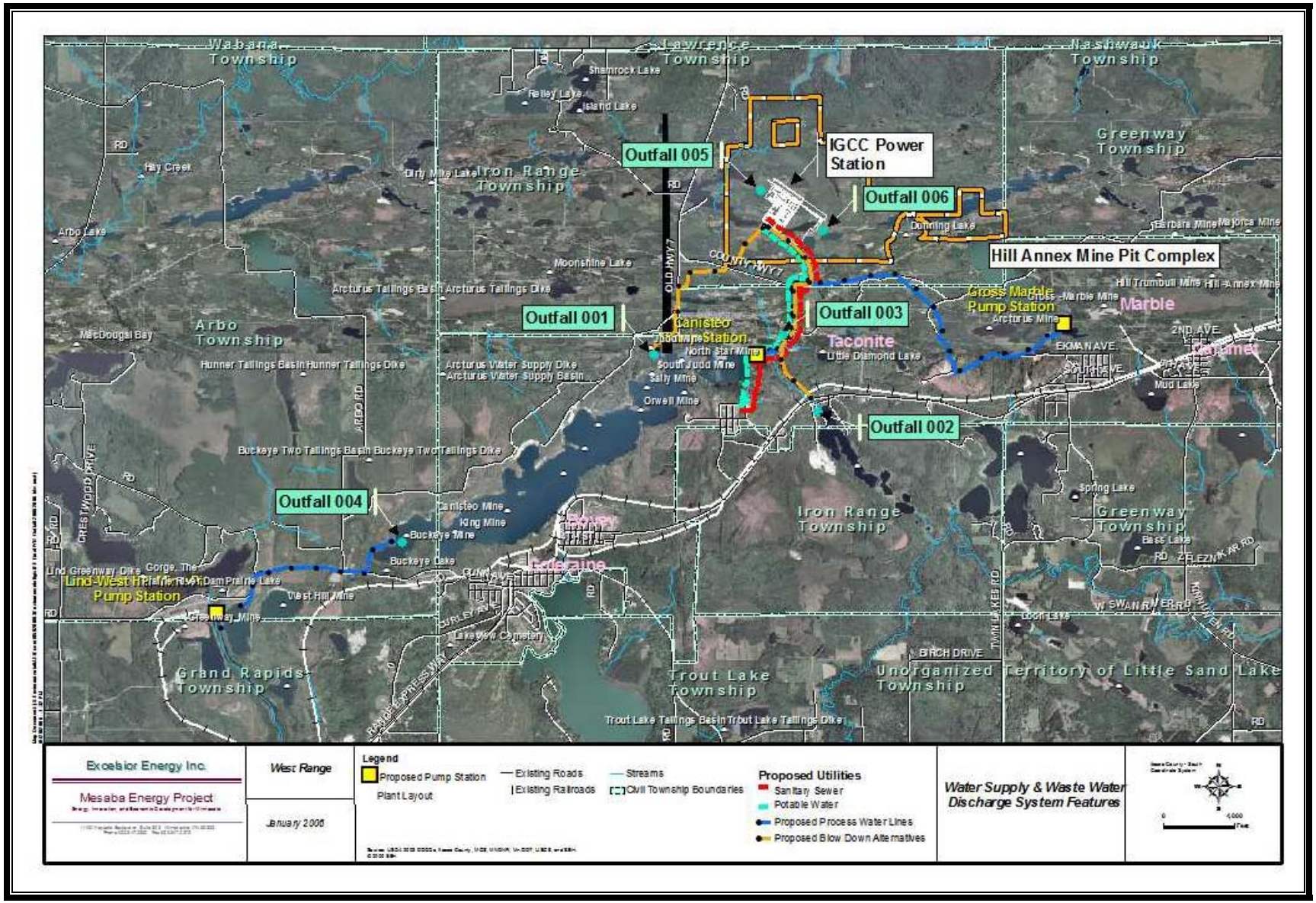


**Figure 3.4-14 NPDES Outfall Locations: West Range Site**



The expected average annual flow rate and proposed permitted peak flow rate for each outfall for Phase I and Phase I and II operation are summarized in Table 3.4-21. The expected average annual discharge rates are based on the water balances presented in Figures 3.4-12 and 3.4-13. The proposed peak discharge rates are based on modeled peak rates plus additional capacity to provide operational flexibility.

**Table 3.4-21**
**Discharge Flow Rates**

| Outfall | Phase I | | Phase I and II | |
|---|---|---|---|---|
| | Average (gpm/MGD) | Peak (gpm/MGD) | Average (gpm/MGD) | Peak gpm/MGD) |
| 001 | 900/1.3 | 3,000/4.3 | 3,500/5.0 | 6,000/8.6 |
| 002 | 600/0.9[a] | 3,000/4.3 | 825/1.2[a] | 6,000/8.6 |
| 003 | 2,000/2.9 | 7,000/10.1 | 3,500/5.0 | 7,000/10.1 |
| 004 | 0 | 0 | 1,800/2.6 | 7,000/10.1 |
| 005 | To be determined | To be determined | To be determined | To be determined |

[a] Limited by mercury mass discharge.

The current water quality of the receiving water is provided in Table 3.4-22.

**Table 3.4-22**
**Current Water Quality of Receiving Waters**

| Constituent | Units | CMP | Holman Lake |
|---|---|---|---|
| Hardness | mg/l | 308 | --[a] |
| Alkalinity | mg/l | 180 | 186 |
| Calcium | mg/l | 55.3 | 50.2 |
| Magnesium | mg/l | 40.8 | -- |
| Iron | mg/l | <0.05 | 0.75 |
| Manganese | mg/l | <0.02 | 0.04 |
| Chloride | mg/l | 5.15 | 8.4 |
| Sulfate | mg/l | 103.5 | 10.1 |
| TDS | mg/l | 337 | 236 |
| pH | mg/l | 8.4 | 7.9 |
| Aluminum | ug/l | <25 | -- |
| Barium | ug/l | 28.6 | -- |
| Cadmium | ug/l | <10 | -- |
| Chromium (6+) | ug/l | <5 | -- |
| Copper | ug/l | <10 | -- |
| Fluoride | mg/l | n/a | -- |
| Mercury | ng/l | 0.9 | <4.0 |
| Nickel | ug/l | <5 | -- |

| Constituent | Units | CMP | Holman Lake |
|---|---|---|---|
| Selenium | ug/l | <2 | -- |
| Sodium | mg/l | 6.6 | 7.4 |
| Specific Conductivity | umhos/cm | 476 | -- |
| Zinc (3) | ug/l | <10 | -- |
| BOD | mg/l | <2 | -- |
| COD | mg/l | <2 | -- |
| TOC | mg/l | 1.9 | -- |
| TSS | mg/l | 1.5 | -- |
| Ammonia (as N) | mg/l | <0.1 | <0.1 |
| Phosphorus | mg/l | <0.1 | 0.01 |

[a] – Indicates that no data was collected.

A comparison of expected IGCC Power Station discharges and applicable state numerical water quality standards (Minn. R. 7050.0222) is summarized in Table 3.4-23. None of the abandoned mine pits is listed on the PWI or are published in rules that Class 2B water standards are applicable (Minn. R. 7050.0430). Holman Lake is listed on the PWI, but not in Minnesota Rules, so Class 2B water standards apply. In the absence of formal guidance with respect to the "classification of the West Range Water Resources, the Proponent has determined that the Class 2B water standards are applicable (Min. R. 7050.0430).

**Table 3.4-23**
**Expected IGCC Power Station Discharges and Applicable State Numerical Water Quality Standards**

| Constituent | Units | Class 2 WQ Standard | Anticipated Effluent Water Quality – Phase II (5 COC) | Anticipated Effluent Water Quality – Phase II (3 COC) |
|---|---|---|---|---|
| Hardness | mg/l | 250 | 0 .07 | 0.03 |
| Alkalinity | mg/l | n/a | -- | -- |
| Calcium | mg/l | n/a | -- | -- |
| Magnesium | mg/l | n/a | -- | -- |
| Iron | mg/l | n/a | -- | -- |
| Manganese | mg/l | n/a | -- | -- |
| Chloride | mg/l | 230 | 38 | 16 |
| Sulfate | mg/l | n/a | 470 | 280 |
| TDS | mg/l | 700 | 2,317 | 1,039 |
| pH | mg/l | 6 - 9 | 6 - 9 | 6 - 9 |
| Aluminum | ug/l | 125 | 73 | 31 |
| Arsenic | ug/l | 53 | Note 4 | Note 4 |
| Barium | ug/l | n/a | -- | -- |
| Cadmium | ug/l | 2.0[1] | Note 3 | Note 3 |
| Chromium (6+) | ug/l | 32[1] | Note 3 | Note 3 |
| Copper | ug/l | 15[1] | Note 3 | Note 3 |
| Fluoride | mg/l | n/a | -- | -- |

| Constituent | Units | Class 2 WQ Standard | Anticipated Effluent Water Quality – Phase II (5 COC) | Anticipated Effluent Water Quality – Phase II (3 COC) |
|---|---|---|---|---|
| Mercury | ng/l | 6.9 | 6.6 | 2.8 |
| Nickel | ug/l | 283[1] | 37 | 16 |
| Selenium | ug/l | 5 | Note 3 | Note 3 |
| Sodium | mg/l | n/a | -- | -- |
| Specific Conductivity | umhos/cm | 1000 | 12,380 | 1,400 |
| Zinc (3) | ug/l | 191[1] | Note 3 | Note 3 |
| Phosphorus | mg/l | 1[2] | 0.07 | 0.03 |

[1] indicates a hardness based standard. It is assumed hardness in the receiving water is >200 mg/L based on available data.
[2]phosphorus standard is an effluent limit and not a water quality standard.
[3]results below detection limit.
[4]not analyzed.

A mass balance model was constructed to estimate the IGCC Power Station effluent water quality over various periods of operation of the IGCC Power Station and under various operating scenarios. The model is described and detailed study results are presented in Appendix D of the NPDES Permit Application attached as Appendix 6 to this Joint Permit Application. The model calculates the anticipated water quality from the IGCC Power Station discharge and that anticipated in the CMP as a result of various inflows from the HAMP Complex and the LMP, and discharges from the IGCC Power Station.

The modeling results indicate that key water quality constituents associated with Outfall 001 and 002 discharges will be mercury, total dissolved solids (TDS), and hardness. As shown below, mercury will be addressed by operating the IGCC Power Station such that the concentration of mercury in its effluent discharges will not exceed the water quality standard of 6.9 ng/L. In addition, operation of the system will be such that the mass of mercury discharged to Holman Lake through Outfall 002, combined with the mass of mercury discharged to Panasa Lake from the continued pumping of the HAMP Complex, will not exceed the mass of mercury currently permitted to be discharged to Panasa Lake under existing NPDES Permit No. MN0030198. Both Holman Lake and Panasa Lake are tributary to the Swan River. Therefore, this system will not contribute additional pollutants to the Swan River watershed. TDS and hardness discharge concentrations will be acceptable with the inclusion of a mixing zone as allowed under Minn. R. 7050.0210, subp. 5.

The volume of water discharged directly to Holman Lake will be adjusted approximately every five years, or as needed during Phase I and II operation, to limit the mass of mercury discharged to Holman Lake.

Similarly, it is anticipated that the concentration of sulfate in the IGCC Power Station discharge water will also increase over time and concern has been raised regarding the link between sulfate and methyl mercury. However, as with mercury, no additional mass of sulfate will be discharged

to the Swan Lake watershed from the IGCC Power Station. While it has been demonstrated that the addition of sulfate may stimulate the formation of methyl mercury in peatlands (Branfireun et al. 1999; 2001)[11], the relationship may depend on several variables in addition to sulfate. These include organic carbon, the fraction of bioavailable mercury, and the microbial community structure (not all sulfate reducing bacteria methylate mercury) (Porvari and Verta 1995; Branfireun et al. 1999; Macalady et al. 2000).[12] In addition, the thermal modeling presented in Section 5.3 below has demonstrated that the discharge water from the IGCC Power Station is anticipated to remain at or near the surface of the receiving water and will have limited mixing with the bottom waters.

The reader is referred to Appendix 6 for a complete discussion of the mass balance conducted in support of demonstrating that there will be no increase in the mass discharges to the Swan Lake watershed above those that are presently permitted.

#### 3.4.2.3 East Range (Alternate Site)

##### 3.4.2.3.1 Management of Cooling Tower Blowdown

Discharge of cooling tower blowdown to any receiving waters in the Lake Superior Basin watershed is likely infeasible in the absence of use of an existing permit having sufficient discharge rights, and whose operating authority could be transferred to the Applicant. The Applicant is not aware of the existence of any such permits.

The Hoyt Lakes POTW was considered as an alternative but was determined to not have sufficient existing capacity to manage the quantities of cooling tower blowdown that would be produced. In addition, an expansion of the existing system cannot be undertaken without a major non-degradation study.

These options, in addition to uncertainties associated with treating the IGCC Power Station's cooling tower blowdown to remove mercury, were deemed less likely to be approved than the ZLD system described above.

Expanding the capacity of the ZLD system would leave domestic wastewater as the only effluent discharge from the IGCC Power Station on the East Range Site. The option selected for dealing

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[11] Branfireun BA, Roulet NT, Kelly CA & Rudd JWM (1999) In situ sulphate stimulation of mercury methylation in a boreal peatland: toward a link between acid rain and methylmercury contamination in remote environments. Global Geochemical Cycles 13: 743-750.

Branfireun BA, Bishop K, Roulet NT, Granberg G & Nilsson M (2001) Mercury cycling in boreal ecosystems: The long-term effect of acid rain constituents on peatland pore water methylmercury concentrations. Geophys. Res. Lett. 28: 1227-1230.

[12] Macalady JL, Mack EE & Scow KM (2000) Sediment Microbial Community Structure and Mercury Methylation in Mercury-Polluted Clear Lake, California. Appl. Environ. Microbiol. 66: 1479.

Porvari P & Verta M (1995) Methylmercury production In flooded soils - a laboratory study. Water, Air, and Soil Poll. 80: 765-773.

with this waste stream is identified in Section 3.6.4.2 of this Application; the alternatives considered are provided in Section 1.12.6.3 of the ES.

### 3.4.3 Pollution Prevention, Recycling and Reuse Plans

#### 3.4.3.1 Site Independent Features

The IGCC Power Station will be designed to minimize process-related discharges to the environment and will represent a significant step toward demonstrating industrial ecology in the use of coal for power generation. Mesaba One and Mesaba Two will stand out as a state-of-the-art example of incorporating pollution prevention concepts into practically every aspect of the IGCC Power Station's design and operational plan. The following are the key pollution prevention, recycling, and reuse features that will be employed as part of that plan:

##### 3.4.3.1.1 Spill Prevention Control and Countermeasure (SPCC) Plan

The SPCC Plan will anticipate contingency spill events, thereby insulating environmental media from the effect of accidental releases. All above ground chemical storage tanks will be lined or paved, curbed/diked, and have sufficient volume to meet all regulatory requirements.

Each Project Site will have a drainage plan that isolates routine process-related operations from affecting the surrounding environment.

##### 3.4.3.1.2 Feedstock Material Handling

The feedstock storage area is paved or lined so that runoff can be collected, tested, and treated as necessary. The feedstock storage area has facilities to control fugitive dust emissions. The feedstock conveyors are covered.

##### 3.4.3.1.3 Feedstock Grinding and Slurry Preparation

The feedstock grinding equipment is enclosed and any vents will be collected and routed to the tank vent boiler/auxiliary boiler. The water used to prepare the feedstock slurry includes stripped process condensate (recycled).

##### 3.4.3.1.4 Gasification, High Temperature Heat Recovery, Dry Char Removal and Slag Grinding

The char produced in gasification is removed and recycled to the first stage of the gasifier. This improves carbon conversion in the gasifier and reduces the amount of carbon contained in the gasifier slag.

##### 3.4.3.1.5 Slag Handling

The slag dewatering system generates some flash gas (gas released as a result of a rapid and significant drop in pressure to which a material is exposed) that contains $H_2S$. The flash gas will be recycled back to the gasifier via the syngas recycle compressor. Water that is entrained with the slag is collected and sent to the sour water stripper for recycle.

#### 3.4.3.1.6 Sour Water System

Sour water is collected from slag dewatering and the low temperature heat recovery system, and the $NH_3$ and $H_2S$ are stripped out and sent to the SRU. The stripped condensate is used to prepare coal slurry. Surplus stripped condensate is sent to the ZLD unit.

#### 3.4.3.1.7 Zero Liquid Discharge Unit

The ZLD unit concentrates and evaporates the process condensate. The ZLD unit produces high purity water for reuse and a solid filter cake for disposal off site (the ZLD unit concentrates heavy metals and other contaminants into this filter cake). The ZLD is also a recycle unit since the recovered water is reused, reducing total plant water consumption.

#### 3.4.3.1.8 COS Hydrolysis

The gasifier produces small quantities of COS that cannot be absorbed in the AGR system. The COS hydrolysis unit converts COS to $H_2S$ so that it can be removed in the AGR unit. The COS hydrolysis unit improves the sulfur recovery efficiency of the Power Station and reduces the total amount of sulfur in the syngas, and ultimately, the release of $SO_2$ from the HRSG stacks.

#### 3.4.3.1.9 Mercury Removal Features

The mercury removal unit uses specially formulated activated carbon to capture trace quantities of mercury that remain in the syngas. Mercury in the sour water handling system is captured via activated carbon filters strategically placed prior to potential release points.

#### 3.4.3.1.10 Acid Gas Removal

The AGR system removes $H_2S$ from the raw syngas and produces a sweet (low sulfur) syngas for use in the combined cycle power block. The AGR system produces concentrated $H_2S$ feed for the SRU.

#### 3.4.3.1.11 Sulfur Recovery Unit (SRU)

The SRU converts the $H_2S$ to elemental sulfur that will be marketed for use as a fertilizer additive or for production of sulfuric acid. The tail gas from the SRU is recycled back to the gasifier. This eliminates the tail gas unit emissions commonly found in Claus plants.

#### 3.4.3.1.12 Fuel Gas Moisturization

The fuel gas moisturization system improves the recovery of low level heat from the gasification process and serves as a diluent for the syngas used in the combustion turbines. Nitrogen from the ASU is also used as a diluent. Dry, clean syngas typically has a heating value in the range of 250 to 300 Btu/scf. If the dry syngas was used directly in the combustion turbines, the thermal $NO_x$ formed would be too high. Earlier IGCC plants used steam injection for $NO_x$ control, which is less efficient at reducing $NO_X$ than using fuel moisturization and nitrogen.

#### 3.4.3.1.13 Integration of the ASU and Power Block

The ASU produces nitrogen as a by-product which is an effective diluent for $NO_x$ control. The ASU also requires large amounts of electrical power for air compression. Part of the air compression requirements will be provided by the combustion turbine compressors, further integrating the gasification and combined cycle power block portions. This integration reduces the ASU auxiliary power requirement and increases the Power Station's net electric output.

#### 3.4.3.1.14 Other Reuse Plans

Boiler blowdown and steam condensate will be recovered from the combined cycle power block and gasification facilities, and will be reused as cooling tower makeup water.

#### 3.4.3.1.15 Training and Leadership

Finally, all corporate and plant personnel will be trained in a culture focused on continuous operational improvement and environmental performance. Training and programs will include setting, measuring, evaluating and achieving performance and waste reduction goals.

### 3.4.3.2 West Range IGCC Power Station

One of the most important site dependent pollution prevention features of the West Range Site offers is the long term role it will play as a flood control mechanism for the Hill-Annex State Park and the communities, highways, and railroad facilities located south of the CMP. Although there may be other means to control the flooding threat in these locations, none offers the Power Station's capability for water reuse and its attendant socio-economic benefits.

### 3.4.3.3 East Range IGCC Power Station

Eliminating cooling tower blowdown discharges from the IGCC Power Station that would be constructed on the East Range Site (via the ZLD system described in Section 1.8.2.3) provides significant pollution prevention opportunities and operational synergies with nearby projects that either have acquired construction permits or are in the environmental review/permitting process. The other nearby projects must cope with similar issues regarding stringent regulations for process water discharges in the Lake Superior Basin watershed. Further, the MPCA must cope with existing stringent rules to license and permit such projects, realizing the socio-economic benefits they will bring. The IGCC Power Station equipped with the ZLD system to eliminate cooling tower blowdown may allow Mesaba One and Mesaba Two to utilize as source water the process wastewaters released by nearby projects. This feature could integrate well with the proposed industrial mining facilities to be located on CE's properties by eliminating wastewaters that would otherwise represent new discharges to impaired waters downstream.

The IGCC Power Station's possible later in-service date relative to other projects' start-up dates is not a fatal flaw to this water management concept. The Applicant will use the 2West Extension ("2WX") Mine Pit as a reservoir from which to supply water to the IGCC Power Station. Until the IGCC Power Station is ready to take water from the 2WX Mine Pit, other projects could potentially direct their effluent waters there for intermediate storage.

### 3.4.4 Solid Waste Generation, Handling, and Treatment/Disposal

Solid wastes produced at either Site will include miscellaneous janitorial streams associated with clean-up of the IGCC Power Station, commercial waste paper, spent activated carbon beds, and spent catalyst materials (associated with the COS hydrolysis and SRU systems). The solid waste stream produced by the ZLD system is discussed in Section 3.4.4.1.3 below. Off-site disposal of wastes that cannot otherwise be recycled or reused on-site will be conducted in compliance with all local, State and Federal rules and regulations.

Slag and elemental sulfur produced as a result of the mineral matter and sulfur contained in the feedstocks utilized are considered to be potential revenue producing streams that will be actively marketed.

#### 3.4.4.1 Operational Wastes

##### 3.4.4.1.1 Site Independent Listing of Operational Wastes

Table 3.4-24 summarizes the expected waste streams that will be generated during operation of the Phase I and II IGCC Power Station. These estimates are based on experience gained at Wabash River and adjusted for differences in capacity and configuration. Operational wastes generally include the following process wastes:

- Spent catalysts, adsorbents, and process solvents
- Used oils and fluids
- Cleaning and maintenance wastes
- Miscellaneous materials

##### 3.4.4.1.2 West Range Site

The West Range Site has no additional operational wastes to add to the list in Table 3.4-24.

##### 3.4.4.1.3 East Range Site

Residual solids from the ZLD system serving the power block and gasification island cooling towers will be produced in addition to the materials listed in Table 3.4-24. The worst case amount of solids produced is based upon the highest TDS levels measured in any of the mine pit waters, which in this case were measured in Mine Pit No. 6 (1,800 mg/L, see Section 3.4.1.1.6). At a peak make-up rate of 5,060 gpm for Mesaba One and 5,060 for Mesaba Two, and assuming worst case water quality, the peak solids produced by this system would total about 109 tons per day:

$$\text{Solids} = 5{,}060\ \text{gal/min-phase} * 2\ \text{phases} * 8.33\ \text{lb/gal} * 1{,}440\ \text{min/day} * 1{,}800\ \text{lbs}/10^6\ \text{lbs water} * 1\ \text{ton}/2000\ \text{lbs} \approx 109\ \text{tons/day}$$

On an annual average basis, make up to the cooling towers is projected to be 3,400 gpm. Using the same worst case water quality conditions noted above, the solids production rate would be about 73 tons per day:

Solids = 3,400 gal/min-phase*2 phases*8.33 lb/gal*1,440 min/day*1,800 lbs/$10^6$ lbs water*1 ton/2000 lbs ≈ 73 tons/day

Assuming a 92% capacity factor, total solids production from the ZLD system would be about 24,500 tons per year.

