[Crandon Mine Project comments]. Volume 3 1984

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State of Wisconsin \ **DEPARTMENT OF NATURAL RESOURCES**

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

March 28, 1984

File Ref: 1630 (Exxon)

Dear Librarian:

Please place the enclosed document with the rest of the Exxon Environmental Impact Report (EIR) material. This item is a copy of Exxon's responses (dated March 16, 1984) to recent Department comments (made during meetings with Exxon on February 29, and March 1, 1984) on the firm's proposed Crandon Mine Project Air Permit Application. Department comments are reiterated in Exxon's response.

Persons wishing to comment, or who have questions regarding this item, may contact Steve Klafka, DNR, Bureau of Air Management, Box 7921, Madison, WI 53707.

Thank you for your assistance.

Sincerely,
Bureau of Environmental Impact

Carol Nelson

Carol Nelson
Environmental Specialist

CN/bjb
Enc.

cc: S. Klafka/AIR-3

EXXON MINERALS COMPANY

P. O. Box 813, RHINELANDER, WISCONSIN 54501

CRANDON PROJECT

March 16, 1984

Reference No. 4530
Air Pollution Control Permit
Application

Mr. Steven J. Klafka
Engineering & Surveillance Section
Bureau of Air Management
Wisconsin Department of Natural Resources
P. O. Box 7921
Madison, WI 53707

Dear Mr. Klafka:

As per telephone conversations and the meetings with Richard Herbst, Wayne Sadik, and Joseph DeMarte February 29 and March 1, 1984, this letter presents responses to comments from the Bureau of Air Management staff. Since no formal written review comments were submitted to EMC by DNR, we have presented the comments in separate form as recorded in our meeting notes. We believe the major aspects of all the comments are presented and the responses adequately address the content of the comment. Should any of these comments and/or responses not represent adequately the requested information, please notify Richard Herbst as soon as possible.

We concur with your recommendations to use the estimated emission rates that we have previously provided for the mobile and stationary TSP sources in the modeling for the revised air permit application. The stationary source emission rates will be adjusted to include operating efficiency rates with our permit conditions, but they will not be below required state or federal levels. The estimated emission rates for the fugitive sources will be provided to you at the end of the month. Hopefully, we can finalize with you all of the emission rates to be simulated in the modeling efforts by the second week in April. This would maintain the schedule agreed upon at the meetings.

Richard Herbst will contact you in early April to discuss the need for a meeting on the emission rates. Should you have any questions or comments, please do not hesitate to contact Mr. Herbst or me.

Very truly yours,

EXXON MINERALS COMPANY

Barry J. Hansen
Permitting Manager

BJH:JAD:ef

February 29, 1984 Meeting Comments

Comment No. 1:

Provide manufacturer's brochures describing the insertable collectors used in the coarse ore storage building.

Response:

The insertable particle collectors presently included in our design are a DCE Vokes Model DLM-V or equivalent. The attached vendor supplied information describes the principles of operation and other detailed specifications.

Comment No. 2:

Provide manufacturer's brochures describing the wet scrubber used in secondary and tertiary crushing and screening.

Response:

The wet scrubber presently included in our design is a Ducon Type UW-4, Model IV or equivalent. The attached vendor supplied information describes the principles of operation and other detailed specifications.

Comment No. 3:

Provide a copy of the source used for determining the emissions from the temporary diesel generators.

Response:

The emission factors used to estimate the emitted air contaminants from the temporary diesel generators were extracted from EPA, NEDS, Section 3, Chapter 7, Subject 0, p. 5, dated January 3, 1976. This information was provided to the DNR at the meeting in Madison on February 29, 1984 and is also attached as part of this response.

Comment Nos. 4 and 5:

Where are the estimated fugitive dust emissions accounted for from the construction of the access road (Comment No. 4) and railroad spur (Comment No. 5)?

Attachment for Comment No. 1

see us for dust

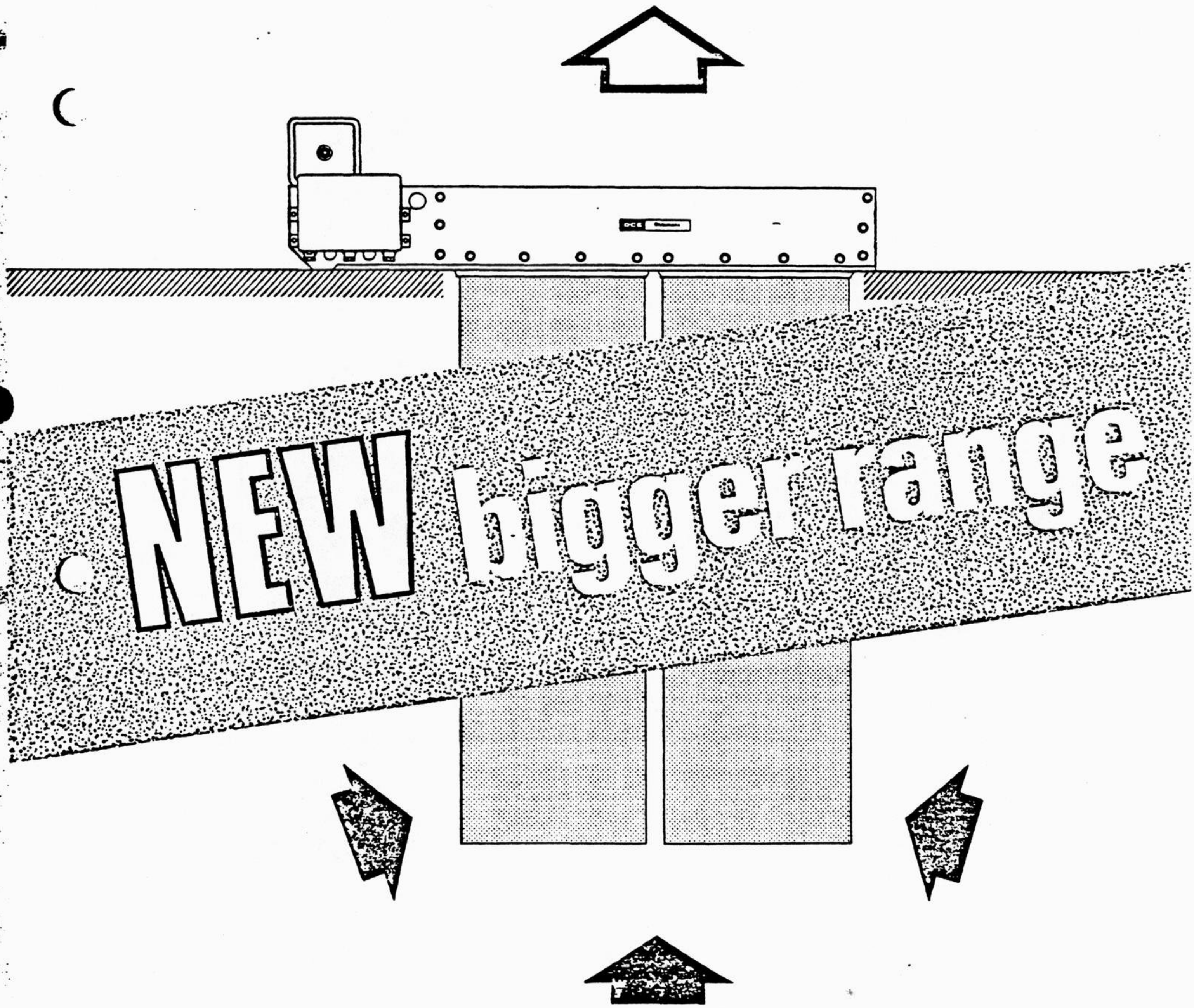
DCE VOKES

DCE VOKES Inc.
11301 Electron Drive
Jeffersontown
KENTUCKY 40299
Tel. (502) 267-0707
Telex 204306

DCE VOKES

Dalamatic

insertable filters



DCE Dalamatic Insertable Filters

NEW BIGGER RANGE

DCE has more than doubled its range of Dalamatic automatic Insertable reverse jet filters by introducing a new 1·5m long filter element and increasing the maximum number of modules from two to three. The range now consists of 79 filters made up from 14 sizes of fabric area, 15 different filter configurations and four types. The new bigger sizes ($30m^2$ and $45m^2$ fabric area) have been developed to meet the increasing need for larger filters in the handling, processing and storage of bulk materials and powders. At the same time more sizes have been added to the middle of the range to increase its flexibility.

The new filters enjoy the other advantages of Dalamatic Insertables. They are easy to assemble and have excellent seals. Flat pad-shaped filter elements ensure compactness. No moving mechanical parts are involved. Filter elements are cleaned in turn by a brief burst of compressed air in the reverse direction to that of the main air flow. This is automatic and continuous, using an electronic controller of total solid state design. Only top quality felt media — vital to proper filter performance — is used. Advanced automated production methods ensure accurate components and inherently strong high quality products.

TYPES OF FILTER

There are four types in the DCE range of Dalamatic Insertable Filters:

Type B *Basic* filter for pressure systems sited internally.

Type H Filter with exit *Header* for connection to a fan or discharge ducting. The filter is weather-proof and suitable for internal and external applications.

Type W Filter with a *Weather cowl* for pressure systems where the filter is located outside or exposed to adverse site conditions.

Type F Weatherproof filter fitted with a *Fan* for applications normally operating below atmospheric pressure. All fans are integral, with a choice of two or three on most sizes.

SIZE RANGE

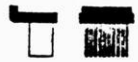
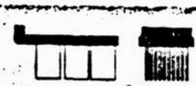
Each type is available in 14 different sizes with varying filtration capacities. They are based on two sizes of seal frame, containing either six or ten filter elements in one of three lengths: 0·7m, 1·0m or the new 1·5m. These are assembled into single module sizes which can be joined together in twos or threes as shown in the configurations opposite.

FILTER DESIGNATION

Dalamatic Insertable Filters are identified by the letter reference DLM-V followed by figures denoting (i) the fabric area and (ii) the length of element (see table opposite). A final letter is added to indicate the Type. For example: DLM-V4/7B; DLM-V30/15F etc.

