Mosaic Potash Esterhazy K2
Phase IV TMA Expansion

Environmental Impact Statement
Volume I – Main Document
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1.0 INTRODUCTION

Mosaic Potash Esterhazy K2 (K2) is proposing an expansion to their existing Tailings Management Area (TMA). The proposed expansion involves the construction of a new 60 hectare (148 acre) (Phase IV) brine and flood storage pond. The new brine pond will provide the mine with approximately 1,500,000 m$^3$ of additional brine storage volume and potential subsequent placement of mine tailings. This expansion is referred to as the K2 Phase IV TMA Expansion. Construction of the K2 Phase IV TMA Expansion is proposed for the 2009 construction season and will assist with TMA optimization and increase the overall TMA design life by approximately 12 years. This Environmental Impact Statement provides: a) a project description; b) a description of the physical environment; c) a summary of the environmental impacts of this project; d) a summary of public involvement during the planning process, and; e) a description of the associated benefits of the expansion to Mosaic, local communities, and the Province of Saskatchewan.

This Environmental Impact Statement (EIS) and supporting information consists of three Volumes of material. A list of the documents associated with this EIS is:

Volume I – Main EIS Document

Volume II – Appendices A-H

Volume III – Stratigraphic Drilling, Instrumentation, and Field Investigation in Support of Proposed Tailings Management Area Expansion

1.1 Location

The Mosaic Potash Esterhazy K2 potash mine is located in southeast Saskatchewan, approximately 14 km east of Esterhazy, SK. A site plan showing the mine location and regional features is shown on Figure 1.1. The mine site is situated southwest of Cutarm Creek Valley in the Rural Municipality of Spyhill (RM152). The legal description for the mine site is Sections 27, 28, 32, and 33, Township 19, Range 32, west of the 1st Meridian.
The current TMA is located west of the existing mine site (Figure 1.2). An expanded TMA is required for continued operation of the mine. In order to accomplish this, a 60 hectare brine and flood storage pond (Phase IV) is proposed for the area immediately west of the existing TMA. The proposed expansion will occur on land already owned by Mosaic. The boundaries of this proposed TMA expansion are shown Figure 1.2. This expansion will provide the area to increase the overall TMA design life by approximately 12 years.

1.2 Mining Background

Mosaic is the world’s leading producer of potash and phosphate crop nutrients. Mosaic was founded in 2004 by a merger between Cargill Crop Nutrition and IMC Global. Mosaic operates four potash production facilities in Saskatchewan, one in Carlsbad, New Mexico, and one in Hersey, Michigan. Mosaic also has phosphate and nitrogen fertilizer operations, based in the USA, plus specialty products such as K-Mag® and MicroEssentialsTM S15. Mosaic directly employs approximately 7,400 people, including 511 at the K2 mine.

Construction of the K2 mine began in 1962. Production of potash began in 1967 and has continued to present day. The mine produces approximately 2.2 million metric tonnes of fertilizer product (KCl) annually. The sylvinite deposits mined at the K2 site are approximately 1,000 m below surface and contain potassium chloride (KCl), sodium chloride (NaCl), with some carnallite (MgCl2 KCL 6H20) and trace amounts of silt and clay. The ore is mined with conventional room and pillar techniques using automated mining machines.

Salt tailings, brine, and a small amount of silt and clay (fine tailings) are produced as by-products of the potash mining operation. The tailings and brine are separated from the potash in the mill and deposited in the K2 TMA, where they are stored within containment dykes. Brine is stored in ponds and circulated in the TMA for re-use in the mill. Excess brine is disposed of by deep well injection into the Interlake Formation, approximately 1200 m below ground surface.
Construction of the K2 TMA has been performed in stages. As one stage begins to fill with tailings, another stage is required for brine storage. Construction of Phase I and II of the TMA were completed in 1965 and 1968, respectively. Solid tailings were deposited in Phase I until 1978, at which time tailings began to overflow into Phase II. The Phase III area was added to the TMA in 1981 and 1982. Salt tailings are currently being deposited directly into Phase III, reducing the brine storage capacity at the site.

Brine was discovered entering the underground working at K2 in 1985. The flooding conditions have affected both the K2 and K1 mines (located approximately 10 km northwest of K2) because the underground workings are connected. A continuous pumping system installed in the mine collects and transports the brine to the surface ponds. From the ponds, the brine is disposed of by deep injection. A drilling and grouting program is in place on surface to help control the magnitude of the inflow. Wells are drilled from the surface into the Dawson Bay Formation and injected with calcium chloride. The calcium chloride reacts with minerals in the brines to produce gypsum, which is then deposited in the formation to reduce the permeability.

### 1.3 Statement of Need

The effective storage and reclamation of waste is a critical component of sustainable and economic potash mining operations. Expansion of the current Tailings Management Area is required for continued operations of the mine. On-going tailings deposition within the TMA will result in the need for additional brine storage. The proposed 60 hectare Phase IV Brine Pond will provide the mine with approximately 1,500,000 m$^3$ of additional brine storage volume and potential subsequent placement of salt tailings. At the current production rates, the proposed brine pond will increase the overall TMA design life by approximately 12 years.

The K2 TMA is divided into three primary zones; Phase I, Phase II, and Phase III (Figure 1.3). The storage capacity of the existing K2 TMA is constrained by legislated dyke stability and freeboard requirements, as well as brine management requirements with respect to the K2 Aquifer, located immediately under Phase II (Figure 1.3). Mosaic commissioned MDH Engineered Solutions Corp. (MDH) to complete a number of studies.
to optimize the storage capacity of the existing TMA at the K2 mine site. A summary of their findings are provided in the following sections.

1.3.1 Limitations of Tailings Storage in Phase I

Long-term stability of the K2 tailings pile is a function of pile height, brine level, and excess porewater pressure in the foundation soils beneath the pile. MDH completed slope stability investigations of the K2 tailings pile in 2004, 2005, and 2006. The results of the MDH (2004) and MDH (2006d) investigations indicated that the Phase I pile was in a “high risk” category for failure and measurable movement was occurring in the foundation soils. Measurements of field instrumentation and completion of stability modelling indicate that the existing Phase I salt pile has reached a critical height, and solid tailings can no longer be added to this area of the TMA. Deposition of any additional salt to the Phase I portion of the TMA could result in failure of the tailings pile, putting the integrity of the containment dykes at risk. Pile optimization studies completed by MDH evaluated the effect of pile benching alternatives on the stability of the pile. This study determined that hydraulic conditions within the pile have a significant affect on the pile factor of safety ($F_s$). A bench width of 75 m at the base of the pile and maintaining low brine heights in the pile were recommended to decrease risk of failure (MDH, 2006c). As a result, Phase I is full and is not available for additional storage of tailings, under the present configuration.

A minimum freeboard of 1.0 m is required to allow for storm water storage and containment of waves that develop within the brine ponds. During the summer of 2005, brine levels within the K2 TMA encroached on the allowable dyke freeboard elevation. Brine levels remained high in 2006 and 2007. Construction to increase the height of the Phase I dykes was performed in 2007 and 2008 (MDH, 2008a). The purpose of this construction effort was to increase short-term brine storage requirements.

1.3.2 Limitations of Tailings Storage in Phase II

Stratigraphic and hydrogeological investigations in the vicinity of the K2 mine site have revealed an extensive paleochannel aquifer referred to as the K2 Aquifer. The K2 Aquifer trends regionally from the northwest to the southeast and is present immediately beneath the Phase II Brine Pond (Figure 1.3). As a result, the Phase II Brine Pond provides a source for brine to enter the groundwater flow system and migrate laterally
through the K2 Aquifer System. The current operational permit does not allow additional
discharge of tailings or brine into the Phase II area of the TMA, and requires ongoing
efforts to remove the salt from this area (as operating conditions allow) in order to
decrease the influx of brine into the groundwater system.

During the summer of 2005, Mosaic requested special permission from Saskatchewan
Ministry of Environment (MOE) to allow brine into the Phase II Brine Pond to control high
brine levels in the remainder of the TMA. The K2 Approval to Operate issued by MOE
stated that, the K2 mine site is required to maintain a minimum factor of safety ($Fs$)
of 1.5 for perimeter dykes. Due to the temporary storage of brine within the Phase II Brine
Pond, MDH performed stability analyses of the Phase II containment dyke at the K2
mine site (MDH, 2006b; MDH, 2007b). Modelling was performed to determine the effect
of changing brine elevations on porewater pressure, and therefore the factor of safety
($Fs$), against failure of the dykes. The results of the analysis were utilized to recommend
a maximum brine elevation that satisfies the minimum $Fs$ requirement for containment
dykes ($Fs>1.5$). The results of the modelling indicated that although brine storage in
Phase II was only temporary, it reduced the factor of safety against failure below
legislated values ($Fs<1.5$). The combination of the location of the Phase II pond (located
over the K2 Aquifer), as well as the low factor of safety of the existing dykes, result in the
Phase II pond not being available for long-term storage of brine.

1.3.3 Limitations of tailings storage in Phase III

Without the ability to deposit tailings within Phase I and Phase II of the TMA, Mosaic is
filling the Phase III Brine Pond with solid tailings, continuously reducing available brine
storage volumes. A minimum freeboard of 1.0 m is required for the Phase III dykes.
Dyke modifications to increase the Phase III dyke height by approximately 30 cm (1 ft)
were completed in 2006 (MDH, 2007a). Stability analyses indicate that Phase III is
stable for maximum operating brine levels at this configuration (MDH, 2007b). This
construction effort successfully increased the available freeboard to provide some
additional brine storage within the TMA. However, as deposition of salt tailings into
Phase III continues, additional waste storage outside the existing licensed tailings facility
will be required.
1.3.4 TMA Volume Requirements Summary

Tailings optimization studies on the K2 tailings pile indicate that additional storage outside the licensed TMA is required for continued operations of the K2 mine site. Pile stability analyses indicate that the pile in the Phase I area is at (or beyond) its stable height, therefore no additional storage is available in Phase I. Brine and salt can no longer be added to Phase II because of the presence of the K2 Aquifer system below Phase II, and any temporary storage of brine in Phase II poses a threat to the stability of the dykes in the present configuration. As a result, salt deposition within the TMA is essentially limited to Phase III. Increasing the height of the Phase I and Phase III dykes was performed in 2006, 2007, and 2008. These height increases helped to maintain minimum required freeboard levels of 1.0 m as well as provided some additional brine storage in the short-term. However, continued deposition of tailings within Phase III resulted in the need for additional brine storage. Additional waste produced through the expansion of mining operations will exacerbate the tailings storage volume shortage at the K2 site and expansion of the TMA is required for continued operation of the mine.

The Phase IV pond will allow for an increase in the overall life of the tailings management facility. It has been identified that the addition of the Phase IV area will not allow for management of tailings to the full reserves of the mining operation. Work is underway to establish the tailings storage location and area required to accommodate future mill expansions and long-term operations of the facility. However, the present capacity of the facility is such that Mosaic is unable to wait for completion of the full mine life plan before seeking approval of this interim expansion.

1.4 Project Benefits

Mosaic Potash Esterhazy K2 has provided several decades of employment and substantial taxation revenues for the Province of Saskatchewan. A significant amount of the materials required and employment provided for operations and these expansions has come from Saskatchewan resources.

The Phase IV pond expansion represents extension of the mine life and continued employment for the 511 people directly employed by the K2 mine and for the rural
communities surrounding the mine site. It is estimated that this project will also require approximately 3,000 person-days of construction labour. As a result, local businesses (hotels, restaurants, etc) will benefit from contractors working in the area during the expansion.

Detailed geological investigations conducted as part of the expansion have provided an increased understanding of the hydrogeology of the area surrounding the mine site. These investigations have provided information necessary to design an enhanced brine containment strategy for the mine. This strategy is intended to reduce the long-term environmental impact from the mine.

The K2 Phase IV Brine Pond Expansion will also help optimize salt storage in the TMA. The proposed pond will provide sufficient brine storage area such that the tailings pile can continue to grow using benched construction. The benches, which are currently about 75 m wide, result in a more stable and secure alignment. With a more suitable geometry, the height of the tailings pile may be increased so that more salt tailings may be stored in a given area, reducing the impact of mine operations on the subsurface environment.

The proposed brine pond expansion will provide approximately 12 years of continued mining at the K2 site. The Mosaic Company believes in strengthening the communities which they live and work through both monetary donations and volunteer efforts. These activities will continue following the expansion. Recent examples include a $450,000 donation to Habitat for Humanity to help broaden Habitat’s presence in the province of Saskatchewan. This is the largest single gift ever received by Habitat for Humanity in Saskatchewan. Mosaic also recently made a $2 million commitment to establish the Mosaic Heart Centre at the Regina General Hospital in 2006. In September 2008, Mosaic hosted the “8th Annual Charity Golf Tournament”, which raised $150,000 to purchase equipment for both the local St. Anthony’s Hospital and the Esterhazy Centennial Special Care Home. Mosaic Potash Esterhazy contributed $25,000 to this event. In October 2008, Mosaic agreed to donate a total of $100,000 over the next two years to the Health Foundation’s cardiac equipment campaign. $50,000 will be donated immediately and the remainder will be donated to a matching gift program, where Mosaic will match donations made by others in the community up to an additional $50,000. As well, Mosaic has agreed to donate a total of $37,000 over the next three
years to the Town of Saltcoats to help cover the mortgage costs for their Town Hall Renovations.

1.5 Regulatory Requirements

A project proposal for the K2 Phase IV TMA expansion was submitted to Saskatchewan Ministry of the Environment (MOE) on 11 September 2008. This proposal provided a summary of Mosaic Potash’s plan to construct a 60 hectare brine pond west of the existing TMA. MOE submitted a response letter to Mosaic on 18 November 2008 stating that the Technical Screening process has determined that the project is deemed to be a development and meets the criteria of Section 2 (d) of the Environment Assessment Act and is therefore required to undergo an Environmental Impact Assessment (EIA).

Mosaic has elected to proceed with the EIA prior to receiving Project Specific Guidelines from MOE. Instead, Mosaic has asked MOE to provide review comments. This EIS is submitted in accordance with the requirements of the Saskatchewan Environmental Assessment Act for the review and approval of the project.
2.0 PROJECT DESCRIPTION

2.1 Current Mining Operations

The K2 mine and mill currently produces approximately 2.2 million tonnes of potash product annually. Mining is conducted in the Esterhazy member of the Prairie Evaporates located 945 m below surface. The underground mining operation uses a conventional room and pillar mining technique which consists of a series of equally-spaced rooms interconnected by access tunnels. The ore is mined with a continuous mining machines consisting of rotating heads studded with tungsten carbide steel bits. The continuous miners feed the ore on to an extensible belt conveyor attached to the rear of the miner. The extensible conveyors feed a number of conveyor belts which carry the ore to storage bins. From the storage bins, the ore travels by conveyor to the crushers which reduce the ore into pieces no larger than about six inches in diameter. Following crushing, the ore is transported by conveyor belt to the shaft skips. Each of the two shafts is equipped with a pair of ore-hoisting skips which operate in tandem - one skip moving up to the surface to be unloaded, while the other is on its way down to pick up more ore. The K2 skips currently carry 41.7 metric tonnes (46 tons) and daily capacity is 22,680 metric tonnes (25,000 tons).