**Table 3.4-24 Estimated Operational Waste Streams (Phase I and II)**

| Waste Description | Comments | Annual Quantity | H/NH* | Likely Disposition |
|---|---|---|---|---|
| **Used Catalysts and Sorbents** | | | | |
| COS hydrolysis catalyst | Proprietary composition | 42 tons | NH | Non-hazardous landfill |
| Hydrolysis catalyst support balls | Alumina silicate | 14 tons | (NA) | Recycle |
| Claus sulfur recovery catalyst | Activated alumina | 28 tons | NH | Non-hazardous landfill |
| Claus catalyst support balls | Activated alumina | 10 tons | (NA) | Recycle |
| Hydrogenation catalyst | Cobalt Molybdenum | 6 tons | (NA) | Metals reclaim |
| Hyd. catalyst support balls | Alumina silicate | 2 tons | (NA) | Recycle |
| Amine regenerator carbon filter | Activated carbon | 26 tons | H | Stabilize, hazardous waste landfill |
| Syngas treatment carbon | Activated carbon | 60 tons | H | Stabilize, hazardous waste landfill |
| Mercury removal carbon | Impregnated carbon | 14 tons | H | Stabilize, hazardous waste landfill |
| Sour water carbon | Activated carbon | 48 tons | H | Stabilize, hazardous waste landfill |
| MDEA reclaim ion exchange | Ion exchange resin | 0.4tons | NH | Non-hazardous waste landfill |
| **Other Process Wastes** | | | | |
| ZLD filter cake (Gasification Island) | Inorganic and organic salts | 4400 tons | H | Stabilize, hazardous waste landfill |
| Refractory brick and insulation | Gasifier repairs | 360 tons | NH | Non-hazardous waste landfill |
| MDEA sludge | Reclaimer bottoms | 10,000 gal | H | Incinerate or hazardous waste landfill |
| Sour water sludge | Char carryover in syngas | 30 tons | H | Incinerate |
| Waste char and ash | Maintenance cleaning | 160 tons | N | Non-hazardous waste landfill |
| Amine absorber residues | Iron and salts | 20 $yd^3$ | N | Non-hazardous waste landfill |
| Metallic filter elements | | 60 $yd^3$ | H | Stabilize, hazardous waste landfill |
| Spent citric acid | Cleaning solution | 40 drums | H | Approved disposal facility |
| Spent soda ash | Cleaning solution | 40 drums | H | Approved disposal facility |
| Spent sulfuric acid | Line cleaning solution | 14,000 gal | H | Approved disposal facility |

**Table 3.4-24 Estimated Operational Waste Streams (Phase I and II)**

| Waste Description | Comments | Annual Quantity | H/NH* | Likely Disposition |
|---|---|---|---|---|
| Off-line combustion turbine wash wastes | Detergent and residues | 15,000 gal | Probably NH | Characterize, dispose as non-hazardous or hazardous wastes |
| HRSG wash water (infrequent) | Detergent, residues, neutralized acids | 100,000 gal | Probably NH | Characterize, dispose as non-hazardous or hazardous wastes |
| Raw water treatment sludge and used water filter media | Solids removed from makeup water to plant | TBD | Probably NH | TBD |
| **Miscellaneous Streams** | | | | |
| Used oil | Lube oils, oil from oil/water separator | 8000 gal | (NA) | Send to reclaimer |
| Spent grease | | 16 drums | NH | Blend to gasifier feed |
| Miscellaneous solvents, coal tars | | 2 drums | H | Solvent reclaimer |
| Flammable lab waste | | 2 drums | | Blend to gasifier feed |
| Scrap metal | Steel, aluminum, etc. | 200 $yd^3$ | NH | Recycle |
| Waste paper and cardboard | Office, shops, packing, etc. | 320 $yd^3$ | NH | Recycle |
| Combined industrial waste | Used PPE, materials, small amounts of refractory, slurry debris, etc. | 320 $yd^3$ | NH | Non-hazardous waste landfill |

***Legend:** NH = Non-Hazardous; H = Hazardous; NA= Not Applicable

The environmental features of E-Gas™ technology avoid two significant solid waste streams – flue gas desulfurization (FGD) solids and ash – associated with other types of coal-based power generation:

- Conversion of mineral materials in the plant feed to a non-hazardous, marketable slag by-product eliminates the need to dispose of fly ash and bottom ash waste streams.[13] The properties of the slag product are described in Table 3.4-25.[14]
- Removal of sulfur from IGCC syngas in a relatively concentrated form and the subsequent production of elemental sulfur, another marketable by-product, eliminate the significant solid wastes that could result from the flue gas desulfurization process needed for other types of coal-based plants.

The use of a ZLD process will prevent the discharge of heavy metals and other gasification wastes with the plant wastewater effluent (Sections 3.1.6.3 and 3.4.2.1.2 present a description of the ZLD process). The solid waste stream from this process, consisting mainly of crystallized solids in a "filter cake," will likely be classified as a hazardous waste due to metals content and will be disposed in an approved hazardous waste landfill or other licensed facility. Table 3.4-26 presents a typical composition of ZLD filter cake from the system serving the gasification island, based on data from Wabash River.

Other wastes resulting from the operation and maintenance of the IGCC facility include:

- Worn and broken internal refractory from the gasifier vessel that is periodically removed and replaced.
- Spent activated carbon used for purification of syngas fuel, process solvents, and other purposes.
- Sludge resulting from internal amine solvent recycling.
- Detergents and used chemicals from cleaning of the power generation equipment and other facilities.

The Company will manage operational wastes in accordance with applicable regulations, good industry practices and established internal company procedures. Waste minimization and pollution prevention programs will be implemented (see Section 3.4.3). Hazardous and non-hazardous wastes will be properly collected, segregated, and recycled or disposed at approved waste management facilities within regulatory time limits and in accordance with requirements. Plant staff will be adequately trained in proper waste handling procedures. Waste manifests and other records and reporting will be maintained as required by regulations and company procedures.

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[13] In some plants that use wet limestone FGD or lime spray dryer FGD systems, a cost cutting step is to remove fly ash along with $SO_2$ in the post combustion flue gases and place the combined calcium sulfate/sulfite and ash mixture in an on-site landfill.

[14] Trace metals such as chromium, nickel, vanadium, etc., are captured in the impervious glassy matrix of the slag. The slag is non-hazardous, and will pass EPA's TCLP leachate test for metals, semi-volatile and volatile organics listed under RCRA.

## Table 3.4-25 E-Gas™ Slag Properties

| Mesh Size | Wt. % |
|---|---|
| +8 | 28 |
| +12 | 20 |
| +16 | 20 |
| -16 | 32 |

| TCLP Metals | RCRA Regulatory Level, mg/l | Leachate from E-Gas Slag, mg/l |
|---|---|---|
| Arsenic | 5 | <0.1 |
| Barium | 100 | <0.5 |
| Cadmium | 1 | <0.5 |
| Chromium | 5 | <0.1 |
| Lead | 5 | <1 |
| Mercury | 0.2 | <0.002 |
| Selenium | 1 | <0.1 |
| Silver | 5 | <0.1 |

| TCLP Organics | RCRA Regulatory Level, mg/l | Leachate from E-Gas Slag, mg/l |
|---|---|---|
| Pyridine | 5 | <0.05 |
| 1,4-Dichlorobenzene | 7.5 | <0.05 |
| o-Cresol | 200 | <0.05 |
| m- & p- Cresol | 200 | <0.05 |
| Hexachloroethane | 3 | <0.05 |
| Nitrobenzene | 2 | <0.05 |
| Hexachloro-1,3-butadiene | 0.5 | <0.05 |
| 2,4,6-Trichlorophenol | 2 | <0.05 |
| 2,4,5-Trichlorophenol | 400 | <0.05 |
| 2,4-Dinitrotoluene | 0.13 | <0.05 |
| Hexachlorobenzene | 0.13 | <0.05 |
| Pentachlorophenol | 100 | <0.05 |

| TCLP Volatile Organics | RCRA Regulatory Level, mg/l | Leachate from E-Gas Slag, mg/l |
|---|---|---|
| Vinyl Chloride | 0.2 | <0.005 |
| 1,1-Dichloroethylene | 0.7 | <0.005 |
| Methyl Ethyl Ketone | 200 | <0.005 |
| Chloroform | 6 | <0.005 |
| 1,2-Dichloroethane | 0.5 | <0.005 |
| Benzene | 0.5 | <0.005 |
| Carbon Tetrachloride | 0.5 | <0.005 |
| Trichloroethylene | 0.5 | <0.005 |
| Tetrachloroethylene | 0.7 | <0.005 |
| Chlorobenzene | 100 | <0.005 |
| 1,4-Dichlorobenzene | 7.5 | <0.005 |

**Table 3.4-26 Typical Estimated ZLD Solids Composition**

| COMPONENT | Wt. % (dry) |
|---|---|
| Calcium | 0.02 |
| Sodium | 35.31 |
| Magnesium | 0.00 |
| Potassium | 0.04 |
| Silica | 0.06 |
| Chloride | 27.94 |
| Total Sulfur | 0.19 |
| Sulfate | 0.19 |
| Fluoride | 4.46 |
| Total Inorganic Carbon | 0.27 |
| Ammonia Nitrogen | 0.50 |
| Sulfide | 0.01 |
| Thiosulfate | 0.16 |
| Thiocyanate | 0.18 |
| Total Phosphorus | 0.01 |
| Total Organic Carbon | 6.02 |
| Volatile Organic acids | 21.34 |
| Aluminum | 0.01 |
| Arsenic | 0.04 |
| Barium | 0.00 |
| Boron' | 3.10 |
| Cadmium | 0.00 |
| Chromium | 0.00 |
| Copper | 0.00 |
| Iron | 0.01 |
| Lead | 0.00 |
| Manganese | 0.00 |
| Nickel | 0.00 |
| Selenium | 0.12 |
| Silver | 0.00 |
| Strontium | 0.00 |
| Zinc | 0.00 |
| Total | 100.00 |

### 3.4.4.2 Construction Wastes

The construction activity associated with the IGCC Power Station will also generate certain amounts of wastes. A preliminary estimate of hazardous and non-hazardous construction wastes is presented in Table 3.4-27. More significant temporary waste streams may include site clearing vegetation, soils, and debris, hydrostatic pressure-testing (hydrotest) water, used equipment lube oils, surplus materials, and empty containers.

Surplus and waste materials will be recycled to the extent practical. If feasible, removed site vegetation will be salvaged for pulp and paper production, or recycled for mulch. Hydrotest water will be reused for subsequent pressure tests if practical. Prior to disposal, used hydrotest water will be checked for contaminants and hazardous characteristics. Potential hydrotest water disposal methods, depending on the quality of the wastewater, include discharge to surface waters via the detention basin (pursuant to NPDES permits), trucking to a local POTW, or disposal at some other approved facility. Scrap and surplus materials and used lube oils will be recycled or reused to the maximum practical extent, or otherwise properly disposed.

**Table 3.4-27 Estimated Construction Waste Streams (Phase I and II)**

| Waste Description | Comments | Approx Quantity Per Period | Likely Disposition |
|---|---|---|---|
| **Hazardous or Non-hazardous Liquids** | | | |
| Used lube oils, flushing oils | | 10 drums/mo | Recycle |
| Hydrotest water | One time during commissioning, reuse as practical, test for hazardous characteristics | 1.2 million gallons (total Phase I and 2) | Hazardous – approved disposal facility Non-hazardous – drain to detention basin and release (need permit) |
| Steam turbine and HRSG cleaning wastes | Chelates, mild acids, TSP, and/or EDTA - one time during commissioning | 700,000 gallons (total Phase I and 2) | Approved hazardous or non-hazardous disposal facility |
| **Hazardous Liquids** | | | |
| Solvents, used oils, paint, adhesives, oily rags | Containerize | 200 gal/mo | Recycle or approved hazardous waste disposal facility |
| **Hazardous Solids** | | | |
| Spent welding materials | Containerize | 400 lb/mo | Hazardous waste landfill |
| Used oil filters | Containerize | 100 lb/mo | Hazardous waste landfill |
| Fluorescent/mercury vapor lamps | | 30 units/yr | Recycle |
| Masc. oily rags, oil adsorbents | Containerize | 1 drum/mo | Recycle or Hazardous waste landfill |
| Empty hazardous material containers | | 1 $yd^3$/wk | Hazardous waste landfill |
| Used lead/acid and alkaline batteries | Separate and containerize | 1 ton/yr | Recycle |
| **Non-hazardous Liquids** | | | |
| Sanitary waste from workforce | Portable chemical toilets | 400 gal/day | Pumped and disposed by contractor |
| **Non-hazardous Solids** | | | |
| Site clearing - vegetation | Salvageable (?) timber and waste wood, brush, leaves and vegetative wastes | See Land Use/Land Cover Impacts for West & East Range Power Station Footprint | Sell salvageable timber for pulp and paper production, sell or donate waste wood for use as fire wood, mulch for recycle, or dispose in non-hazardous landfill. |

**Table 3.4-27 Estimated Construction Waste Streams (Phase I and II)**

| Waste Description | Comments | Approx Quantity Per Period | Likely Disposition |
|---|---|---|---|
| Site clearing – excavation of non suitable soils, masc. debris clearing | Stockpile soils on site | See Grading Plan Cut and Fill Estimates for West and East Range Grading Plans in Figure 3.2-3 and 3.2-5, respectively | Reuse soils for berms and landscaping, mulch and recycle organic debris, recycle or landfill inorganic debris. |
| Scrap materials, debris, and trash | Wood, metal, plastic, paper, packing, office wastes, etc. | 40 $yd^3$/wk | Recycle or non-hazardous waste landfill |

Construction management, contractors, and their employees will be responsible for minimizing the amount of waste produced by construction activities and will be required to fully cooperate with project procedures and regulatory requirements for waste minimization and proper handling, storage, and disposal of hazardous and non-hazardous wastes. Each construction contractor will be required to include waste management and waste minimization components in their overall project health, safety, and environmental site plans. Typical construction waste management measures will include:

- Dedicated areas and a system for waste management and segregation of incompatible wastes, with waste segregation occurring at time of generation.
- A waste control plan detailing waste collection and removal from the site. The plan will identify where waste of different categories will be collected in separate stockpiles or bins, and appropriate signage provided to clearly identify the category of each collection stockpile.
- Hazardous wastes, as defined by the applicable regulations, will be stored separately from non-hazardous wastes (and other, non-compatible hazardous wastes) in accordance with applicable regulations, project-specific requirements, and good waste management practices.
- Periodic construction supervision inspection to verify that wastes are properly stored and covered to prevent accidental spills and releases.
- Appropriately labeled waste disposal containers.
- Good housekeeping procedures. Work areas will be left in a clean and orderly condition at the end of each working day, with surplus materials and waste transferred to the waste management area.
- Appropriate waste management training for the construction workforce.

### 3.4.5 Liquid Waste Generation and Disposal

Information on liquid wastes is presented in Table 3.4-24 and 3.4-27 above.

### 3.4.6 Primary and Secondary Products

The primary product of the IGCC Power Station is electric power. The Project will also produce elemental sulfur and a vitreous inert slag. A world-wide market already exists for elemental sulfur, although its value will vary considerably with location, purity, and end use. No large scale market exists for slag at this time. It is expected that slag can be marketed for asphalt aggregate, construction backfill, or landfill cover applications. Slag with a carbon content of less than 5 percent by weight should be marketable as a higher value product such as roofing shingle applications. There is also a potential to market the slag produced from petroleum coke gasification for metals recovery. Excelsior conducted a preliminary market analysis for slag and sulfur that has been attached to this Application as Appendix 8.

### 3.4.7 Storage Requirements and Locations

Storage areas and requirements for the major process feedstocks and byproducts are shown in Table 3.4-28. The numbers are for each phase, with the total storage for both phases being double that reported in the table below.

**Table 3.4-28**
**Feedstock and Byproduct Storage Requirements (Each Phase)**

| Material | Location | Storage Requirements |
|---|---|---|
| Coal Pile | Refer to Plot Plan | 395,000 tons (5/45 day active/inactive storage based on maximum PRB-1 coal usage);<br>Dust control; Water run-off control |
| Pet Coke Pile | Refer to Plot Plan | 111,000 tons (5/45 day active/inactive storage;<br>Dust control; Water run-off control |
| Flux Silo | Refer to Plot Plan | 1,120 tons (5 day active storage) |
| Sulfur Tanks | Refer to Plot Plan | (~ 160 tons/day generated, based on Illinois No.6 coal) |
| Slag Pile | Refer to Plot Plan | 32,265 tons (45 day storage, wet basis, using Illinois #6 coal) |

### 3.4.8 Toxic and Hazardous Materials

Hazardous materials that will be used or stored for project operations include relatively small quantities of petroleum products, liquid oxygen and nitrogen, molten sulfur, catalysts, flammable and compressed gases, amine replacement and reclamation chemicals, water treatment chemicals, and minor amounts of solvents and paints. Materials and estimated quantities for the gasification/ASU blocks are based on experience at Wabash River. Power block requirements are estimated from similar combined cycle units. Catalyst materials such as those used in the COS Hydrolysis system and SRU are discussed in Sections 3.1.4.2 and 3.1.4.4, respectively. Spare catalyst may be selectively stored on-site.

Table 3.4-29 provides a list of potentially hazardous materials to be utilized and/or stored on-site. For the major bulk items, the approximate quantities expected to be stored on site are estimated, and may be adjusted as the frequency and methods of re-supply (railcar or truck) are optimized. Quantities shown are for Mesaba One and Mesaba Two, with individual phase quantities being approximately one-half of the total.

**Table 3.4-29 On-Site Toxic and Hazardous Materials (Total For Phase I and II)**

| Material | Form | Quantity (Phases I and II) | General Location On-Site | Use |
|---|---|---|---|---|
| **GASIFICATION/AIR SEPARATION UNIT AREAS** | | | | |
| **BULK CHEMICALS** | | | | |
| Chlorine or Sodium Hypochlorite | Gas or Liquid | TBD | | Cooling Towers |
| Sodium Hydroxide | Liquid | 60,000 gal | Outdoor | Amine Reclamation and Sour Water Treatment |
| Potassium Hydroxide | Liquid | 2,000 gal | Indoor | Dry Char Filter Cleaning |
| Water Treatment Chemicals | Liquid | Typ. Small (55 gal) Drums to less than ~ 500 gal tank | Indoor | Pump Bldg, Slurry Prep Bldg, Cooling Towers |
| Oxygen (95%) | Liquid | 1,800 tons | Outdoor | ASU Backup Supply |
| Nitrogen | Liquid | 5,000 tons | Outdoor | ASU Backup Supply |
| Molten sulfur | Liquid | 200,000 gal | Outdoor | By-product for Sale |
| Ammonium lignosulfonate | Liquid | ?? | Indoor | Slurry Prep Bldg for maintaining % solids in slurry |
| **MASC./DISTRIBUTED MATERIALS** | | | | |
| Paint/Thinners/etc. | Liquid | Minimal | Indoor | Shop/Warehouse |
| Lubrication Grease/Oils | Solid/Liquid | Minimal | Indoor | Pump Bldg, Slurry Prep Bldg., Shop/Warehouse |
| Compressed Gases ($Ar$, $He$, $H_2$) | Pressurized Gas | Minimal | Indoor | Lab |
| Chemical Reagents (acids/bases/standards) | Liquid | Minimal | Indoor | Lab |
| **OTHER HAZARDOUS MATERIALS** | | | | |
| Flammable/Toxic Gases ($H_2$, $CO$, $H_2S$, $SO_2$) | Pressurized SynGas Mixture | | Distributed | Process Piping/Vessels |
| Acetylene, Oxygen, other welding gases | Gas | Minimal (approved cylinders) | | Welding |
| Natural Gas | Gas (high pressure) | | Supply piping only | Startup/Backup Fuel |
| Diesel Fuel | Liquid | 2,000 gal | Outdoor | Emergency generator/fire water pump fuel |
| ***POWER BLOCK AREA*** | | | | |
| **MASC./DISTRIBUTED CHEMICALS** | | | | |
| Sulfuric Acid | Liquid | 12,000 gal | Outdoor | Cooling water and BFW pH control; battery acid |
| Sodium Hypochlorite | Liquid | 20,000 gal | Outdoor | Cooling Tower biological control |

| Material | Form | Quantity (Phases I and II) | General Location On-Site | Use |
|---|---|---|---|---|
| Circulating Water Chemical Additives (e.g., Magnesium nitrate, magnesium chloride, 2-bromo-2-nitropropane-1,3-Diol, 5-chloro-2-Methyl-4-Isothizaoline-3-one) (Note 1) | Liquids | Typ. Small (55 gal) Drums to less than 500 gal tank | Indoor | Corrosion Inhibitor/ Biocides |
| Boiler Feedwater Chemicals, e.g., Carbonic Dihydrazide, Morpholine, Cyclohexamine, sodium sulfite (Note 1) | Liquids | Typ. Small (55 gal) Drums to less than 500 gal tank | Indoor | Boiler feedwater pH/Corrosion/ Dissolved Oxygen/Biocide control |
| Mineral Insulating Oil | Liquid | 30,000 gal (estimated, to be confirmed) | Indoor | Electrical Transformers |
| Lubricating Oil | Liquid | 21,000 gal (estimated, to be confirmed) | Indoor | Combustion Turbine/Steam Turbine/Masc. Equipment Lube Oils |
| Combustion turbine wash chemicals | Liquids | Intermittent use/ Chemicals not stored onsite/ cleaning by contractor | | Combustion Turbine Generator cleaning |
| HRSG Cleaning Chemicals (e.g., HCl, Citric acid, EDTA Chelant, Sodium Nitrite) (Note 1) | Liquids | Multiyear cleaning requirement/ Temp storage only | | HRSG Chemical Cleaning |
| Carbon Dioxide | Pressurized Gas | 50,000 scf | Outdoors | Generator purging |
| Hydrogen | Pressurized Gas | 29,000 scf | Outdoors (Assumes use of multi-tube trailer. Active volume based on 1 of 10 tubes per trailer) | Generator cooling (To be verified - Assumes use of $H_2$-cooled generators – dependent on selected manufacturer) |

Notes: "Typical" chemicals for the application are identified.

Natural gas and syngas, which are flammable, will be used in the power block. Natural gas will be used as a startup or auxiliary fuel and will be utilized directly from the on-site pipeline (which connects to the off-site main pipeline). Natural gas will not be stored on site. Syngas will be the primary fuel for the combustion turbines. The syngas is a mixture of carbon monoxide, hydrogen, carbon dioxide, and water vapor. Gaseous hydrogen ($H_2$) will be used as a generator coolant. Hydrogen will be stored in pressurized gas tubes on a multi-tube trailer. The tube trailer will be stored outside near the turbine-generators and meet required building and fire codes. Carbon dioxide will be stored and utilized for purging of the generators after normal and emergency shutdowns.

Bulk quantities of liquid oxygen and nitrogen will be stored in tanks in the ASU to provide capacity for startups and continued plant operation during short-duration ASU system outages.

Other gases stored and used at the facility include those typically used for maintenance activities, such as shop welding, emission monitoring, and laboratory instrument calibration. These gases will be stored in approved standard-sized portable cylinders, and in appropriate locations.

Water treatment chemicals will be required and stored onsite. Bulk chemicals, such as acids and bases for pH control, will require storage in appropriately designed tankage with secondary containment and monitoring. Gaseous chlorine (used/stored in compliance with all applicable regulatory requirements) or hypochlorite bleach may be used for biological control of the various circulating and cooling tower streams.

Other water treatment chemicals will be required and used as biocides, pH control, dissolved oxygen removal, and corrosion control for boiler feed water (BFW), cooling tower and cooling water treatment. For raw water treatment, coagulants and polymers may also be used. Chemicals used for these purposes are generally specified by the water treatment provider, and are available under a number of trade names. Typical chemicals are identified in Table 3.4-19. Stored quantities of these materials are relatively small, ranging from 55 gal drums to 500 gal tanks.

Combustion turbine and HRSG washes are performed by contractors on an intermittent basis. Combustion turbines are cleaned by injecting wash water into the turbine for three to five minutes while cranking at full speed just prior to shutting down. The wash water is allowed to soak on the blades for required periods of time. Following the soak, the turbine is accelerated and rinse water is injected for 15 to 20 minutes. The turbine is then allowed to drain and dry. The process is repeated until rinse water exiting the drains is clear. The waste water is collected for disposal. HRSG finned tubes are cleaned with high pressure water jets. Waste water and deposits are drained from the bottom of the HRSG and collected for disposal. The chemicals required for the washes are usually provided by the contractors and are typically not stored long-term on site.