THE FULL RANGE OF SIZES

NEW filters shown on blue panels

Filter Size Designation	Total Fabric Area	Filter Elements			Approx. Air Volume*	
		Number	Length	Configuration	m³/hr	c.f.m.
DLM-V4/7	4m² (43ft²)	6	0·7m		700	400
DLM-V6/10	6m² (64ft²)	6	1·0m		1000	600
DLM-V7/7	7m² (75ft²)	10	0·7m		1250	700
DLM-V8/7	8m² (86ft²)	12	0·7m		1350	800
DLM-V9/15	9m² (97ft²)	6	1·5m		1550	900
DLM-V10/10	10m² (108ft²)	10	1·0m		1750	1000
DLM-V12/10	12m² (129ft²)	12	1·0m		2000	1200
DLM-V14/7	14m² (150ft²)	20	0·7m		2400	1400
DLM-V15/15	15m² (161ft²)	10	1·5m		2550	1500
DLM-V18/15	18m² (194ft²)	12	1·5m		3050	1800
DLM-V20/10	20m² (215ft²)	20	1·0m		3500	2000
DLM-V21/7	21m² (226ft²)	30	0·7m		3600	2100
DLM-V30/10	30m² (323ft²)	30	1·0m		5100	3000
DLM-V30/15	30m² (323ft²)	20	1·5m		5100	3000
DLM-V45/15	45m² (484ft²)	30	1·5m		7650	4500

*NOTE: The air volumes shown above must be taken as a rough guide only. They can vary considerably according to the nature of the dust involved.

THE DALAMATIC

DALAMATIC reverse jet fabric filters are designed for continuous operation on applications where product or nuisance dusts are involved and where high collection efficiencies are required. The Dalamatic is capable of filtering heavy dust burdens at a high filtration velocity and a constant level of resistance. Collection efficiency often exceeds 99·99%.

The Dalamatics have proven themselves through years of successful performance and have gained wide acceptance in the world's most demanding markets. The improvements in the current design have resulted from the experience gained through thousands of installations cleaning millions of CFM. These modifications have improved filter performance, capacity, and convenience of maintenance, without increasing costs. Today's Dalamatics meet today's rigid requirements.

Some Dalamatic advantages:

● **Downward Flow**
The top inlet of this filter insures a downward flow and more effective operation. Other types with bottom inlet and upward air flow have a higher pressure loss for a given filtration velocity.

● **Cleanside Access**
Full width access from the clean air side makes inspections and changing of filter envelopes easier and safer. Access from the dust side — as on some competitive models — is always unpleasant and may even be dangerous when toxic contaminants are involved.

● **Convenient Envelope Size**
Filter elements are designed so that one man can change a filter envelope without help. In some designs this is impossible.

● **No Moving Parts**
Filter envelopes are cleaned in turn by a brief burst of compressed air in the reverse direction of the main air flow. This is electronically controlled, automatic and continuous. With no moving parts, filter reliability is greater than with mechanical cleaning systems.

● **Advanced Production Methods**
Our designs utilize sophisticated manufacturing techniques which produce a sturdy filter casing at a relatively low cost.

● **Tight Envelope Seals**
The Dalamatic method of sealing each filter envelope by compressing an integral sealing ring between the insert header and the seal frame insures a tight seal — without screws and toggle bolts.

● **Easy Access to Controls**
The controller and filter cleaning assembly are located below the clean air chamber for easy access and adjustment. Top-mounted equipment can be difficult to reach.

● **Very Compact**
The flat envelope configuration of filter elements makes the Dalamatic extremely compact and insures maximum filtration area in a given space.

● **Double Banking**
To save additional space two multi-bank assemblies can be jointed on either the dirty or the clean air sides. This means a considerable saving in the need for access platforms and inspection doors while keeping the advantage of easy access for envelope changing.

APPLICATIONS

Dalamatics are applied in almost every industry which processes powdered or granulated materials, or uses equipment producing large quantities of dust. Some examples are: aluminum, asbestos, carbon, cement, chemicals, detergents, dyestuffs, flour, foodstuffs, graphite, glass, insecticides, pharmaceuticals, plastics, sugar, tobacco, and many others.

The Dalamatic *insertable* filters were originally designed to deal with the heavy dust burdens and high filtration velocities encountered in pneumatic conveying systems handling particulate products. Simply inserted into silos, the filter provided continuous filtration of the conveying air with a high collection efficiency. The range of the insertable filter has been expanded and now extends over many other applications, including mechanical conveying of bulk materials and a wide variety of process equipment into which the filter can be integrated.

DALAMATIC FILTER ASSEMBLY

Each filter assembly or 'cell' comprises a number of flat rectangular envelope-shaped filter elements inserted through parallel recessed slots in a seal frame which separates the dust side from the clean air side of the filter. Each filter element consists of a felted envelope supported on a rigid open mesh frame or insert which has an integral header and sealing flange welded to its mouth. A multi-nozzle jet tube is located along the mouth of each insert header. It is connected via a diaphragm valve to a compressed air manifold. The valves are linked to a solenoid timer specifically designed for use with Dalamatic filters.

PRINCIPLE OF OPERATION

The dust laden air is drawn onto the filter envelope, where the dust is retained on the outer surface of the fabric. Cleaned air passes through the fabric and out of the insert header as shown in Fig. 1, on the clean side of the filter. To maintain continuous operation each envelope must be regularly cleaned. This is achieved by reverse jet cleaning. An electronic timer activates each pilot valve in sequence at predetermined intervals on a continuous cycle. The pilot valve in turn opens the diaphragm valve (see Fig. 2). A short burst of compressed air is released and injected by the multi-nozzle jet tube through the insert header into the filter envelope. This causes a momentary reversal of the air flow through the filter envelope. The effect is a brief controlled inflation of the envelope so that the accumulated dust or dust cake is dislodged from its surface. Simultaneously the reversed air flow through the fabric assists dust removal. The collected dust falls either into a collection hopper beneath or directly back into the process served.

FILTER FABRIC

Well-designed reverse jet filters avoid mechanical stresses on the filtration medium, so that felted fabrics with their inherently higher efficiency and lower resistance compared with woven materials can be used without risk of damage. Felted fabrics in a number of synthetic and natural fibers are available, but the majority of applications are best served by standard polyester felt. Other felted materials include Nylon and Orlon while another — Nomex — is suitable for temperatures up to 400°F. All fabrics are manufactured to a strict specification and undergo stringent quality control testing. The quality of the fabric and the high standard of envelope manufacture are an intrinsic part of the filter design and govern the filtration properties of the filter. The use of substitutes could reduce the efficiency of the filter.

PAINT FINISH

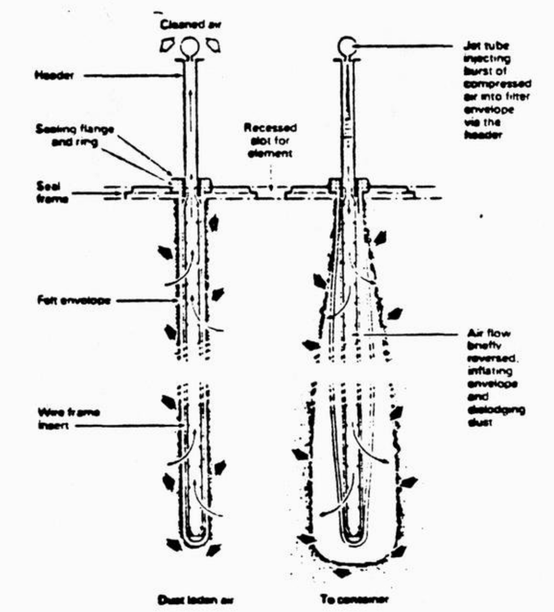
Series DLM

The main case, seal frame and internal components (except filter envelope inserts) are degreased, coated with epoxy powder by an electrostatic powder spray gun and then baked. Envelope inserts are degreased and dipped in a tank containing an electrophoretic water-based epoxy paint and then baked.

Series DLM-V

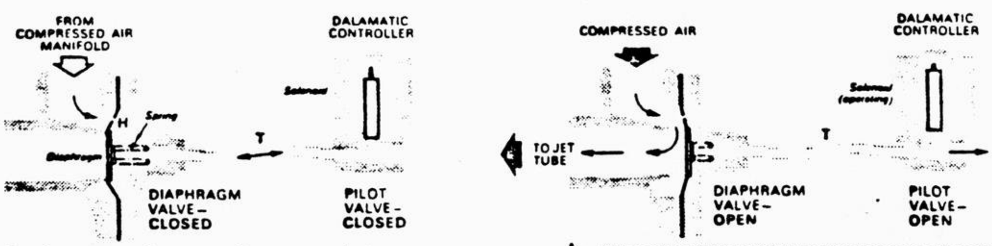
The same two processes are employed as follows: electrostatic epoxy powder for seal frames and electrophoretic epoxy dip for envelope inserts and all other components.

Note: For corrosive operating conditions reference should be made to DCE VOKES Inc. for alternative methods of protection.



a Filtering **b** Cleaning

Fig. 1 Section through filter elements



a Compressed air from the manifold penetrates diaphragm through fine hole 'H' into connecting tube 'T'

b When solenoid is activated the pilot valve opens, releasing the compressed air from connecting tube 'T' and allowing diaphragm to open

Fig. 2 The valve system

SIZE RANGE

The range of cased filters is based on a single cell size each consisting of a seal frame and ten filter envelopes with a total fabric area of approximately 105 sq. ft. Cells are then built up in banks and tiers to handle the air volume required by the particular application. Examples are given in the table below.

Units are available pre-assembled up to the maximum dimensions permitted by freight restrictions. Where conditions require larger units, they can be erected on the site from pre-assembled sub-assemblies.

CONSTRUCTION AND OPERATION

The Dalamatic reverse jet filter comprises an outer case enclosing the required number of cells. The benefits of long experience in types of joint and methods of sealing have been incorporated in the filter construction. Joints have been stiffened by double fold, and overlapped between case panels. The supporting structure and the collection hopper are bolted onto the main case underneath. The hopper has a bottom flange for attachment of a suitable device for removing the collected dust.