The underground workings of the K1 and K2 mine are connected. Four different potash products are produced between the two mills. The four products are classified according to size or grade. These products, in descending order from largest to the smallest, are: Compacted Granular, Natural Crystal Granular, Standard, and White Muriate. Various production processes are utilized in making these products, but all start with crushing the ore into particles less than 9.5 mm. Reduced to this size, the ore separates into individual crystals of either potassium chloride or sodium chloride. The crushed ore is mixed with brine and screened. Particles which are larger than 1.7 mm are diverted to heavy media and particles smaller than 1.7 mm drop through the screen and go on to flotation.

The heavy media process produces Natural Crystal potash. In this process, the particles of potassium chloride and sodium chloride are introduced into a brine solution to which magnetite has been added. The specific gravity of potassium chloride is less than that of sodium chloride, and the magnetite increases the brine’s specific gravity to a point
midway between that of potassium chloride and sodium chloride. In this heavy media solution, and when centrifugal force is applied in a cyclone, the potassium chloride floats to the top of the cyclone and the sodium chloride and most other impurities sink to the bottom of the cyclone. The potassium chloride is then washed to remove the last of the impurities and is de-brined and dried.

The flotation process is used to separate particles smaller than 1.7 mm. This process produces the standard and special standard grades. In the flotation process, the particles are slurried with brine and then pumped through a desliming circuit. Desliming utilizes screens and cyclones to remove insoluble materials and excess brine. After desliming, the ore is conditioned with various chemical reagents which coat the particles of potassium chloride but will not adhere to the particles of sodium chloride. This conditioned ore is slurried in brine and fed into flotation cells. Air is injected into the slurry, forming bubbles which attach themselves to the coated particles of potash and float them to the surface, where they are skimmed off as product and de-brined and dried. The sodium chloride sinks to the bottom of the tank; from there it is drawn off and disposed of as tailings.

Granular grade potash is made by the high-pressure compacting of a mixture of standard and special standard sizes. The compacting of these two products produces a solid slab of potash which is then crushed and screened to size.

Potash particles that are too small to be recovered in original flotation are recovered separately in a scavenger flotation circuit. These scavenger recoveries plus the potassium chloride dust that has accumulated in the various drying, screening, and compacting procedures are used to produce White Muriate. Production is by a crystallization process in which the fines are first dissolved in heated brine. Then three stages of cooling transform the fines into larger and purer crystals of potassium chloride. As in the other production procedures, the final step is debrining and drying.

Once dried and screened to size, all final products are dispatched to a loadout facility or inventory storage bins. The loadout facility is equipped to handle rail cars and trucks.


2.2 Current Mine Tailings Handling and Containment System

Tailings are hydraulically transported (via brine slurry) to the current TMA, which is approximately 280 ha in size. The TMA consists of a salt pile, brine and flood storage ponds, and control structures that limit migration of process brines from the TMA. The K2 TMA is divided into three primary zones; Phase I, Phase II, and Phase III (Figure 1.3). The tailings placement on the pile utilizes spigots and earth moving equipment to form the pile. The K2 mine produces approximately 2.2 million metric tonnes of fertilizer product (KCL) per year, and approximately 515 metric tonnes of tailings are pumped onto the face of the pile per hour (4.5 million metric tonnes per year). The coarse tailings (salt) pile presently covers about 150 ha in total and occupies all off the legislated storage area in Phase I and Phase II, and approximately 12% of Phase III. The tailings pile is up to approximately 75 m high in some locations.

Fine tailings (insolubles) are deposited along with the tailings stream directly onto the salt pile and eventually settle out into the brine and flood storage ponds. At K2, the insoluble clays account for approximately 2% of the solids in the tailings stream.

Brine is created by salt dissolution during processing and a smaller amount is also produced from precipitation falling on the salt tailings pile. Brine is currently stored in Phase III and in the Brine Reclaim Pond. Brine return channels along portions of the toe of the tailings pile in Phase I and Phase II collect brine that discharges from the tailings. The brine, along with fresh water, is used in the potash milling and for hydraulic transport of tailings to the TMA. Excess brine is disposed of by deep well injection into the Interlake Formation utilizing eight injection wells. The current brine injection annual capacity is 12,087,000 m³ (33,115 m³/day). The current annual fresh water usage by the mine and mill is 1,720,155 m³ (compared to a licensed fresh water allotment of 2,344,000 m³ per year).

The tailings and seepage from the tailings is controlled by a combination of dykes, seepage interception ditches, and interception ditch wells, shown in Figure 2.1. Containment for the proposed Phase IV Brine Pond will utilize the same containment measures as the existing ponds.
2.2.1 Salt Tailings Pile

A significant volume of tailings has been deposited at the Mosaic Potash Esterhazy K2 mine site since it began operations in 1967. The tailings pile contained approximately 48,000,000 m$^3$ of tailings at the end of 2007 (based on measured tailings deposition tonnage and a density of 1900 kg/m$^3$). The maximum height of the tailings pile is approximately 75 m. The tailings pile covers an area of approximately 150 ha, and includes TMA Phases I, II, and III (Figure 1.3). The tailings pile consists of a combination of coarse salt tailings and fine tailings (insolubles). The tailings pile contains about 2% insoluble minerals, predominantly silt and clay sized particles.

Coarse and fine salt tailings are currently being slurried and conveyed from the mill to the TMA in large high density polyethylene (HDPE) pipes. The tailings are being deposited directly into Phase III, continually reducing the brine storage capacity at the site. Methods to separate coarse and fine salt tailings, such as the gravity sedimentation method, are not utilized at the K2 mine due to the low percentage of fine tailings. The tailings are deposited onto the face of the tailings pile in Phase III (Figure 2.1). The fine tailings and brine accompanying these tailings is collected and contained in the Phase III Brine Pond. Heavy construction equipment (loaders and scrapers) is used to stack and shape the salt to optimize the storage space.

Fine salt tailings and brine are discharged along with the coarse tailings into Phase III directly through the tailings discharge pipe. These tailings flow in a counter-clockwise direction through the Phase III Brine Pond, along a brine return channel on the southeast side of Phase I, and into the Brine Reclaim Pond at the east corner of Phase I (Figure 2.1). The majority of the fine tailings settle out on the pile, with the remainder settling out as the brine flows through the system. Brine retained in the reclaim pond is pumped back to the mill for re-use or eventual disposal.

Geotechnical instrumentation has been installed at a number of locations in and around the tailings pile. This instrumentation is used to assist in the evaluation of the stability of the tailings pile; and to aid in the secure placement of tailings. Slope inclinometer casings are installed near the edge of the tailings pile to monitor for foundation movements related to instability. Piezometers are used to monitor porewater pressures in the foundation soils near the toe of the tailings pile and within the tailings. Monitoring
of porewater pressures in the tailings pile is critical component of tailings pile management. This is because the elevation of the ‘brine mound’ has a significant impact on slope stability. The location of instruments used for stability monitoring is shown in Figure 2.2. Monitoring of piezometers and slope inclinometers occurs at various times during the year, depending upon where tailings are being placed. New instrumentation is installed as the tailings pile grows. Data collected from the instrumentation is used to calibrate numerical stability assessments. Numerical slope stability assessments are used to determine the factor of safety of the slope. A Risk Management System (RMS) was developed by MDH for the Saskatchewan Potash Producers Association and is used at the K2 site to evaluate storage availability and new instrumentation requirements. The tailings pile is divided into several segments that are each approximately 500 m long. The stability, consequence of failure, and level of uncertainty are evaluated for each segment to determine the Risk associated with the Segment. Based upon application of the RMS, incorporating results from the MDH (2004) and MDH (2006b) slope stability investigations, salt deposition in Phase I has been discontinued.

2.2.2 Fine Tailings

Approximately 0.038 metric tonnes of fine tailings are generated per tonne of product at the K2 mine. As stated above, the fine tailings (clay sized insolubles) are co-mingled with salt tailings in a slurry using recycled brine and spigotted onto the gentle backslope of the tailings pile. A small portion of the fine tailings settle out on the back slope and the remainder flow into the Phase III Brine Pond where they are sub-aqueously deposited. The fine tailings continue to settle out as the brine flows from the Phase III pond into the Brine Reclaim Pond.

2.2.3 Brine Ponds and Flood Storage

The Phase III Brine Pond, located southwest of the tailings pile, is the normal settling area for fine tailings in the decant brine from the tailings disposal operations. Clear brine is recirculated to the mill from the Brine Reclaim Pond, located in Phase I. The Phase I
and III Brine Ponds function at essentially the same elevation and provide the main brine storage for the TMA. The Phase II Brine Pond is normally only used to capture local flows and is kept near empty by pumping to the Phase III Brine Pond. Injection wells and overland pipelines from the K2 mine to the nearby K1 mine, are used to dispose excess brine, and maintain the ponds at least 1.0 m (3.3 ft.) below the top of the dykes. The overland pipelines to K1 also provide reserve disposal capacity. The total current brine and potential precipitation (flood) storage required on the K2 mine site ranges from approximately 1,800,000 m$^3$ to 2,000,000 m$^3$. Of this amount, 800,000 m$^3$ to 1,000,000 m$^3$ is for brine storage and 1,000,000 m$^3$ is for flood storage. The flood storage requirement is based upon a theoretical maximum precipitation event of 300 mm over a 24 hour period.

The area available for brine storage in Phase III is 112 ha and is continually decreasing as a result of salt placement in the area. The pond is approximately 3 m deep (assuming base elevation of 509 masl), and is typically operated close to full capacity. The average brine composition is 18.5% NaCl and 6.9% KCL. These values vary somewhat seasonally.

The K2 tailings pile retains an estimated 330,000 m$^3$ of brine each year during salt deposition (Appendix D - Volume II). A saturated ‘brine mound’ in the tailings pile provides the gradient allowing for a slow release of brine to the surrounding ponds. The ‘brine mound’ height varies with precipitation, mine operations, and spigot locations. The proposed Phase IV Brine Pond will allow the tailings pile to grow using benched construction as well as tailings deposition at isolated areas so that less brine will absorb into the pile. Lower brine mound levels will allow the pile to be constructed to higher elevations, reducing the required storage area.

The current TMA flood storage capacity is maintained by keeping brine levels sufficiently low such that the theoretical maximum precipitation event can be contained within the perimeter dykes. Flood storage capacity is predominately maintained in Phase I and Phase III. If the ponds were near their upper operating limit before a moderately severe storm, the freeboard would be reduced below 1.0 m. Phase II has operated with an average freeboard of approximately 2.5 m since 2000. The excess brine in Phase I and Phase III resulting from the storm can be absorbed by Phase II so the freeboard in the TMA could be re-established quickly after the storm. The freeboard would be reduced
below 1.0 m in all three Phases in an extreme storm event; however, the ponds can absorb the rainstorm without overtopping. The proposed Phase IV Brine Pond will increase the flood storage capacity such that the safe freeboard level (1.0 m) can be maintained during normal operating conditions, and the dykes will not be overtopped in severe storm events.

2.2.4 Brine Injection Wells

Mosaic Potash Esterhazy K2 disposes of surplus brine through eight deep injection wells (Figure 4.3). These wells were installed to a depth of about 1,200 m to 1,400 m below ground. The receiving formation is the Interlake (fractured dolomite) Formation.

Injection wells #1 and #2 were constructed in 1972 and 1981, respectively. The maximum injection rates for these wells are approximately 3,590 m³/day and 3,190 m³/day, respectively. Injection wells #3 and #4 were constructed in 1986 and have a maximum injection rate of about 4,190 m³/day and 3,130 m³/day, respectively. Injection wells #5 through #8 were constructed in 2007 and have a maximum injection rate of about 4,300 m³/day, 4,120 m³/day, 5,390 m³/day, and 5,200 m³/day, respectively. The total current brine injection annual capacity is approximately 12,087,000 m³ (33,115 m³/day).

An inflow was discovered in the K2 mine, in December 1985. The current inflow that can be brought to the surface at K2 is approximately 22,100 m³/day. This inflow water is pumped to the TMA brine ponds and disposed of by the eight injection wells. Aboveground pipelines to the K1 mine site (located approximately 10 km northwest of K2) are used to transport excess brine from the K2 TMA. The rate at which the excess brine is transported to K1 is dependent on the K2 brine pond levels and mill operations. The amount of brine injected is controlled to maintain brine levels in the TMA at as low as acceptable levels (i.e. low enough to provide flood storage, and high enough to provide brine for production requirements). The total brine injection required per year between all eight wells varies with mine inflow, precipitation, evaporation, and potash production. The brine injection volume in 2007 was 6.3 million m³. The average salt concentration of the injected brine is about 25.4%.
2.2.5 Salt and Brine Tailings Control Structures

Salt and brine tailings containment at the K2 TMA utilizes site geology/hydrogeology, containment dykes, perimeter interceptor ditches, and interceptor ditch wells. The alignment of the existing perimeter dykes, ditches, and interception wells are shown on Figure 2.1.

2.2.5.1 Dykes

Dykes are the primary brine and tailings control structures at the K2 mine. The existing tailings areas and brine ponds are surrounded by about 6.4 km of external dykes. The height of the dykes varies from under 2 m to 7 m. Upstream and downstream slopes of the dykes are 3H:1V or greater. The typical minimum top dyke width is 5 m. The dykes are primarily constructed of relatively impervious compacted oxidized Battleford till. A shallow dyke key (<3 m deep) is constructed under the containment dykes to improve dyke stability and limit horizontal brine migration. All ponds are designed to operate with a 1 m freeboard limit. The dykes are inspected daily by mine personnel and an annual visual dyke inspection is conducted by an external professional geotechnical engineering consultant. Mine personnel regularly participate in dyke inspection workshops that provide instruction on inspection practices. Maintenance efforts are also carried out as required to ensure that the long-term performance of the dykes is maintained.

2.2.5.2 Seepage Interception Ditches

A system of deep open ditches were installed around the perimeter of the TMA to collect both surface water runoff from outside the pond as well as groundwater moving laterally away from the brine pond. The ditches are excavated and keyed into the unoxidized glacial till material. Seepage water collected in the ditches is pumped back to the brine pond at several pumping stations. The location of interception ditches and pump stations, along with arrows indicating direction of flow along the ditches is shown on Figure 2.1.
2.3 Proposed Expansion

The proposed K2 Phase IV TMA Expansion will provide the mine with approximately 1,500,000 m³ of additional brine and flood storage capacity. Assuming future placement of salt tailings in the area, this expansion will increase the overall TMA design life by an estimated 12 years. The footprint of the expansion area is approximately 60 hectare and will include the construction of approximately 1,800 m of containment dyke. The conceptual design of the pond layout and key features are presented in Figure 2.3.

The containment system for the proposed Phase IV Brine Pond will utilize the same measures as the existing TMA; perimeter dykes and interceptor ditch, dyke key, and interceptor ditch wells. Further detail of the containment system is presented in Section 4.0. Completion of the proposed TMA expansion would include:

- Site preparation;
- Dyke key construction;
- Construction of approximately 1,800 m of perimeter dykes and interceptor ditch;
- Installation of interceptor ditch wells;
- Installation of perimeter ditch infrastructure; and
- Installation of brine flow control structures to hydraulically connect the Phase IV expansion with the existing TMA.