Diesel fuel will be used for the emergency generator and for the fire water pumps. The stored quantity is currently based on approximately 8 hours of operation of the diesel generator at full output (about 3 MW). This limited storage would require the Proponent to have contracts with fuel providers specifying that deliveries of diesel fuel be provided in less than 8 hours in the case of an emergency. Appropriate containment and monitoring for spillage control will be provided.

Other petroleum-containing hazardous materials include the combustion and steam turbine lube oils, steam turbine hydraulic fluid, transformer oils and miscellaneous plant equipment lube oils. These materials will be delivered in approved containers, stored in areas with appropriate secondary containment, and used within curbed areas that only drain to internal drains connected to an oil-water separator system. Oil reservoirs, containment areas, and the separators will be checked regularly to identify potential leakage issues and initiate appropriate actions.

### 3.4.9 Health and Safety Policies and Programs

Facility design features and management programs will be established to address hazardous materials storage locations, emergency response procedures, employee training requirements, hazard recognition, fire control procedures, hazard communications training, personal protection equipment training and accidental release reporting requirements. Significance criteria will be determined on the basis of federal, state and local guidelines, and on performance standards and thresholds adopted by responsible agencies. For example, the Project will comply with all applicable OSHA hazardous material requirements including the following specific OSHA regulations:

- 1910.120(q)(1) (Emergency Response Plan)
- 1910.120(q)(2) (Elements of Emergency Response Plan)
- 1910.120(q)(2) (Elements of Emergency Response Plan Decontamination)
- 1910.120(q)(2) (Elements of Emergency Response Plan: Personnel Roles)
- 1910.120(q)(2) (Elements of Emergency Response Plan, Critique of Response)
- 1910.120(q)(3) (Skilled Support Personnel)
- 1910.120(q)(6) (Training)
- 1910.120(q)(6) (Training - Hazardous Materials Technician
- 1910.120(q)(6) (Training - Hazardous Materials Technician - Implementation of Employer's Emergency Response Plan)

Basic approaches to prevent spills to the environment include the initial design of the Power Station Footprint, comprehensive containment structures, and worker safety and training programs. The comprehensive containment program ensures that appropriate tanks, walls, dikes, berms, curbs, etc. are used to accomplish effective containment. Worker safety programs will be established to ensure that workers are aware and knowledgeable of spill containment procedures and related health and environmental protection policies.

## 3.5 TRANSPORTATION INFRASTRUCTURE

### 3.5.1 Roadways

#### 3.5.1.1 West Range Site

The West Range Site is located about 1.5 miles north of State Highway 169 (a four-lane east-west highway), about 0.4 miles to the east of Itasca CR 7, a two-lane highway running mostly in a north-south direction and about 0.25 miles north of an east-west stretch of CR 7. Other road corridors in the Project area include the Cross-Range Heavy Haul Road, a gravel road which has

been in place for generations to allow heavy or slow loads to be transported between mines across the Iron Range. In the Project area, the Cross-Range Heavy Haul Road also serves as access to a small cluster of homes in the Big Diamond Lake/Dunning Lake area. The existing roadway system in the area of the West Range Site is shown in Figure 3.5-1.

#### 3.5.1.1.1 Access Road 1

In discussing access to the IGCC Power Station with Itasca County, the County Engineer indicated the County's interest in re-routing the alignment of CR 7 to better serve local traffic patterns and the additional traffic related to the two large projects currently undergoing environmental review (the Mesaba Energy Project and the Minnesota Steel Industries, LLC project designed to produce sheet steel from taconite ore). This realignment of CR 7 would serve as the primary access road (hereafter "Access Road 1") to the IGCC Power Station, and would better handle heavy equipment and increased traffic volumes resulting from construction activities related to the two projects. The realignment would involve constructing a new two-lane roadway beginning at a new access point on State Highway 169, approximately 7,000 feet east of CR 7. The new road would cross underneath the adjacent rail line, proceed due north, then curve west between Big Diamond and Dunning Lakes before terminating in its connection with CR 7, just southwest of the Station Footprint.

Itasca County would construct and own Access Road 1. The County would seek to move the CR 7 designation to the new roadway and include it as part of the County's State Aid system. This would put all future maintenance of the road under the County's responsibility. The section of existing CR 7 between the plant and State Highway 169 would remain in place as either a lower level County Road, or turned back to the City of Taconite as a City street. The benefits to moving the designation would be to provide a better access point to U.S. Highway 169. The current intersection of CR 7 and State Highway 169 has poor visibility, relatively steep grades, and problems with slope stability. The IGCC Power Station would be served by one driveway off Access Road 1 (hereafter, the driveway off Access Road 1 or CR 7, as the case may be, will be termed "Access Road 2"). The proposed roadway system is shown in Figure 3.5-1.

Access Road 1 would be designed to meet Minnesota State Aid standards (the standards used by Minnesota cities and counties for the construction of roadways eligible for State funding). All alignments, horizontal curves, and clear zones would be designed for 55 miles per hour. A typical roadway cross section is shown in Figure 3.5-2.

**Figure 3.5-1 Existing Highway System in the Vicinity of the West Range Site**

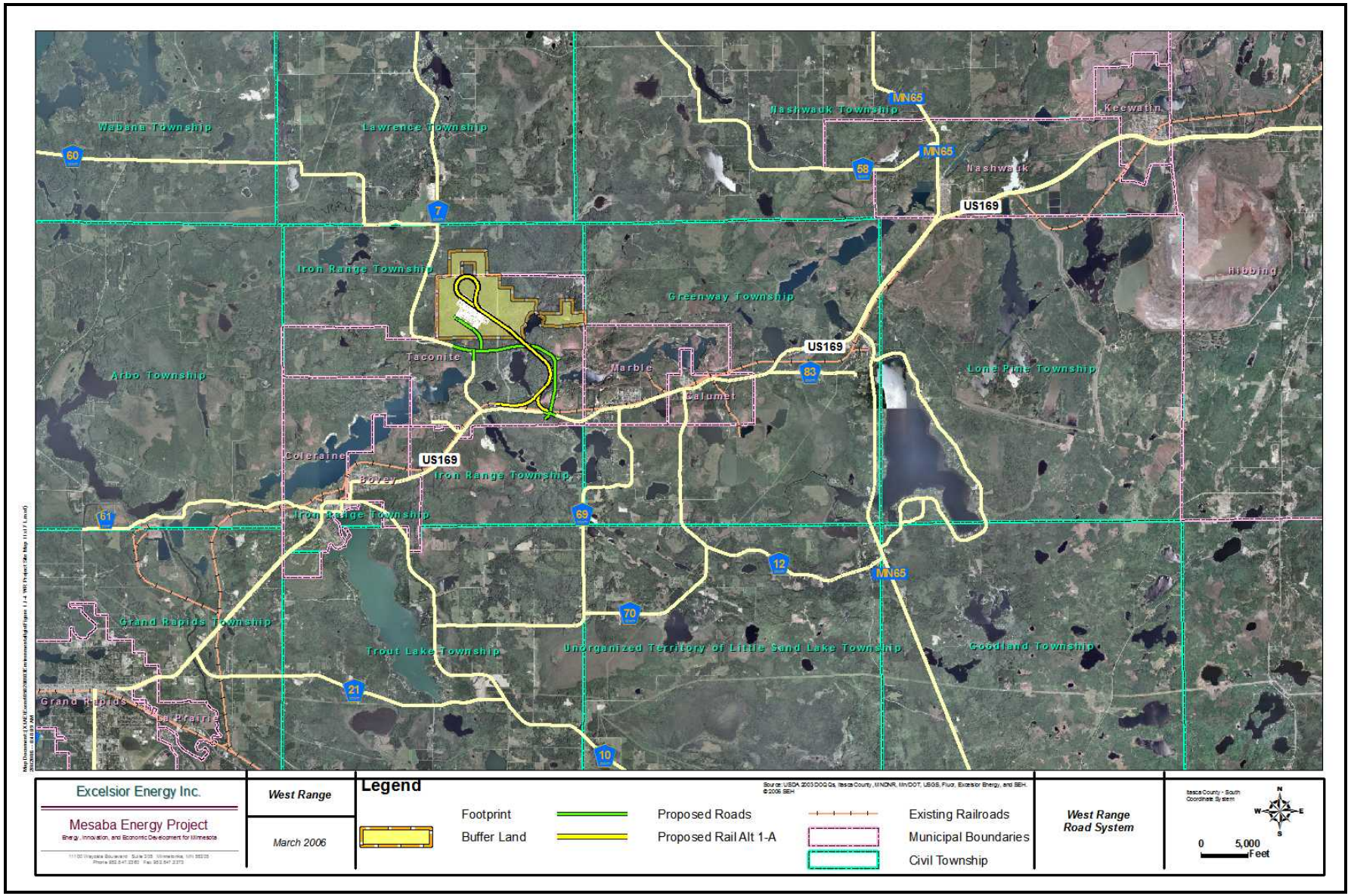
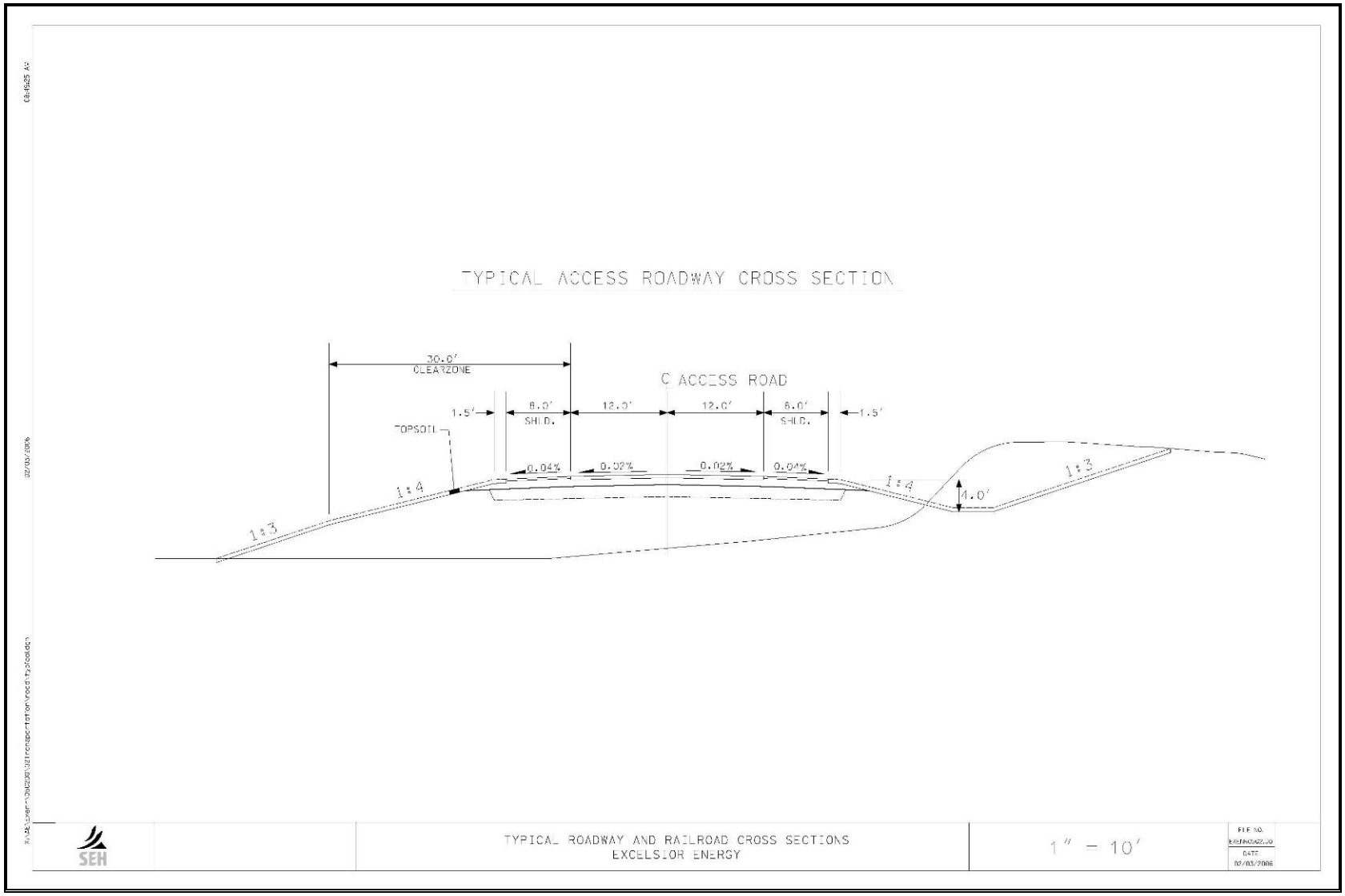


**Figure 3.5-2 Cross Section of a Typical Access Road**



If Access Road 1 is in place prior to construction of Mesaba One, all construction and plant employee traffic would use it to access the IGCC Power Station. However, it may be necessary, based on the timing of Itasca County's construction of Access Road 1, for the plant to be served by a driveway off existing CR 7 (a simple extension of Access Road 2) until Access Road 1 is completed.

The impacts associated with the County's construction of Access Road 1 have been fully studied and are included at Section 7.1.9.

##### 3.5.1.1.2 Discussion

The connection to U.S. Highway 169 under either scenario (timely construction of the new access road or delayed construction) will require that both right and left turn lanes be constructed on Highway 169. A permit from the Minnesota Department of Transportation will be required to complete this work. Minnesota Department of Transportation staff has been involved in the discussions about the location of the new connection to Highway 169. The preferred alternative was selected after studying all potential options. Originally, there were discussions about providing access by simply adding driveways off CR 7 near the plant. After discussions with the County, this option was dismissed because of concerns about adding plant truck and passenger traffic to the poor intersection of CR 7 and State Highway 169.

Another option that was reviewed and dismissed was the upgrade of the Cross-Range Heavy Haul Road and connection of plant driveways from there. This option was abandoned because of the number of substandard horizontal and vertical curves on the haul road. In addition, it required utilization of the problem intersection of CR 7 and State Highway 169.

The preferred alternative connects to both CR 7 and State Highway 169, and provides the flexibility to have heavy equipment vehicles use either direction, which will be helpful when CR 7, U.S. Highway 169, or Access Road 1 are closed or reconstructed in the future.

A Traffic Volume Forecast Memorandum was completed for the West Range Site, the results of which are provided in Section 7.10.2. This Memorandum shows existing traffic volumes, as well as forecast volumes, during construction (2008) and the 20 years following plant construction (2028).

Only minor modifications will be required for the north-south segment of CR 7 (between State Highway 169 and the east-west segment of Access Road 1) to tie-in to Access Road 1. These modifications are discussed in Section 7.10.1. The proposed access roadway will be in place prior to peak construction activities of the plant, so there should be little impact to the existing system from the construction of the IGCC Power Station.

#### 3.5.1.2 East Range Site

##### 3.5.1.2.1 Regional Roadway System

The existing transportation system in the area of the East Range Site consists entirely of county roads. The nearest state highway is State Highway 135 that serves the west edge of Aurora, approximately 7 miles to the west. The primary county road in the area is CR 110 which connects with State Highway 135 in Aurora, then passes through Hoyt Lakes. CR 110 forms the

western terminus of the Superior National Forest Scenic Byway. This Byway, also known as Forest Highway 11, has been recently constructed and serves to connect the North Shore of Lake Superior with the Mesaba Iron Range. The east-west section of CR 110 that runs through Hoyt Lakes parallels and is about 1.6 miles south of the southern boundary of the proposed East Range Site. The regional roadway system is shown in Figure 3.5-3.

#### 3.5.1.2.2 Access to the East Range Site

In order to access the East Range Site, traffic approaching from the west will travel on CR 110 and turn north onto CR 666 at the first major intersection in Hoyt Lakes. This intersection is controlled as a four-way stop. CR 666 travels to the north about 1.6 miles where it adjoins the eastern boundary of the East Range Site for a distance of about 1.4 miles. CR 666 continues beyond the East Range Site a distance of about 2.1 miles further north-northeast to the Cliffs-Erie administration building.

Traffic approaching Hoyt Lakes from the east will be traveling on CR 110, turn north onto Hampshire Drive at the first major intersection upon coming into town, travel about 0.3 miles, and turn northeast onto CR 666 toward the site.

On August 10, 2005, President Bush signed into law Public Law 109-59, which authorized $2.4 million for construction of a new highway between the bridge over the Partridge River on County Road 565 in Hoyt Lakes to the intersection of Highways 21 and 70 in Babbitt. This project will create a feasible option for approaching the Hoyt Lakes area from the north. Previously, the only approach from the north would have been a circuitous trip south on State Highway 135. Once in Hoyt Lakes, traffic would approach the site as described above.

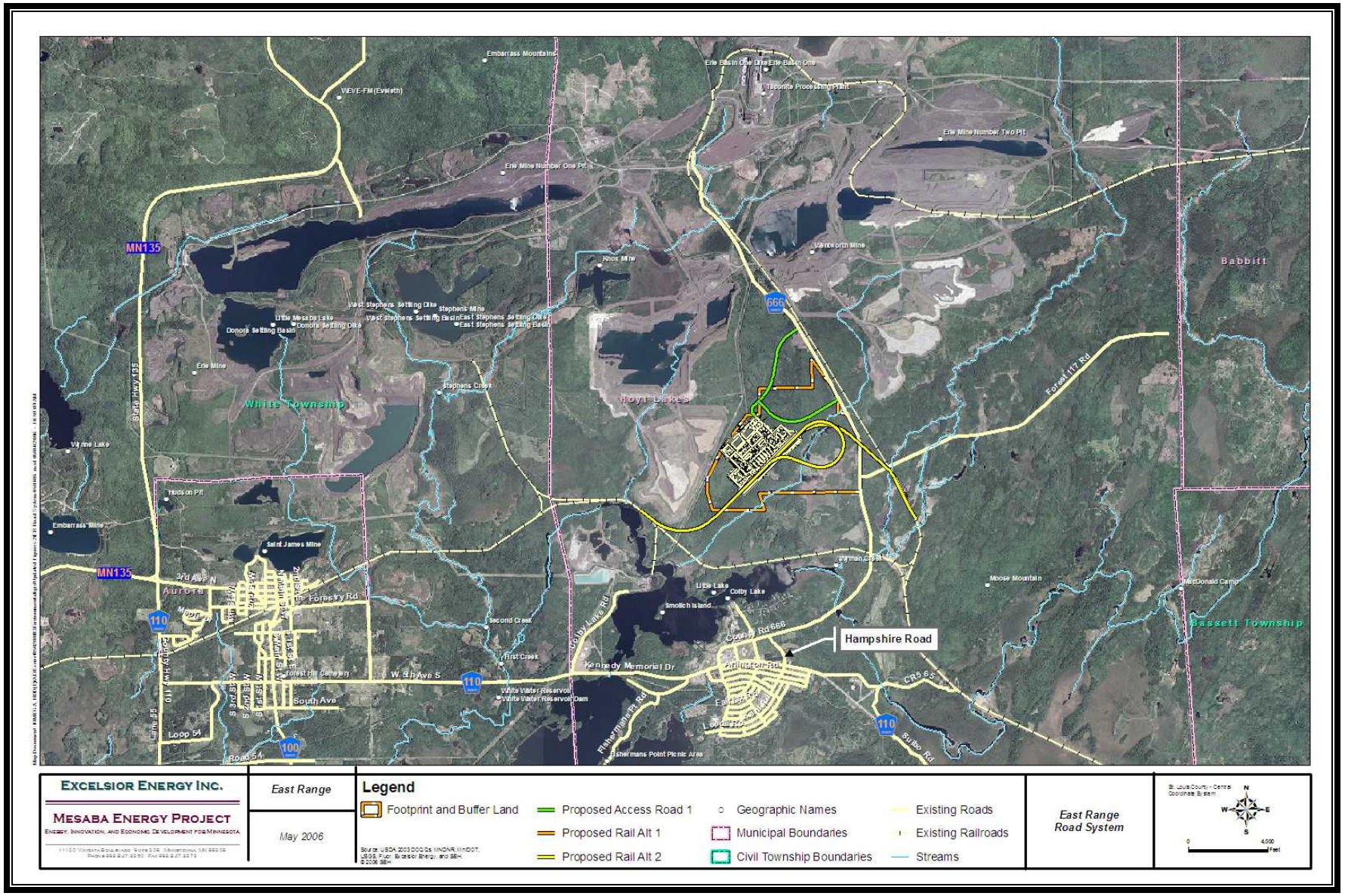
#### 3.5.1.2.3 Access Road 1

CR 666 passes just to the east of the proposed site and is the only feasible option to serve the site via the public road system. Proposed Access Road 1 consists of a loop roadway to serve the IGCC Power Station from County Road 666. This loop will have two access points onto CR 666 and was designed to provide gentle curves, good sightlines, minimal impacts to wetlands, and avoidance of the historic drilling site to the east of the plant.

Traffic will enter the site from the north access point. During construction and other periods of peak volumes, traffic will exit the site at the south access point. After the IGCC Power Station assumes normal operations and traffic patterns have been established, traffic may be allowed to exit the Station from either access point. Having two access points off CR 666 will also provide flexibility in accessing the Station during construction of Access Road 1 and in the future when maintenance or construction work is performed on CR 666.

Easements would be required over lands currently owned by St. Louis County and a minimal number of private parties.

**Figure 3.5-3 Regional Roadway System in Vicinity of East Range Site in Relationship to Proposed Access Road 1**



### 3.5.2 Rail

The Project will require coal and other materials to be delivered to the Project Sites by train. The BNSF Railway (the Burlington Northern Santa Fe Railroad changed its official corporate name in the spring of 2005 to the BNSF Railway, hereafter "BNSF") and the Canadian National Railroad ("CN") are the two predominant rail providers in the region serving the West and East Range Sites (the CN purchased the Duluth Mesabi & Iron Range Railroad in 2003). A map of the rail trackage owned and operated by these two entities in the Project vicinity is provided in Figure 3.5-4.

An important element in the site selection process was whether a site could be served by more than one rail provider via their own trackage. Having such capability would provide consumers with more competition and flexibility in the fuel supply equation, and should result in lower fuel costs over the life of the Project.