The dust laden air enters the cased Dalamatic through an inlet at the top and is directed downwards. After passing through the filter elements the air is discharged through an outlet above the clean side of the filter.

There are several methods of dust disposal. Single bank units are normally supplied with hoppers terminating in a flanged outlet to accept various sizes of rotary valve. Multibank assemblies are normally supplied with trough hoppers and screw conveyors; alternative arrangements can be made to suit special applications.

CONTROLLER

A 10-valve controller assembly is fitted to Dalamatic cased filters. It contains a fully automatic solid state dual timer, which activates the solenoid valves in the required sequence and governs the interval between the pulses of compressed air. The time interval is adjustable to suit the severity of the application and has a range of 5 to 35 seconds with a factory setting of 12 seconds.

The controller consists of a steel box, solid state transistorized circuit board, multi voltage transformer, plug-in uni-selector and quick acting fuse. It is recommended that a fused isolator, fitted with 2 amp HRC fuses, be installed between the controller and the incoming supply.

AIR SUPPLY

A supply of clean, dry compressed air at a pressure of 90 p.s.i.g. (7 atm) is required for efficient filter operation. (Moisture separators are supplied with cased filters.) Recommended design air volumes are given below.

Filter Size	AIR VOLUME (free air delivered) at 12 sec. intervals
DLM 1/2/10 DLM 1/3/10 DLM 1/4/10	8 c.f.m.
DLM 2/3/10 DLM 2/4/10	16 c.f.m.

In most applications experience will allow increasing the interval with a resulting decrease in compressed air consumption.

Designation	No. of Banks (a)	No. of Tiers (b)	No. of Cells (a) x (b)	No. of Envelopes (10 per cell)	Nominal Filter Area* sq. ft.	Approx. Air Volume† c.f.m.
DLM 1/2/10	1	2	2	20	210	1,500
DLM 1/3/10	1	3	3	30	315	2,250
DLM 1/4/10	1	4	4	40	420	3,000
DLM 2/3/10	2	3	6	60	630	4,500
DLM 2/4/10	2	4	8	80	840	6,000
DLM 3/4/10	3	4	12	120	1,260	9,000
DLM 4/4/10	4	4	16	160	1,680	12,000
DLM 5/4/10	5	4	20	200	2,100	15,000
DLM 6/4/10	6	4	24	240	2,520	18,000
DLM 7/4/10	7	4	28	280	2,940	21,000
DLM 8/4/10	8	4	32	320	3,360	24,000
DLM 9/4/10	9	4	36	360	3,780	27,000
DLM 10/4/10	10	4	40	400	4,200	30,000
DLM 20/4/10	20	4	80	800	8,400	60,000

*Exact filter area is 107.6 sq. ft. per cell. †This is a rough guide only, based on average dust burden and particle size distribution.

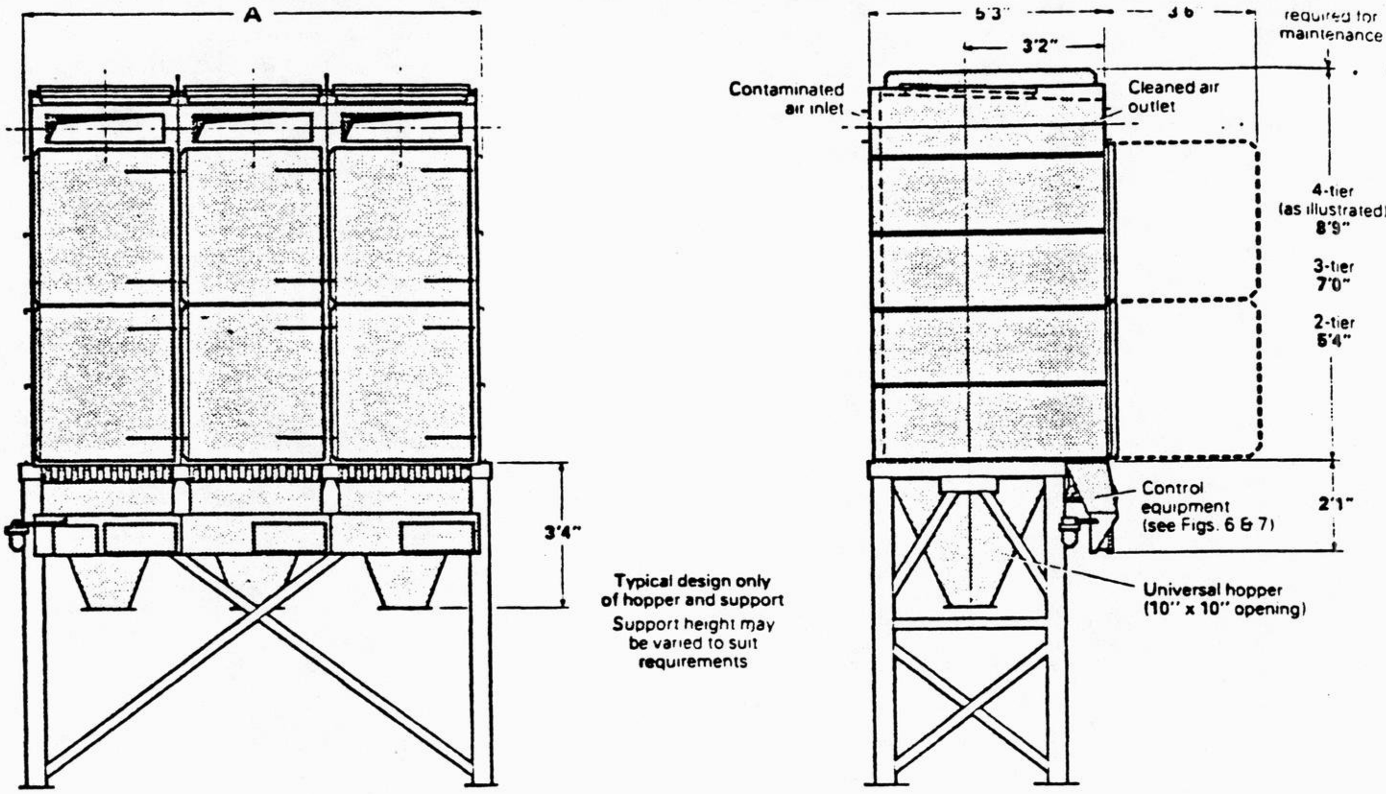


Fig. 3 Dalamatic 3-bank 4-tier filter (DLM 3/4/10) with universal hopper

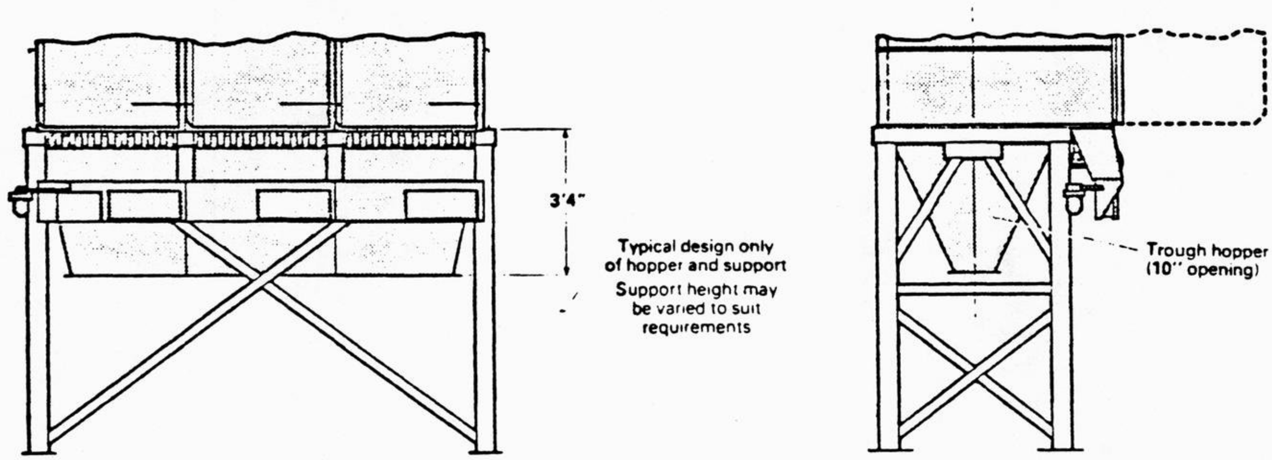


Fig. 4 Trough type hopper for attachment to screw conveyor

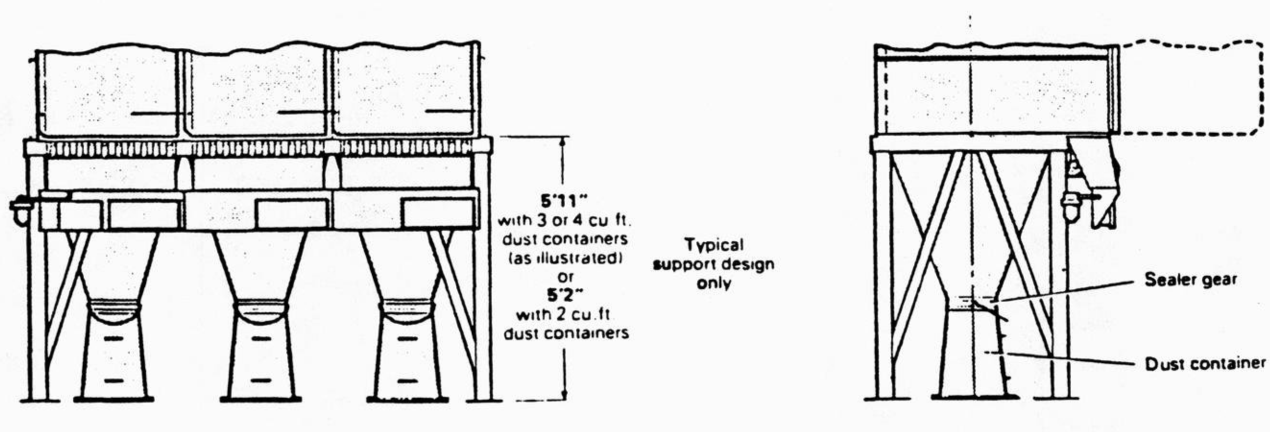


Fig. 5 DCE 'UMA' type dust containers with quick-release sealer gear

OVERALL WIDTHS OF SERIES DLM FILTERS

	1/2/10	–	–	–	–	–	–	–	–	–
	1/3/10	2/3/10	–	–	–	–	–	–	–	–
	1/4/10	2/4/10	3/4/10	4/4/10	5/4/10	6/4/10	7/4/10	8/4/10	9/4/10	10/4/10
	1/6/10	2/6/10	3/6/10	4/6/10	5/6/10	6/6/10	7/6/10	8/6/10	9/6/10	10/6/10
Dim. 'A'	3' 8"	6' 11"	10' 3"	13' 6"	16' 10"	20' 2"	23' 5"	26' 9"	30' 0"	33' 4"