The only anticipated major pathway for lateral contaminant migration from the proposed facility will be through the oxidized till layer, which will be cut-off with the perimeter ditch. Vertical migration from the facility is significantly limited by the low hydraulic conductivity silt and clay tills and shale that provide natural geologic containment for the facility. As a result, no engineered liner is proposed for the facility. An interceptor ditch will be excavated outside the perimeter dykes and will be keyed into the unoxidized glacial till. The perimeter ditch will be tied into the existing containment ditches. The interceptor ditch will capture shallow lateral brine migration through the Surficial Stratified Deposits and shallow oxidized Saskatoon Group till from the storage area. Dykes will be constructed to the same crest height as the existing TMA dykes (approximately 3 to
A key will be constructed under the footprint of the containment dyke to impede brine flux beneath the dyke. This is the construction methodology that has been utilized for the existing TMA and has proven successful at limiting lateral brine migration through the shallow oxidized till and surficial deposits. The design will also involve an active monitoring and maintenance program to ensure the successful long term operation of the facility.

2.3.1 Project Management and Contacts for the Project Description

The project will be managed by the Mosaic Potash Esterhazy environmental staff. The key contact for the project will be Ms. Jessica Theriault, P.Eng.

Ms. Jessica Theriault, P. Eng.
Environmental Lead
Mosaic Potash Esterhazy
Esterhazy, Saskatchewan S0A 0X0
Phone 306-745-4254
Fax 306-745-2100

2.3.2 Consultants

MDH Engineered Solutions Corp. of Saskatoon, Saskatchewan has been contracted to provide engineering and consulting services related to the design of the Phase IV Brine Pond, monitoring systems, and obtaining environmental approvals for the project.

2.3.3 Schedule

Construction of the K2 Phase IV TMA Expansion is planned for the 2009 construction season. Work related to the final design is currently in progress. A stratigraphic drilling investigation for the proposed pond was completed between April 2008 and November 2008. Heritage, Biology, and Hydrology studies for the expansion area were completed in between June 2008 and November 2008. The tentative schedule for the expansion project is as follows:

- Project Proposal – September 2008;
• TMA Drilling Investigation – April 2008 to November 2008;

• Supplementary Investigations (Biology, Heritage, etc.) – April 2008 to September 2008;

• EIS Groundwater modelling – September 2008 to November 2008;

• EIS Preparation – September 2008 to November 2008;

• EIS submittal – December 2008; and,

• Commencement of Construction of the brine pond – June 2009.

It is anticipated that construction of the Phase IV pond will take approximately 3 to 5 months and will be commissioned by November 2009.
3.0 PHYSICAL ENVIRONMENT

Aspects of the physical environment presented in this report include the geology and groundwater setting, the surface water hydrology, the biological environment, and a heritage resources assessment.

The K2 mine and proposed expansion area are located in the Aspen Parkland Ecoregion of the Prairie Ecozone of Canada. The site is located in the Yorkton Plain Landscape area. The land use in the region is predominately agriculture. Black Chernozemic soils prevail throughout the Aspen Parkland ecoregion. Dark Brown soils occur on prominent south-facing local and regional sloped where more arid conditions result in reduced plant growth. Dark Gray Chernozemic and Dark Gray and Gray Luvisols occur on prominent north-facing slopes and at higher elevations. The area around the K2 mine site is a mixture of deep black, high lime Yorkton soils and black, slightly eroded Oxbow soils on slopes and knolls. Soil is classified as a medium textured loam. The area is slightly affected by soil salinity and classified as moderately stony.

The project site is located in the Assiniboine River Plain physiographic section of the Saskatchewan Plains Region, which is a part of the Great Plains Province of the Interior Plains. Glacial and post-glacial deposits cover this region and the landscape is relatively flat to undulating. Hummocky moraines and till plains dominate the landscape and are intersected with small glaciofluvial channels and flat glaciolacustrine basins. The Qu’Appelle River Valley, located approximately 13 km south of the K2 mine site, is the dominant hydrologic feature in the area. The elevation of the K2 mine site ranges from approximately of 504 metres above sea level (masl) to 514 masl.

3.1 Geology and Hydrogeology of the Existing Mine Site and Phase IV TMA Expansion

3.1.1 Preface

The following sections provide an overview of the geology and hydrogeology of the K2 area based on existing information from over 300 boreholes drilled in the vicinity of the mine site. A summary of the geology and hydrogeology at the proposed Phase IV
The silts and clays of the Upper Cretaceous Pierre Formation Shale (Pierre Shale) form the bedrock subcropping in the K2 area. All material between the bedrock and the ground surface are collectively referred to as drift. The drift is comprised of Quaternary deposits of till, and both intratill and intertill stratified deposits of the Sutherland Group and Saskatoon Group. The contact between the Upper Cretaceous marine shale and the Quaternary drift is an erosional unconformity. The most recent post-glacial
sediments are referred to as the Surficial Stratified Deposits (SSD) and belong to the Saskatoon Group. An overview of each unit is provided in the following section.

3.1.2 Geology

3.1.2.1 Upper Cretaceous Stratigraphy

The Upper Cretaceous Pierre Shale of the Montana Group forms the bedrock surface in the vicinity of the K2 mine site. The Pierre Shale is generally comprised of grey, unoxidized, very soft to hard, non-calcareous, blocky to laminated clays and silts. The softening and brecciation of the Pierre Shale from its overconsolidated intact state provides evidence of strong glacial disturbance at the site.

Beneath the K2 TMA, the top of bedrock surface elevation ranges from approximately 421 masl (beneath the west dyke of Phase II) to approximately 498 masl (beneath the southwest corner of TMA). The bedrock surface topography is characterized by a linear depression trending northwest to southeast beneath the Phase II Brine Pond. This paleochannel forms the most dominant hydrologic feature in the K2. The K2 paleochannel is approximately 350 m wide near the K2 TMA and widens to over 2,000 m northwest of the site where it joins the glacial/preglacial Hatfield Valley near the K1 mine site. A linear bedrock low extends south of the Phase III portion of the TMA. Connection of this tributary to the main portion of the K2 paleochannel south of the TMA has not been confirmed. A bedrock depression also exists beneath the proposed Phase IV expansion site, discussed further in Volume III. The bedrock surface contours in the vicinity of the K2 mine site are provided in Appendix F (Volume III). The contours are based on lithologies encountered during the stratigraphic drilling completed at the site and from the bedrock depths interpreted from ERT data (MDH, 2003).

3.1.2.2 Quaternary Deposits

The successive advance and retreat of continental glaciers deposited the materials that characterize much of the present regional overburden stratigraphy. The accumulations of sediments from the bedrock surface to the ground surface are known collectively as "drift". These deposits range from 12 m to 87 m thick beneath the K2 TMA, and are
approximately 13 m to 16 m thick throughout most of the proposed expansion area. The northwest corner of the proposed Phase IV Brine Pond encroaches upon the estimated limits of the K2 paleochannel. The drift thickness in this area was encountered at depths up to 52 m.

The Quaternary sequences in the vicinity of the K2 mine site can be subdivided into the Saskatoon Group and the Sutherland Group (Figure 6.1 – Volume III). In the vicinity of the K2 mine site, the Floral Formation till (and associated stratified deposits) overlies the bedrock surface to the west and central portions of the mine site. The Sutherland Group deposits are present beneath the Saskatoon Group as valley fill sediments along the K2 Aquifer (and its tributaries), and as thin till deposits (with inter-beds of stratified sediments) overlying the bedrock uplands at some locations. The following sections provide a description of the Quaternary deposits encountered around the perimeter of the proposed Phase IV Brine Pond during the 2008 investigation, as well as from previous investigations in the vicinity of the expansion area. The drift is comprised of glacial and post-glacial deposits of the Saskatoon Group and Sutherland Group.

**Sutherland Group**

The Sutherland Group is defined as the glacial drift that occurs between the Empress Group and the Saskatoon Group (Christiansen, 1968; Christiansen, 1992). No Empress Group sediments have been delineated in the immediate vicinity of the K2 mine site. In ascending order, the Sutherland Group is divided into the Warman Formation, the Dundurn Formation, and the Mennon Formation. No differentiation of the Sutherland Group sediments has been made at the site; however, it is likely the majority of the Sutherland Group belongs to the Dundurn Formation. The Sutherland Group consists of till and both intertill and intratill sands, gravels, silts, and clays. The most significant accumulations of these sediments occur within the bedrock lows of the K2 paleochannel.

In the vicinity of the K2 TMA, the Sutherland Group can be divided into two distinct units: 1) the glaciofluvial sediments deposited on the bedrock surface (lower channel sand and gravel (unofficially referred to as the Lower Channel Aquifer) and upper channel sands and gravels (unofficially referred to as the Upper Channel Aquifer); 2) till deposits with interbedded stratified deposits.
The Lower Channel Aquifer (LCA) can be divided into upper and lower horizons (MDH, 2003). The upper horizon is generally comprised of unoxidized, poorly graded, silty, fine to medium grained sand. The lower horizon is generally comprised of unoxidized, well graded, sandy, rounded to subangular, glacially derived gravels that are of predominantly shield and carbonate lithos. While the LCA is considered to be predominantly Sutherland Group, some of the basal sands and gravels may be preglacial and part of the Empress Group. The top of the LCA was interpreted to occur at an elevation of approximately 440 masl to 450 masl beneath Phase II of the TMA, within the bedrock paleochannel. No soils belonging to the LCA were encountered during along the perimeter of the proposed pond.

The Upper Channel Aquifer (UCA) is a discontinuous sand and gravel unit that directly overlies the LCA in the vicinity of the K2 mine site but are separated by till, silt, and clay deposits northwest and southwest of the site. These deposits are found within the paleochannel beneath the K2 mine site and vary in thickness from 0 to 50 m beneath the Phase II portion of the TMA. The UCA is characterized as interbedded, unoxidized, well graded, fine to coarse-grained sands and gravels. Interbedded silt, clay, and till horizons are also present within this unit. The depth to the top of this unit is variable as a result of post-depositional glacial erosion. The top of the UCA is unconformable to the overlying till and stratified deposits.

Sands and gravels thought to be associated with the UCA were encountered along the northwest boundary of the Phase IV area (M1346-19 and M1346-21). Pumping tests conducted as part of the 2008 site investigation (Section 3.3 – Volume III) suggests that these sands are noncontiguous with those encountered in the K2 paleochannel (K2 Aquifer). The approximate areal limits of the isolated UCA sands are shown in Appendix G (Volume III).

Overlying the UCA are till, glaciofluvial, and glaciolacustrine deposits that form the Sutherland Group till and Unnamed Stratified Deposits. In some locations, interbedded sands, gravels, and silts, with thin clay and/or till layers are encountered between the Sutherland Group till and the Upper Channel Aquifer. These materials are referred to as Unnamed Stratified Deposits (MDH, 2003) and are interpreted to occur beneath a portion of the western dyke of the Phase II cell and south of the Phase III cell. This unit is also interpreted to be present in isolated patches northwest, east, and southeast of the
K2 mine site. The contact between these stratified sequences and the overlying tills is unconformable.

The Sutherland Group till is generally comprised of massive, grey, unoxidized, firm to very stiff, calcareous, sandy silt till with lesser fractions of coarser and finer lithologies. Generally, tills of the Sutherland Group are harder, more massive, have a higher clay content, lower permeability and exhibit a lower electrical resistivity response compared to those of the overlying Saskatoon Group. The tills are usually identified on the basis of carbonate content, their geophysical log-signatures, the presence or absence of shale clasts, and by sub-aerial weathering zones that sometimes occur at the interface between the formations. The contact between the Saskatoon Group and the Sutherland Group is unconformable and often marked by the presence of an intertill sand and gravel deposit at the K2 site.

The Sutherland Group till is not generally present in the vicinity of the bedrock highs (> 490 masl) and does not exist beneath much of the K2 TMA. The Sutherland Group till exists as erosional remnants across the majority of the K2 site. The Sutherland Group till occurs in the bedrock depressions that exist beneath the southwest corner of Phase II, beneath the southeastern and eastern dyke of Phase III, and at the northwest section of the proposed Phase IV site.

Correlation of sediments that infill the paleochannel “thumb” (east of the K2 site, Figure 1.3) to the sediments in the main paleochannel is difficult due to the complex hydrostratigraphy in this area. Accumulations of Sutherland Group till are interpreted to directly overlie the bedrock surface and occur between three sand units in the K2 area. While these aquifers may correspond to the Lower Channel Aquifer, the Upper Channel Aquifer, and the Unnamed Stratified Aquifer, there is limited hydraulic connection between these sand units and the K2 Aquifer. A bedrock high within the K2 paleochannel, combined with a thick sequence of Sutherland Group till found in this area appears to separate these aquifers. Hydraulic response data from pumping tests completed by MDH (2001) confirm this interpretation. As a result, there is limited potential for brine to migrate laterally to the Cutarm Creek in this area.
Saskatoon Group

The Saskatoon Group was first proposed by Christiansen (1968) as the portion of drift lying between the Sutherland Group and the topographic surface. In ascending order, the Saskatoon Group is subdivided into the Floral Formation (Christiansen, 1968), the Battleford Formation, and the Surficial Stratified Deposits. The contact between the Sutherland Group and the Saskatoon Group is unconformable. This contact is often marked by the presence of an intertill sand and gravel deposit (informally referred to as the Floral Formation Aquifer). This aquifer is discontinuous across the study area. In the vicinity of the K2 TMA, the thickness of the Floral Formation Aquifer varies from 0 m to 17 m (west of the southwest corner of the Phase III cell).

The Saskatoon Group is divided into the Floral Formation and the overlying Battleford Formation. The total thickness of the Saskatoon Group ranges from 7.3 m (IWB20) to 40.8 m (MDH01-K2-02) within the vicinity of the K2 area. Saskatoon Group encountered along the perimeter of the proposed pond ranged in thickness from approximately 13 m to 31 m. The Saskatoon Group is comprised of Floral Formation till, Battleford Formation till, and both intratill and intertill sand, silt, and gravel deposits.

The Floral Formation is composed of till with intertill sand and gravel units and is subdivided into an upper and lower unit. The upper and lower units of the Floral Formation till have similar lithologic and geophysical log-signatures. In the proposed Phase IV site, the thickness of the Floral Formation varies from approximately 9 m at the north boundary of the pond (M1346-02) to 30 m at the northwest corner of the pond (M1346-13).

The lower unoxidized portion of the Floral Formation till is comprised primarily of massive, grey to dark grey, calcareous, firm to stiff, sandy, silt till to silty clay till. The upper portion of the Floral Formation till is generally comprised of oxidized, soft to firm, calcareous, sandy silt till to silt till. Prevalent iron (Fe) and manganese (Mn) stained fractures and fracture haloes are typically present within this upper unit as a result of subaerial weathering. Visible fracturing and associated oxide precipitants typically decrease with depth, grading into the massive, unoxidized Floral Formation till. The oxidized portion of the Floral Formation till is usually between 0 m and 4 m thick.
Shale blocks were encountered in three boreholes during the 2008 investigation at depths ranging from approximately 10 m (M1346-17) to 36 m (M1346-19) within the till of the Floral Formation and Sutherland Group in the vicinity of the proposed Phase IV expansion. The presence of blocks of Pierre Shale within the upper Quaternary sequences is indicative of glacial thrusting and is a common occurrence in the area.