#### 3.5.2.1 Site Independent Project Elements

##### 3.5.2.1.1 Feedstock Deliveries

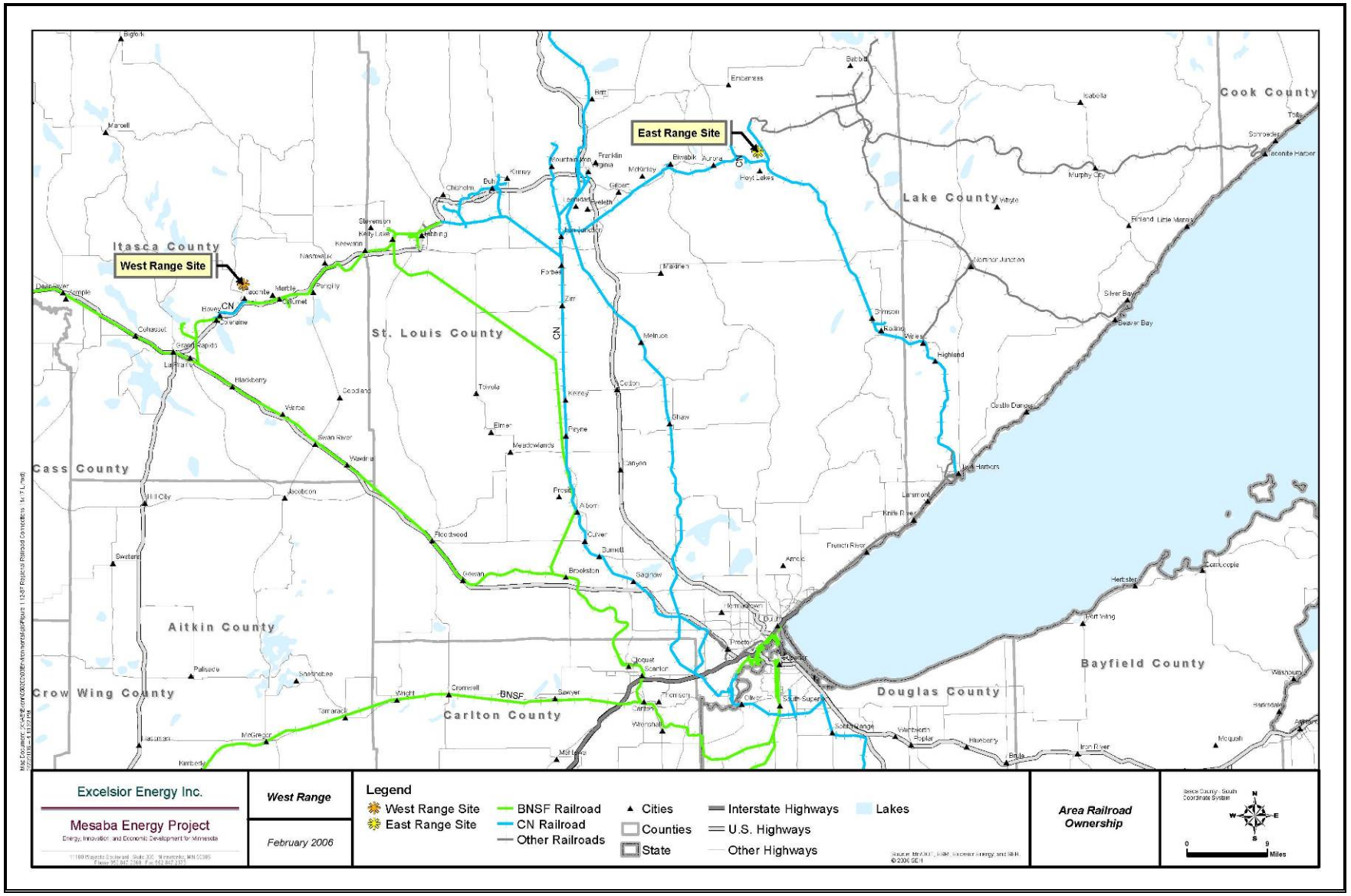
Coal is the most significant commodity that will be delivered to the Project Sites. Delivery of coal under peak operation and material handling operations are discussed in Sections 3.1.1 and 3.4.1.1.5. Table 3.5-1 presents the variation that could be expected in coal deliveries under the best and worst case conditions as a function of the feedstock consumed.

**Table 3.5-1**
**Projected Coal Deliveries to the West Range Project Site**

| COAL CONSUMED | PEAK USE (TPD) | UNIT TRAIN DELIVERIES (RND TRIPS/WEEK)[1] | |
|---|---|---|---|
| | | WORST CASE | BEST CASE[2] |
| Sub-Bituminous (Powder River Basin) | 8,550 | 4-5 | 3-4 |
| Bituminous (Ill. No. 6) | 6,120 | 3-4 | 2-3 |
| Sub-Bituminous/Pet. Coke Blend (50:50) | 6,450 | 3-4 | 2-3 |

1. Phase I IGCC Power Station deliveries; number of deliveries for Phase I and II Power Station would double.
2. Best case conditions represented by 135 car unit train with 119 tons per car or about 16,070 tons per unit train.

**Figure 3.5-4 BNSF and CN Rail Trackage Operated in the Project Vicinity**



Rail cars arriving via unit trains will be unloaded using a state-of-the-art rapid discharge rotary dumper with an automatic railcar positioner. The rail loop and positioner allow a full-length 8,000-foot long coal train (a 135 car unit train) to be pulled through the site without uncoupling any of the cars. Each rail car would be rotated upside down inside the rotary dumper building to unload the coal. The dumper building would be enclosed and maintained under negative pressure during the unloading process to minimize fugitive emissions. Design of the dumper building's dust control system is further described in Section 3.4.1.1.5.

Each unit train would take approximately 4 hours to unload. The impact of peak unit train rail deliveries on local traffic is discussed in Sections 7.9.7 and 8.9.

Other incoming materials using train delivery could include petroleum coke, slag, flux, and construction materials and equipment. Construction deliveries would likely total two trains per week. Outgoing trained material would likely include elemental sulfur, the source of which would be hydrogen sulfide in syngas produced by the gasifier. Depending upon the fuel being used, the Phase I IGCC Power Station would produce between 500 and 800 tons per day of slag, a black, non-hazardous, glass-like material that may have industrial uses. Also, depending upon the fuel being used, the Station would produce between 30-165 tons per day of elemental sulfur that may be sold and/or transported off site.

There are three major design criteria essential for a unit coal train unloading facility. The first is the length of track. A 135 car unit coal train, about 8,000 feet in length, must be completely clear of the mainline track during the unloading operation. The second major design consideration involves the maximum degree of curve. A rail track curve greater than six degrees will have higher levels of track maintenance and may cause problems for the computer guided unloading system. Third is the issue of track profile grade. During the unloading operation, the computer-guided system will control the movement of the train. To facilitate the use of such computer-guided systems, it is important that the track be level as 135 car unit trains will weigh some 20,000 tons. Track grades in non-unloading areas also need to be restricted to the ruling grades on the mainline tracks.

A Railroad Design Guideline based on BNSF and CN unit train standards was developed to formalize site selection criteria and identify major considerations in site layout. The minimum acceptable curvatures, grades and turnout size specified in the Guideline are presented in Table 3.5-2.

Finally, connecting the BNSF and/or CN with the IGCC Power Station on the West or East Range Project Sites requires approvals from each of those companies, but does not require other public approvals.

**Table 3.5-2**
**Railroad Design Criteria for Phase I: West and East Range Sites**

| ATTRIBUTE | PREFERRED CRITERIA | MAXIMUM CRITERIA |
|---|---|---|
| Train size, cars per unit train | 115 | 135 |
| Coal per car, tons | 119 | |
| Train length, feet | 6,600 | 7,700 |
| Maximum grade approach track | 0.3 % | 0.4 % |
| Maximum grade on unloading track | 0.00% | 0.1% |
| Maximum grade on coal train tracks | 0.5 % | 1.0% |
| Maximum curvature, empty coal train | 5° (1,146ft. radius) | 6° (955 ft. radius) |
| Maximum curvature, loaded coal train | 2° (2,865 ft. radius) | 3° (1,910 ft. radius) |
| Maximum curvature, plant tracks | 7.5º (764 ft. radius) | 9.5º (603 ft. radius) |
| Public grade crossings | None allowed in unloading areas | |

### 3.5.2.2 West Range Site

#### 3.5.2.2.1 General

The proposed IGCC Power Station Footprint for West Range Site is located approximately 1.5 miles north of the mainline tracks of the BNSF and CN (see Figure 2.1-3).

Historically, the BNSF and CN railroads had their own mainline tracks throughout the area around Grand Rapids, Minnesota. In the 1960s, the BNSF and CN railroads combined their regional operations to a single track. The BNSF currently owns most of the 80 mile track from Gunn (an unincorporated "railroad town" located immediately east of La Prairie, MN) to Brookston (near Carlton, MN), except for a 4.5-mile portion of track beginning about 0.5 mile east of CR 7 and west to Bovey. The location of this section of track is shown in Figure 3.5-6. A detail of the eastern boundary of CN's ownership point is provided in Figure 3.5-7. Since railroads are restricted from originating or delivering traffic from another railroad's line, even though many share each other's tracks, this short section of rail track owned by CN allows it direct access to the West Range Site (the mechanism allowing such access is discussed in the section below titled "CN Rail Deliveries"). BNSF deliveries of coal to the West Range Site can only originate east of the ownership boundary shown in Figure 3.5-7.

**Figure 3.5-5 Typical Cross Section of Rail Track Meeting Design Guideline**

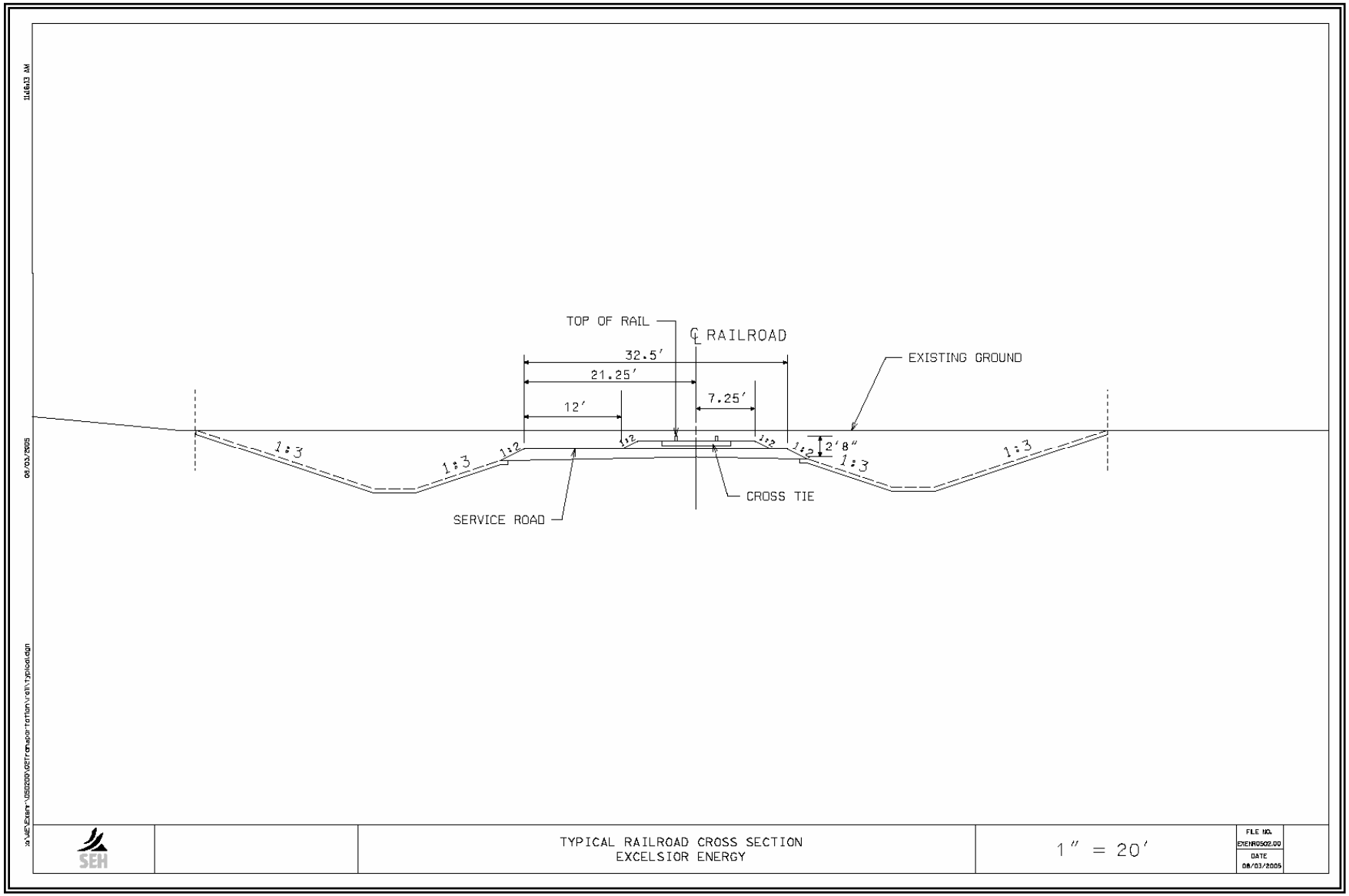


**Figure 3.5-6 Regional Railroad Tracks Showing 4.5 mile Section of Track Near West Range Site Owned by CN**

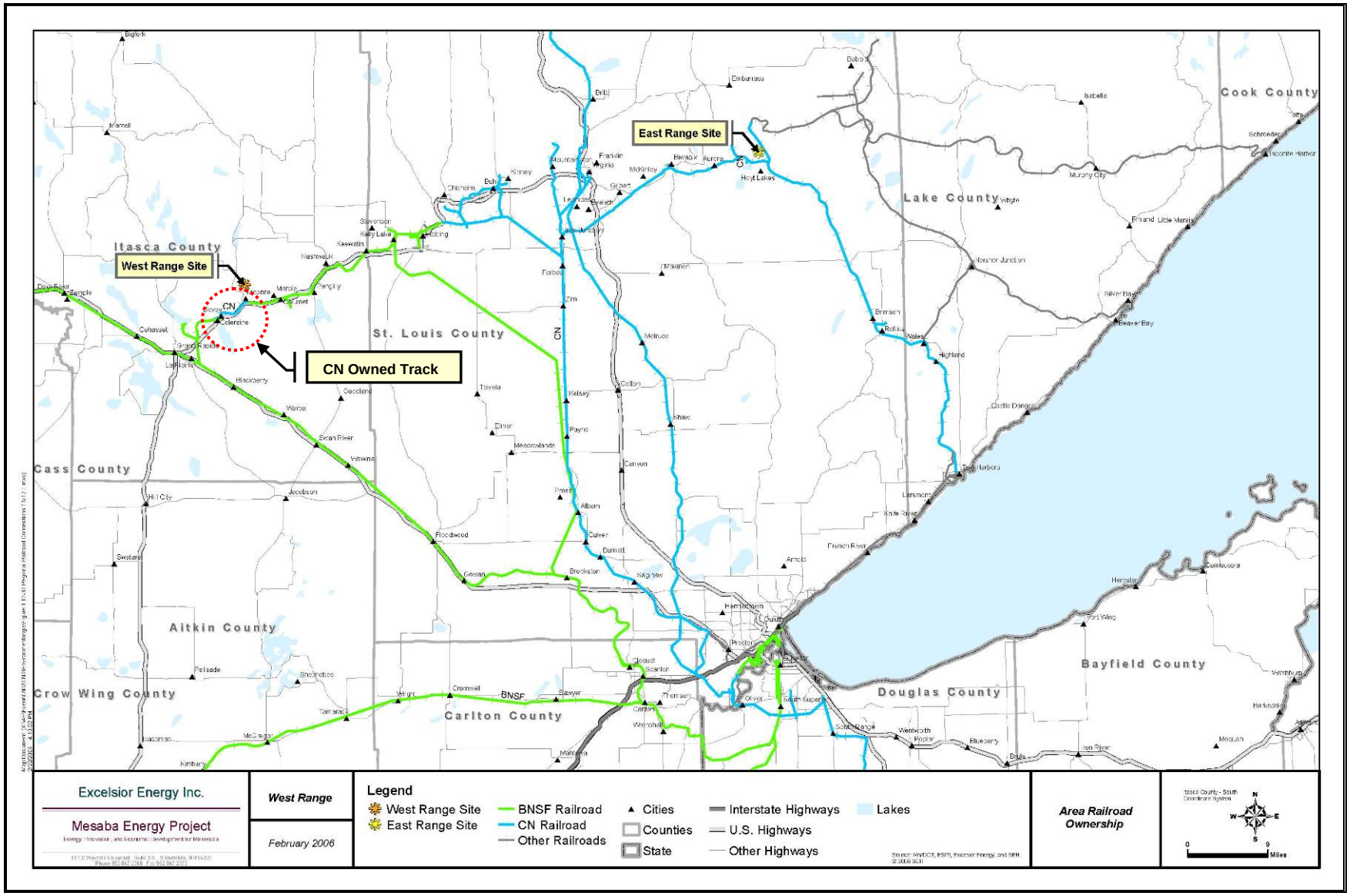
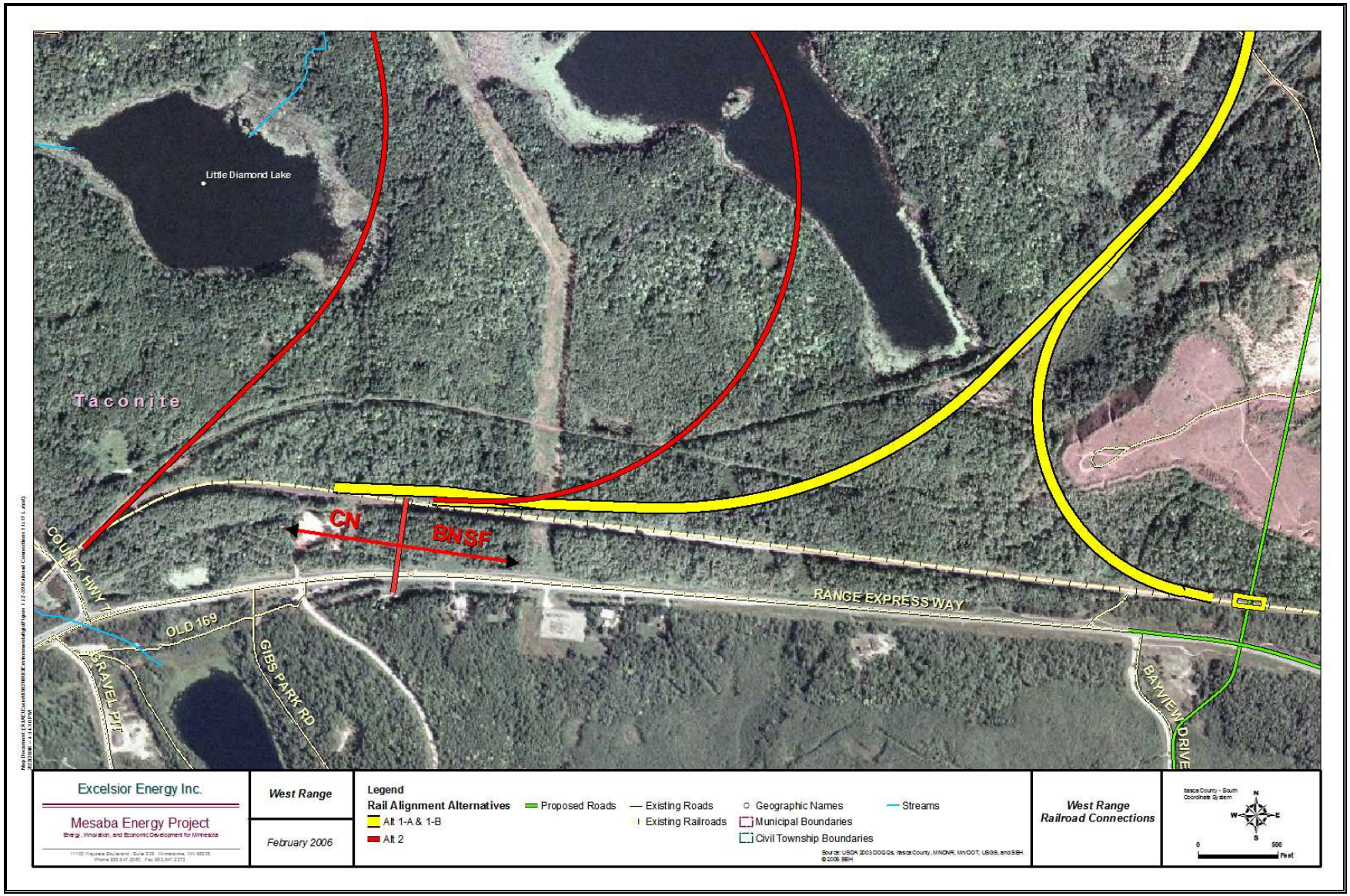


**Figure 3.5-7 BNSF and CN Ownership Boundary Near the West Range Site**



#### 3.5.2.2.2 BNSF Rail Operations in the Project Vicinity

The shortest route for delivering coal from the Powder River Basin to the West Range Site is via the BNSF trackage across North Dakota. The preferred route would pass through Fargo, ND, north to Grand Forks, ND and across Minnesota through Grand Rapids to Gunn and then to Taconite. About six trains per day currently travel on the BNSF line through Grand Rapids at speeds up to 25 mile per hour. Traveling at 25 miles per hour, a unit coal train would take approximately three to four minutes to clear each grade crossing. Nine grade crossings (a location where a public highway, road, street, or private roadway, including associated sidewalks and pathways, crosses one or more railroad tracks at grade) are located within the city limits of Grand Rapids and La Prairie.

The track from Gunn to the West Range Site (about 12.5 miles in length) also operates at speeds of 25 miles per hour and has traditionally carried 4 to 10 trains per day. This track segment has another six public grade crossings.

An alternate route to the West Range Site via BNSF trackage would be from Brookston northward to Kelly Lake and Keewatin and westward to the plant site. This alternate route is illustrated in Figure 3.5-8. This route would also have a speed limit of 25 miles per hour and would primarily be used for non-coal train operations. Use of this route by unit coal trains would add over 100 miles to the trip in each direction and would require the trains to ascend a significant grade north of Brookston. Unit coal trains would only use this route if there were a major track problem east of Gunn. If this were the case, BNSF trains would access the West Range Site using the east "Y" trackage. Although the 5º curvature of the east "Y" track is outside the design criteria for unit coal trains presented in Table 3.5-2, this trackage could support occasional unit train deliveries of coal.

#### 3.5.2.2.3 CN Rail Deliveries

The CN delivery of PRB coal would be from the Superior, WI area northward to Virginia and then west past Hibbing and Keewatin to Taconite/Bovey. The CN trackage within this route is shown in Figure 3.5-9. CN unit coal trains would access the West Range Site by approaching from the east, travel past the site, and either back into the Site, or stop in Bovey, disconnect the locomotives from in front of the train, and reconnect to the end of the train, thereby accessing the Site from the west.

A reverse move by the CN would be required for the empty train. To accommodate such maneuvers, unit coal trains supplied by CN would use an existing siding in Bovey that would need to be lengthened. Other CN deliveries to the plant would occur via the same type of movement, but with much shorter trains. Neither CN unit train movements nor non-coal movements required to access the West Range Site in the manner described would block any public grade crossings near the site.