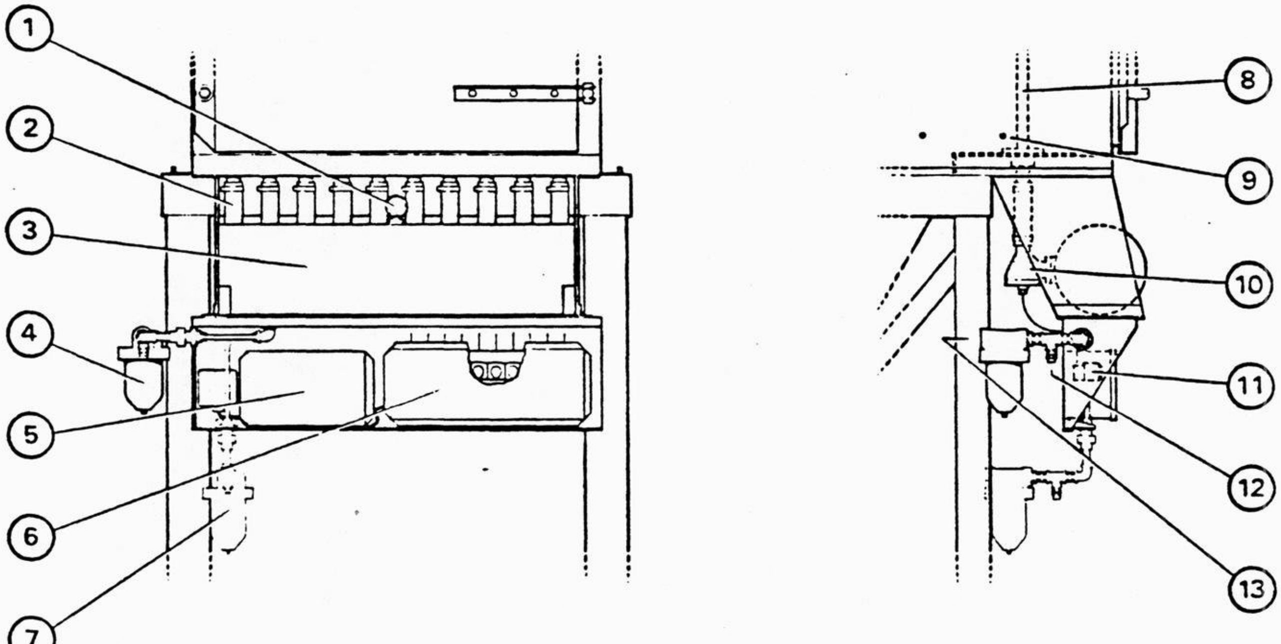
APPROXIMATE NET WEIGHTS

	FILTER COMPLETE (as Fig. 3)		FILTER WITHOUT SUPPORT, HOPPER OR DUST CONTAINER							
	1 Bank	2 Banks	3 Banks	4 Banks	5 Banks	6 Banks	7 Banks	8 Banks	9 Banks	10 Banks
2 Tiers	2100 lb	–	–	–	–	–	–	–	–	–
3 Tiers	2550 lb	5200 lb	–	–	–	–	–	–	–	–
4 Tiers	3100 lb	6200 lb	9300 lb	9050 lb	11300 lb	13500 lb	15700 lb	18150 lb	20300 lb	22550 lb
6 Tiers	3550 lb	6650 lb	9750 lb	12800 lb	15900 lb	19000 lb	22100 lb	25200 lb	28300 lb	31400 lb

DESIGN LIMITS (STANDARD EQUIPMENT)

Temperature range: *(two choices available, according to type of sealer used):* (a) 15°F to 140°F; or (b) 15°F to 400°F
For lower temperature applications consult with DCE VOKES Inc.

Pressure limits: –20"WG to ±8"WG **Dimension tolerances:** ±$\frac{3}{16}$" on main dimensions; ±$\frac{1}{16}$" on detail dimensions



Figs 6 & 7 Front and side elevations of Control Equipment
(see table below)

STANDARD COMPONENTS

1	Pressure gauge	8	Jet tube
2	Rubber connecting hose	9	Manometer connections
3	Compressed air distribution manifold	10	Diaphragm valve
4	Moisture separator (up to 6-bank)	11	Pilot valve – inside solenoid terminal box, item 6
5	Dalamatic controller	12	Pressure relief valve
6	Solenoid terminal box	13	Compressed air inlet
7	Moisture separator (over 6-bank)		

Note: The illustrations on these two pages show the latest design of control equipment, giving improved access to all components.

TYPE

There are four types in the Dalamatic insertable filter range:

Type B Basic filter for pressure systems in applications for indoor use.

Type H Filter with exit header for connection to fan or for conveying filtered air from the filter. The filter is weatherproof and suitable for outdoor applications.

Type W Filter with a weather cowl for pressure systems in applications where the filter is sited outside or exposed to adverse site conditions.

Type F Filter fitted with integral fan for applications normally operating at below atmospheric pressure. This filter is also weatherproof.

SIZE

Each type is available in seven different single cell sizes with varying filtration capacities. They are based on two sizes of seal frame, one holding six envelopes and the other ten. Two lengths of envelope in combination with the two sizes of seal frame make up the size range as shown in the table below.

FILTER DESIGNATION

The designation of Dalamatic insertable filters begins with the prefix DLM-V and is followed by a figure denoting the size and a letter denoting the type, for example:

DLM-V 4B = Dalamatic Insertable with filter area of 40 sq. ft., Basic Type. (See inside back cover).

CONTROLLER

A 3-valve controller assembly is fitted to Dalamatic insertable filters sizes V4, V6 and V12, while a similar assembly incorporating 5 valves is fitted to sizes V7, V10, V14 and V20.

It contains a fully automatic solid state dual timer. The time interval has a range of 6 to 30 seconds with a normal initial setting of 20 to 25 seconds. A fused isolator fitted with a 2 amp HRC fuse should be installed between the controller and the incoming supply.

In the case of the DLM-V Type F model the fan should only operate in conjunction with the controller, but wherever possible the controller itself should be capable of independent operation so that the filter elements can be cleaned under static air conditions.

AIR SUPPLY

A supply of clean and dry compressed air, at a pressure of approximately 90 p.s.i.g. (7 atm.) is required for efficient filter operation. Recommended atmospheric air volumes are given below:

Filter Size	AIR VOLUME — F.A.D. 20-25 sec. interval
DLM-V4 DLM-V6	3·1 c.f.m.
DLM-V7 DLM-V10	5·1 c.f.m.
DLM-V12 DLM-V14 DLM-V20	5·5 c.f.m.

Filter size Designation	Nominal Filter Area sq. ft.	Filter Elements No. & Size	Filter Elements Arrangement	Approx. Air Volume* c.f.m.
DLM-V4	40	6 – Short		400
DLM-V6	63	6 – Long		600
DLM-V7	70	10 – Short		700
DLM-V10	105	10 – Long		1000
DLM-V12	126	12 – Long		1200
DLM-V14	140	20 – Short		1500
DLM-V20	210	20 – Long		2000

*This is a rough guide only, based on average dust burden and particle size distribution

ELECTRICAL SUPPLY

All Insertables require a two-wire supply of 115v or 230v to operate the controller. In addition, Type F filters require a three-phase supply to drive the fan motor — DCE VOKES standard motors being suitable for 230/460v, 3ph, 60Hz.

TYPICAL APPLICATIONS

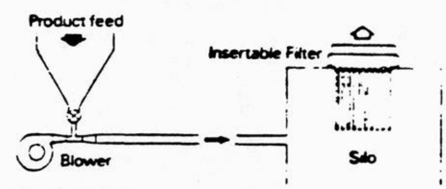
(a) Venting Silos in Pneumatic Conveying Systems

1. Blowing system in which every part is under positive pressure and the fan or blower is at the beginning of the line, providing the motive power. (See Fig. 8a.)

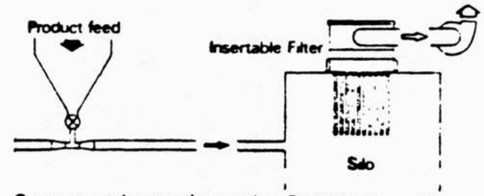
2. Suction system where a suction fan at the end of the line draws the product along the line and keeps the whole system under suction. (Fig. 8b.)

3. System employing both blower and suction fan (see Fig. 8c). Examples are applications involving delivery to a silo which has to be kept below atmospheric pressure to avoid escape of dust through leakage, or where direct inspection of the interior of a silo is required while working.