A stratified sand unit sometimes separates the Floral Formation and Battleford Formation tills (informally referred to as the Battleford Formation Aquifer (MDH, 2003)). This aquifer is discontinuous in the vicinity of the K2 mine site. The thickness of this unit varies from 0 m to approximately 12 m, and is encountered at depths (where present) less than 4 m below the ground surface. This unit was encountered in one borehole (M1346-28) outside the expansion area in the 2008 Phase IV investigation.

The Battleford Formation is located between the Floral Formation and Surficial Stratified Deposits. Encountered thicknesses along the perimeter of the proposed Phase IV expansion range between 0.8 m (M1346-06) and 4.4 m (M1346-20). The Battleford Formation encountered during the 2008 investigation was generally comprised of brown, oxidized, very soft to stiff, medium plastic, calcareous, sandy silt till with trace gravel and clay portions. Patchy oxide (iron and manganese) staining was prevalent throughout the unit. Occasional mottled iron and manganese stained fractures were encountered at the base of the unit indicating incorporation of the fractured portion of the underlying Floral Formation. Naturally occurring Glauber salts were prevalent within the formation. The stratigraphic contact with the underlying Floral Formation is primarily based on the presence of intact fractures within the Floral Formation, color change, and consistency variation (due to the highly overconsolidated nature of the Floral Formation till compared to that of the Battleford Formation till).

Discontinuous intratill sand and/or sand and gravel layers were found in the several of the 2008 Phase IV boreholes within the Floral Formation. These stratified deposits ranged in thickness from 0.4 m (M1346-09) to 1.8 m (M1346-05). These isolated layers are expected to be insignificant with respect to contaminant migration from the proposed brine pond.

Intertill sand and/or sand and gravel layers (Floral Formation Aquifer) were encountered at the base of the Saskatoon Group tills along portions the of proposed pond perimeter.
as well as in several historic boreholes conducted in the area of the proposed pond and surrounding TMA. Pumping tests conducted as part of the 2008 investigation (Section 3.3 – Volume III) suggests that these intertill sands are not hydraulically connected to those encountered in the K2 paleochannel (K2 Aquifer). Appendix G (Volume III) shows the approximate areal limits of the intertill stratified sediments (sand and gravel, and silt).

The Surficial Stratified Deposits of the Saskatoon Group range in thickness from 0.1 m (M1346-10) to 15.2 m (MDH01-K2-10) in the vicinity of the K2 area. Surficial Stratified Deposits are found over most of the proposed pond area at thicknesses up to 5.03 m (M1346-06). These deposits are mainly derived from weathered or re-worked Battleford Formation till and both water and wind derived, sand, silt and clay deposits. The silt and sand layers encountered during this investigation were typically soft or loose, calcareous, and oxidized. Thin, highly organic Surficial Stratified Deposits or topsoil, are present over most of the site.

3.1.3 Groundwater

3.1.3.1 Hydrostratigraphy

Sand and gravel units deposited by retreating or advancing glaciers are often found at breaks between till units (intertill stratified sediments) or within one till unit (intratill stratified sediments). These intertill/intratill deposits are the path of least resistance for groundwater flow and solute transport and are called aquifers. The following principal aquifers have been identified beneath the K2 mine site, in ascending order:

1. K2 Aquifer System:
   
   (a) Lower Channel Aquifer;
   
   (b) Upper Channel Aquifer; and,
   
   (c) Unnamed Stratified Aquifer;

2. Floral Formation Aquifer (at the Sutherland/Saskatoon Group contact);
3. Battleford Formation Aquifer (at the Floral Formation till/Battleford Formation till contact); and,


Volume III of the EIS contains interpreted areal limit maps, as well as hydraulic head (potentiometric elevation), and Piper Plot diagrams. Note that because of the dense nature of elevated total dissolved solids (TDS) fluids, at high concentrations, density effects are the dominant brine transport mechanism and brine plumes may not flow in the direction of advective groundwater flow (i.e. brine plumes can migrate against the direction of groundwater flow because they are dense). The following discussion provides a summary of the encountered aquifer units in the vicinity of the K2 TMA.

The Lower and Upper Channel Aquifers are unofficially called the K2 Aquifer since they are hydraulically connected in the vicinity of the K2 TMA (MDH, 2003). These aquifers are separated by varying accumulations of clay northwest of the TMA. The Unnamed Stratified Aquifer is not considered to be a significant aquifer in the vicinity of the K2 site and is much more prevalent further north, in the vicinity of the K1 mine site. However, some erosional remnants of the aquifer exist southeast and northwest of the site.

The K2 Aquifer is found mainly in the paleochannel present to the northwest and east of the K2 TMA. Appendix G (Volume III) outlines the approximate extent of the K2 Aquifer in the vicinity of the mine site. There is limited hydraulic connection between the K2 Aquifer System and the Hatfield Valley Aquifer System in the vicinity of the Mosaic K1 mine site. The natural groundwater flow direction is in a south to southeast direction in the K2 Aquifer System, while easterly in the Hatfield Valley Aquifer System (toward Cutarm Creek). The groundwater flow direction within the K2 Aquifer has been altered by mine activity due to pumping from two wells west of the Phase II Brine Pond (MDH00-12 (PW1), IMC #20232; Appendix A). Hydraulic response tests and pumping tests completed in the vicinity of the K2 mine site indicate a range in hydraulic conductivity from $3 \times 10^{-7}$ to $4 \times 10^{-4}$ m/s for the K2 Aquifer. As described in Section 3.1.2.2, sands and gravels thought to be associated with the K2 Aquifer where encountered within the Phase IV area. Testing conducted as part of the 2008 site investigation (Section 3.3 – Volume III) suggests that these sands are noncontiguous
with those encountered in the K2 paleochannel (K2 Aquifer). The approximate areal limits of the isolated K2 Aquifer sediments are shown in Appendix G (Volume III).

The Floral Formation Aquifer (Intertill Stratified Sediments 2 on stratigraphic column, Figure 6.1 - Volume III) is found (where present) at depths ranging between approximately 15 and 20 mbgs and has a typical thickness of less than 10 m. The Floral Formation Aquifer (Sutherland/Saskatoon Group contact) appears to be laterally discontinuous across the site (due to post-depositional erosion), but is interpreted to be interconnected. It is assumed that the groundwater flow direction in this unit is east toward the K2 Aquifer System. Little hydraulic data exists for this sand unit due to its discontinuous nature. The hydraulic conductivity of the Floral Formation Aquifer is estimated to range between $1 \times 10^{-5}$ and $1 \times 10^{-4}$ m/s. The approximate areal limits of the Floral Formation Aquifer are shown in Appendix G (Volume III).

A bedrock low exists south of the Phase III portion of the TMA (Appendix F – Volume III). This low may be a tributary to the main portion of the K2 paleochannel south of the TMA, but this connection has not been confirmed. The Floral Formation Aquifer found within this paleochannel has been informally called the Phase III aquifer (MDH, 2003).

The Battleford Formation Aquifer is found at the contact between the Battleford Formation and the Floral Formation. The unit is discontinuous in the vicinity of the K2 TMA. The assumed hydraulic conductivity range is from $1 \times 10^{-6}$ to $1 \times 10^{-4}$ m/s.

Thin accumulations of surficial sand are often present overlying the Battleford Formation till. These sediments, along with the relatively permeable oxidized till, are considered an important unconfined aquifer with respect to shallow brine migration in the vicinity of the mine site.

Table 3.1 lists the ranges of hydraulic conductivities for the hydrostratigraphic units in the vicinity of the K2 mine site. Much of the tabulated data is site-specific; however, hydraulic properties for the units are generally consistent regionally and provincially over southern Saskatchewan. There is little site-specific information on the hydraulic properties of the Battleford and Floral formation Aquifers, the Unnamed Stratified Aquifer, or the Pierre Shale.
Table 3.1 - Hydraulic conductivities for major hydrostratigraphic units in the vicinity of the K2 mine site (adapted from MDH, 2006a).

<table>
<thead>
<tr>
<th>Hydrostratigraphic Unit</th>
<th>Hydraulic Conductivity</th>
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<tr>
<td></td>
<td>Upper (m/s)</td>
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<tr>
<td>Surficial Stratified Sediments</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>(5.0 \times 10^{-4})</td>
</tr>
<tr>
<td>Silt</td>
<td>(2.0 \times 10^{-4})</td>
</tr>
<tr>
<td>Sand/Silt</td>
<td>(4.1 \times 10^{-6})</td>
</tr>
<tr>
<td>Clay</td>
<td>(1.0 \times 10^{-9})</td>
</tr>
<tr>
<td></td>
<td>(2.5 \times 10^{-6})</td>
</tr>
<tr>
<td>Saskatoon Group Till</td>
<td></td>
</tr>
<tr>
<td>Oxidized</td>
<td>(1.0 \times 10^{-5})</td>
</tr>
<tr>
<td>Unoxidized</td>
<td>(3.2 \times 10^{-6})</td>
</tr>
<tr>
<td></td>
<td>(1.54 \times 10^{-9})</td>
</tr>
<tr>
<td></td>
<td>1.0 \times 10^{-7})</td>
</tr>
<tr>
<td>Saskatoon Group Aquifers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.4 \times 10^{-4})</td>
</tr>
<tr>
<td></td>
<td>(6.0 \times 10^{-3})</td>
</tr>
<tr>
<td>Sutherland Group</td>
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</tr>
<tr>
<td>vertical</td>
<td>(1.54 \times 10^{-8})</td>
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<tr>
<td></td>
<td>(1.0 \times 10^{-10})</td>
</tr>
<tr>
<td>Unnamed Stratified Aquifer</td>
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</tr>
<tr>
<td>K2 Aquifer</td>
<td>(4.0 \times 10^{-4})</td>
</tr>
<tr>
<td>Pierre Shale</td>
<td>(1.0 \times 10^{-10})</td>
</tr>
</tbody>
</table>

Note:
(1) Maathuis and van der Kamp (1994a)**
(2) Domenico and Schwartz (1998)
(3) Maathuis and Schreiner (1982)**
(4) van der Kamp and Maathuis (1985)**
(5) MDH (2003)*
(6) Freeze and Cherry (1979)
(7) Maathuis and van der Kamp (1983)**
(8) Keller et. al. (1988) and Keller et. al. (1989)**
* denotes site-specific data
** data from other sites in Saskatchewan

Figure 7.1 (Volume III) provides the piezometric surface obtained from the piezometers installed in the fractured Floral Formation till as part of the 2008 investigation as well as from selected historic piezometers west of the site. The head data indicates that shallow horizontal groundwater flow in the vicinity of the Phase IV Brine Pond is in an east and southeast direction. Limited data is available in the vicinity of the existing Phase III Brine Pond. In this area, shallow groundwater flow will be controlled by the existing perimeter ditch. Hydraulic response tests indicate a range in hydraulic conductivity from...
5.4x10^{-9} m/s to 1.2x10^{-9} m/s (Table 3.4 - Volume III) for the fractured oxidized till of the Floral Formation. Hydraulic conductivity of the oxidized and unoxidized till from the triaxial permeability tests conducted as part of this investigation are 5.7x10^{-9} m/s and 2.4x10^{-11} m/s, respectively.

3.1.3.2 Groundwater Quality

Groundwater chloride concentrations from piezometers in the vicinity of the K2 TMA area are tested annually by Mosaic (Figure 3.1). Results obtained from piezometers in the general area of the proposed expansion are compiled in Appendix C. In general, chloride concentrations are utilized to determine impact from potash mine sites, as it is one of the primary constituents of the mine waste (i.e. NaCl salt) and is a conservative tracer. Concentrations of <50 mg/L are typical in shallow groundwater as there are limited naturally-occurring chloride sources within the Interior Glaciated Plains. The small concentrations of chloride present in the shallow groundwater occur as a result of incorporation of airborne particulate matter into the groundwater as it infiltrates into the subsurface. The Pierre Shale will likely have much higher background concentrations, and could be in excess of 10,000 mg/L as a result of high total dissolved solids (TDS) connate water (water trapped within the pores spaces during deposition) filling the pore spaces. This is consistent with background chloride data for existing piezometers at the site. A summary of the chloride concentrations from monitoring wells in the vicinity of the proposed expansion area from 1999 to 2007 is provided in Appendix C. The measured range of chloride concentrations within the K2 Aquifer range between 12 mg/L (DP5) and 32,317 mg/L (#9717). Most wells completed at or near the base of the K2 Aquifer in the immediate vicinity of the TMA show elevated and/or increasing chloride values due to impact from mine activity.

Piezometers installed in the 2008 Phase IV investigation were sampled to provide preconstruction chemistry for the shallow sediments and the lower sand and gravel unit. The groundwater chemistry measured from these piezometers is provided in Table 5.2 (Volume III) and in the Piper plot in Figure 7.2 (Volume III). The shallow groundwater chemistry is generally calcium-magnesium-sulphate type water indicative of glacially derived groundwater that has undergone considerable chemical evolution. The measured sulphate concentrations are high and quite variable (2,310 mg/L to 12,100 mg/L) (M1346-16, M1346-17, and M1346-18). The high sulphate concentrations
within the till are a result of oxidization of the pyrite within the tills. The measured range of chloride concentrations within the oxidized till range between 60 mg/L (M1346-18) and 444 mg/L (M1346-16). These concentrations are low; however, without background chemistry available for the site, chloride concentration values excess of 100 mg/L are considered indicative of anthropogenic impact. The measured chloride concentrations are a clear indication of the effectiveness of the existing containment system at the K2 site.

Information gathered elsewhere in the K2 TMA indicates horizontal brine migration takes place through the oxidized till near the surface. This movement is controlled by the use of shallow interception ditches and keyed dyke construction. Electromagnetic (EM) surveys completed in the vicinity of the Phase III Brine Pond indicate that the perimeter ditch is successful in containing the shallow brine migration. As a result, strong impact in the vicinity of the proposed expansion area is not expected.

### 3.2 Hydrology and Surface Water Quality

A regional and local hydrological assessment was conducted for the proposed Phase IV expansion (Appendix D). The regional assessment includes a study and description of the dominant hydrological processes, topography, hydrological features, soils, and land use within and surrounding the proposed expansion area. The study also includes assessment of the impacts of the proposed TMA expansion on the hydrological processes and water features in the area around the proposed and existing TMA locations. A water balance assessment was also conducted to determine the affect of the expansion on the water management at the mine.

The hydrologic features and/or concerns in the study area consist of:

1. The Qu’Appelle River south of the site;

2. Cutarm Creek and Kaposvar Creek that discharge to the Qu’Appelle River south of the site; and,

3. Site runoff around the mine and TMA, and the water balance required for brine and flood storage requirements at the site.
The K2 mine is located in the Yorkton Parkland Ecoregion of the Prairie Ecozone of Canada. The land use in TMA expansion area is predominantly agricultural. Surface water runoff is limited due to the land use characteristics. Gently sloping (2 to 5%) to moderately sloping (5 to 10%) topography characterize the area. The ground elevation in the vicinity of the mine varies from approximately 504 masl to 514 masl.

The Qu’Appelle River, Cutarm Creek, Kaposvar Creek, and Cutarm Creek Reservoir are the main regional hydrologic features in the study area. The K2 mine is located between Cutarm Creek (located 2 km east of the mine), and Kaposvar Creek (located 13 km west of the mine). Cutarm Creek flows in a southeast direction and discharges to the Qu’Appelle River approximately 20 km downstream of K2. The peak flows during normal weather conditions in Cutarm Creek range between approximately 5 to 13 m$^3$/s. Kaposvar Creek is located approximately 13 km west of K2. Kaposvar Creek flows in a southeastern direction adjacent to the town of Esterhazy, SK and discharges into Qu’Appelle River near the town of Tantallon, SK, approximately 13 km south of K2. The peak flows during normal weather conditions in Kaposvar Creek range between approximately 4 to 13 m$^3$/s. Regional hydrologic features are highlighted on Figure 3.2.