**Figure 3.5-8 Alternative Routes for the BNSF to Serve the West Range Site**

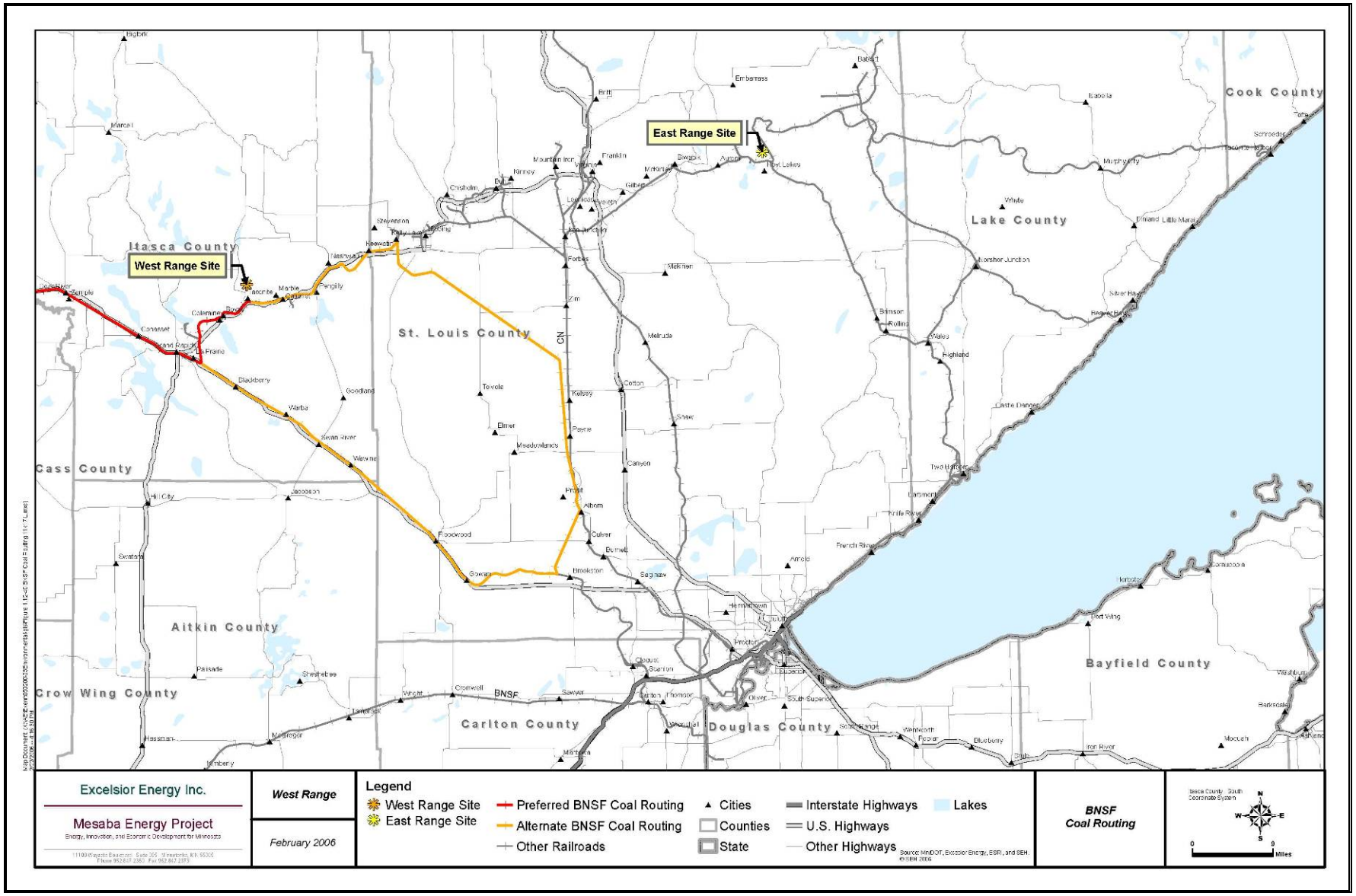
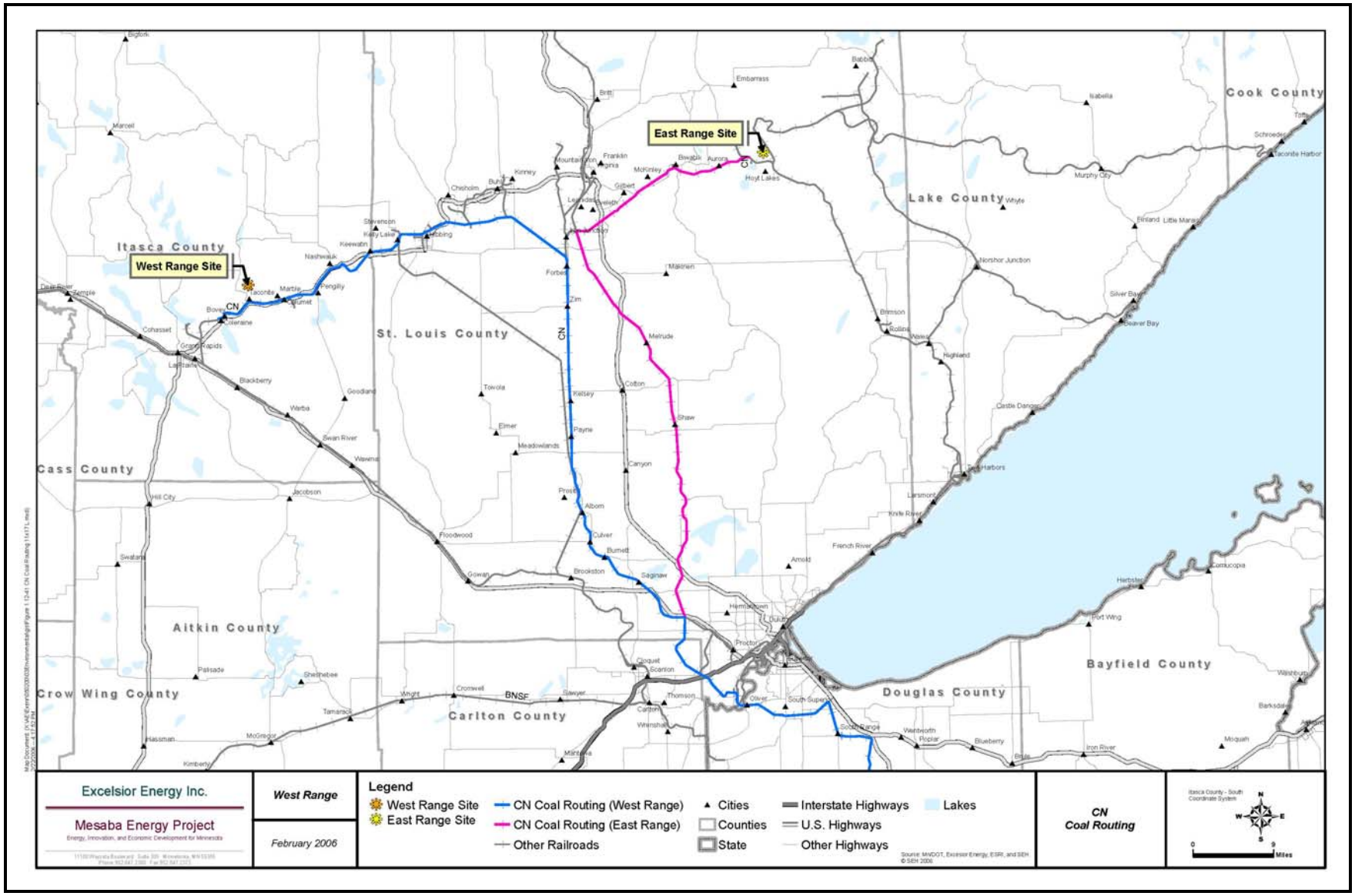


**Figure 3.5- 9 Alternative Routes for the CN to Serve the West Range or East Range Sites**



The short length of CN track near the West Range Site is temporarily out of service because of rising water levels in the CMP. Since the cessation of mining, the CMP has continued to fill with water and as of May 2005, the sloughing of bank material separating the current CN track through Bovey from the steep edge of the mine pit has decreased in distance from 100 feet to 50 feet (a useful discussion about the rising water levels and their effect on rail traffic can be found at the following link: http://www.mepartnership.org/mep_whatsnew.asp?new_id=756). The Mesaba Energy Project would greatly rectify this circumstance by lowering water levels in the CMP, thereby enhancing the ability to make use of the CN track (CN has determined that repairs to this line were not appropriate in the absence of a long term solution to keep water levels from rising). At the request of the BNSF or another local shipper, the track would be required to be placed back in service under current common carrier regulations of the Surface Transportation Board (an agency of the US Department of Transportation that regulates railroad service and provides a forum for rate and service disputes).

#### 3.5.2.2.4 Alternatives

##### *3.5.2.2.4A Introduction*

The major issues involved with providing railroad access into the West Range Site include following: site elevation/topography relative to that of the existing trackage; avoiding undue impacts to Big Diamond and Dunning Lakes; avoiding mine dumps (locations where soils and rock overlying natural resources that have been mined have been permanently placed, such historical placement often not subject to rules governing reclamation) and pits; and rail connection and operational issues. In considering these elements, three rail alignments were identified and evaluated. These alternatives were initially deemed to be viable and all appeared to have a reasonable chance to meet prescribed engineering criteria. However, during subsequent detailed review, Alternative 2 proved to be compromised from both engineering and environmental perspectives and was dropped from further consideration. The detailed review process is discussed in the section below titled "Alternative 2."

##### *3.5.2.2.4B Alternative 1*

Figure 3.5-10 illustrates the general plant site area relative to the location of the existing rail lines and identifies the additional trackage needed to access the Phase I IGCC Power Station under Alternative 1. This alternative includes a rail corridor that would allow access to the IGCC Power Station from the west by both BNSF and CN unit trains. The eastern approach would normally be used by the BNSF for delivering materials other than coal. Unit coal trains would only use the eastern approach in the situation where a western approach was unavailable.

Two miles of new track would be constructed between the existing mainline track and the boundary of the Buffer Land. An additional four miles of new track would be constructed to form a portion of the rail loop lying within the Buffer Land.

Two different alignments were evaluated as part of Alternative 1. As shown on Figure 3.5-10, the alignment for Alternative 1-A bifurcates from the existing CN and BNSF main lines that run parallel to Highway 169 and then turns to the northwest between Big Diamond Lake and Dunning Lake. The alignment for Alternative 1-B, also shown in Figure 3.5-10, would split from the CN and BNSF rail lines in the same location, but instead of diverting northwest between Big Diamond and Dunning Lakes would continue running north on the east side of Dunning Lake and, once north of the lake, would run west to the proposed IGCC Power Station

Footprint. Both Alternatives 1-A and 1-B would include a loop to the north of the proposed facility and in both instances the coal trains would exit via the same route of entry.

The alignments for Alternatives 1-A and 1-B meet the general design criteria provided in Table 3.5-2 and can accommodate access by two rail service providers. Acceptable curve radiuses require that the track alignment be directed east of Big Diamond Lake. The new alignment south of Big Diamond Lake generally follows an old railroad grade around the southern tip of the lake. In order to avoid a large mine dump, Alternative 1-A turns to the northwest to follow a new corridor between Big Diamond Lake and Dunning Lake. To provide an acceptable grade for the Alternative 1-A track requires filling low areas located between the two lakes and cutting from terrain obstacles into the proposed Facility. The rail loop for Alternative 1-A will be mostly on a fill section.

Alternative 1-B follows the same alignment as 1-A for the first 6,000 feet but then heads due north and to the east of Dunning Lake. At a point north of Dunning Lake, Alternative 1-B curves 90º to the west and follows a straight line to the Station Footprint. To provide an acceptable grade for the Alternative 1-B track requires cutting through a large mine dump east of Big Diamond Lake and Dunning Lake, passage through a large wetland area on the north east corner of Dunning Lake, and significant additional contouring on-route to the rail loop. The rail loop would be mostly on a fill section.

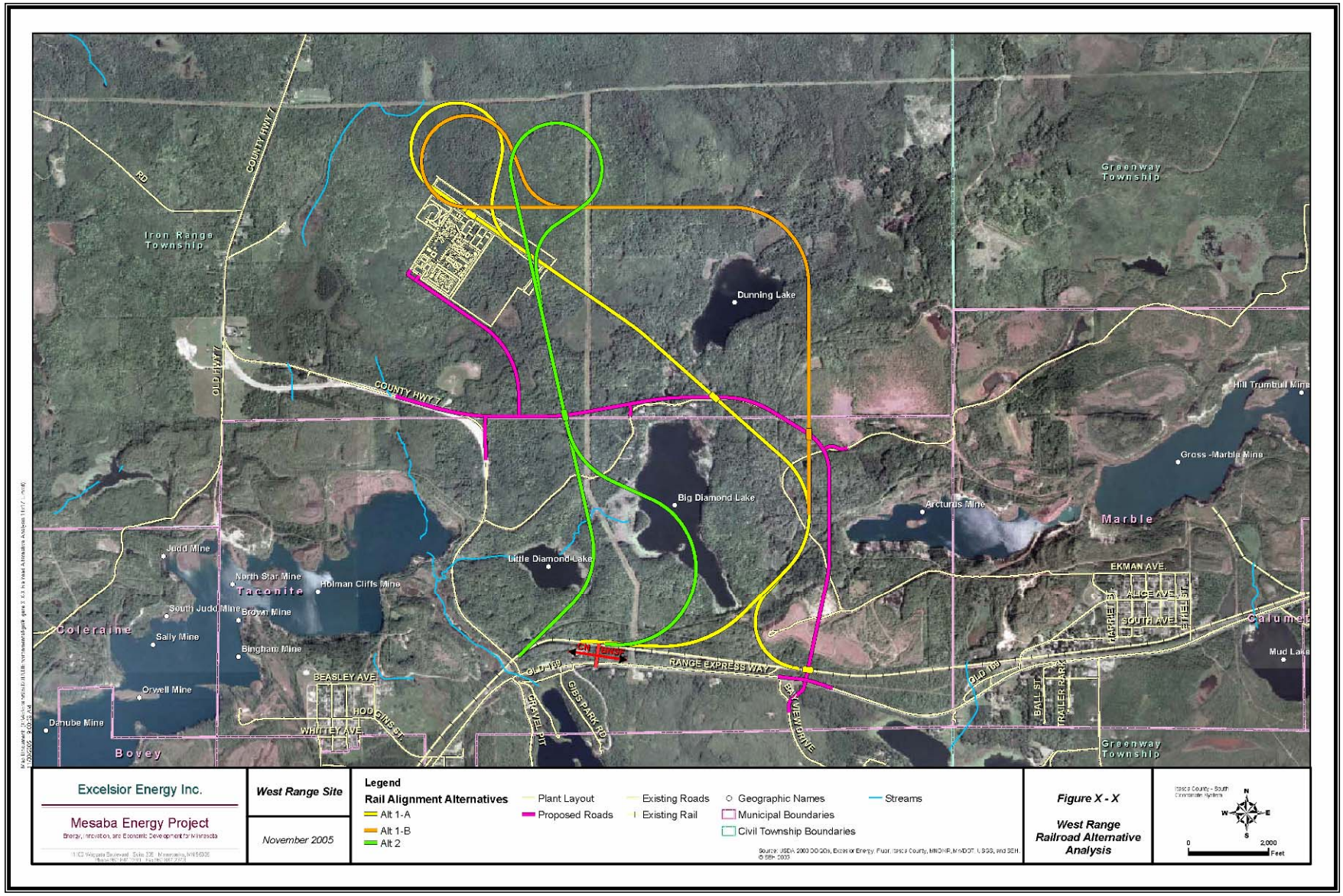
Alternative 1-A will be situated within 400 feet of one four-season residence located north of the track near Dunning Lake. Alternative 1-B is about 1,200 feet from this residence. The closest residence on Big Diamond Lake is about 700 feet from the proposed track. Section 7.9.7 addresses the general noise and vibration impacts in the vicinity of the West Range Site and on these properties in particular.

Both Alternatives 1-A and 1-B would meet acceptable alignment, grade, and rail operations criteria. The length of rail line required for construction of these alternatives would total approximately six and seven miles, respectively. A rail bridge over the new access roadway to the West Range Site would be constructed to avoid crossings that could cause major traffic interruptions close to the IGCC Power Station. Existing roadways that would be affected by the rail spur into the Station Footprint are forest roads that can be re-routed without causing major traffic disruptions. The traffic impacts associated with such changes are discussed in Section 7.10.2.

The alignment for Alternative 1-B would result in greater impacts to wetland areas, would place the rail dumper building in the wrong part of the Buffer Land (requiring coal to be conveyed across a significant distance to the IGCC Power Station), and would require more significant earth removal work (as the route would cut across several large mine dumps and existing terrain features). The only practical benefit this alignment offers over Alternative 1-A is that it would divert rail traffic away from the small number of residential properties located on Big Diamond and Dunning Lakes. Alternative 1-A would require easements over or acquisition of some additional private property. Wetland impacts for each alternative and mitigation requirements are discussed in detail in Sections 7.7.11 and 7.7.12. Table 3.5-3 presents a summary of these impacts for the two alternatives.

Excess soil from cuts will be used as fill as detailed in Section 3 of the ES.

**Figure 3.5-10. Alternative Rail Layouts Evaluated for the West Range Sites**



Alternatives 1-A and 1-B were judged to be similar with regard to roadway impacts. Both alternatives would have a surplus of cut/fill material that would need to be disposed of near the Station Footprint. Alternative 1-A is deemed to be superior to Alternative 1-B for the following reasons:

1. Less impact to wetlands
2. Avoids an area of high probability of historic artifacts near Dunning Lake (see Section 7.11.2.1)
3. Better alignment of the curves
4. Lower cost

**Table 3.5-3**
**Railroad Alternatives Analysis**

| | Alternative 1A | Alternative 1B | Alternative 2 |
|---|---|---|---|
| Total length of track (miles) | 6.0 | 6.9 | 4.5 |
| Length of track outside of Buffer land (feet) | 15,900 | 19,000 | 9,000 |
| Train speed (mph) | 10 | 10 | 10 |
| Maximum grade | 0.30 % | 0.35% | 0.40% |
| Maximum Curvature (loaded coal train) | 2 degrees 30 minutes | 3 degrees | 3 degrees |
| New right-of-way (acre) | 35 | 43 | 20 |
| Largest cut (ft) | 65 | 120 | * |
| Largest fill (ft) | 25 | 25 | * |
| Approximate cut Qty (cu.yd.) | 3,000,000 | 8,500,000 | * |
| Approximate fill Qty (cu.yd.) | 2,000,000 | 2,000,000 | * |
| | | | |
| No of residences within 1000 feet | 3 | 0 | 0 |
| Closest residence (FT) | 400 | 2,000 | 1,200 |
| Acceptable alignment | Yes | Yes | No |
| Comments | Preferred | | Discarded |

*Was not computed because alignment was unacceptable.

**West Range Rail Line Alternative 2**

The Company evaluated the possibility of accessing the West Range Site via a rail corridor that would split from the existing CN rail line at a point due south of Little Diamond Lake as shown on Figure 3.5-10 and run north between Little and Big Diamond Lakes. This alternative would include a loop to the northeast of the Station Footprint as in Alternative 1 and allow CN unit coal trains to exit via their same route of entry. There would be a slight impact to Little Diamond Lake on the southeast corner.

The BNSF would not be able to originate a shipment using the CN trackage that would be constructed as part of this alternative rail supply option. Instead, BNSF shipments would be

required to originate from a point west of the proposed CN rail spur and southwest of Big Diamond Lake. This origination point would require a sizable portion of Big Diamond Lake to be filled to maintain acceptable curvatures as per the Railroad Design Guideline. Figure 3.5-10 shows that the amount of filling required to allow BNSF to access this route from the west would be prohibitive.

The BNSF access from the east would require coal trains to be routed an additional 100 miles through Carlton. The disadvantages to this routing have been discussed earlier in the Section labeled "BNSF Rail Operations in the Project Vicinity." Additional track work, including a railroad diamond for the Minnesota Steel project, would also be required (a railroad diamond is where two tracks cross each other at the same elevation; such diamonds are difficult to maintain and are to be avoided if possible).

An additional alternative provided the CN access from the west side of Big Diamond Lake and the BNSF access from the east side of the Lake. This too was discarded because of duplication of tracks, direction difficulties relative to the position of the coal dumper, impacts to a much larger area around Big Diamond Lake, and the same impact to residents as Alternative 1-B.

Alternate 2 is not acceptable from railroad engineering, environmental impact, and cost perspectives, and has been eliminated from consideration.

### 3.5.2.3 East Range Rail Line Alternatives

#### 3.5.2.3.1 Alternatives

##### *3.5.2.3.1A Introduction*

The proposed East Range Site does not provide for the option of immediate competition between rail providers. The nearest competitive railroad to the CN is the BNSF Railway near Hibbing, 40 miles from the East Range Site. The CN will be the only feasible near-term rail service provider into the East Range Site. Longer term, it may be possible to utilize the port at Taconite Harbor and CE's privately own railroad to provide feedstock to the East Range Site, but for now, this option is considered uneconomic.

The East Range Site is located approximately one mile north and one mile west of two CN tracks. The east-west track runs from Eveleth, Minnesota to Two Harbors, Minnesota. The north-south track connects with the east-west track at Wyman Junction (about 1.7 miles southeast of the boundary of the Buffer Land) and extends northward to Embarrass. Coal would be delivered by other railroads to the CN at either Superior, Wisconsin or to a railroad yard south of Eveleth, Minnesota. The CN would deliver coal to the site from Eveleth as shown in Figure 3.5-9. Empty unit trains would return by the same route. The layout of the proposed rail alignments are presented in Figure 2.1-5.

The CN operates daily on the track servicing Laskin, CE, and several proposed and existing industrial customers.

Existing roadways that would be affected by the rail spur into the Site are forest roads that can be re-routed without causing major traffic disruptions. The traffic impacts associated with such changes are discussed in Section 7.10.2.

The East Range Site is divided between upland and wetland areas. Most of the southern area is wetland. The railroad loop will impact this wetland area and the most significant rail routing issue of the site is to maintain the rail elevation high enough to minimize wetland impacts, but low enough to achieve acceptable grades. The wetland elevation is about 1,470-1,475 ft msl.

The Railroad Design Guideline presented in Table 3.5-2 was used to identify and avoid major flaws in the East Range Site rail alignments. A typical track section consistent with the Design Guideline was illustrated in Figure 3.5-5.

#### *3.5.2.3.1B East Range Rail Line Alternative 1*

Alternative 1 is a traditional coal loop that will handle a complete coal train and allow return in the same direction. The track would start near MP's Syl Laskin Generating Station spur and travel east northeast to the Station Footprint. The track would be about 17,800 feet long plus additional plant track for miscellaneous chemicals and products. The track would begin at about elevation 1,455 ft and the coal loop will be at set at about 1,465-1,470 ft.

No residential dwellings are located near the proposed track but some wetland mitigation would be required. The track is near the base of a waste rock dump that may require special treatment to avoid sloughing onto the rail track.

#### *3.5.2.3.1C East Range Rail Alternative 2*

Alternative 2 is an alignment that would handle a complete coal train, but would cross the Buffer Land (rather than looping within it) and connect with the CN north-south track just north of Wyman Junction. This track would be about 18,500 feet long and have the coal dumper centered in the middle. The train would leave the track at an elevation of 1,455 ft, climb to a dumper elevation of about 1,465-1,470 ft. and continue to climb to the about 1,485 ft at the north-south CN track. To maintain a workable grade, this track would have to cross under CR 666, requiring construction of a roadway bridge.

#### *3.5.2.3.1D Comparison of Alternatives*

The primary advantage of Alternative 2 is that less environmental impact will occur to wetlands within the proposed East Range Property Boundary. The primary disadvantages are i) there are limited locations at which to construct the rotary coal dumper; ii) the track elevation on the east end is 35 feet higher in elevation than the west end (making the profile grades difficult); and iii) the total coal train aesthetic impacts are spread over a larger area (the trains will be more visible from CR 666, noise impacts will be more discernable, and dusting from the rail cars would increase because the cars would be more exposed to the wind).

Similar to Alternative 1, the track is not located near any residential buildings, requires some wetland mitigation, and is impacted by its proximity to the nearby waste rock dump.

Table 3.5-4 provides a quantitative comparison between the two rail alignments.

**Table 3.5-4**
**East Range Railroad Alternatives Analysis**

| | Alternative 1 | Alternative 2 |
|---|---|---|
| Total length of track (miles) | 3.4 | 3.5 |
| Length of track outside Buffer Land (miles) | 1.25 | 2.1 |
| Train speed (mph) | 10 | 10 |
| Maximum grade | 0.40 % | 0.40% |
| Maximum Curvature (loaded coal train) | 2 degree 30 minutes | 3 degrees |
| Off site right-of-way (acre) | 15 | 26 |
| Largest cut (ft) | 50 | 50 |
| Largest fill (ft) | 20 | 20 |
| Approximate cut Qty (cu.yd.) | 2.3 million | 2.1 million |
| Approximate fill Qty (cu.yd.) | 60,000 | 65,000 |
| | | |
| No of residences within 1000 feet | 0 | 0 |
| Closest residence (ft) | 3.750 | 3,750 |
| Acceptable alignment? | Yes | Yes |

#### 3.5.2.4 Construction

Construction of the new railroad trackage will require rights of way to be obtained. The proposed right-of-way will be 100 feet wide with additional width needed in some of the cuts or fill sections. A typical track cross section based on the Railroad Design Guidelines summarized in Table 3.5-2 was developed and is presented in Figure 3.5-5.

The track work would begin immediately after construction approval has been received. The track and grading would take approximately 6 to 9 months to construct.

Railroads are constructed similar to roadways. The track will be constructed on a 100-foot wide right-of-way with a 32-foot wide prepared roadbed on which the track will be constructed. There may be areas where permanent or temporary easements will be needed to accommodate the larger fill or cut sections. Native soils are suitable for use in embankment construction on 1:3 side slopes. The side slopes will be 1:3 with a 5-foot wide flat bottom ditch for drainage. The prepared roadway will have the track offset to one side of centerline to allow for a 12-foot railroad inspection road along side. Finished embankments will be top-soiled and vegetation reestablished.

The coal unloading process requires the track elevation to be level. The grading and track work will be built using best practices and conform to the American Railway Engineering and Maintenance of Way Association ("AREMA") standards.

The track alignment and construction limits will be established by a field survey. The ROW will be cleared following accepted industry practices and sound construction guidelines. In areas where timbering is required, the trees would be cut in uniform length and stacked along the ROW for recycling. Debris created from preparation of the ROW would be disposed of using approved methods.