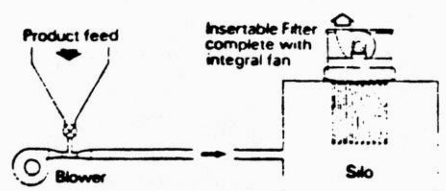
The filter is inserted in the top of the silo or storage vessel to separate the product from conveying air so that product loss and dust nuisance are both prevented. The reverse jet cleaning system removes the collected dust continuously from the filter elements and returns it directly to the bulk content of the silo. The DLM-V Type B and DLM-V Type W are normally applied in blowing systems and the DLM-V Type H in suction systems. The DLM-V Type F is used in the third case on systems where the suction fan is needed to assist in the relief of pressure from the system.



a System under pressure, using DLM-V Type B or W



b System under suction, using DLM-V Type H



c System under suction, using DLM-V Type F

Fig. 8 Venting silos fed by pneumatic conveying systems

(b) Mechanical Conveyors

The dust cloud which arises at loading, discharge and transfer points on mechanical conveyors can be controlled by a DLM-V Type F mounted in or above an aperture cut in the enclosure. The collected dust is returned directly to the product. This saves space, makes ducting and other ancillary equipment unnecessary and avoids the secondary dust problems associated with disposal of the collected dust. (See Fig. 9.)

(c) Silo Fed by Mechanical Conveyor

The DLM-V Type F is either mounted above the tipping point or in a separate opening adjacent to it. The filter keeps the silo under suction and so retains airborne particles which would otherwise be carried away by the displaced air escaping from the silo. The collected dust is continuously returned to the product in the silo.

(d) Ventilation of Air Slides

A DLM-V may be directly mounted at the end of an air slide powder transport system for air release. If the air slide system is extensive, it may be convenient to install the DLM-V at an intermediate junction or bend.

(e) Dust Control System with Pre-separation

With certain dusts, of extremely fibrous or abrasive nature for example, it is sometimes preferable that the filter should not come into direct contact with the bulk dust load.

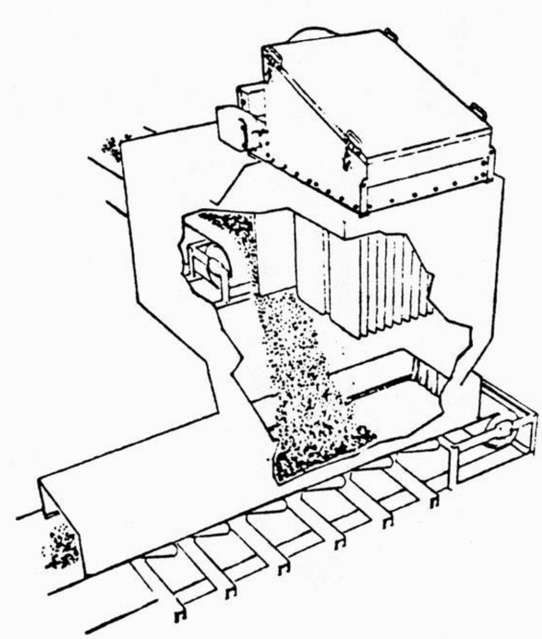


Fig. 9 DLM-V Type F mounted above belt transfer point

A typical solution (see Fig. 10) is to insert DLM-V filters in the top of a cone-shaped housing; the dust is then introduced tangentially to the housing below the filter elements, causing most of the dust to pre-separate to the bottom of the cone. The remaining fine dust is carried at low velocity to the filters above and the air discharged in cleaned condition to atmosphere. Depending on the duty involved, one or more Dalamatic filters may be inserted into the coned filter housing; either DLM-V Type H units each linked to an external fan or DLM-V Type F units with integral fans can be used.

As housing dimensions and operating conditions are critical in meeting the performance required, these applications must have careful assessment.

(f) Bin Fluidization

Powder storage bins may be fluidized by air blown in at the base of the vessel to prevent material 'packing' and to assist discharge without the need for steep angle trough hoppers or bin vibrators. A DLM-V inserted at the top of the vessel insures continuous clean discharge of the fluidizing air.

(g) Integration with Process Machinery

Dalamatic Insertable Filters may be actually integrated within specific process machinery requiring dust control such as fluid bed reactors, mixers, blenders, mills, crushers and similar equipment, or utilized for the ventilation of certain types of powder spray booths and automatic bag slitting machines. The field of application is virtually unlimited.

MOUNTING POSITIONS

All types of Insertable Filter may be mounted vertically or horizontally as shown in Fig. 11. All are suitable for in- or outdoor locations except the DLM-V Type B — the only model not fully weatherproof.

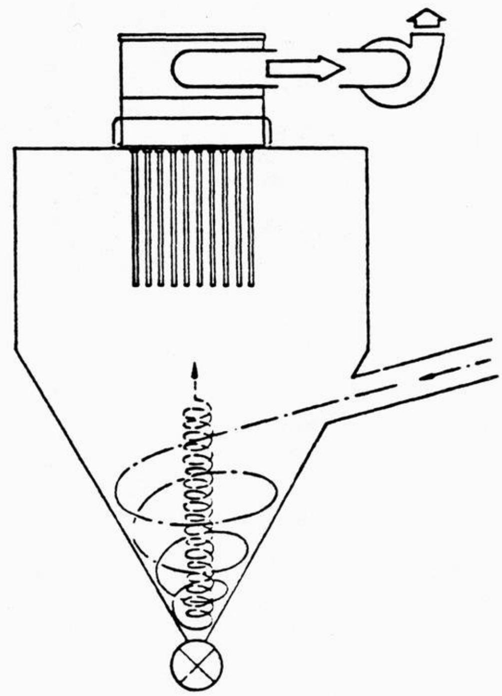
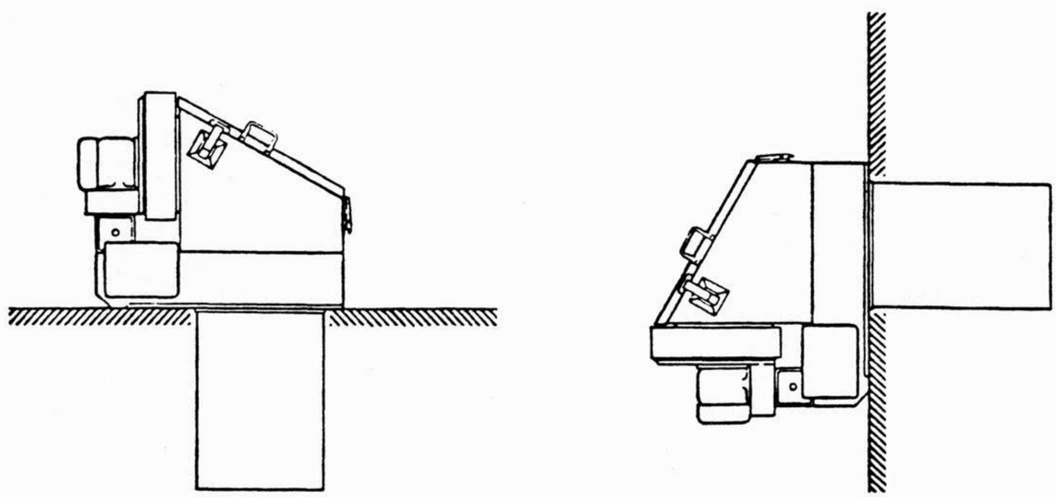


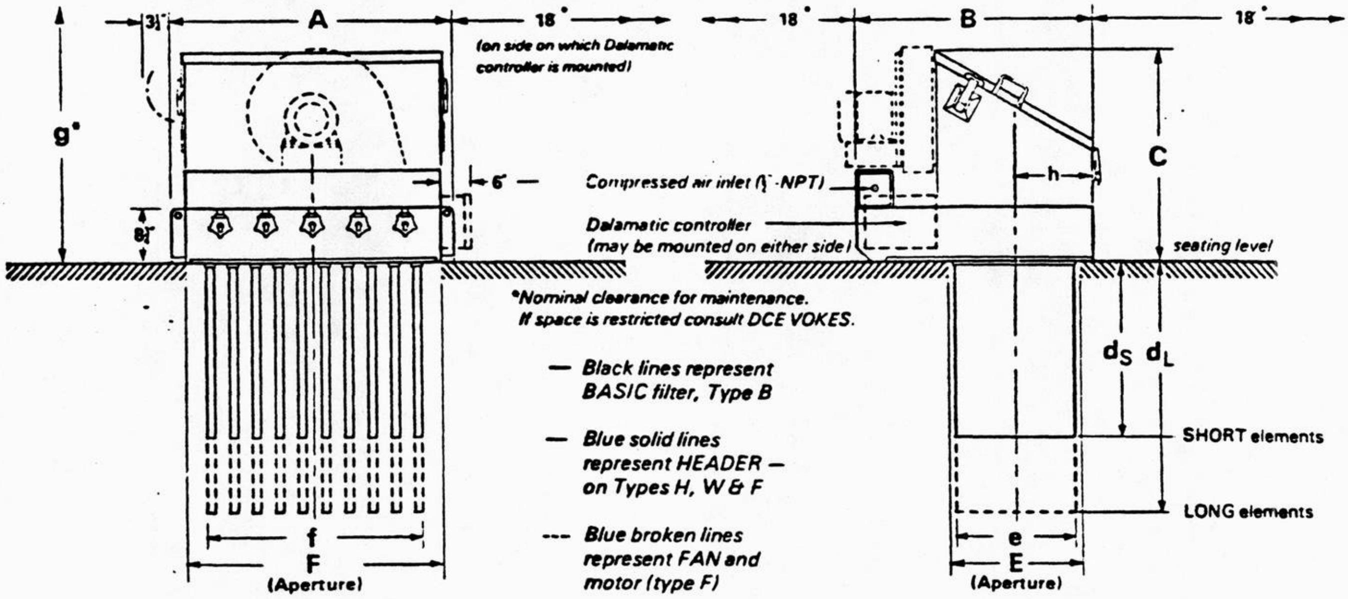
Fig. 10 DLM-V Type H used in dust control system with pre-separator



a Vertically mounted

b Horizontally mounted

Fig. 11 Alternative mounting positions for DLM-V insertable filters (Type F illustrated)