Shallow groundwater flow around the mine site occurs through the surficial sediments and oxidized Battleford Formation till. Surface water runoff flows east towards Cutarm Creek. While mine facilities may locally affect groundwater flow directions in the underlying aquifers, the overall regional flow pattern consists of downward hydraulic gradients and a south to southeast direction of groundwater flow. Intermittent streams are present throughout the study area and contribute water primarily to Cutarm Creek and Kaposvar Creek, which discharge to the Qu’Appelle River. Infiltration through the surficial sediments likely contributes recharge into the groundwater flow system in the study area. A detailed discussion of groundwater quality in the Quaternary aquifers is presented in Section 3.1.

The Phase IV expansion area does not intersect any shallow watercourses; therefore, surface water diversion is not required. The proposed Phase IV pond is bordered to the east and south by the existing TMA. Surface runoff north of the proposed site flows away (north) from the proposed pond towards the Phase II interception ditches, and eventually discharges to Cutarm Creek, east of the mine. An approximately 171 hectare drainage area was identified west of the proposed pond using a Digital Elevation Model.
of the study area (Figure A1 - Appendix D). Approximately 105 dam$^3$ runoff volume would be experienced in the local watershed on the west side of the proposed TMA expansion area, for a 1 in 50-year return period rainstorm with a 24 hour duration. A portion of this water would likely flow overland towards the proposed Phase IV pond. It is difficult to estimate the exact amount of runoff water that will reach the perimeter ditches of the proposed pond as a significant amount of runoff is expected to fill local depressions (small ephemeral wetlands) initially. As well, the majority of this runoff will be intersected by the Vallar Road ditch which runs north/south through the drainage basin. Surface runoff collected in this ditch is diverted around the mine site, flowing south towards Highway 22, then east along the south side of the mine, eventually discharging to Cutarm Creek. This has been the observed drainage pattern at the K2 site for moderate to severe rain events. A hydrologic evaluation of this drainage area is presented in Volume II - Appendix D.

Water management at the mine site includes providing sufficient storage capacity for flood storage during a maximum theoretical precipitation event of 300 mm within a 24 hour period. All precipitation that occurs within the TMA areas must be contained safely within the perimeter dyke system as it becomes contaminated with salts. A local water balance assessment was conducted to determine the impact of Phase IV on the mine water management. The assessment included the following scenarios: 1) annual water balance, 2) 100 year rainstorm, and 3) 300 mm design rainstorm. The Phase IV pond is located within a 990 hectare drainage basin (Appendix D – Volume II). It was assumed that all runoff generated from this drainage area will be collected in the perimeter ditches and pumped into the TMA for storage. This is a conservative analysis since it is expected that a significant portion of the runoff will be stored in local depressions and/or diverted around the mine site by existing infrastructure, particularly Vallar Road on the TMA west boundary.

The water balance assessment considers the contribution of precipitation, evaporation, mill brine, mine inflow, injection wells, perimeter ditch and brine pond storage, aquifer dewatering, surface runoff, and overland brine transfer to K1. Details on these parameters are presented in Appendix D.

Results of the annual water balance assessment determined that approximately 1,926 dam$^3$ of brine would have to be transferred to K1 annually to maintain the required
1.0 m freeboard in the brine ponds. This is approximately 13% of the capacity which can be transferred to K1 using the overland pipelines, allowing for 87% reserve capacity for above normal operating conditions. The annual water balance assessment concluded that through a combination of storage in the brine ponds, disposal of brine through injection wells, and transfer of brine to K1, the water balance at the K2 mine can be readily managed with reserve capacity for severe precipitation conditions.

In a moderately severe, 100-year rainstorm (110 mm), the proposed Phase IV pond would receive approximately 69 dam³ of brine and rise approximately 0.20 m. Phase I and Phase III would receive 277 dam³ of brine, causing pond levels to rise by 0.27 m. The Phase II Brine Pond would receive 75 dam³ of brine and would rise 0.38 m. The 100-year rainstorm would raise the level in the perimeter ditches approximately 4 m and would not completely occupy the available storage. The water collected in the perimeter ditches could be transferred to the brine ponds in approximately 81 days where it would add 464 dam³ to the brine volume. The reserve capacity of the K2 injection wells and the surface transfer pipelines to K1 can be used to dispose the estimated 955 dam³ of excess brine in approximately 28 days.

An extreme rainstorm of 300 mm will add approximately 207 dam³ of brine to the proposed Phase IV pond, resulting in a freeboard of approximately 0.53 m. The design storm would add approximately 766 dam³ of brine to the Phase I and Phase III Brine Ponds which would raise the brine level by approximately 0.74 m. The Phase II Brine Pond would receive 210 dam³ of brine and would rise approximately 1.06 m. Phase II is normally operated at least 2.5 m below the dykes, therefore, would have 1.44 m of freeboard. The perimeter ditches will overflow as a result of the design storm, eventually draining towards Cutarm Creek. Once the perimeter ditches are at full storage capacity (650 dam³) after the storm, it would take approximately 100 days to transfer the excess water into the brine ponds. It would take approximately 80 days for the K2 injection wells and the overland pipelines to K1 to dispose the estimated 1,933 dam³ of excess brine.
3.3 Air Quality

Annual air emission tests are conducted for all of the mine refinery dryer stacks. Monitoring is performed by the Saskatchewan Research Council and the results are submitted to the Saskatchewan Ministry of the Environment. In addition, visual observation and monitoring of process parameters aid in ensuring ongoing compliance.

3.4 Terrestrial and Aquatic Resources

3.4.1 Preface

A detailed assessment of the biological resources was completed in spring and summer 2008 at the site of the proposed Phase IV Brine Pond. A report was prepared that provides a detailed summary of the assessment. This report has been included with the EIS and is located in Appendix E (Volume II). The report includes a description of the field assessments, species lists, maps of biophysical features in the study area, and Rare Plant Species Occurrence Forms.

The project is located in the Aspen Parkland Ecoregion of the Prairie Ecozone. The site is located in the Melville Plain Landscape area. This region is now mainly farmland, but is characterized by trembling aspens, oak groves, mixed tall shrubs, and intermittent fescue grasslands in its native state. The Aspen Parkland is considered transitional between the boreal forest to the north and the grasslands to the south. Open stands of aspens and shrubs occur on most sites, generally occupying the moist lower, mid, and north-facing slopes. Grasslands occupy the drier upper and south facing slopes. Bur oak can be found along the Qu’Appelle River Valley and its tributaries. Plant species which are provincially tracked within the RM of Spy Hill (RM 152) are listed in Table 2.1 (Volume II – Appendix E).

The landscape in this region includes many tree-ringed small lakes, ponds, and sloughs that are a major habitat for waterfowl. White tailed deer are the most prevalent wildlife species. Also common are the coyote, snowshoe hare, cottontail, red fox, northern pocket gopher, and Franklin’s ground squirrel. Typical birds include the sharp-tailed...
grouse, black-billed magpie, house wren, least flycatcher, western kingbird, and yellow warbler.

The assessment of the terrestrial biological resources was completed at the site of the proposed project at K2. The assessment included a field survey to identify rare plants, bird, mammal, reptile, and amphibian species of special concern that might be impacted by the proposed project. Environmental impacts were also identified and mitigation measures recommended.

3.4.2 Phase IV Expansion Area

The assessment of biological resources for the proposed Phase IV TMA expansion was conducted in June and July 2008. A survey was also completed in May and July 2007. The 2007 survey covered portions of the Phase IV expansion area (overlapping with the 2008 survey) as well as additional areas north and west of the Phase IV site (Figure A2 - Appendix E). The 2008 survey was required to fill in a small area east of the brine injection well access road that was not covered in the 2007 survey. The boundaries of the 2007 survey extended north and west of the Phase IV area study and consisted of habitats with cropland, wetland, and treed areas. The 2007/2008 overlap study area is shown in Figure A2 (Appendix E) along with the habitat classification of the proposed TMA footprint. Most areas are currently used as cropland.

The protocols recommended by the Saskatchewan Conservation Data Centre (SCDC) for rare flora surveys were followed. Requirements for the survey included advance planning, pre-field preparations, examining air photos, selecting a survey type, and documenting and reporting pertinent information. The survey was conducted by a qualified botanist with a background in plant taxonomy, experience as a field botanist, and knowledge of local flora and regulations regarding rare species in the area. The survey identified all species within the study area (floristic survey).

A total of 151 plant and 27 wildlife species were identified within the proposed TMA expansion. This expansion area is comprised of upland and wetland habitats. The upland areas consist of cropland, hayland, treed, and grassland vegetation types. No patches of native grassland vegetation were observed within the study area. The
wetland areas were characteristic of permanent, temporary, and ephemeral ponds. The wetland complex was composed of drainage ditches, flooded areas, dugouts, marsh, wet meadow, and shrub (willow) areas.

One provincially tracked plant species, narrowleaf cattail (Typha angustifolia), was recorded within the project footprint during the 2008 assessment. Three small groups of narrowleaf cattail were observed in wetlands along the western boundary of the study area and near the brine injection well access road. The status of narrowleaf cattail is in question but it is currently listed as extremely rare (S1?) by SCDC. Its presence in the study area indicates it is at the western edge of its distribution, as it is common in Manitoba. It was observed within deep marsh zones in wetlands next to common cattail (Typha latifolia). There were approximately 300 individuals observed within the study area. No other rare or uncommon species were observed within the study area during the 2008 surveying.

There were sightings of three juvenile turkey vultures (Cathartes aura) within and outside the study area in 2007. The turkey vulture is ranked as an uncommon (S2) species by SCDC and it was observed near a treed area flying over the northern cropland. Its breeding range stretches into southern British Columbia, east-central Alberta to southern Saskatchewan and Manitoba, and western and southern areas of Ontario (Kirk and Mossman, 1998). No turkey vulture nests were observed during the survey, as the most important requirement of a nest site appears to be isolation from human disturbance. Thus the likelihood of the bird nesting within the study area is low to very low. The agricultural and mine site activities provide disturbances that would prevent this species from nesting in the area.

One Eastern cottontail (Sylvilagus floridanus) was observed in a treed area just north of the present study area. This species is provincially ranked as uncommon (S3). The Eastern cottontail prefers edge environments and was observed in an area adjacent to cropland. It is within its typical range in southeast Saskatchewan (Secoy, 2006) also being found in southern Manitoba and Quebec to Central and northwest South America (Mikita, 1999). The species nests in hollows beneath shrubs, logs, or in tall grass.

Mitigation for narrowleaf cattail is not required, as its ecology will allow this species to continue to expand its distribution. The loss of individuals within the study area will not
have a large impact on its distribution within the province as narrow-leaf cattail is known to be very invasive, out-competing native vegetation and forming dense monocultural stands.

Mitigation for the turkey vulture and Eastern cottontail is also not recommended. The turkey vultures do not appear to be nesting in the area as juvenile individuals were observed, a suitable location for a nest site was not found within the footprint, and the species prefers to nest away from disturbance activities. Nesting activities of the Eastern cottontail were also not observed during the spring and summer surveys and the one individual observed did not appear to have a breeding partner. It was observed in habitat that was common among the surrounding landscape allowing for suitable nesting areas outside of the project footprint. Its adaptability for nest selection and ability to rear several young throughout the year will facilitate successful reproduction in areas beyond the project footprint.

The cropland, hayland, treed and grassland habitats have previously been impacted by agricultural uses and/or land clearing; therefore no mitigation is recommended for these habitats.

There are approximately 7.7 hectares of wetlands within the proposed expansion area. Although the wetlands have been impacted by the surrounding agricultural uses, the function of these areas is locally important. The wetlands provide hydrological, water quality and habitat benefits for the inhabitants of the area. Mitigation for the loss of wetland habitat is recommended firstly through avoidance, then through minimization or compensation. If wetland areas cannot be avoided and are lost due to development, the proponent can enhance an existing wetland within the region or create a new wetland area. Wetland enhancement can be accomplished through a conservation easement or through installing structures (i.e. artificial duck nests) that will enhance wildlife habitat. If replacement is necessary, the determination of an appropriate replacement ratio should be negotiated between the proponent and the regulators.

The impacts to the Qu’Appelle River are negligible as the wetlands within the study area have no direct surface connection to the river. The potential for fisheries habitat in wetlands within the study area is also negligible. Reduced water depths, a lack of a
direct connection to fish bearing waters, and barriers to migration have diminished the potential for fisheries habitat.

### 3.5 Heritage Resources

A heritage resource impact assessment (HRIA) of the Phase IV Brine Pond area was completed by Western Heritage Services Inc (WHSI) in May 2008. The detailed report for the heritage resources impact assessment is presented in Volume II - Appendix F, including maps and photographs related to the assessments.

The majority of the proposed TMA expansion area has been impacted by agricultural activities. However, since the area consists of level to undulating native parkland near the Cutarm Creek Valley with seasonal sloughs, WHSI recommended a HRIA be completed prior pond construction. The Cutarm Creek Valley is located approximately 3 km northeast of the development. Water sources of this kind were known to be of importance to the hunting and gathering populations that once occupied the area.

An evaluation of potential heritage resources in the proposed Phase IV area was undertaken to: (1) locate and document the presence of heritage resources within the project area; (2) to determine the content, structure, and integrity of the resource; (3) to establish the significance of the heritage resource; and, (4) to facilitate heritage resource avoidance when necessary.

A detailed assessment of the proposed brine pond area was carried out in May 2008. The HRIA consisted of a conventional pre-impact archaeological survey by way of multiple pedestrian transects supplemented by subsurface shovel testing. The pedestrian survey included inspection of the surface for any cultural features such as stone circles, stone cairns, and historic features. In addition, during the pedestrian survey, all disturbances including rodent burrows, cattle trails, and exposures were examined for the presence of archaeological materials. Shovel tests were judgementally placed in areas deemed habitable such as on the tops and bases of hills, near water sources, and in open native prairie.
The assessment of the proposed TMA expansion area identified two areas deemed of having a high heritage potential. Undisturbed forest areas with adjacent wet areas were present along the northern portion of the site and on the west side of the study area. Twenty-seven shovel tests were conducted in these areas and did not encounter any artifacts or features of archaeological significance.

An abandoned farm residence is located in the southern portion of the expansion area. Inspection of the farm structures suggest that they were constructed recently, possibly in the 1950s. Evidence of recent activity was observed. Modern locks and chains installed on two small sheds as well as an adjacent debris field containing discarded items from possibly the late 20th century were identified. Since the farm residence was deemed to be recent, there is no heritage significance.