The low areas will be filled and hills will be removed to provide a smooth grade. Drainage structures and bridges will be built. These activities will be done with large earth moving equipment normally used for road building. The embankments will be compacted and 12 inches of finely graded compacted granular material (sub-ballast) will be placed on the top. Vegetation will be reestablished on the slopes and other impacted areas. Detailed discussion regarding wetland impacts and treatment are in Sections 7.7.11 and 8.7.4.11.

After the sub-ballast is placed, specialized construction equipment will be used to construct the track. The track will consist of railroad ballast (rock), steel rails, timber crossties and other miscellaneous materials. A stockpile area for the track material will be located on the plant site. The material will be distributed by truck to the final location and the rails will be carefully spiked to the proper gage on the crossties. Railroad ballast will be dumped using construction equipment mounted on the rails. A specialized piece of construction equipment, called a tamper, will be used to raise the track through the ballast, and the ballast will be compacted under the crossties. The track surface will be smoothed to a tolerance of 1/16 of an inch. The ballast will then be shaped to form a uniform ballast section.

## 3.6 WATER SUPPLY AND WATER/WASTEWATER MANAGEMENT INFRASTRUCTURE

### 3.6.1 Process Water Supply

#### 3.6.1.1 West Range Process Water System

One of the reasons the West Range Site is an exceptional location for a power plant site is that abundant sources of water are located nearby. Several abandoned mining pits located in proximity to the boundary of the Buffer Land are either currently filled with water and overflowing, are being pumped to avoid flooding of important historical resources due to rising water levels, or are threatening to flood due to rising water levels. Specifically, these Pits include the LMP, the HAMP Complex, and the CMP. (These mine pits are shown on Figure 3.4-6. As noted in Table 3.6-1 below, the Arcturus, Gross-Marble, and Hill-Annex Mine Pits combine to form the HAMP Complex). The present circumstances allow Mesaba One and Two to become part of the solution to a difficult problem for the communities surrounding these resources and for the State of Minnesota, which is currently paying to pump water out the HAMP Complex to maintain acceptable levels. Tables 3.6-1 through 3.6-4 and the discussions that accompany them outline the analysis undertaken to assess the unique match between water resources and power station requirements.

The Applicant has identified the resources listed in Table 3.6-1 as the sources of process water for operation of the Phase I and II IGCC Power Station at the West Range Site. The chemistry of the waters listed in the table is presented in Table 3.4-20 in Section 3.4.2.2.3.

**Table 3.6-1**
**Process Water Resources Identified for Use at the West Range Site**

| Potential Resource | Over-Flowing Or Rising? | Information Source | Phase | Alternative |
|---|---|---|---|---|
| CMP | Rising | MDNR | I/II | 1 |
| HAMP Complex* | Dewatered on ongoing basis to avoid flooding of Hill-Annex State Park | MDNR and Barr | I/II | |
| LMP | Overflowing | SEH Field Data | I/II | |
| Prairie River | NA | Minnesota Power | I/II | |
| Greenway Mine Pit | Overflowing | SEH Field Data | II | Considered as Part of Alternative No. 1, but Rejected on Basis of Cost Effectiveness |
| Mississippi River | NA | MDNR | II | 2 |
| Groundwater | NA | None | I/II | 3 |

*The HAMP Complex includes the Arcturus, Gross-Marble, and Hill-Annex Mine Pits. NA = Not Applicable

The amount of water currently available in each of the source water mine pits is presented in Table 3.6-2.

**Table 3.6-2**
**Abandoned Mine Pit Water Sources**

| Water Source | Water Surface Elevation (feet) (November 2005) | Surface Area (acres) (November 2005) | Estimated Volume (acre-feet) (November 2005) |
|---|---|---|---|
| CMP | 1,309 | 1,400 | 150,000 |
| HAMP Complex | | | |
| Hill-Annex Mine Pit | 1,249 | 216 | 20,600 |
| Arcturus Mine Pit | 1,269 | 105 | 4,490 |
| Gross/Marble Mine Pit | 1,249 | 141 | 11,100 |
| LMP | 1,265 | 82 | 8,310 |

The sustainable[15] supply capability for each water source was estimated using information supplied by the MDNR, previous engineering studies, and information supplied by local government units. The actual sustainable rates that will be realized are dependent on factors including precipitation, evaporation, pit water levels and hydrogeological conditions. The estimated water source supply capabilities are presented in Table 3.6-3.

**Table 3.6-3**
**Water Source Supply Capability**

| Water Source | Est. Range of Flow (gpm) | Assumed Sustainable Flow for Water Balance Modeling (gpm) |
|---|---|---|
| CMP | 810-4,190 | 2,800 |
| HAMP Complex | 1,590-4,030[a] | 2,000[b] |
| Lind Mine Pit | 1,600-2,000 | 1,800[c] |
| Prairie River | 0-2,470[d] | 2,470[d] |
| Discharge from IGCC Power Station | 350-3,500 | Varies[e] |

[a]Maximum flow occurs at minimum operating elevation.
[b]At an operating elevation of 1,230 ft msl.
[c]Estimates of flow are based on one summer flow measurement at the LMP outlet and one summer and one winter measurement taken at the West Hill Mine Pit outlet.
[d]Maximum available flow assumed to be 25% of the 7Q10 flow of the Prairie River.
[e]Water returned to the CMP is expected to be 300 gpm during Phase I operations and 2,650-3,500 gpm during Phase II operations.

Table 3.6-4 matches the water needs shown for the IGCC Power Station (this table contains information from Table 3.4-16 with two columns added) with the potential supplies shown in Table 3.6-3. The assessment regarding long term sustainable flows was based on: i) discussions with the MDNR regarding the availability of water in each of the above resources; ii) analyzing stage-storage data made available by the MDNR; iii) reviewing information the MDNR had published on each such resource; and iv) collecting primary data to confirm the available resource. The last column in Table 3.6-4 represents the Applicant's conclusion with regard to the capability of the resources listed to meet the operational requirements of Mesaba One and Mesaba One and Mesaba Two. The conclusion regarding water supplies is that sufficient water supplies are available to demonstrate the long term, sustainable provision of water for the Station's needs.

[15] The term sustainable is used in this context to imply that water levels within all pits be kept at levels that will be somewhat consistent with existing uses.

**Table 3.6-4**
**Water Appropriation Requirements Matched with Water Supply Capabilities**

| Phase | Average Annual Appropriation (GPM) | Peak Appropriation (GPM) | Long Term Sustainable Flow (GPM) | Sufficient to Meet Annual Avg. Flow Requirement (Yes/No) |
|---|---|---|---|---|
| Mesaba One | 4,000[a]-4,400[b] | 6,500 | > 9,100[c] | Yes |
| Mesaba One & Two | 8,800[b]-10,300[d] | 15,200 | > 9,100[c]<br>> 11,700[e] | Yes |

[a]Based on 8 COC in the gasification island and the power block cooling towers
[b]Based on 5 COC in the gasification island and the power block cooling towers
[c]The flow presented is the sum of the values in the third column of Table 3.6-3 rounded to two significant figures; greater than symbol is applied because quantity does not account for 300 gpm recycled to CMP during Phase I operations (see Figure 3.4-12)
[d]Based on 3 COC in the gasification island and the power block cooling towers
[e] The flow presented is sum of the values in the third column of Table 3.6-3 and includes the minimum quantity of water expected to be returned to the CMP during the combined operation of Mesaba One and Mesaba Two rounded to two significant figures; greater than symbol is applied because quantity assumes minimum quantity recycled to CMP (see Figure 3.4-13)

For the combined needs of Mesaba One and Mesaba Two, existing data currently shows that greater flows than those presented in Table 3.6-4 for the CMP might possibly be available as inflows of water may increase (relative to the value presented in Table 3.6-4) with decreasing water levels in the CMP. To be conservative, the Applicant has not assumed the availability of such potential excess flows.

Information available for the HAMP Complex also suggests increased water flows into the HAMP Complex with decreasing water elevations. For example, records show evidence of flows between 3,900 and 4,000 gpm during the initial years following cessation of mining. However, this increased flow is also not used in the sustainable flow values presented in Table 3.6-4. Additional flow is available from non-contact cooling water discharges from the IGCC Power Station directly into the CMP. The basis for direct discharges into the CMP is discussed in greater detail in Section 7.6.4.4 and in the NPDES Permit Application that is provided at Appendix 6. Such discharges would be conducted in accordance with all rules and regulations and could decrease reliance on one or more of the water resources listed. However, because of the uncertainty of sufficient flows for Mesaba One and Two from such sources, the Applicant has chosen to also propose water appropriation from the Prairie River and the LMP to ensure adequate water supplies for both phases.

Each of the water resources identified above is at a lower surface elevation than that of the IGCC Power Station. Therefore, conveyance of the water to the Station requires that it be pumped. Figure 3.4-6 provides the location for the process water pump stations and pipelines.

Section 7.6-1 supplies additional information regarding each of the water resources discussed above.

### 3.6.1.2 East Range Process Water Supply

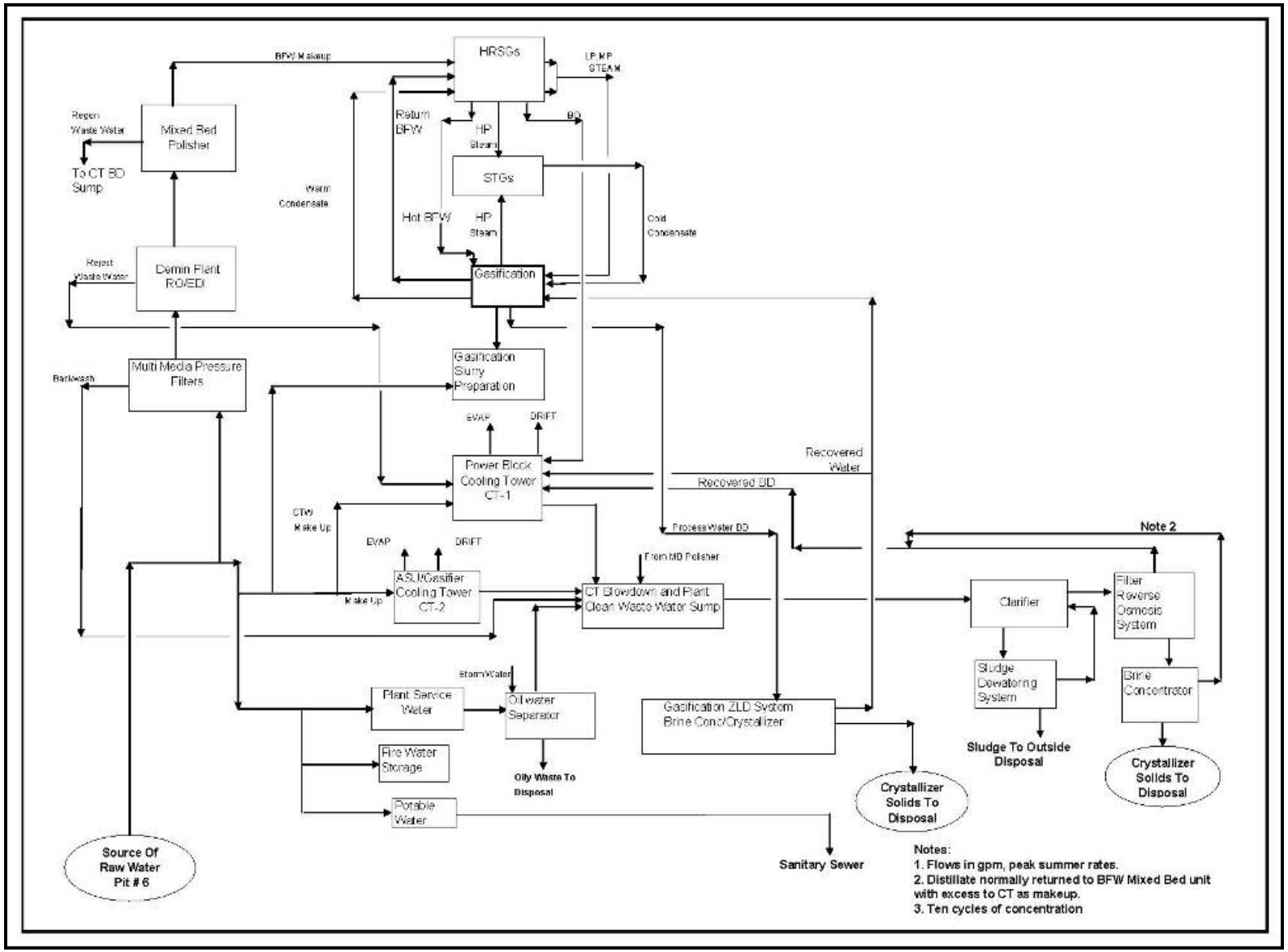
#### 3.6.1.2.1 Water Supply Requirements

As shown in Section 3.6.2.1 and in Table 3.6-6, the water supply required to serve the East Range IGCC Power Station is reduced in comparison to that required for the IGCC Power Station located on the West Range Site. Figure 3.6-1 shows that cooling tower blowdown that would otherwise be discharged to receiving water (for example, CMP and Holman Lake in the case of the West Range IGCC Power Station) is processed through a reverse osmosis ("RO") system to recover water that can be recycled within the Station. The brine wastewater from the RO is processed in a mechanical vapor recompression evaporator/crystallizer that serves as the principal component of the ZLD system (see Section 3.1.6.3 for a description of the ZLD system applied to contact water cooling). Water recovered from the ZLD system is recycled for make up water where needed.

As shown in Table 3.6-6, water appropriations can be reduced by up to 700 gpm per phase through use of such recycling efforts. The auxiliary power required to operate the ZLD system is estimated to be about 2 MW per phase. In addition, the TDS present in the East Range mine pit waters produces significant quantities of additional solids that must be disposed of in an industrial solid waste landfill (see Section 3.4.4.1.3).

Although the ZLD system's power consumption and solids production are negatives in an economic context, the ZLD system allows the IGCC Power Station to potentially play a synergistic role with industrial mining operations seeking to locate on the East Range industrial site. The potential for such industrial synergies is discussed in Section 3.4.3.3. In the following section, the opportunities for reusing water (turning what might be considered a waste stream from the mining entities into a source of water for the IGCC Power Station) are identified.

**Figure 3.6-1 East Range ZLD System to Eliminate Cooling Tower Blowdown**



#### 3.6.1.2.2 Process Water Sources

Sources of water to meet the needs of Mesaba One and Two on the East Range Site are identified in Table 3.6-5 below. The sustainable supply capability for each water source was estimated using information supplied by the Minnesota Department of Natural Resources, previous engineering studies, and information supplied by local government units. The actual sustainable rates that will be realized are dependent on several factor, including precipitation, evaporation, pit water level and hydrogeological conditions. These sources are shown relative to the location of the facility in Figure 3.6-2. Water levels in several of the pits are rising, but pose no current threat to public health and/or welfare unlike levels in the HAMP Complex and CMP. And, unlike the CMP and HAMP Complex, there is no immediate need to control water levels in any of the pits on the East Range Site. Therefore, water supplies from any of the individual East Range pits can be over-pumped as necessary to meet demands of Mesaba One and Mesaba Two. As noted for the West Range Site, the water supply plan for the East Range Site is subject to environmental review and permitting process approvals.

**Table 3.6-5**
**Water Supply Alternatives for the East Range IGCC Power Station**

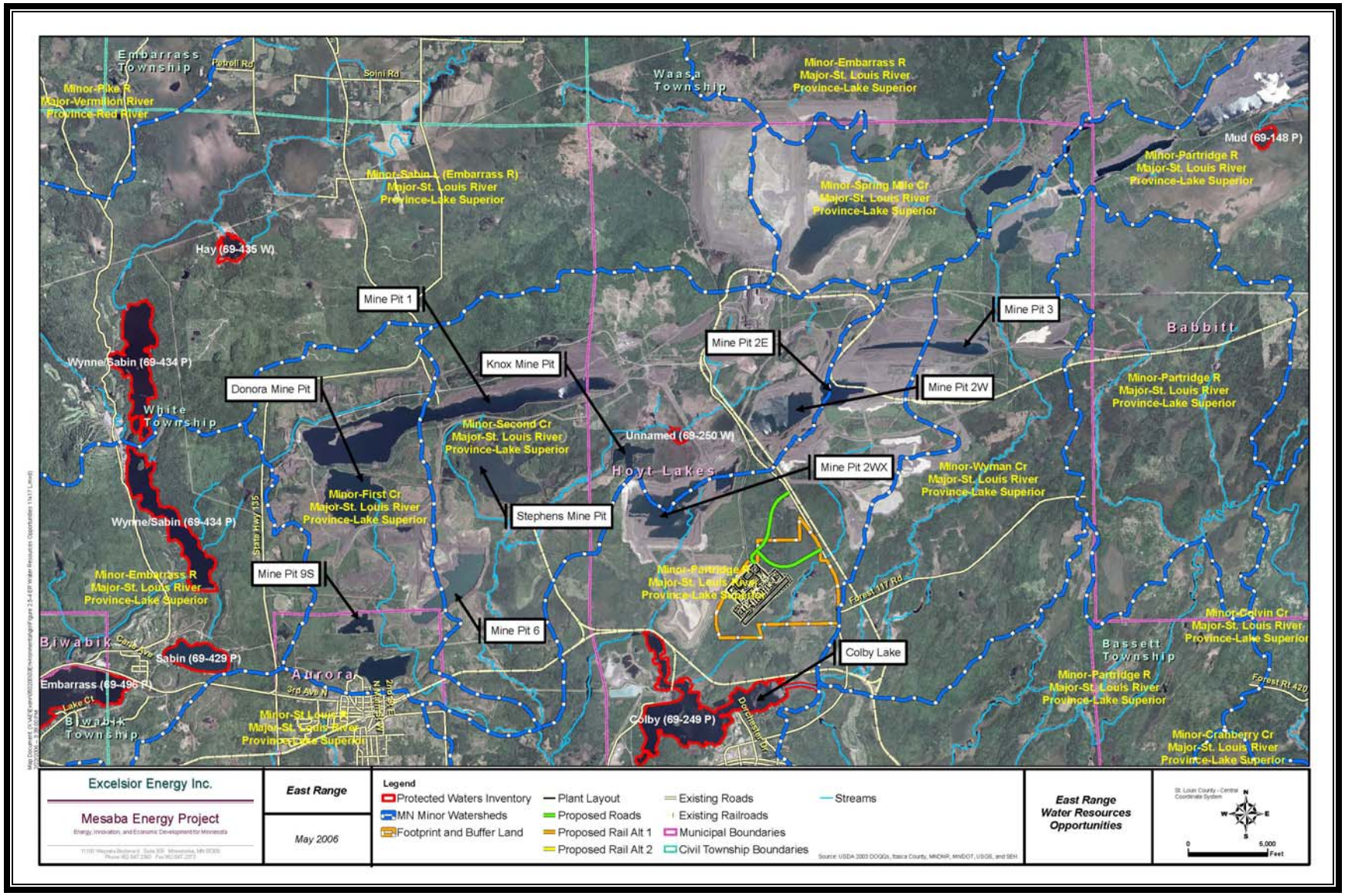
| Abandoned Mine Pit | Estimated Range of Flow (gpm) | Information Source (See Table Footnotes) | Average Annual Flow (gpm) |
|---|---|---|---|
| Mine Pit 6 | | 1 | 1,800 |
| Mine Pit 2 WX(West Extension) | | 1 | 700 |
| Mine Pit 2 West | | 1 | 900 |
| Mine Pit 2 East | | 1 | 100 |
| Mine Pit 3 | 150-450 | 2 | 300 |
| Donora Mine Pit | 130-380 | 2 | 260 |
| Stephens Mine Pit | 190-590 | 2 | 390 |
| Knox Mine Pit | 20-70 | 2 | 45 |
| Mine Pit 9S | 90-270 | 2 | 180 |
| Mine Pit 1 Effluent | 0-1000 | 3 | 1,000 |
| PolyMet Mining Dewatering Operations | 2,000-8,000 | 4 | 4000 |
| Colby Lake | | 5 | 2,900 |
| | | Total Resource (gpm) | 12,600 |

1. East Range Hydrology Report, MDNR, Division of Lands and Minerals, Division of Waters, March 2004.
2. Range of flow based on the surface drainage area to the pit and average yearly rates of runoff. This should be considered a gross approximation as the actual flow rates are likely much more dependent on groundwater components. The groundwater inflow/outflow component in this area can be highly variable as a result of fractures in the bedrock and/or highly pervious tailings dikes. Due to the complexity associated with the groundwater component, groundwater inflow/outflow has not been evaluated.

3. MPCA NPDES Permit Issued to Mesabi Nugget. Mine Pit 1 effluent represents the wastewater discharged from Mesabi Nugget's permitted operation of Mine Pit 1 in accordance with terms of a NPDES Permit.
4. North Met Mine Environmental Assessment Worksheet.
5. Cliffs-Erie Omnibus Agreement, Exhibit I-B-1.

The total water available in these pits is considerable, having a combined surface area on the order of 1,300 acres. The Applicant continues to refine its Water Resource Management Plan for the East Range Site. However, given the number of voluminous sources of water on the site, the flexibility of operating them over a wide range of water levels, and the capability of supplementing such sources with water from Colby Lake during periods of high flow, the amount of water to sustain Mesaba One and Two over the long term is reasonably assured.

**Figure 3.6-2 East Range Site Water Resources in Relationship to IGCC Power Station**



### 3.6.2 Process Water Infrastructure

#### 3.6.2.1 Site Independent Infrastructure

Process water is required at the IGCC Power Station for the following purposes: i) as the prime mover in the steam cycle, ii) to condense steam used in the power cycle (the water from which the steam in the power cycle will originate is of very high quality and, for economic reasons, could not simply be vented to the atmosphere as low grade steam); iii) for slurrying coal fed to the gasifier; and iv) for various other contact/non-contact cooling purposes. Table 3.6-6 is provided to show the annual average and peak rates at which water would be appropriated for all such purposes.

**Table 3.6-6**
**Water Appropriation Requirements**

| Phase | West Range IGCC Power Station | | East Range IGCC Power Station | |
|---|---|---|---|---|
| | Average Annual Appropriation (GPM) | Peak Appropriation (GPM) | Average Annual Appropriation (GPM) | Peak Appropriation (GPM) |
| Mesaba One | 4,000[a]-4,400[b] | 6,500 | 3,700[a] | 5,000 |
| Mesaba One & Two | 8,800[b]-10,300[c] | 15,200 | 7,400[a] | 10,000 |

[a]Based on 8 COC in the gasification island and the power block cooling towers
[b]Based on 5 COC in the gasification island and the power block cooling towers
[c]Based on 3 COC in the gasification island and the power block cooling towers

The largest share of the water appropriated is consumed by evaporative cooling. Figures 3.4-9 and 3.4-10 indicate that the annual average rate of evaporative loss would be on the order of 3,320 gpm for Mesaba One, with evaporative losses from Mesaba Two expected to be identical. Peak evaporative losses for each phase of the IGCC Power Station are identified in the NPDES permit application as approaching 3,500 gpm. Peak utilization rates will occur on hot summer days.

The maximum appropriation of water from the resources at either site will be dependent upon many factors, including: cycles of concentration in the cooling towers; fuel consumed; ambient conditions; the extent to which cooling tower blowdown is treated to remove total dissolved solids; the chemistry of the receiving waters; and the water quality criteria standards applied to those waters. The cycles of concentration in the cooling towers will be dependent upon source water chemistry, including the concentrations of mercury, total dissolved solids and hardness. In general, if the source water is relatively low in total dissolved solids, the cycles of concentration in the IGCC Power Station's cooling towers can be increased, resulting in lower make-up rates.