FRONT ELEVATION SIDE ELEVATION

Size DLM-V7 illustrated, larger elements representing DLM-V10

DIMENSIONS

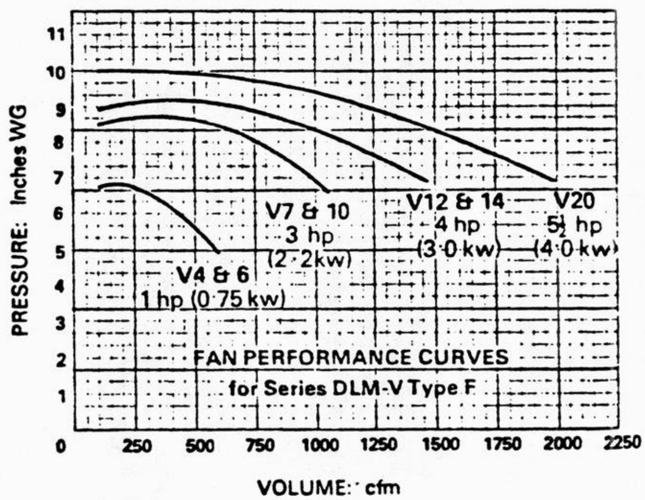
(Tolerance ± ⅛" on main dimensions)

MODEL*	All Types								Type B			Types H, W & F†		
	A	d_S	d_L	E	e	F	f	h	B	C	g	B‡	C‡	g
DLM-V4	2' 3½"	2' 3½"	–	20½"	19"	23½"	18½"	12¼"	2' 11¾"	14¾"	2' 10"	2' 11¾"	2' 6⅛"	3' 7"
DLM-V6	2' 3½"	–	3' 3½"	20½"	19"	23½"	18½"	12¼"	2' 11¾"	14¾"	4' 0"	2' 11¾"	2' 6⅛"	4' 11"
DLM-V7	3' 7½"	2' 3½"	–	20½"	19"	3' 3¼"	2' 8½"	12¼"	3' 0⅜"	14¾"	2' 10"	3' 0⅜"	2' 8⅞"	3' 7"
DLM-V10	3' 7½"	–	3' 3½"	20½"	19"	3' 3¼"	2' 8½"	12¼"	3' 0⅜"	14¾"	4' 0"	3' 0⅜"	2' 8⅞"	4' 11"
DLM-V12	2' 3½"	–	3' 3½"	3' 5¼"	3' 3½"	23½"	18½"	22⅜"	5' 0"	15¾"	4' 0"	5' 0"	2' 10"	4' 11"
DLM-V14	3' 7½"	2' 3½"	–	3' 5¼"	3' 3½"	3' 3¼"	2' 8½"	22⅜"	5' 0"	15¾"	2' 10"	5' 0"	2' 10"	3' 7"
DLM-V20	3' 7½"	–	3' 3½"	3' 5¼"	3' 3½"	3' 3¼"	2' 8½"	22⅜"	5' 0"	15¾"	4' 0"	5' 0"	2' 10"	4' 11"

*For number of elements and total filter areas see chart on page 8 †For fan details see below
‡Type F fan motors and cases may project by up to 2½" beyond these dimensions

APPROX. NET WEIGHTS

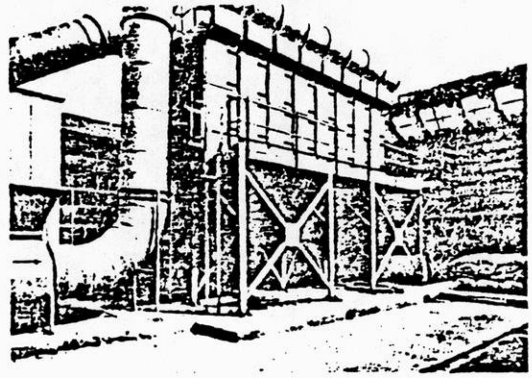
MODEL	Type B	Type H	Type W	Type F
DLM-V4	220 lb	270 lb	280 lb	320 lb
DLM-V6	250 lb	300 lb	310 lb	350 lb
DLM-V7	490 lb	540 lb	560 lb	630 lb
DLM-V10	540 lb	600 lb	620 lb	680 lb
DLM-V12	510 lb	560 lb	580 lb	660 lb
DLM-V14	620 lb	740 lb	760 lb	850 lb
DLM-V20	710 lb	830 lb	850 lb	960 lb



OPERATING DESIGN LIMITS

Temperature range: **Types B, H & W** *Two choices available:* **(a)** 15° to 140°F; **(b)** 15° to 250°F; **Type F** 15° to 140°F
For lower or higher temperature applications consult with DCE VOKES Inc
Pressure limits for Type H: −15" to +2" WG.

Typical Installations — Cased Dalamatics



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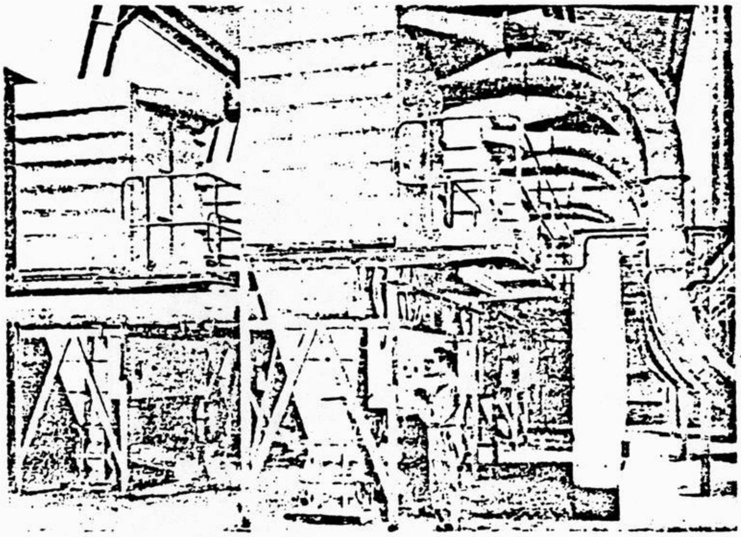

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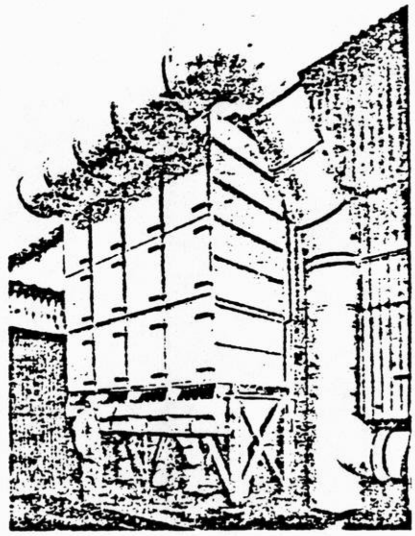

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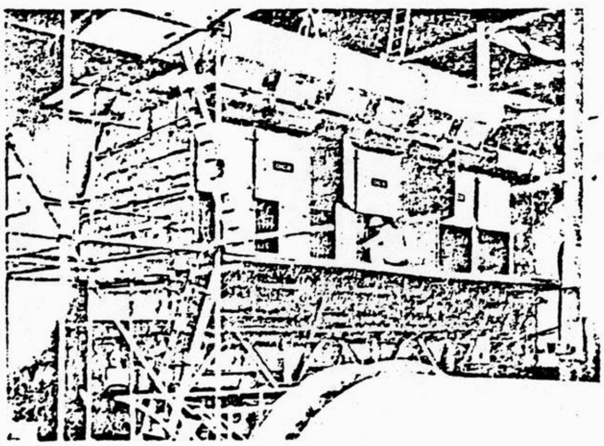

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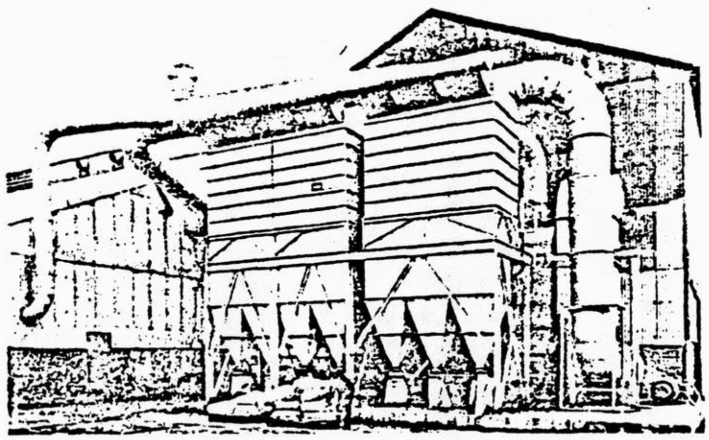


5

1 Dalamatic installation for collecting asbestos dust from board cutting operations.

2 Product recovery from the grinding of animal foodstuffs.

3 Dalamatic installation handling carbon dust.

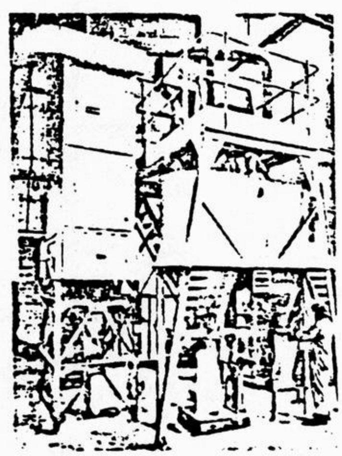
4 Dalamatic filter installation under construction for a cement mill.