As the archaeological survey of the Phase IV Brine Pond area did not result in the identification of any archaeological sites, there are no further concerns with the development of this area.
4.0 POND CONTAINMENT SYSTEM

4.1 Introduction

This section presents the recommended containment system for Mosaic’s proposed Phase IV brine and flood storage pond. The pond is intended to be used for the long-term storage and handling of brine, as well as the potential subsequent placement of mine tailings. This section also presents the results of the coupled contaminant transport/seepage modelling study used to evaluate the containment system. This report titled “Mosaic Potash Esterhazy K2 Phase IV Brine Pond Expansion Contaminant Transport Modelling” is contained in Appendix G. The recommended strategy involves the use of the native soil and favourable site geology/hydrogeology to provide natural containment, as well as barriers such as perimeter dykes, dyke key, and interceptor ditches.

4.2 Background

The proposed Phase IV site is geologically and hydrogeologically favourable for construction of a traditional unlined brine pond. The hydrostratigraphy for the majority of the proposed expansion area consisted of oxidized Saskatoon Group till over low permeability unoxidized Saskatoon Group till and Pierre Shale. Discontinuous aquifers within the Surficial Stratified Deposits and Saskatoon Group have been identified along the northern perimeter during the 2008 investigation. Pump tests demonstrated that these units are not hydraulically connected to the main K2 Aquifer sediments. The only anticipated major pathway for contaminant migration from the proposed facility will be through the oxidized till layer, which will be cut-off with the perimeter ditch. As a result, no engineered liner is proposed for the facility.

4.3 Groundwater Modelling

The hydraulic performance of the proposed containment system was examined in the modelling study. A coupled 1D and 2D seepage/contaminant transport model was developed to predict the impact of the proposed expansion on the underlying
stratigraphic deposits and to evaluate the effectiveness of controls (perimeter dyke and interceptor ditch) to reduce brine migration. The reduction in vertical brine migration with the addition a 1 m thick compacted till liner was also examined.

A coupled SEEP/W-CTRAN/W model (Geoslope, 2004 and 2007) was created to incorporate density-dependent analyses of brine migration. This analysis incorporates advection, dispersion, and density-dependent contaminant flow. The total dissolved solids (TDS) concentration in groundwater was used to represent the potential brine plume in the models. TDS has proven to be an effective parameter for simulation of brine migration because of the quantified relationship between density effects and concentration.

The 2008 Phase IV site investigation (Volume III) indicated that the stratigraphy over the majority of the area of the proposed brine pond consists of oxidized Saskatoon Group till overlying unoxidized Saskatoon Group and Sutherland Group till. Bedrock marine shales underlie the Quaternary stratigraphy across the entire area. However, beneath the northwest corner of the proposed expansion area, a hydraulically isolated deposit of K2 Aquifer sediments was encountered. These sediments were also encountered in historic borehole logs conducted in the Phase IV area (Appendix G – Volume III). As a result, the following cross-sections were selected for modelling.

1. Cross-Section 1:

- 1D cross-section based on MDH borehole M1346-19.
- Modelled to determine potential vertical migration of brine into the isolated K2 Aquifer sediments, with and without the 1 m compacted till liner.

2. Cross-Section 2:

- 2D cross-section based on representative stratigraphy.
- Modelled to determine vertical migration of brine beneath pond, and to determine effectiveness of interceptor ditch in reducing lateral brine migration.
A conservative approach to modelling was utilized for selection of material properties and boundary conditions. Details of the predictive modelling work, including descriptions of the model domain, boundary conditions, material properties, modelling assumptions, and analysis of the predictive modelling are contained in Appendix G.

For the 1D model (Cross-Section 1), a 1 m wide model was simulated. The purpose of the geometry was to allow interpretation of predicted mass flux on a unit scale (per m$^2$) below the proposed pond footprint. For the 2D model (Cross-Section 2), mass flux rates and breakthrough times into and beneath the interceptor ditch were analyzed. Breakthrough times were considered to occur at a TDS concentration of 3500 g/m$^3$, which corresponds to 1% of source concentration. Background concentrations of TDS in all materials were assumed at 1,000 g/m$^3$. A 100-year simulation period was selected as an appropriate model time limit. This is consistent with the time frames established with MOE for decommissioning and reclamation modelling for the potash mining industry. To further illustrate the slow vertical brine migration rates, the 1D model was extended to a 1000-year time frame. The 1D model was used to examine the effectiveness of a 1 m thick compacted till liner. The top 1 m of Cross-Section 1 was assigned material properties representative of compacted till. Vertical plume migration with time, with and without the compacted till liner were estimated.

Results from the modelling has concluded that vertical migration of the predicted brine plume over the isolated K2 Aquifer sediments from the proposed unlined pond occurred at an approximate rate of 30 cm/year through the oxidized till units (Battleford and Floral Formation) and 1.5 cm/year through the unoxidized till units (Floral Formation and Sutherland Group). The isolated K2 Aquifer sediments were not impacted under the simulated conditions over a 1000-year period, with or without the liner. The 1 m thick compacted till liner is expected to reduce the initial vertical flux rate during the first 20 years; however, migration rates into the unoxidized tills are not significantly improved. The modelling has also demonstrated the effectiveness of the interceptor ditch at reducing the shallow downstream migration of the brine plume. Only 0.03% of flux into the ditch was predicted to pass beneath the ditch over the 100-year simulation period.

The proposed Phase IV pond will be used for brine storage and potential subsequent salt tailings storage. The use of a plastic liner to provide additional containment is not practical since it will create a potential slip surface under the salt tailings pile. As well,
the long-term performance of the liner will likely be poor due to the strong possibility of differential settlement, which will result in liner destruction. Therefore, the hydraulic performance of a plastic liner was not examined for this study.

4.4 Conceptual Design

The proposed 60 ha pond will be located west of the existing TMA (Figure 1.2). A schematic cross-section of the proposed Phase IV containment area is shown in Figure 2.3. The containment system will utilize the same measures as the existing TMA, including:

- native soil and site geology/hydrogeology;
- perimeter dykes and interceptor ditch;
- dyke key; and,
- interceptor ditch wells.

The proposed system will provide a high level of containment, as shown by the results of the contaminant transport modelling. Topsoil material in the footprint of the expansion will be stripped and stockpiled. An approximately 5 m deep gravity drainage/interceptor ditch will be excavated outside the perimeter dykes and will be keyed into the unoxidized glacial till. The perimeter ditch will be tied into the existing containment ditches. The interceptor ditch will capture shallow lateral groundwater migration through the Surficial Stratified Deposits and shallow oxidized Saskatoon Group till from the storage area. It will also provide additional storage capacity in the event of a rapid rainfall event or unlikely dyke breach. Piping and wells for the pump-back system will be installed along the ditches.

The fill material required for construction of the containment dyke will be obtained from the interceptor ditch excavation. Fill will be placed in lifts and compacted to set guidelines to ensure adequate strength and containment. Dykes will be constructed to the same crest height as the existing TMA dykes (approximately 3 to 4 m). It is anticipated that the top width and slide slopes would be 5 m and 3H:V1, respectively. The top of the dyke would also have a slight (approximately 2%) grade towards the
slopes. A key will be constructed under the footprint of the containment dyke to impede brine flux beneath the dyke. This is the construction methodology that has been utilized for the existing TMA and has proven successful at limiting lateral brine migration through the shallow oxidized till and surficial deposits. This type of passive barrier will provide a significant reduction in lateral mass flux beneath the dyke. This dyke key would be constructed in the same manner as the containment dyke using material excavated from the key cut.

After completion of the new containment system, the existing Phase II and Phase III dykes will be breached to connect the Phase IV expansion with the remainder of the TMA. If required, gated check structures installed in the existing dykes will control flow of brine to and from the Phase IV expansion. This will involve the construction of cofferdams to hold the brine in the existing TMA and provide a dry working zone.

As part of this expansion, existing infrastructure within the proposed pond limits will have to be relocated and/or permanently removed. A buried SaskPower line (Figure 4.3) which runs through the centre of the site will be decommissioned and removed. A pumphouse located on the existing Phase III northwest dyke, the pipeline transporting brine to injection wells #3 and #4, and associated buried power and water lines will also need to be relocated. This will involve either moving the existing pumphouse or demolishing and constructing a new pumphouse on an external dyke.

4.5 Alternative Waste Management Options

The size of the proposed pond was dependant on operating make-up brine for the mill and space required for a major rainfall event (flood). The new brine pond is required due to inadequate brine storage space in the current TMA for the above brine storage requirements. Approximately 6,300,000 m³ of excess brine (waste) was disposed of by deep well injection in 2007. Approximately 1,400,000 m³ of the excess brine is from the milling operation while the remainder is from the inflow from underground mine workings. This waste is the net result, after evaporation, from recycling of brine back to the mill, precipitation, and release of salt pile brine. The 1,400,000 m³ of excess brine that was injected, represents approximately 396,000 tonnes of salt that was removed from the TMA system in 2007.
The Saskatchewan Potash Producers Association has researched ways to minimize brine handling and disposal over the years. There is little that can be done about the rainfall that directly lands on the TMA. Dry stacking of salt tails using a conveyor belt system to transport tails has been reviewed as an alternative method that would minimize the use of brine. However, due to the anticipated problems that would be encountered in cold conditions, dry stacking has never been used within the Canadian potash industry.

4.5.1 Alternative Containment Options

There are few viable alternate containment options for brine other than a pond. A large quantity of brine needs to be stored for the mine’s use, due in part to the ability of the pile to absorb brine during particular times of the year. This can leave the mill short of brine required for its operations. Theoretically, large tanks could be used to hold brine; however, a large number of super-sized tanks would present other risks, and is therefore not considered practical. Ponds also have a benefit of returning some water to the hydrologic cycle through evaporation.

4.5.2 Alternative Sites

Several alternatives for the TMA expansion location were evaluated with respect to containment optimization, operational efficiency, cost, and constructability. These options included expansion both inside and outside the existing footprint of the K2 TMA.

The Phase II portion of the TMA overlying the K2 Aquifer is currently not usable for brine or salt storage because of brine influx to the K2 Aquifer System and ongoing efforts by Mosaic to remove salt and brine from this area. Studies on the design of a combined slurry wall and dyke to isolate the portion of the Phase II Brine Pond that exists over the K2 Aquifer footprint are ongoing. Numerical modelling completed as part of this exercise has shown that removing the contaminant source from Phase II will provide the greatest decrease in mass flux to the K2 Aquifer. Therefore, using this area for long-term salt storage was not considered to be an option at this time. The portion of Phase II not underlain by the K2 Aquifer would be available for solid tailings storage once the K2
Aquifer footprint is isolated, but will only be available for deposition of solid tailings as a considerable amount of solid tailings already exists in this area. Dyke raises completed (Phase III dykes and Phase I brine channel dykes) and planned (remainder of Phase I dykes) provide short-term relief from the brine storage shortage.

Expansion of the existing TMA is limited by infrastructure to the north, east, and south of the existing facility. The plant site is located on the east side of the TMA. Railroad tracks run along the north and east sides of the TMA, and southern expansion is limited by Highway No. 22 (Figure 4.4) and the grout injection site which is utilized to help control the inflow of water to the mine workings that has been occurring since December of 1985. Deep brine injection wells are located west of Phase II and the K2 Aquifer runs northwest and southeast of the site (Figure 4.4). One alternative location was assessed near the Cutarm Creek Valley (Figure 4.4). This alternative location has several drawbacks due to its location immediately adjacent to the Cutarm Creek Valley. The Cutarm Creek Valley wall in this area is unstable and has evidence of historic slides and measured movement in the vicinity of the Cutarm Creek Dam. Adding a new brine pond (and future potential tailings pile) to this area will only exacerbate instabilities along the valley wall. A valley slope failure into the Cutarm Creek Reservoir could have significant implications to the stability of the Cutarm Creek Dam and environmental damage to the reservoir. This alternative site would also likely require a liner due to its environmental sensitive location and less favourable hydrostratigraphy. The addition of a liner to the facility design would result in multimillion dollar increases from the anticipated costs of a new brine pond in the proposed location. Installation of a tailings storage facility at this location would also require the placement of major production lines beneath the railway.

Construction of the Phase IV Brine Pond to the west allows connection to existing TMA without requiring costly decommissioning of infrastructure or logistical problems associated with either rail lines or a major highway through the TMA. Dyke construction and infrastructure requirements (i.e. pumps, piping, electrical) are minimized by connecting the Phase IV pond to the existing TMA. Expansion west of the existing site also maintains the current counter-clockwise flow of brine through the system, minimizing alterations to the existing TMA. Brine injection wells and a freshwater supply well are located west of Phase II of the TMA (Figure 1.3). Decommissioning these wells will not be required with the proposed pond configuration.
The proposed construction is located on land already owned by Mosaic, limiting disruption to neighbors. Current monitoring programs indicate the K2 Aquifer and the Phase III Aquifer to be most susceptible to brine contamination by flux from the K2 TMA. Stratigraphic investigations completed to date indicate that these aquifers (or tributaries) are not present beneath the proposed expansion site, limiting the potential for additional brine influx from the TMA.

4.6 Future Operations

The proposed Phase IV Brine and Flood Storage Pond will be used for the long-term containment and storage of brine required for milling operations and possible subsequent salt storage. It has been identified that the addition of this area will not allow for management of tailings to the full reserves of the mining operation. A TMA development plan is currently in progress to establish the tailings storage location (including salt tailings placement) and area required for future mill expansions and long-term operations of the facility. However, as stated in Section 1.3, the present capacity of the facility is such that Mosaic is unable to wait for completion of the full mine life plan before seeking approval of this interim expansion.
5.0 SOCIO–ECONOMIC AND LAND USE ISSUES

5.1 Existing Infrastructure

The predominant land use in the area is agricultural (limited crops, cattle grazing and poultry), based from widely spaced farm dwellings. A regional site plan showing land classification and land use is shown in Figure 4.1. Additional drawings showing biophysical features in the proposed expansion locations are included with the biology assessment reports presented in Appendix E. A regional map showing the location of domestic groundwater wells that were found in the Saskatchewan Watershed Authority (SWA) Database in the area is shown in Figure 4.2. The Village of Gerald is the closest population centre and is located approximately 4 km east of the mine site (Figure 1.1). Gerald has a population of less than 200 people. The Village of Yarbo is located approximately 7.5 km northwest of the site and has a population of less than 100 people. The nearest town to the K2 mine site is the Town of Esterhazy (population approximately 2600) located on Highway 22, approximately 14 km west of the mine site.

The proposed Phase IV Brine Pond expansion will occur on land already owned by Mosaic. The area is comprised of a mixture of cropland, grassland, and trees, as described in the biological assessments (Volume II – Appendix E). Portions of the land were identified as wetland. Mitigation for the loss of wetland habitat was recommended. Mitigation measures may include the creation or enhancement of wetlands at other locations within the vicinity of the mine site to help maintain the form and function of the regional landscape.

As part of this expansion, existing infrastructure within the proposed pond limits will have to be relocated and/or permanently removed. A buried SaskPower line (Figure 4.3) which runs through the centre of the site will be decommissioned and removed. A pumphouse located on the existing Phase III northwest dyke, the pipeline transporting brine to injection wells #3 and #4, and associated buried power and water lines will also need to be relocated. This will involve either moving the existing pumphouse or demolishing and constructing a new pumphouse on an external dyke.

The abandoned farm buildings, described in the HRIA (Volume II – Appendix F), located in the southwest corner of the proposed pond area will be demolished. All materials will
be deposed of in the appropriate manner. Salvageable materials will be re-used or recycled and remaining materials discarded in the existing K2 landfill, located at the northeast corner of the TMA. All utilities and services supplying the farm building will be located and decommissioned outside the pond limits.