The West and East Range IGCC Power Stations do not differ greatly in their need for water, but do differ greatly in how wastewaters from the Power Station must be managed. In the case of the East Range IGCC Power Station, all wastewaters (other than domestic wastewaters) must be processed through a ZLD system such that there will be no process-related wastewaters, including non-contact cooling tower blowdown, discharged from the Power Station. As noted, the reason for the difference in approach between the two sites is a function of the East Range

Site's location in the Lake Superior Basin watershed (see Section 3.4.2 to obtain citations to the rules governing discharges to this watershed). The water quality criteria standards for mercury applied to surface waters in this watershed are 1.3 nanograms per liter. Dischargers to surface waters in that watershed must meet this stringent standard at the end of the discharge pipe (that is, there is no allowance for a mixing zone within which the concentration of mercury is allowed to equilibrate). The background concentration of mercury in the East Range source waters is on the order of 0.5-0.9 nanograms per liter, resulting in cooling tower blowdown concentrations of mercury in the range of 1.5-9.0 nanograms per liter (assuming that three to ten COC were used in the cooling tower).

The site-specific issues identified in the preceding paragraphs (as well as the prohibition on new or expanded discharges of certain chemicals to waters that are impaired because of such chemicals) is discussed in more detail in Section 7.6.4.4. Essentially, the combination of these two considerations lead to the conclusion that at the East Range Site, discharges of cooling tower blowdown must be entirely avoided in order to obtain required preconstruction permits.

#### 3.6.2.1.1 Water Intakes and Pumping Systems

The types of water intake structures and pumping systems will be similar for the West and East Range Sites. Two types of intake structures will be employed for withdrawal from water resources: one designed for permanent withdrawals and one for seasonal withdrawals. Both systems must be designed to be compliant with § 316(b) of the Clean Water Act ("CWA"). Rules promulgated in support of § 316(b) are published at 40 C.F.R. Part 125 ("Criteria And Standards For The National Pollutant Discharge Elimination System"), Subpart I ("Requirements Applicable to Cooling Water Intake Structures for New Facilities Under Section 316(b) of the Act") and contain design criteria pertinent to the Mesaba One and Mesaba Two process water supply system.

As the front end engineering and design of the IGCC Power Station proceeds, the design concepts presented here will be tailored to each specific circumstance and optimized to reduce power consumption demands. A conceptual design for the two types of intake systems (a caisson intake system for permanent applications and a floating intake system for seasonal use), are described below and illustrated in Figures 3.6-3 and 3.6-4, respectively.

##### *3.6.2.1.1A Caisson Intake*

This concept includes construction of a 13–20 foot diameter vertical shaft that will act as a wet well. The caisson will be formed with concrete in the unconsolidated overburden but may utilize the bedrock as a wall in the deeper parts of the structure depending on competence and fractures. The actual diameter of the vertical shaft will be based on equipment requirements such as the number of pumps and the dimensions of the pumping equipment, as well as on constructability issues related to connecting the shaft to the pit. The caisson will be constructed to an elevation necessary to obtain submerged pumping conditions under the lowest anticipated pit water levels, including an emergency buffer. Connecting the shaft to the pit can be accomplished by several methods. One such method includes constructing a large horizontal tunnel, approximately 10 feet diameter, from the caisson to the pit for water collection.

Water will enter the central caisson through the horizontal tunnel and rise to the normal water elevation. The horizontal tunnel would be constructed using hard rock tunneling techniques. The tunneling would be stopped short of the pit to allow the equipment to be removed prior to flooding of the caisson by pit water. The final opening from the horizontal intake tunnel to the pit would be made blasting or drilling on the pit side from a barge on the pit water surface. The horizontal tunnel will be sized to limit intake velocities to 0.5 feet per second. With this method, CWA screening requirements of Section 316(b) of the CWA will be met in the caisson using either tee screens or conventional well screens. Pumps in the caisson will be conventional turbine pumps commonly used in wet well applications.

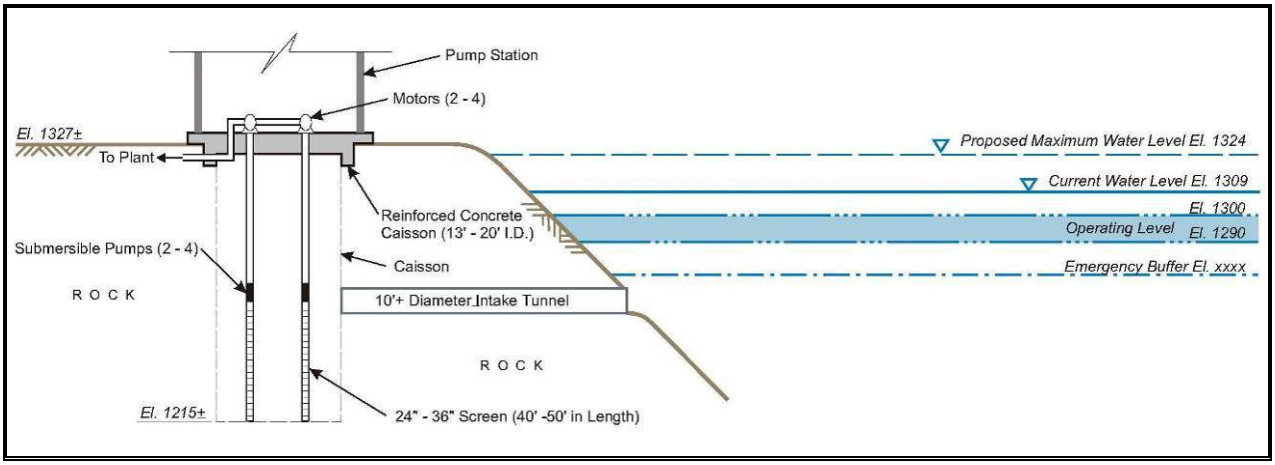
A second method to withdraw water from the pit is to use diagonal drilling methods to install several smaller diameter holes (roughly 36" in diameter) into the pit. Using this method, piping could be fitted with screens that will extend in the pit to meet CWA Section 316(b) intake velocity requirements. Submersible pumps would be used in this configuration.

Using either method, a system will be installed that will allow access to the deeper, cooler water if determined to be necessary or cost effective. A new supply pipe will be constructed from the caisson to deliver water to the IGCC Power Station for cooling and other plant needs.

A section of this concept is shown in Figure 3.6-3. This design provides:

- A system that meets CWA Section 316(b) requirements that reflect the best technology available (BTA) to protect aquatic organisms from impingement or entrainment.
- Reliable construction that will minimize potential maintenance and supply issues.
- An inlet tunnel that is designed to limit intake velocities to 0.5 feet per second to meet CWA Section 316(b) requirements and allow fish to freely swim in and out of tunnel.
- Installation of well screens or tee screens to meet CWA Section 316(b) requirements, thereby eliminating requirements for a flat panel wedgewire intake screen at the entrance to the horizontal tunnel.
- Well screens, if used in the caisson, installed so that they could be removed for maintenance.
- A caisson depth designed to allow access to the deeper water if desired and to ensure thermal stratification is not negatively disrupted. The structure could also be modified to include some form of deeper suction piping to feed the main intake with deeper colder water.

**Figure 3.6-3. Conceptual Illustration of Caisson-Type Intake Structure**



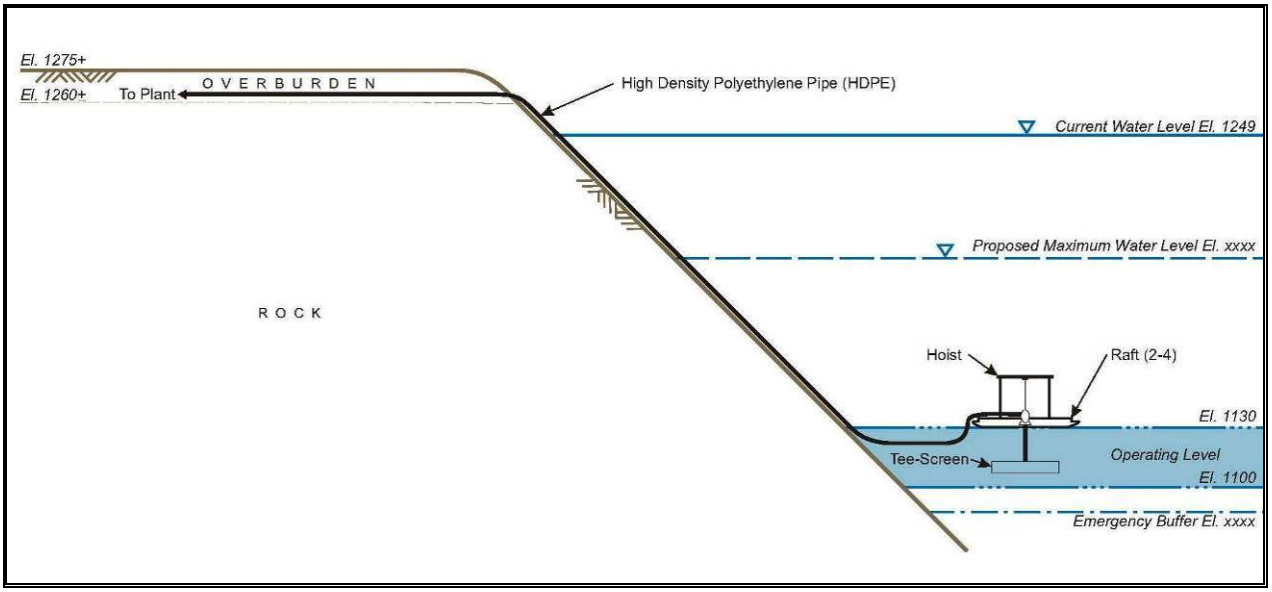

### *3.6.2.1.1B Floating Intake*

Floating intake structures conducive to fluctuating water levels are available and commonly used by mines for pumping systems. This system includes placing pumps and intake structures on a floating platform in the mine pit. A pipe with wedgewire screen is extended to withdraw water from the desired depth. A sufficient length of screen will be provided to ensure intake velocities are maintained below 0.5 feet per second and to ensure thermal stratification is not negatively disrupted. Supply pipe will be designed to convey water from the floating platform to the facility.

A section of this concept is shown in Figure 3.6-4. This design will provide:

- A system that meets CWA Section 316(b) requirements by employing the best technology available (BTA) to protect aquatic organisms from impingement or entrainment.
- Consistent suction characteristics for the pumps (fluctuating water surfaces could otherwise be problematic).
- Readily accessible main components (except for the deeper intake components).
- Economical construction costs.
- Potential for use of off-the-shelf systems.
- An easily accessible submerged pump intake.
- The option for using less expensive horizontally mounted motors.
- A floating dock or other pier structure to allow for maintenance and access to the intake structure. Bubblers or agitators could be utilized to prevent freeze-up if winter operation is necessary.

**Figure 3.6-4. Conceptual Illustration of Floating-Type Intake Structure**




### 3.6.2.2 West Range Process Water Infrastructure

The proposed process water supply system for Mesaba One and Two will consist of three mine pits, three pumping stations, and an engineered orifice to draw water from the Prairie River. In the case of Mesaba One, water in the CMP will be pumped to the IGCC Power Station and water from the HAMP Complex will be pumped to the CMP to maintain appropriate water levels (the intent in the early years of the IGCC Power Station's operation will be to lower water levels in the CMP to eliminate the flooding threat and to allow for construction and utilization of existing railroad facilities). Mesaba One and Two will require an additional pump station on the LMP and installation of an engineered orifice that allows water from the Prairie River to flow by gravity to the LMP. A pumping station in the LMP will then pump water to the CMP. The pumping capacity for each pump station is summarized in Table 3.6-7

**Table 3.6-7**
**West Range Pumping Station Capacities**

| Pump Station Location | Peak Flow (gpm) |
|---|---|
| CMP (see Figure 3.6-5) | 15,200 |
| HAMP Complex (see Figure 3.6-6) | 7,000 |
| LMP (see Figure 3.6-7) | 7,000 |

#### 3.6.2.2.1 CMP Pumping Station

A series of pumps will provide a pumping capacity between 3,500 gpm and 7,000 gpm for Mesaba One and between 8,800 gpm and 15,200 gpm for Mesaba One and Two. This capacity will be provided in a permanent pumping station located at the southeast corner of the CMP (see Figure 3.6-3 for a conceptual illustration of the caisson-type pump station). A standby pump will be incorporated for use during a failure or maintenance of one of the primary pumps. The pump station intake will meet CWA Section 316(b) requirements for cooling water intake structures (addressed in the NPDES permit). The pipeline that extends from the CMP to the West Range Site will be approximately 36 inches in diameter. The length of the pipeline that extends from the CMP to the boundary of the Buffer Land is approximately 11,000 feet.

#### 3.6.2.2.2 HAMP Complex and LMP Pumping Stations

A floating pump station will be installed at the Gross-Marble Mine Pit ("GMMP") end of the HAMP (see Figure 3.6-4 for a conceptual illustration of the floating pump station). The pump station will have a capacity of 7,000 gpm and will be direct water to the CMP. The pipeline that extends from the GMMP to the CMP will be approximately 24 inches in diameter and approximately 25,400 feet in length.

A pump station designed in the same manner as the HAMP Complex pumping station with a capacity of 7,000 gpm will be installed in the northeast corner of the LMP, and will be direct water to the CMP. The pipeline that extends from the LMP to the CMP will be approximately 24 inches in diameter with an approximate length of 11,300 feet.

Pumping capacity at the HAMP Complex and the LMP must allow for the seasonal capture of the 12-month average annual water supply.

#### 3.6.2.2.3 Prairie River Intake

An engineered intake structure capable of accepting a maximum rate of 2,470 gpm from the Prairie River will be installed in the river and directed into the LMP for storage. The engineered intake structure will be approximately 18 inches in diameter and approximately 200 feet in length.

#### 3.6.2.2.4 Pipeline Infrastructure

Routing for the pipelines will be primarily on public property adjacent to existing transportation corridors. Figures 3.4-5, 3.4-6, 3.4-12 and 3.4-13 show an overview of the water supply plan. Figure 3.4-14 provides an overview of the water intakes and discharge points. Finally, Figures 3.6-5, 3.6-6, 3.6-7 and 3.6-8 provide a detailed view of the developments at each intake and discharge location. Mapbooks showing the entire length of each segment of pipeline are attached as Appendix B of the Water Appropriation Permit Application for the West Range IGCC Power Station attached as Appendix 9 herein.

**Figure 3.6-5 Canisteo Pump Station and Gross-Marble Pump Station Discharge Point**

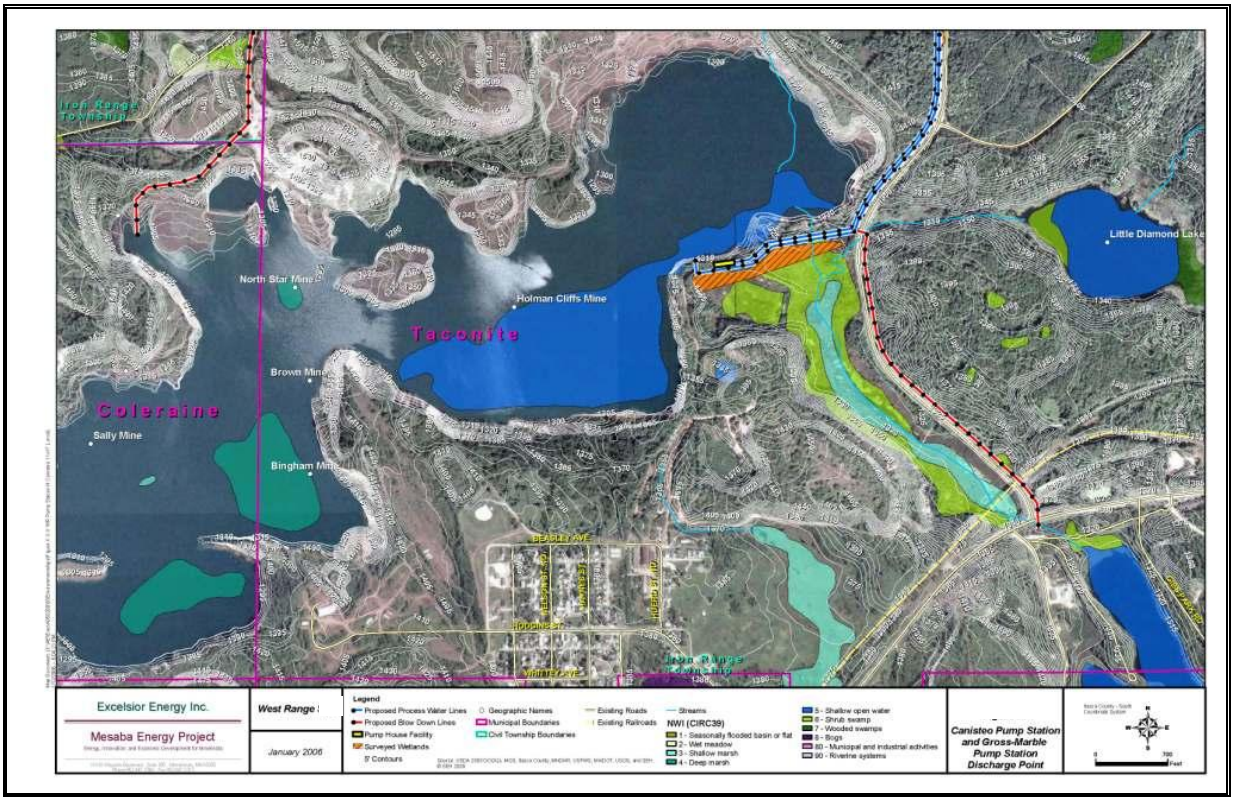



**Figure 3.6-6 Gross-Marble Pump Station**

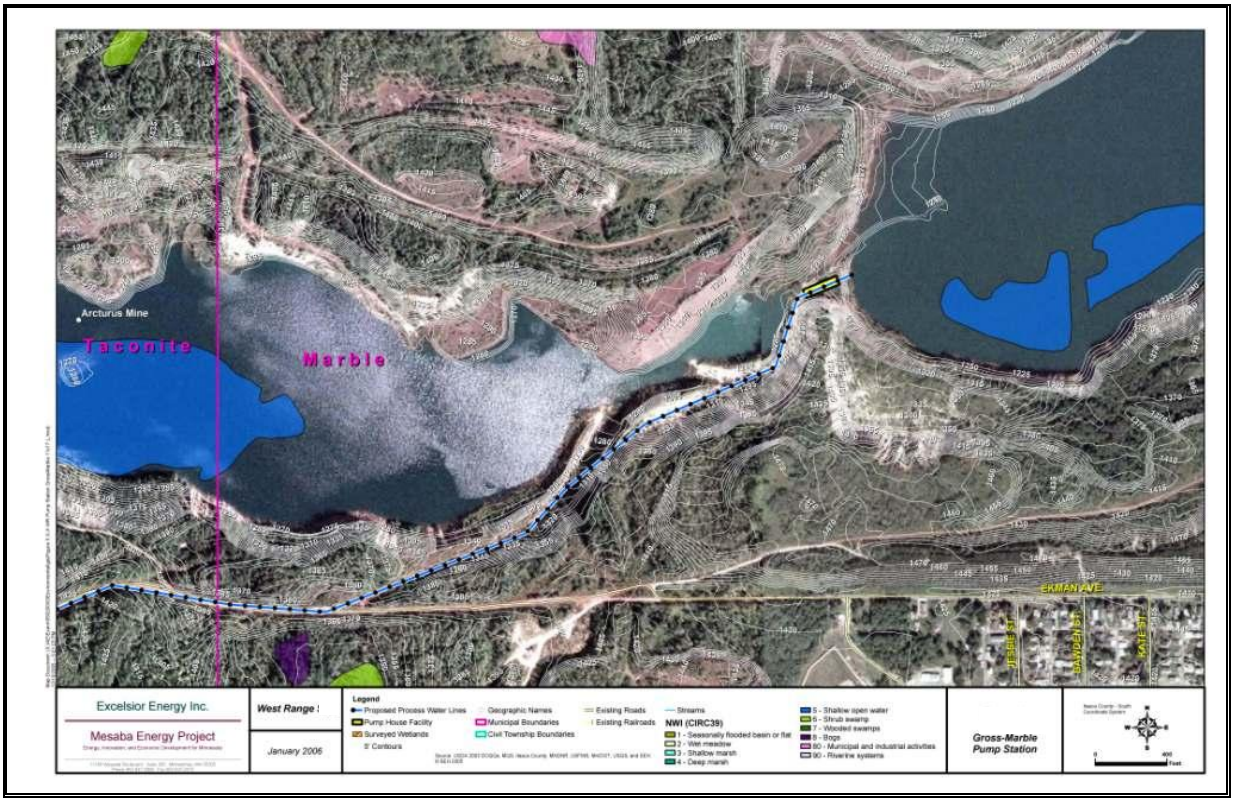


**Figure 3.6-7 Lind Pump Station and Prairie River Intake Structure**

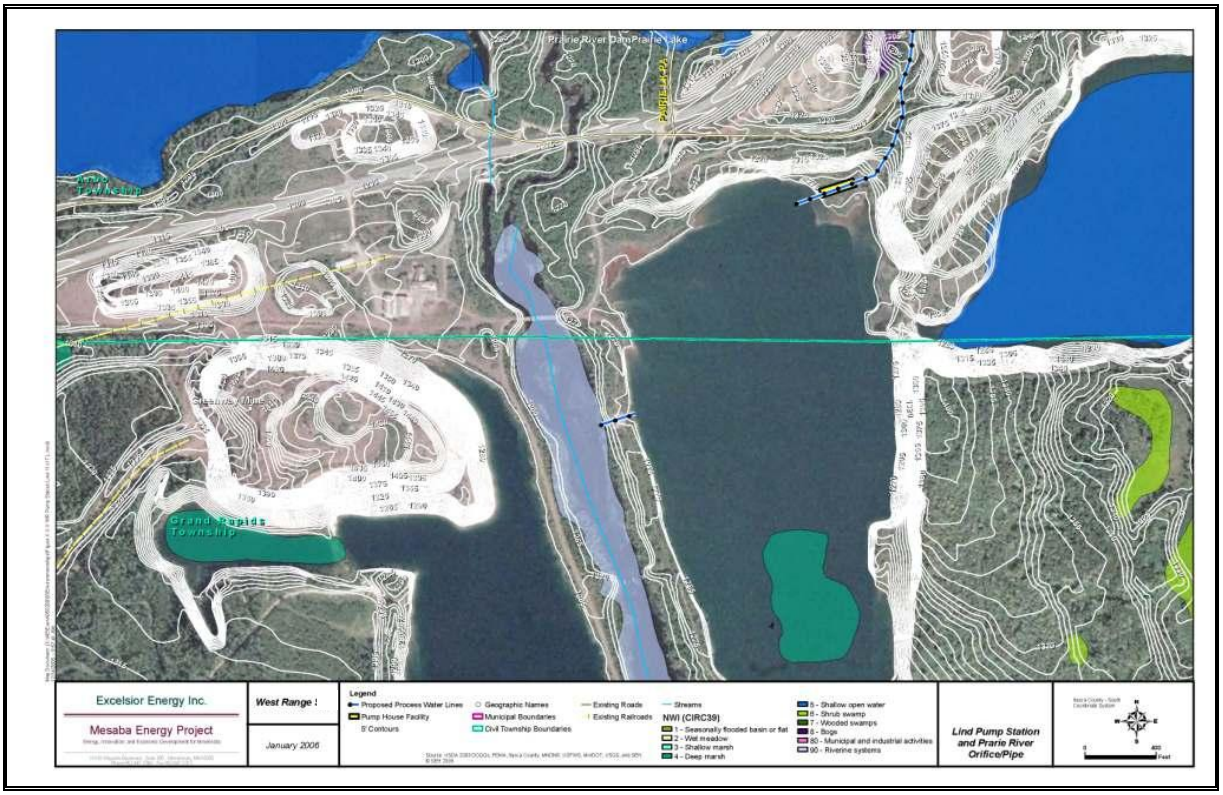
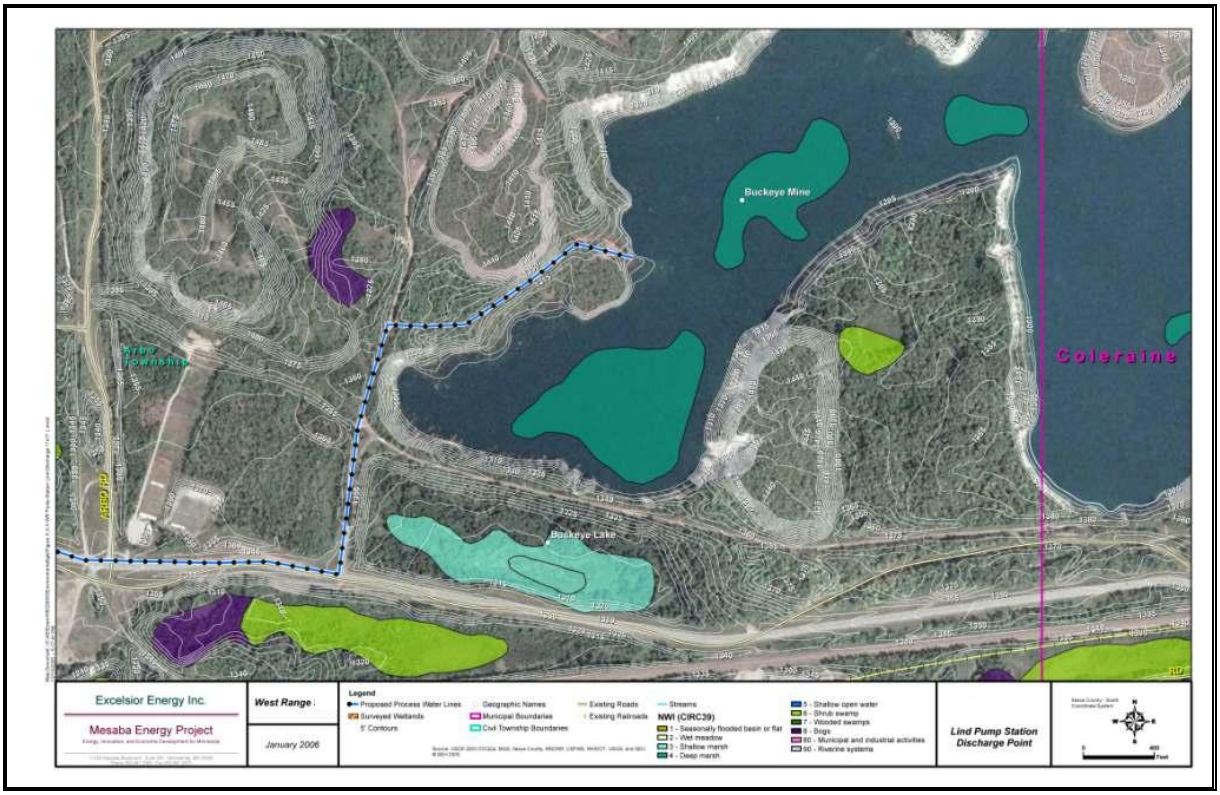



**Figure 3.6-8 Lind Pump Station Discharge Point**



#### 3.6.2.2.5 West Range Site Process Water Discharge Outfalls

The outfalls (water discharge points) associated with the discharge of cooling tower blowdown from the West Range IGCC Power Station are shown in Figure 3.4-14.