5 Two banks of Dalamatics handling graphite and carbon dust.

6 Dalamatic serving ball mills at a metal refinery.

7 Ground sandstone sieving system served by a Dalamatic filter plant.

6



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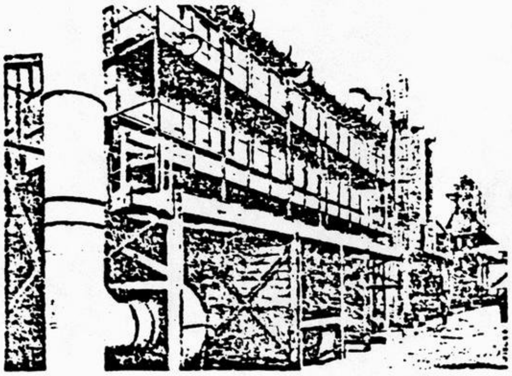
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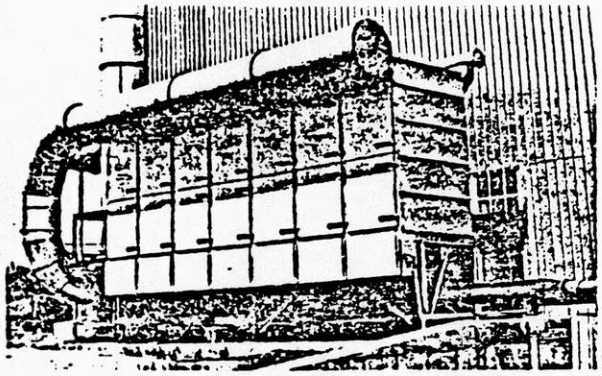
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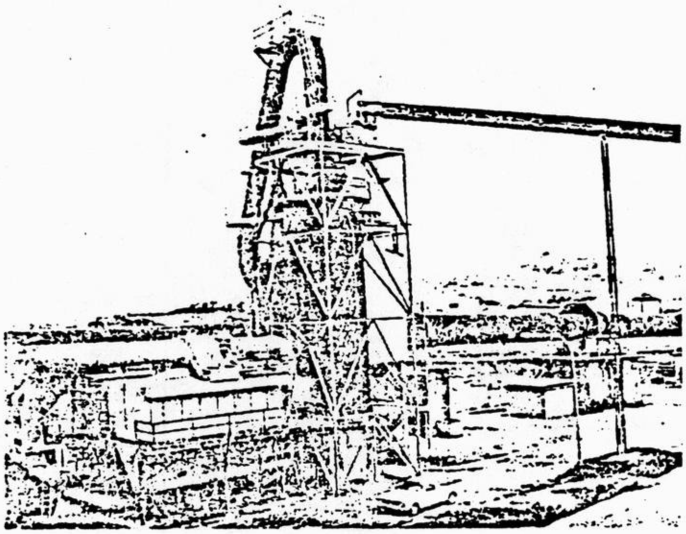
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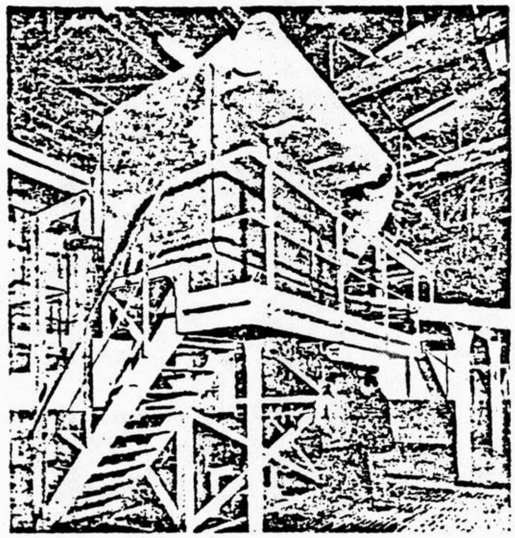
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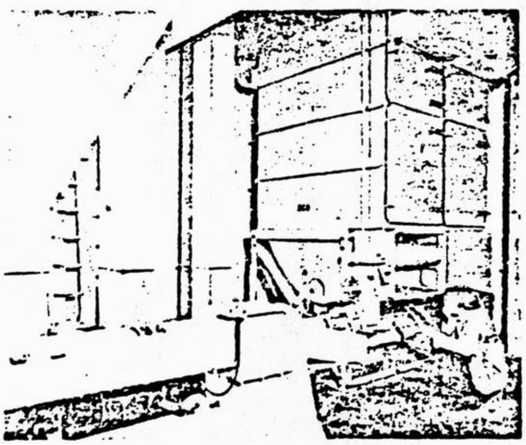
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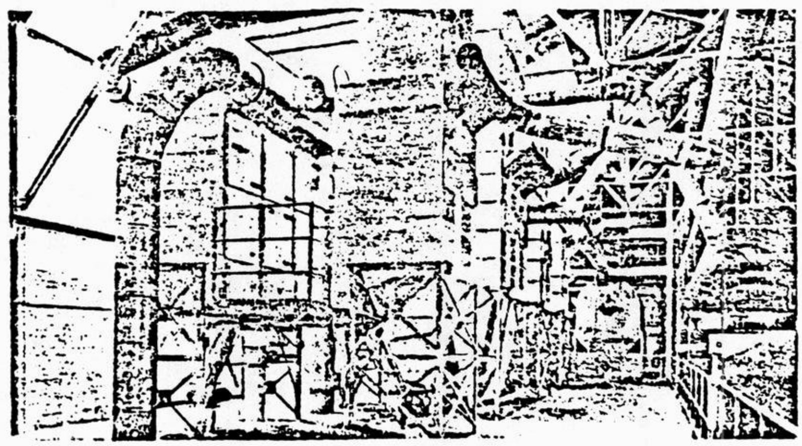
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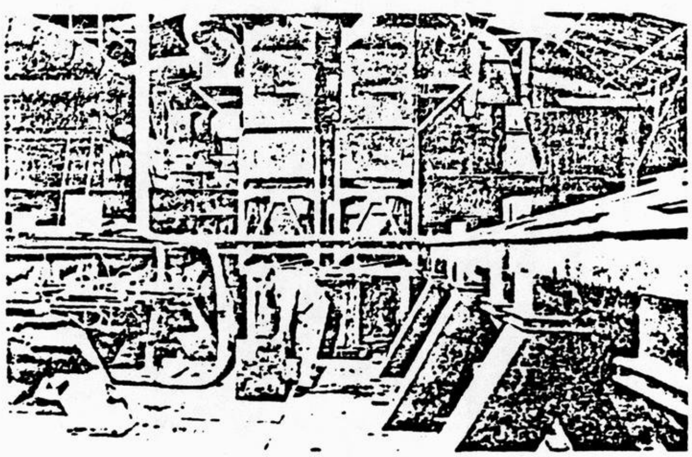
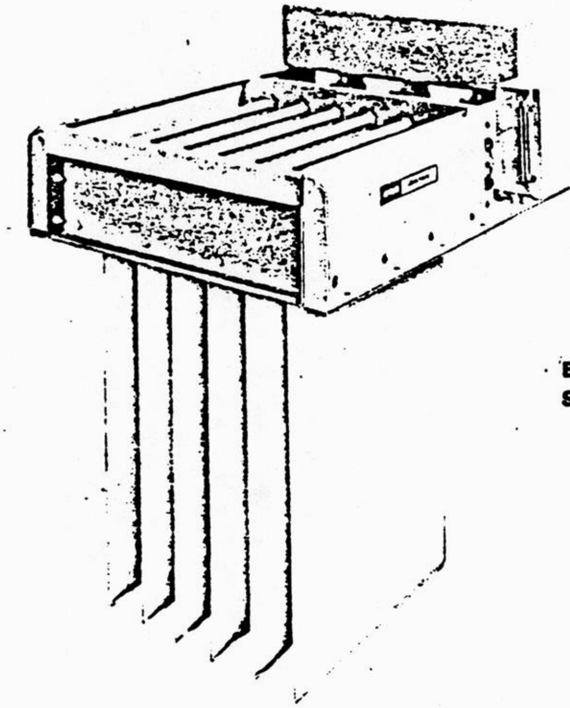
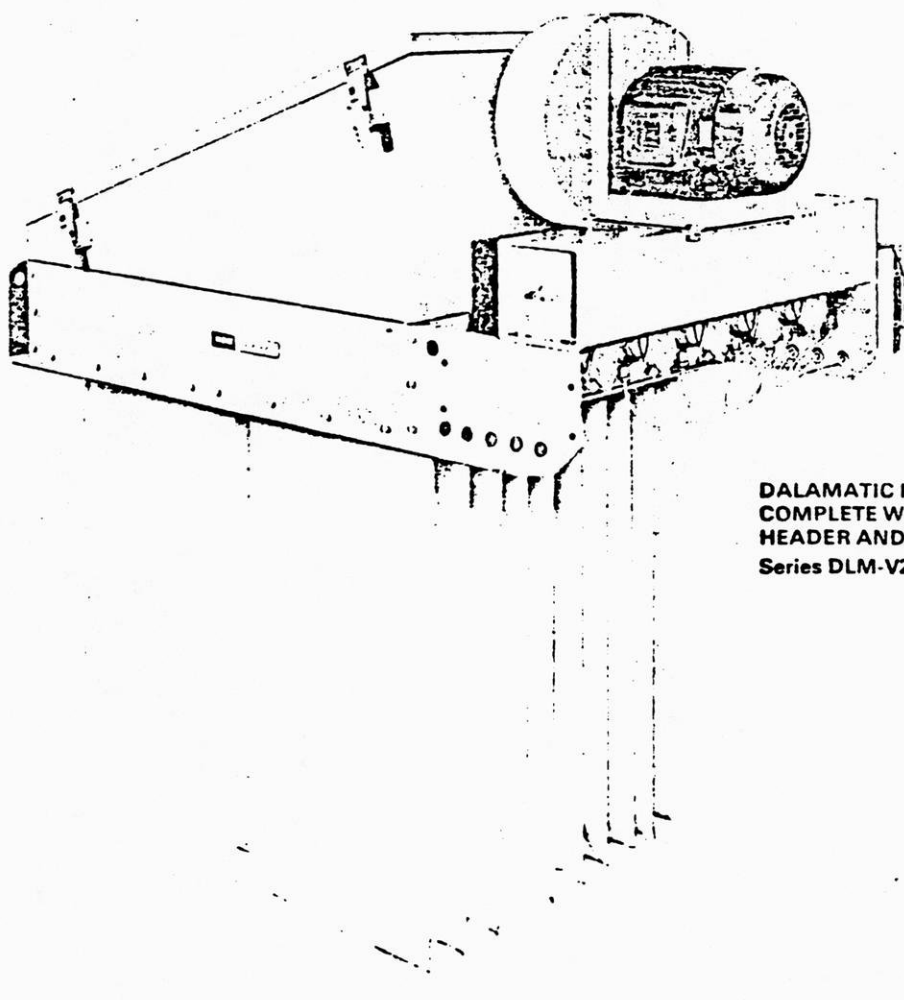

14

8 Dalamatic filter applied to foundry fettling and grinding
9 Dalamatic collecting dust from electric arc furnace
10 Dalamatic collecting dolomite dust from rotary kiln.
11 Dalamatic filter applied to phosphate conveying system.
12 Dalamatic filter handling dust from feed mill.
13 Dalamatic filters applied to sugar drying and packing.
14 Dalamatic installation collecting dust from animal feed preparation.