5.2 Employment/Suppliers

The Phase IV pond expansion represents extension of the mine life and continued employment for the 511 people directly employed by the K2 mine and for the rural communities surrounding the mine site. It is estimated that this project will also require 3,000 person-days of construction labour. As a result, local businesses (hotels, restaurants, etc) will benefit from contractors working in the area during the expansion.

As discussed earlier in the EIS, the mine site actively consults and supports the local community and these activities will continue following the expansion. Recent examples include the “8th Annual Charity Golf Tournament” hosted by Mosaic Potash Esterhazy on 8 September 2008, which raised $150,000 ($25,000 donated by Mosaic directly) to purchase equipment for both the local St. Anthony’s Hospital and the Esterhazy Centennial Special Care Home. As well, Mosaic agreed to donate a total of $100,000 over the next two years to the Health Foundation’s cardiac equipment campaign.
6.0 OCCUPATIONAL HEALTH & SAFETY

Mosaic Potash Esterhazy has a long established priority for programs to manage worker training and occupational health and safety. Each major operational area (K1 Surface, K2 Surface, K1 Mine, K2 Mine, and Water Control) has a full time staff safety specialist and a full time staff training specialist. In addition, each major area has its own Occupational Health Committee which tours the worksite and meets monthly. K1 and K2 sites each have a Health and Safety Technician who is primarily involved in administering regulatory required health monitoring and emergency response.

The facility has a comprehensive orientation and training program to ensure workers are properly trained in their duties. Monthly safety meetings provide opportunities for refresher training. Safety incidents are investigated and corrective actions are taken. Staff and hourly employees participate in regular, documented safety observations to promote safe work practices and to ensure that safe workplace conditions are maintained. Mosaic Potash Esterhazy has a robust underground mine rescue and surface firefighter training program that involves approximately 80 staff and hourly employee volunteers. The facility provides orientations for contractor workers who work on our site, to ensure that they are aware of our site specific safety requirements and emergency procedures.

The facility is subject to a number of inspections conducted by various Provincial and National regulators such as the Canadian Nuclear Safety Commission, Transport Canada, SaskPower, the Boiler and Pressure Vessel Branch, and the Mine Safety Unit of the Saskatchewan Occupational Health Division of Sask Labour. In addition, third party inspections of critical systems are arranged annually by our insurance carriers and brokers, as part of our continuing effort to reduce risk and minimize loss.
7.0 PUBLIC INVOLVEMENT

There have been several forums and opportunities for feedback from the public on the proposed project. Direct notification was provided to the rural municipal government and the land owner local to the mine site. A RM map showing the landowners surrounding the mine site is shown in Figure 6.1. Public notices were provided in local newspapers by Saskatchewan Ministry of Environment and on the internet. Mosaic Potash Esterhazy K2 mine published ads in the local community newspaper regarding an open house at the Town of Esterhazy. Community members and local media attended the open house at the Town of Esterhazy on 25 November 2008.

Supporting information from public consultation activities is provided in Volume II - Appendix H. This information includes copies of advertisements, newspaper articles, and a summary of the feedback and meeting minutes from the various public forums.

7.1 Public Consultation Activities

The Rural Municipality of Spyhill (RM152) council met with Mosaic Potash on 9 October 2008 to discuss the Phase IV expansion. The meeting provided a chance for the RM to voice their comments, concerns, and questions to Mosaic, if any. The project was received favourable by the RM.

A public meeting open house was held on 25 November 2008 from 2 to 7 p.m. in the hall at the Esterhazy Legion. The purpose of the meeting was to inform the public of the proposed expansion and allow them to ask questions, comment, and voice their concerns, if any. Public notices were provided in local newspapers to advertise the open house public meeting to present aspects of the pond expansion. Over 20 attended the meeting. Local people from the community and representatives from Mosaic Potash and MDH were present for the public meeting along with a representative from Saskatchewan Ministry of the Environment. Reporters from two local papers were present to ask questions and document the event. Visitors to the public meeting were asked to fill in questionnaires if they had additional questions, comments, or required additional information. Three questionnaires were returned and are presented in
Appendix H. The visitors to the public meeting generally responded favourably to the proposed project.

7.2 Public Consultation Feedback and Response

The RM of Spyhill met with Mosaic Potash Esterhazy K2 personnel on 9 October 2008 to discuss the proposed expansion and request feedback for any concerns related to the expansion. Six members of council were present at this meeting. A list of attendees is presented with the meeting minutes in Volume II – Appendix H. At the end of the meeting, the Councillors did not have any concerns.

On 25 November 2008, an open house meeting was held at the Esterhazy Legion to inform the public of the proposed expansion. Twenty-seven people attended the open house and the overall response was positive. The main concern or comment was not directly related to the proposed pond expansion, rather the current practise employed by all Saskatchewan potash producers of disposing the salt tailings on surface. A number of residents posed the question “why is the salt not returned underground”. Response to this question was to inform the attendees' that an approved Decommissioning and Reclamation plan exists, which consists of dissolution and injection of salts to dispose of the salt tailing, and that returning salt tailings underground is not practical at this time. The residents were informed that Mosaic participates in research with all Saskatchewan potash producers on tailings management practises through the SPPA.
8.0 CONCEPTUAL TMA DECOMMISSIONING PLAN

8.1 Decommissioning Plan

Mosaic Potash Esterhazy submitted a decommissioning plan in June 2006 to comply with regulatory requirements of s.16 of *The Ministry Industry Environmental Protection Regulations 1996*, with respect to review and resubmission of a decommissioning plan and financial insurance fund once every five years. This report is still under review. The decommissioning report covered the time period up to the year 2075 (anticipated end of production). The proposed expanded TMA will be decommissioned in accordance with the 2006 plan. The essential elements of the 2006 plan are described below.

At the time of mine closure, all buildings not required for decommissioning services will be demolished. All salvageable material will be reused, sold or recycled. The remainder will be abandoned in the mine workings or removed from site. The mine shafts will be plugged and capped. On-site utilities will be isolated, rendered safe, and left in place. Rail lines and roads not required will be removed and the ground contoured to restore natural drainage.

The TMA will remain in-place along with associated brine management structures to enable long-term pile dissolution and chloride leaching from impacted soils. Natural dissolution and injection is the decommissioning method selected by Mosaic Potash Esterhazy to address the generated tailings pile. The tailings pile and ponds will be contained within the existing TMA limits while dissolution occurs. Research on tailings pile dissolutions has shown that the tailings piles are dissolving at a rate of approximately 1 m every 10 to 12 years from natural precipitation falling on the tailings. The existing brine, together with the brine created through precipitation will be disposed in the existing brine injection wells.

Final site decommissioning will take place after the tails pile has been removed. At such time, the brine injection wells will be decommissioned in accordance with applicable legislation. The former TMA and brine ponds will be converted to a water body and its dykes lowered. Drainage and seepage collection ditches will be filled and contoured to conform to existing terrain and drainage patterns. The levelled site will be covered with a lift of uncontaminated till material and topsoil. Finally, monitoring wells surplus to MOE
requirements will be decommissioned. Throughout this period, an extensive monitoring program would be implemented to gauge reclamation progress.

It is anticipated that this decommissioning plan will have no impact on soil or vegetation outside the TMA. Surface water bodies within the immediate area of the TMA could be affected by brine from groundwater movement, but the water quality of these sloughs will meet the standards established for each of these zones. The water quality of sloughs located further from the TMA will not be affected.

The available ore resource was predicted to be approximately 70 years at the time that the decommissioning plan was developed. A hypothetical closure date of 2075 was selected based upon the reasonable estimate of recoverable ore reserves. A review of the plans will be conducted every five years, with an anticipated date for submission of the revised decommissioning plan in July 2011. The review provided for the inclusion of technological change, the incorporation of new data, changes to the operational plan, and the adjustment of production and cost estimates.

To facilitate preparation of the decommissioning plans, MOE, in consultation with the potash industry, developed the document, “Guidelines for Decommissioning and Rehabilitation of Potash Mine Sites, 1994”. On the basis of the established guidelines, a technical working group, chaired by MOE, met on many occasions over the five years prior to the decommissioning plan submission to agree on the industry decommissioning plan approach. Agreement was reached for the Table of Contents used in the decommissioning plan reports. Where practical, generic consultant reports were obtained by the committee for use by all of the mining companies.

Initially, all of the potential tailings disposal options were reviewed and evaluated for proven technical feasibility, economic sustainability, and environmental acceptability. On the basis of this review, the only option that met these criteria was natural dissolution and injection. The Mosaic Potash Esterhazy decommissioning plan was structured around this option.

A state-of-the-art three-dimensional (3D) groundwater flow and contaminant transport model was developed to assess the long-term brine impact to the environment and to the groundwater flow system due to the operation and decommissioning of the Mosaic Potash Esterhazy K1 and K2 mines (MDH, 2003). A significant amount of field work has
been conducted and will continue to collect additional data that may be used to refine the predictions of subsurface brine movement, as required. Contaminant transport modelling was conducted to estimate the downward seepage of brine from the proposed Phase IV Brine Pond (Section 4.3).

8.2 Projected Impacts of the Decommissioning Plan

No impact is expected on the surface environment outside of the proposed operations since the methods for containing, collecting, and injecting runoff and drainage from the mine site and TMA will be maintained during and after the mine operations. This strategy will minimize the chloride footprint while allowing natural flushing to address impacts within the surficial and subsurface soils. It is expected that vegetation will begin to re-establish on most of the mine site soon after decommissioning. Heavily impacted areas will be small and localized and are expected to eventually support salt tolerant vegetation as salt is removed from surface. Salt tolerant vegetation will be followed by other species as the area becomes less saline. The passive containment system utilized at the K2 site (i.e. perimeter dykes and interceptor ditches), supports the long-term decommissioning of the tailings pile.

8.3 Reclamation

Reclamation will occur when the remaining salt in the TMA is reduced to a concentration that salt tolerant vegetation may grow. A thin clay cap will be placed across the TMA followed by a thin lift of topsoil. Dykes will be lowered, flattened, and seeded with salt tolerant vegetation. All ditches will be filled in and contoured to blend with the existing terrain and drainage patterns. With the exception of the TMA, surface drainage will be restored to the state of drainage before the mine was constructed.
9.0 IMPACT ASSESSMENT AND MITIGATION

A significant amount of work has been completed by, and on behalf of Mosaic Potash Esterhazy K2 to study the surface and subsurface environment, develop conceptual containment designs, and create environmental impact mitigation plans. The containment system for the brine pond involves perimeter dykes, and interception ditches, and interception ditch wells. A conceptual representation of the proposed containment system is shown in Figure 2.3. A groundwater brine transport model was developed for the expansion area to predict brine transport from the TMA. Biological and Heritage assessments were conducted for the proposed Phase IV expansion area. The assessments identified mitigation requirements and/or recommendations. A regional hydrologic study and local water balance assessment for the existing TMA and proposed pond was also conducted.

A commitments register is provided at the end of this document that outlines monitoring and mitigation commitments that will be conducted.

9.1 Groundwater

The most significant potential environmental impacts of the proposed Phase IV Brine and Flood Storage Pond will be to the surface and subsurface environment within the footprint of the proposed pond, including shallow groundwater that may become impacted by brine migration below the TMA. However, the design of the containment facility includes measures that will limit potential subsurface migration of brine.

A number of aquifers have been identified beneath the K2 mine site. The 2008 site investigation conducted for the detailed design of the proposed pond encountered an isolated aquifer in the Sutherland Group beneath the proposed expansion area. Testing confirmed that these aquifer sediments are not hydraulically connected to the K2 Aquifer or other aquifers at the K2 site.

Although discontinuous in the study area, aquifers within the Surficial Stratified Deposits and Saskatoon Group have been identified as potential conduits for shallow horizontal brine migration. These units were encountered in several boreholes along the northern
perimeter during the 2008 investigation and were identified in historic borehole logs from within the expansion area. Pumping tests conducted on the aquifer sediments encountered within the Saskatoon Group confirmed that these sediments are not hydraulically connected to the K2 Aquifer sediments. As such, these discontinuous aquifer units are expected to be insignificant with respect to contaminant migration from the proposed pond.

Construction of the proposed brine pond involves removing topsoil over the footprint of the expansion area and keying the dyke through the upper portion of the oxidized Saskatoon Group till (likely only Battleford Formation till). This will significantly reduce brine flow through these materials from the proposed Phase IV Brine Pond.

The oxidized Floral Formation till has been measured to have a hydraulic conductivity as much as two orders of magnitude greater than that of the underlying unoxidized till. Shallow horizontal brine migration will occur through the oxidized Saskatoon Group tills and these units are believed (based on available information) to be the primary medium for potential brine transport from the proposed site. The proposed dyke key will reduce the flow through the upper portions of this horizon and the perimeter ditch will be installed through the entire oxidized portions of the Saskatoon Group till, effectively containing shallow horizontal brine movement.

The low hydraulic conductivity unoxidized Saskatoon Group till the Pierre Shale bedrock will significantly limit the rate of vertical brine migration. Testing on existing piezometers and core samples acquired for the K2 site indicate the hydraulic conductivity of the unoxidized portion of the Floral Formation till is less than 1x10^{-9} m/s, similar to that of a compacted till liner. There is no known receptor for vertical brine migration in the expansion area.

Contaminant transport modelling was conducted for the proposed pond. The analyses predicted that, over the 1000-year simulation period, the isolated K2 Aquifer sediments encountered at the northwest corner of the site would not be impacted. The effectiveness of the perimeter interception ditch at reducing shallow downstream brine migration was also demonstrated.

No significant impact to groundwater quality beyond the mine property by lateral migration of brine impacted groundwater is anticipated due to the proposed containment...
system. The K2 mine currently monitors water levels and routine chemistry in more than 50 piezometers as part of the annual environmental monitoring program. Regular environmental monitoring also includes EM31 and EM34 conductivity surveys around the plant site and the TMA, as well as EM39 profiles in 19 locations around the site. This program will be expanded to monitor the containment system performance of the proposed expansion. Additional piezometers will be installed around the perimeter of the Phase IV pond to monitor porewater pressure and groundwater quality. Further discussions on the groundwater monitoring system are presented in Section 10.2. Should the existing and additional piezometers, completed in the K2 Aquifer north of the site, indicate that the containment system is performing inadequately and the intertill aquifer of the Saskatoon Group, or the isolated K2 Aquifer sediments are hydraulically connected to the K2 Aquifer, Mosaic has committed to the installation of a slurry wall or alternate containment system along a portion of the north boundary of the expansion area. Major variances from the hydrostratigraphic interpretation provided in this document is unlikely due to the high density of information acquired for the proposed site.

9.2 Surface Water

No impact of surface water outside of the proposed TMA boundaries is anticipated as part of the K2 Phase IV TMA Expansion. The proposed expansion does not intersect any watercourses; therefore surface diversion is not expected to be required.

The proposed project will have no impact on the flow or water quality of the Cutarm Creek, Qu’Appelle River, or other creeks and rivers in the area. Potential impacts to surface water quality by migration of brine through groundwater aquifers will be controlled by engineered containment systems (perimeter dykes and interception ditches). Local drainage patterns will be maintained through ditches around the proposed facility.