The CMP outfall (Outfall 001) will consist of a pipe or bored tunnel outlet about 75 feet below the current water level. The outlet may be installed by angled drilling. The other mine pit outfalls would be constructed similarly to the CMP outfall. The Holman Lake outfall (Outfall 002) consists of a conventional outlet entering the lake just below the surface of the water. The outlet will be installed by extending a peninsula of fill into the lake and excavating down to pipe invert level to install the pipe (the peninsula will allow work to be in near dry conditions). Thereafter, the fill will be removed and the lakeshore and lake bottom restored. Riprap will be installed around the flared end section to prevent scour.

### 3.6.2.3 East Range Process Water Infrastructure

#### 3.6.2.3.1 2WX As Storage Reservoir

At the East Range Site, Mine Pit 2WX would be the reservoir from which the IGCC Power Station would appropriate water to meet its needs. This is similar to the function the CMP serves in the West Range Water Resource Management Plan. A permanent pumping station would be placed within Mine Pit 2WX and would receive input from one or more floating pumping stations strategically placed in the remaining mine pits identified in Table 3.6-5. In several instances, mine pit water may be relayed from one mine pit to another on route to the 2WX pit (for example, water from the Denora Mine Pit would be pumped to Mine Pit 6 and then to Mine Pit 2WX). The pipelines interconnecting the pits with one another and 2WX will be transportable to allow for contingency movements. The connection between Mine Pit 2WX and the IGCC Power Station will be a buried pipeline.

In the event of high inflow rates into Colby Lake during spring run off, or during high precipitation events, water will be pumped from Colby Lake into Mine Pit 2WX. The existing pumping station now serving the CE site from Colby Lake appears to be usable, but may require refurbishment.

#### 3.6.2.3.2 Process Water Supply Pipelines

The Process Water Supply Pipelines required to connect East Range Water Resources to Mine Pit 2WX are identified in Table 3.6-8 below. The pipelines are shown in Figure 2.1-4.

**Table 3.6-8**
**Process Water Supply Pipeline Data and Easement Owners**

| Segment ID No. | Process Water Supply Pipeline Segment No. | | Appropriate Length | | Owners | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | Feet | Miles | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 |
| 1 | 2WX | IGCC | 4500 | 0.85 | CE | Divided Interest | State of MN | St. Louis Co. | | |
| 2 | 2W | 2WX | 2670 | 0.5 | CE | State of Mn | Divided Interest | | | |
| 3 | 2E | 2W | 725 | 0.14 | State of Mn | Great Northern | | | | |
| 4 | 3 | 2E | 2925 | 0.55 | CE | State of Mn | | | | |
| 5 | Knox | 2WX | 865 | 0.16 | RGGS | Divided Interest | State of MN | | | |
| 6 | 6-S | 2WX | 11340 | 2.15 | CE Stephens | Du Nord Land Co. | State of MN | RGGS | King | U of Mn |
| 7 | 9S | 6 | 2662 | 0.5 | Du Nord Land Co. | RGGS | CE Stephens | | | |
| 8 | 9N | 6 | 5027 | 0.95 | CE | | | | | |
| 9 | Colby Lake | 2WX | 8440 | 1.6 | CE | | | | | |

#### 3.6.2.3.3 Pumping Station Capability

Preliminary estimates of required pumping station capabilities are presented in Table 3.6-9. Pump station peak flow capability will provide redundancy to supply daily peak and average needs in the event of a failure of a major pump station.

**Table 3.6-9**
**Pumping Station Capability (Phases I and II)**

| Pump Station Location | Ave Yearly Flow (gpm) | Peak Flow (gpm) |
|---|---|---|
| 2WX | 7400 | 10,000 |
| 2E | 112 | 1,000-2,000 |
| 2W | 898 | 2,000-4,000 |
| 6 | 1795 | 4,000-8,000 |
| 3 | 300 | 1,000-2,000 |
| 9/Denora | 260 | 1,000-2,000 |
| 9S | 180 | 1,000-2,000 |
| Stephens | 390 | 1,000-2,000 |
| Knox | 45 | 1,000-2,000 |

The actual estimated pumping rates for the 2WX Mine Pit pump station are summarized in Table 3.6-10.

**Table 3.6-10**
**2WX Mine Pit Pump Station – Expected Operation**

| | Phase I | Phase I and II |
|---|---|---|
| Yearly Average Flow | 3700 gpm | 7,400 gpm |
| Peak Operating Day (80 °F) | 5,000 gpm | 10,000 gpm |

Mine pits will receive excess water in wet years and provide additional supply to cover shortfalls in dry years. The combined Phase I and Phase II Developments will require approximately 12,000 acre-ft (3,889 million gallons per year) of water each year.

Floating pump stations will be selectively installed on Pits 2E, 2W, 6, 3, 5N, 5S, 9, 9S, Stephens, and Knox. Pumping into Mine Pit 2WX will normally occur on a seasonal basis (no winter pumping). The number of pumps required will be determined pending further development of the East Range Water Management Plan.

#### 3.6.2.3.4 Operating Plan

The Applicant will operate the water resources as an integrated system. The system must provide the following:

- Adequate redundancy to supply daily peak and average needs for Mesaba One and Two
- Storage of water in years of excess rainfall
- Delivery from storage in years of lower rainfall
- Emergency discharge of water from mine pits in cases of extreme rainfall

The following narrative describes how each resource is envisioned to be used.

#### 3.6.2.3.5 Pit Operation Description

##### *3.6.2.3.5A Mine Pit 2WX*

The Mine Pit 2WX will be the foundation of the water supply system and will provide the following functions:

- Hosting the main make up water pump house
- Providing the primary supply of water Mesaba One and Mesaba Two,
- Accepting the selected inputs from Pits 2E, 2W, 6, 3, 5N, 5S, 9, 9S, Stephens, Knox, and dewatering flow from nearby mining operations as they are available.
- Providing water storage within a sufficiently wide operating range of pit elevations to accommodate wet and dry years.

##### *3.6.2.3.5B Pits 2E, 2W, 6, 3, 5N, 5S, 9, 9S, Stephens, and Knox*

Water will be seasonally pumped from these pits to maintain the level in Mine Pit 2WX.

#### 3.6.2.3.6 Implementation Plan

The make up water pump house located on the Mine Pit 2WXwill be constructed during Phase I. The floating pumping stations and the associated piping for Mine Pits 2E, 2W, 6, 3, 5N, 5S, 9, 9S, Stephens, and Knox will also be installed during Phase I. Each year or January 1, the Applicant would provide notice of the pumping plan for the five-year period, beginning two yeas therefrom.

#### 3.6.2.3.7 Pit Storage

The Mine Pits identified in the annual implementation will normally be pumped into Mine Pit 2WX during times of the year when average daily temperatures are above freezing. This will lead to an estimated seasonal level fluctuation of 15-20 feet because water will be drawn out of 2WX in the winter and not normally be replaced until the following summer season. It is anticipated that the level of 2WX will operate between the elevations of 1,435-1,455 feet msl. This is slightly higher than the current pit elevation of 1405 feet msl. The levels of Mine Pits 2E, 2W, 6, 3, 5N, 5S, 9, 9S, Stephens, and Knox will fluctuate as seasonal pumping occurs to control the level in Mine Pit 2WX within the 1,435-1,455 feet msl range.

### 3.6.3 Potable Water System

#### 3.6.3.1 West Range Potable Water System

The closest potable water source to the West Range IGCC Power Station Footprint is the City of Taconite, located about 2.5 miles to the south. Taconite is permitted to use 20 million gallons a year based on its current ground water permit and is currently using 8 million gallons a year. Conservatively assuming that, on average, 1,000 construction workers will be working on-site every day during the 5-day work week, year round and using 30 gallons of potable water per

person, the need would total about 11.8 million gallons per year. This is an overly conservative assumption and shows the City has excess well capacity and can provide the required potable water during and after construction of Mesaba One and Mesaba Two without the need to modify its existing groundwater permit.

To provide water to Mesaba One and Two, an 8" diameter pipeline will be constructed from the existing City system to the Station Footprint as shown in Figure 2.1-3. The referenced pipeline routing was chosen as the preferred route because it is the most direct route from the City to the Station Footprint and installation of the pipe at that location would be more economical because it would be bundled along with pipelines serving other processes. The alternate route considered would extend the pipe east from the City to U.S. Highway 169, run parallel along the west side of 169 to CR 7, parallel the west side of CR 7, and cross under the highway to the Station Footprint. This route is longer, would require more piping, and impacts a number of wet areas that would increase the cost of installation.

A booster station will be needed near the connection point to the City water distribution system in order to provide the required water pressure to the IGCC Power Station. The booster station would pump water from the Taconite system at a variable rate of 20 to 100 gpm. The wide pumping range is required due to the fluctuations in water use that would occur throughout the day at the Power Station.

Due to the possible expansion of the water system to the north, the City of Taconite is considering adding a residential/industrial sub-division on the south side of CR 7, south of the Buffer Land. The City has estimated the potable water requirement for the sub-division to be about 10,000 gpd, with an annual use of 4 million gallons. Presuming that peak construction activities associated with the Phase I and II Development do not significantly overlap with the needs of the new subdivision, the City has the well capacity to supply water to both the proposed sub-division and Mesaba One and Mesaba Two under its current ground water permit. Residential water use fluctuates widely over the course of the day and a 50,000 gallon elevated storage tank would likely be required to provide adequate flow for high use times and to provide storage for fire flow requirements. If the City decides to install the tower, the size of the booster station pumps will need to be increased to accommodate the increased head of pressure. The pumps in the booster station would increase in size to pump water at a constant rate of 200gpm. The booster station will pump water into the tower and the tower will provide water to the sub-division and the IGCC Power Station. Water from the proposed tower could also flow back to the City when the pumps were not running, providing additional water capacity to the City's existing system. Due to the higher elevation of the proposed tower, water pressure would need to be reduced prior to entering the existing system.

The City of Taconite would own and maintain the booster station, pipeline, and tower and the Applicant would enter into an agreement with the City to purchase water. The design of the pipeline, booster station, and tower must meet the requirements of, and be approved by, the Minnesota Department of Health.

Construction of the potable water pipeline and booster station would require a full construction season. To ensure potable water is available at the IGCC Power Station during peak construction activities, construction of the pipeline and booster station must be initiated as soon as the

preconstruction permits for the IGCC Power Station are received and the Notice to Proceed is issued. Until such time as potable water can be obtained from the City of Taconite, potable water requirements could be supplied by tanker truck or other means.

#### 3.6.3.2 East Range Potable Water System

Potable water for the East Range IGCC Power Station will be provided by a connection to the City of Hoyt Lakes' water system. The IGCC Power Station Footprint is located approximately 1.6 miles north of CR 110, the main road through the City of Hoyt Lakes. Hoyt Lakes' potable water is supplied from a 1.5 million gallon per day (MGD) surface water treatment plant located on the north end of the City near Colby Lake. The plant was constructed in 1954 and is considered to be in reasonably good condition. Raw water is supplied to the plant from two intakes located in Colby Lake. The intakes are set at different depths and the quality of the water dictates which intake is used to supply water to the plant. Treated water is pumped to a 1.7 million gallon standpipe located in the center of Hoyt Lakes, and to a 150,000 gallon elevated tower located west of the City in the Laskin Energy Park. A pumping station located at the standpipe can pump water to the elevated tower when the water treatment plant is not operating. The booster station has three pumps and can supply water to the elevated tower at a maximum rate of 1,200 gallons per minute (gpm). The elevated tower supplies water to Laskin Energy Park site and MP through a 12-inch distribution main.

Use of the Hoyt Lakes System would require construction of a 6-inch pipeline approximately 11,000 feet from the East Range IGCC Power Station to the 12-inch water main that serves MP. Figure 2.1-5 shows the preliminary routing of the water main. The proposed routing would require a portion of the water main to cross Colby Lake.

The average water use for the City of Hoyt Lakes is 275,000 gpd with maximum daily demands of 700,000 gpd. MP uses an average of 75,000 gpd or 100 gpm over a 24-hour day. This nominal usage allows for capacity in the existing 12–inch pipeline to supply the potable water requirement of 45,000 gpd to Mesaba One and Mesaba Two during construction and peak 7,500 gpd during normal operations. The proposed 6-inch pipeline will provide the required flow and pressure to Mesaba One and Two without the need for a booster station. The City of Hoyt Lakes treatment plant thus has the capacity to provide the potable water needs of Mesaba One and Mesaba Two.

The City of Hoyt Lakes would own and maintain the pipeline and the Applicant would enter into an agreement with the City to purchase water. The City would be responsible for maintaining the quality of the water and the operating and maintenance costs associated with the treatment equipment and distribution system.

### 3.6.4 Domestic Wastewater System

#### 3.6.4.1 West Range Domestic Wastewater System

To dispose of domestic wastewaters produced by the IGCC Power Station, the Station will be connected to the Coleraine-Bovey-Taconite wastewater collection and treatment system. This will require constructing approximately 10,000 feet of 12-inch gravity sewer pipeline, a pump

station, and 2,400 feet of force main from the Station Footprint, in a southerly direction, to the City of Taconite's main pump station located in the northeast corner of the City.

A construction ROW 50 feet wide and a permanent ROW 30 feet wide will be required, resulting in a total impact of approximately 14 acres and 8 acres, respectively. Figure 2.1-3 shows the route for the domestic wastewater sewer system to connect to the City of Taconite's system.

The 12-inch sewer pipeline, pump station, and force main would have ample capacity to convey the maximum projected wastewater flow of 45,000 gpd during construction (and the 7,500 gpd expected flows for the operational phase of Mesaba One and Two) and the existing Coleraine-Bovey-Taconite waste water treatment facility has capacity available to treat such quantities.

#### 3.6.4.2 East Range Domestic Wastewater System

To dispose of domestic wastewater produced by the IGCC Power Station, the Station will be connected to the City of Hoyt Lakes' wastewater collection and treatment system. This would require constructing approximately 9,500 feet of 12-inch gravity sewer pipeline, a pump station, and about 2,500 feet of 4-inch force main. The wastewater piping will parallel the existing high voltage power line easement along the west side of the proposed property boundary, south to Colby Lake. A pump station will be located on the north side of Colby Lake. The force main would be directionally drilled beneath Colby Lake and then connected to the existing city gravity sewer near MP on the north end of Colby Lake Road. The 12-inch sewer pipe would have ample capacity to convey the estimated wastewater flow of 45,000 gpd during construction. The existing Hoyt Lakes wastewater treatment facility has capacity available to treat the estimated flow from the proposed project.

## 3.7 GENERATING PLANT CONSTRUCTION

Construction work will begin on the IGCC Power Station during early 2008 with work being completed in 2011.

Environmentally sensitive areas at construction sites will be identified in more detail prior to the start of construction. These locations will be clearly flagged and will not be disturbed during construction site preparation activities. Best Management Practices for control of storm water runoff and erosion protection will be installed and implemented during this time period.

Most construction activities are expected to occur during a single shift between the hours of 7 a.m. and 5:30 p.m., Monday through Saturday. Additional hours and/or a second shift may be necessary to make up schedule deficiencies or to complete critical construction activities. During the warm weather season, a second shift may be utilized to complete civil and other work activities. X-ray inspection, weld stress-relieving, and some production welding typically occurs during a second shift. Commissioning activities prior to initial plant startup will occur 24 hours per day.

### 3.7.1 General Construction Plans

The EPC contractor will be responsible for the design, procurement and construction of the facility. The following units within the IGCC Power Station will be constructed by the EPC contractor and subcontractors with work on elements occurring concurrently:

- Gasification and Gas Treating
- Power Block
- Air Separation Unit
- Feed and Product Handling
- Sulfur Recovery and Tail Gas Recycle
- Balance of Plant (Water treatment, Switchyards, Buildings, and Interconnecting Pipe Racks)

Work outside the battery limits of the plant is described in subsequent sections of this document.

Mobile trailers or modular offices will be used for owner, contractor and subcontractor personnel, and craft change and lunch areas. Trailers, parking, and material storage will be located within the planned construction site. Construction site access will be controlled for personnel and vehicles. A security fence will be installed around the construction site and other areas requiring security.

Construction material will be delivered to the site by truck and rail. It is expected that 15-20 semi trucks daily will be required to bring material to the site. The early completion of the rail spur will allow major plant equipment to be delivered to the site via rail shipment. Emergency services will be coordinated with the local fire departments, police departments, paramedics, and hospitals. There are major hospitals located in Grand Rapids, Hibbing and Duluth. A first aid office will be established on site for minor first aid incidents. Trained/certified Health, Safety and Environmental personnel will be continuously on site to respond to and coordinate emergencies.

All temporary facilities will have fire extinguishers, and fire protection will be provided in work areas where welding takes place.

During construction, temporary utilities will be provided for construction offices, craft change trailers, lay down areas and the construction areas. Temporary construction power will be provided by the local utility. On site generators may be used until the temporary power system is completed. Area lighting will be provided and strategically located for safety and security.

Local telecommunication lines will be brought in for telephone and information technology communications.

Temporary sanitation facilities will be provided and cleaned daily, with waste hauled to a local disposal facility.

Water bottles will be provided for drinking water and construction water will be supplied either by pumping and treatment of surface waters in the vicinity, or by connection to the local municipal water system.

Construction water use will be heaviest during the testing phase. Spent hydrotest water will be sampled and tested. If allowed by applicable regulations and permits, spent hydrotest water with suitable chemistry will be routed to the detention basin for disposal to local surface waters. If not suitable for routing to the retention basin, the water will be transported by truck to an appropriately licensed off-site treatment facility. See Section 3.4.4.2 for estimated quantities.

### 3.7.2 Phase II Construction

The preceding construction plan description generally applies to both Phase I and Phase II Developments. The Phase II portion of the IGCC Power Station will be installed in the equipment staging and lay down area utilized for Phase I construction and a new Phase II staging and lay down area will be prepared at the beginning of the Phase II work.

Detailed construction plans and specifications for Phase II will include provisions necessary to protect construction and plant operating personnel and equipment from potential impacts from the adjacent operating Phase I plant and to minimize IGCC operational disruption during Phase II construction.

Phase II construction work is expected to take place from spring 2010 to 2013.

### 3.7.3 West Range Construction

The West Range IGCC Power Station Footprint and Buffer Land is wooded and also contains several wooded and shrub wetlands. A new plant access road will be constructed off CR 7 and will be utilized for construction worker daily access and trucked material deliveries. It is expected that most traffic to the site will utilize Hwy 169 to access CR 7 and the plant entry.

The first activities will consist of constructing access roads, clearing brush and trees, leveling, grading, and dewatering construction sites (where appropriate), and bringing in utilities and undertaking other activities that are required to prepare the site for construction. Construction parking, temporary offices and material storage locations will be prepared at this time. Activities during this time period will involve the use of large earthmoving equipment needed to clear and prepare the site for construction. Trucks will remove harvested timber, unsuitable soils, and debris off site; haul in fill material for plant equipment areas and roadways; and stockpile additional fill material. Blasting will be required to remove subsurface rock formations during excavation and grading activities. Gravel and road base will be utilized for temporary roads, material storage, and parking areas. Temporary office plans and site parking areas for construction associated with the Phase II Development are described in Section 1.9 of the ES. Construction priority will be given to the rail spur so that plant equipment may be received on rail shipments as the Project progresses.

Surficial groundwater levels in soils at the West Range Site are likely to require measures beyond temporary construction dewatering. A permanent dewatering system will likely be needed to ensure long-term water table control at the facility site.

### 3.7.4 East Range Construction

The East Range Site is situated north of the City of Hoyt Lakes in St. Louis County, Minnesota. The proposed location of the plant contains some wooded and shrub swamps. Various site areas have been cleared of trees, and transmission lines exist along the west side of the property. The Duluth, Missabe and Iron Railway Co. (CN subsidiary) track runs along the east and south sides of the property.

Station access roads would be constructed off CR 666. These roads will be utilized for worker daily access and trucked material deliveries. It is expected that most of the construction traffic to the site will be from the west where some of the larger communities in the area of St Louis County are located.

It is also anticipated that large equipment required at the site will be shipped by rail. The Duluth, Missabe and Iron Range Railway Company has interchanges with all major railroads operating in Northern Minnesota and large equipment shipments will generally utilize rail service to the site. Equipment will also be trucked to the site when rail shipment is not feasible.

Similar to the West Range Site, the first site activities will consist of preparing the plot for construction of the facility. This work will involve constructing access roads, clearing brush and trees, dewatering, leveling and grading the site, and bringing in utilities. These activities will involve the use of large earthmoving equipment and potential blasting operations, depending on subsurface conditions. Trucks will haul in fill material for roadways, parking areas, and construction material storage areas. Construction parking, temporary offices, worker change trailers, and material storage locations very similar to those described for the West Range Site will be prepared at this time. Gravel and road base will be utilized for surfacing temporary roads, material storage, and parking areas. Construction priority will be given to the rail spur so that plant equipment may be received on rail shipments as the Project progresses.

Construction support facilities and Phase II construction considerations for the East Range alternate site would be very similar those previously described for the West Range Site.