The containment dykes will be designed and constructed in accordance with suitable guidelines for stability and freeboard, to minimize the risk of dyke failure or brine overtopping.
9.3 Biology Resources

Clearing of the planning footprint will result in the loss of a number of plant species. The majority of the species are considered common, and therefore the significance of the impact is considered low and local in extent.

One provincially tracked plant species, narrowleaf cattail (Typha angustifolia), was recorded within the project footprint during the 2008 assessment. Mitigation for narrowleaf cattail is not required, as its ecology will allow this species to continue to expand its distribution. The loss of individuals within the study area will not have a large impact on its distribution within the province as narrowleaf cattail is known to be very invasive, out-competing native vegetation and forming dense monocultural stands (USDA, 2006).

Three juvenile turkey vultures (ranked as an uncommon (S2) species) and one Eastern cottontail (ranked as an uncommon (S3) species) were recorded within the proposed expansion area. Mitigation for the turkey vulture and Eastern cottontail is not recommended. The turkey vulture does not appear to be nesting in the area as juvenile individuals were observed, a suitable location for a nest site was not found within the footprint, and the species prefers to nest away from disturbance activities. Nesting activities of the Eastern cottontail were not observed during the spring and summer surveys and the one individual observed did not appear to have a breeding partner. It was observed in habitat that was common among the surrounding landscape allowing for suitable nesting areas outside of the project footprint.

Mitigation for the loss of wetland habitat is recommended. Mitigation measures may include the creation or enhancement of a wetland at another location within the region to help maintain the form and function of the landscape. If replacement is necessary, the determination of an appropriate replacement ratio should be negotiated between the proponent and the regulators.
9.4 Heritage Resources

The heritage assessment report for the expansion area is presented in Volume II – Appendix F. No heritage resources were identified at the Phase IV site and there are no further concerns with the development of this area.

9.5 Subsidence from Mining Activities

Monitoring of surface subsidence at the Mosaic Potash Esterhazy mining operations is conducted in compliance with the 2003 Saskatchewan Mines Regulations. Suitable surveys are performed every two years in active and inactive areas of the mine to determine surface subsidence induced by the mining, if any. Subsidence monitoring at the Esterhazy operations started in 1968. Twenty-five conventional levelling surveys and two airborne Light Distance and Ranging (LiDAR) surveys have been conducted to date. From 1968 to 2004, a total of 811 surface benchmarks were surveyed to first order standards (+/- 4 mm/km) every two years using conventional levelling methods. Since 2006, this method has been replaced with LiDAR. Replacement benchmarks as well as new benchmarks are installed as required along road allowances for the correlation/calibration of field data with predictive modelling data. The effects of subsidence can be observed up to 1300 m from the edge of mining with a zero influence at approximately 1730 m. Surface subsidence can be detected 1 to 2 years after mining at movement rates that decrease exponentially with time depending on extraction rate, ore mineralogy, and age of mine workings. Mining under the existing K2 TMA and the Phase IV TMA expansion area was started in the late 1970’s and completed by the late 1980’s. No further mining is planned for this area. Total subsidence adjacent to the TMA ranges from 0.7 to 0.85 m over a 1200 m distance at subsidence rates of less than 0.01 m per year. To date, there have been no reports of structural damage or remedial measures taken on surface (dykes, pipelines, buried power lines, fiber optic communication lines, and water wells) or underground due to the effects of subsidence.
9.6 Sustainability of Deep Well Injection Facilities

The Potash Industry in Saskatchewan uses deep well injection as a disposal strategy for excess brine at the sites. Mosaic Potash Esterhazy K2 currently has eight injection wells (Figure 4.3). Aboveground pipelines to K1 are used to transport excess brine from the K2 TMA. The total injection and overland pipeline capacity must be capable of injecting/transferring excess brine stored in the TMA following a theoretical maximum precipitation event of 300 mm in a 24 hour period.

9.7 Noise

Excluding the brine pond construction period, there will not be an increase in noise at the mine site. The Phase IV expansion will occur adjacent to the existing TMA, on land already owned by Mosaic. The brine pond will not further encroach upon the neighbouring residence, located west of the Phase III brine pond. The existing mine site is located in a rural area of Saskatchewan and no noise complaints have been received by Mosaic from neighbours of the mine.

The majority of noise emissions will be from operation of heavy equipment during construction. Heavy equipment will be outfitted with mufflers to dampen noise pollution. The project will be completed in a rural setting. Local residents are expected to experience only short-term noise disturbance from construction activities. Adjacent landowners have also been advised regarding the expansion activities. Construction noise is not expected to significantly add to the existing ambient noise levels from equipment used for agricultural activities, as well as from machinery, equipment, and infrastructure from the K2 mine site.

Given the existing disturbance within the project area from agricultural and industrial activities (e.g., brush clearing, modified pasture, and the Mosaic mine site including rail lines, roads, and other support infrastructures), wildlife is expected to have become habituated, or at least tolerate to increased noise and activity levels. Construction for the brine pond is scheduled to start before the breeding periods for sensitive species, such that they will naturally find alternate breeding areas. If there are conflicts with
individual species during the construction period, consultation with Saskatchewan Ministry of Environment will occur to develop an appropriate mitigation plan.

9.8 Regional/Cumulative Assessment

The cumulative effects of the proposed project are positive when considering the benefits of the Phase IV Brine Pond Expansion. The existing milling process, production rates, and transportation and containment of the tailings will be unaltered.

The Phase IV expansion is required for continued operation of the K2 mine which employees 511 people. The expansion of the TMA provides benefits associated with optimizing the storage of coarse tailings. Expansion of the tailings pile will result in a more favourable geometry that will make benching possible, thereby increasing the storage volume per unit of TMA area.
10.0 ENVIRONMENTAL MONITORING AND PLANNING

10.1 Introduction

Mosaic’s environmental monitoring programs are conducted to comply with the requirements of Saskatchewan’s *The Environmental Management and Protection Act and Regulations* and *The Clean Air Act and Regulations*. Results of environmental monitoring are reported annually to the Saskatchewan Ministry of the Environment in accordance with the mine approval to operate. Selected environmental data is stored in an electronic format at the mine, and all data is available to Saskatchewan Ministry of the Environment on request.

A commitments register is provided at the end of this document that outlines monitoring and mitigation commitments that will be conducted.

10.2 Surface and Groundwater Monitoring

There are 53 monitoring instruments located in the vicinity of the K2 mine site (Figure 3.1) that are licensed by MOE. Monitoring of these instruments includes annual acquisition of water level measurements and groundwater chemistry (for standpipe piezometers, productions wells, and domestic wells) or monitoring of potentiometric elevations (for pneumatic piezometers). The acquired groundwater samples are taken to either the Saskatchewan Research Council (SRC) or the K2 Analytical Lab for determination of electrical conductivity, pH, and concentrations of Cl, Na, K, Ca, Mg, SO4, HCO3, and TDS. Surface water quality near the K2 mine site is monitored at three separate locations along Cutarm Creek east of the mine site (Figure 3.2). Samples are taken on a weekly or monthly basis (year round), as per the MOE Approval to Operate Licenses. Results are submitted to MOE in Mosaic’s annual environmental report. All field work associated with the data acquisition is performed internally by Mosaic personnel based on schedules required by MOE.

No existing surface sample locations will change and no new sampling locations will be added as a result of the proposed facilities. No other changes to the frequency or type of analyses performed as part of the surface water monitoring program are planned.
Several monitoring wells inside the expansion area will require decommissioning. These wells will be decommissioned using a cement-bentonite based grout mixture developed by the Saskatchewan Potash Producers Association (SPPA) for use in brine environments. Properly decommissioning these piezometers with grout is important to limit the environmental liability associated with a well that is typically installed into aquifers at the site. Proper record keeping will be maintained to document the decommissioning of these monitoring wells. Although some monitoring wells will require decommissioning, seven new monitoring wells were installed as part of the geological investigation for the proposed Phase IV pond and others will be installed as part of the expansion construction. Details of the monitoring system will be confirmed during the final design of the expansion. The sampling frequency and type of chemical analysis will be the same as for the existing monitoring wells. Note that some of the Phase IV piezometers may have to be decommissioned, if after the final design is complete, they are located directly in the pond area.

10.3 Subsidence

Monitoring of surface subsidence at the Mosaic Potash Esterhazy mining operations is conducted in compliance with the 2003 Saskatchewan Mines Regulations. Suitable surveys are performed every two years in active and inactive areas of the mine.

10.4 Tailings Containment Dykes

The containment dykes at the mine are inspected daily to check for failures or seepages. Mosaic Potash personnel participate in Dyke Inspection Workshops that teach the principals of dyke inspection and what potential indicators of instability to watch for during inspections. A more detailed inspection is conducted on a monthly basis to visually assess geometry and alignment, and look for slumping, cracking, erosion, or seepage. Monthly observations are recorded and filed, with any required work being completed as soon as possible. An annual visual inspection of the dykes is conducted by an independent geotechnical engineer and the written report provided to Saskatchewan Ministry of the Environment.
The dykes of the proposed TMA Expansion will be designed to meet the requirements outlined in the Canadian Dam Safety Guidelines and as outlined by the Saskatchewan Ministry of Environment. The new dykes will be inspected as part of the existing ongoing monitoring program. Maintenance is routinely conducted on the dykes, as required.

10.5 Tailings Pile Stability Monitoring

Mosaic Potash Esterhazy K2 conducts tailings pile stability monitoring a minimum of 2 times per year (typically 4 times a year). Monitoring consists of collecting data at slope inclinometer casings and piezometers installed at various locations within, and around the perimeter of the existing TMA (Figure 2.2). Results of the monitoring are reviewed by a professional geotechnical engineer and monitoring data is provided to Mosaic personnel in a timely manner following monitoring events. Monitoring results are compared to numerical stability analysis assessments that have been conducted specifically for the K2 tailings pile.

Mosaic Potash Esterhazy K2 is also the location of one of Saskatchewan’s first automated remote data acquisition and data management systems for tailings pile stability monitoring. Three in-place-inclinometer sensors (IPI) are installed at the M830-04 location (Figure 2.3) and one IPI at the M1191-01 location. One vibrating wire piezometer is installed at the M659-01B and M1191-01 location. The instrumentation at these three sites may be remotely monitored from any location using a secure website.

Mosaic Potash Esterhazy K2 implemented the new Risk Management System (RMS) for potash tailings piles during 2007. The RMS is applied to the tailings pile by dividing the tailings pile into segments and evaluating Risk as a function of pile stability and consequence of failure. The RMS presents a way to prioritize areas that require additional monitoring and/or risk mitigation. The RMS also provides guidance for mine site personnel regarding future tailings pile development and instrumentation requirements for monitoring stability.
10.6 Electromagnetic Surveys

Electromagnetic (EM) surveys are commonly used at Potash mines as a monitoring tool to evaluate potential brine migration. Salt impacted groundwater becomes an electrolyte and exhibits higher electrical conductivity than fresh water. EM surveys measure the electrical conductivity in the subsurface and can, therefore, be used to provide an indication of potential impact boundaries. Regular environmental monitoring at the K2 site includes surface geophysical surveys (EM31 and EM34) around the plant site and the TMA to monitor horizontal brine migration, as well as EM39 profiles in 19 locations around the site to gauge vertical brine migration. Monitoring is completed on a rotating schedule. In 2007, a helicopter electromagnetic (HEM) survey was performed by Fugro Airborne Surveys Corp., covering an area of approximately 155 km². Flight lines were flown at an azimuthal direction of 53° with a line separation of 100 m. Tie lines were flown orthogonal to the traverse lines with a line separation of 1000 m. Data was collected at six different frequencies in order to map geology and evaluate potential brine movement.

Future EM geophysical monitoring will be expanded to include the K2 Phase IV TMA Expansion.

10.7 Brine Control

Brine levels are kept as low as possible in the ponds to minimize the hydraulic head acting on the base of the pond and the dykes. Brine pond levels are recorded daily during the week. This mitigates the risk of discharge/overflows from the pond. Excess brine is injected into deep, highly saline, aquifers located below the Prairie Evaporite beds. Annulus testing and downhole pressure falloff testing are performed annually on each of the eight injection wells, as required by the provincial Oil and Gas Conservation Act. Injection wellhead pressures are checked and recorded daily. Injection brine is sampled monthly and analyzed for K, Na, Cl, and Mg. Pressure transducers will be installed in selected injection wells to monitor formation pressures. This information will be collected for future evaluation of the long-term sustainability of injection capacity.
10.8 Soils

Soil sampling and analysis to assess the potential impact from air emissions from the mill operation is not currently required at the K2 mine site. As stated in Section 10.6, EM surveys are used to monitor and determine potential brine impact boundaries in the subsurface.

10.9 Other Environmental Monitoring

Annual air emission tests are conducted for all of the mine refinery dryer stacks. Monitoring is performed by the Saskatchewan Research Council and the results are submitted to the Saskatchewan Ministry of the Environment. In addition, visual observation and monitoring of process parameters aid in ensuring ongoing compliance. Subsidence or surface settling due to mining has been monitored regularly since 1968.

No changes to these monitoring programs are planned as a result of the proposed expansion.

10.10 Contingency Plan

The mine has an environmental contingency plan to identify actions in the event of spills or incidents outside normal operations that may have environmental impact. The plan will be reviewed with respect to requirements for the new brine pond.
11.0 REFERENCES


M138-T03-120400.

Mosaic Potash Esterhazy, April 2006. Decommissioning and Reclamation Plan.

Michigan, Museum of Zoology. Retrieved October 03, 2007 from
http://animaldiversity.ummz.umich.edu/site/accounts/information/Sylvilagus_florida
anus.html.

Kirk, D. A., and M. J. Mossman, 1998. Turkey Vulture (Cathartes aura). In The Birds of
North America, No. 339 (Eds. A. Poole and F. Gill). The Birds of North America,
Inc., Philadelphia, PA.

Plains Research Centre, University of Regina. Regina, Saskatchewan.

van der Kamp, G. and Maathuis, H., 1985. Excess pore pressure in aquitards under
solid waste emplacements. IAH Memoires, XVI.
12.0 SUMMARY AND CLOSURE

The K2 Phase IV TMA Expansion consists of construction of a new 60 hectare brine and flood storage pond west of the existing TMA. This environmental impact statement was prepared to summarize the costs and benefits of the expansion, including the potential impacts and mitigation measures of the proposed pond. A description of the natural environment of the study area was presented that included the geology and groundwater setting, surface water, biological resources, and heritage resources.

This Environmental Impact Statement (EIS) is submitted in accordance with the requirements of the Saskatchewan Environmental Assessment Act for the review and approval of the project.

Mosaic Potash Esterhazy has provided employment and substantial taxation revenues to the Province of Saskatchewan since 1957. The K2 Phase IV TMA Expansion is required for continued mine operations. The proposed TMA expansion will provide an estimated additional 1,500,000 m$^3$ of brine storage for the mine immediately, and could provide additional salt storage optimization; increasing the overall TMA design life by an estimated 12 years (should salt be placed in this area). A long-term TMA Development Plan is currently in progress to establish the tailings storage location and area required for future mill expansions and long-term operations of the facility.

This expansion will create both long-term and short-term economic benefits for the local area as well as the province of Saskatchewan. In addition to the socioeconomic benefit realized during the initial construction, the TMA expansion will allow continued operation of the mine. This will provide security for current jobs at the mine as well as continued royalty and tax benefits for the province of Saskatchewan.
MDH Engineered Solutions Corp

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