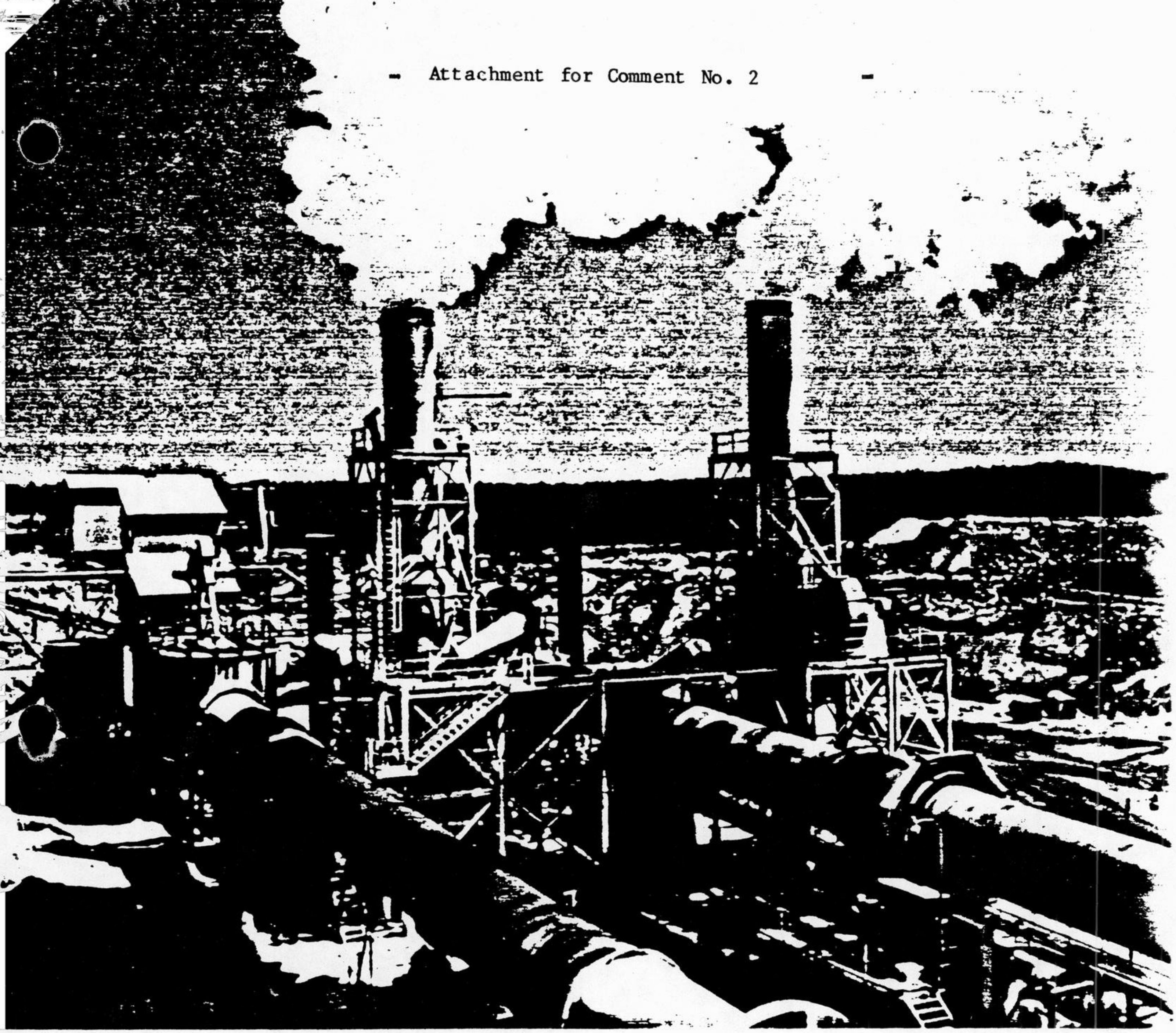


BASIC DALAMATIC INSERTABLE FILTER
Series DLM-V4 Type B



DALAMATIC INSERTABLE FILTER COMPLETE WITH WEATHERPROOF HEADER AND FAN
Series DLM-V20 Type F

Attachment for Comment No. 2



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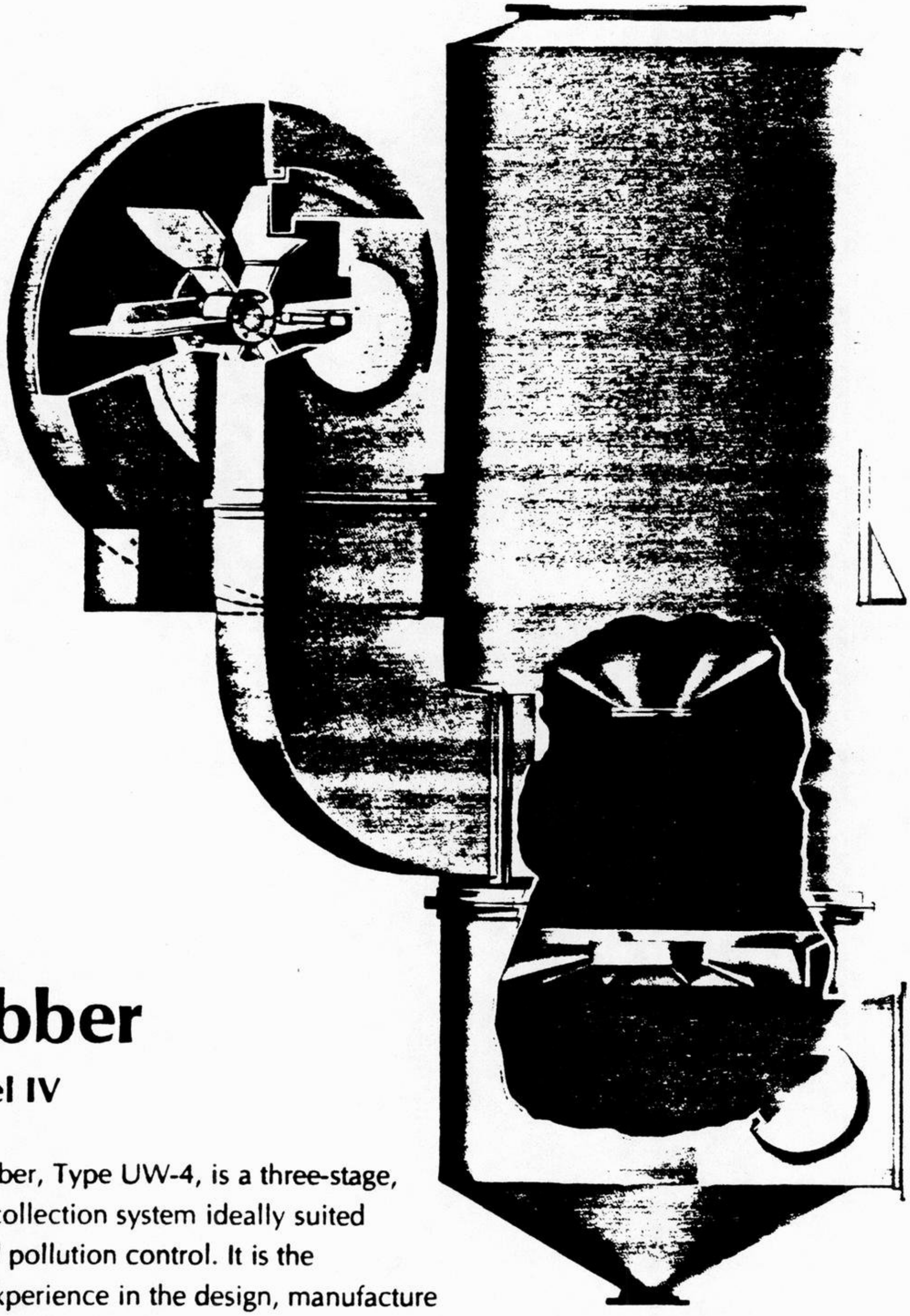
SAN JOSE, CA 95128

DUCON

Dynamic Gas Scrubber

Type UW-4, Model IV

W-7578



Dynamic Gas Scrubber

Type UW-4, Model IV

The Dynamic Gas Scrubber, Type UW-4, is a three-stage, non-plugging, wet dust collection system ideally suited for product recovery and pollution control. It is the result of over 25 years experience in the design, manufacture and application of Dynamic Scrubbers. Hundreds of UW-4 scrubbers are in operation in the mining, fertilizer, chemical, steel, rock products, pulp and paper and allied industries. Its high collection efficiency of up to 99+% in the 1 to 2 micron range is achieved through "Dynamic" action. "Dynamic" scrubbing involves the use of a wet fan to mix gas, dust and water, in extreme turbulence, which forces dust particles into the scrubbing liquid.

Advantages

1. Continuous performance at maximum collection efficiencies.

2. Constant speed of "Dynamic Fan" assures peak performance even when gas flows are as low as 60-70% of design capacity.

3. Ability to handle upset conditions.

4. Built-in fan also acts as prime mover which eliminates need for additional exhaust fan to overcome system resistance external to scrubber. This also results in savings in installation cost.

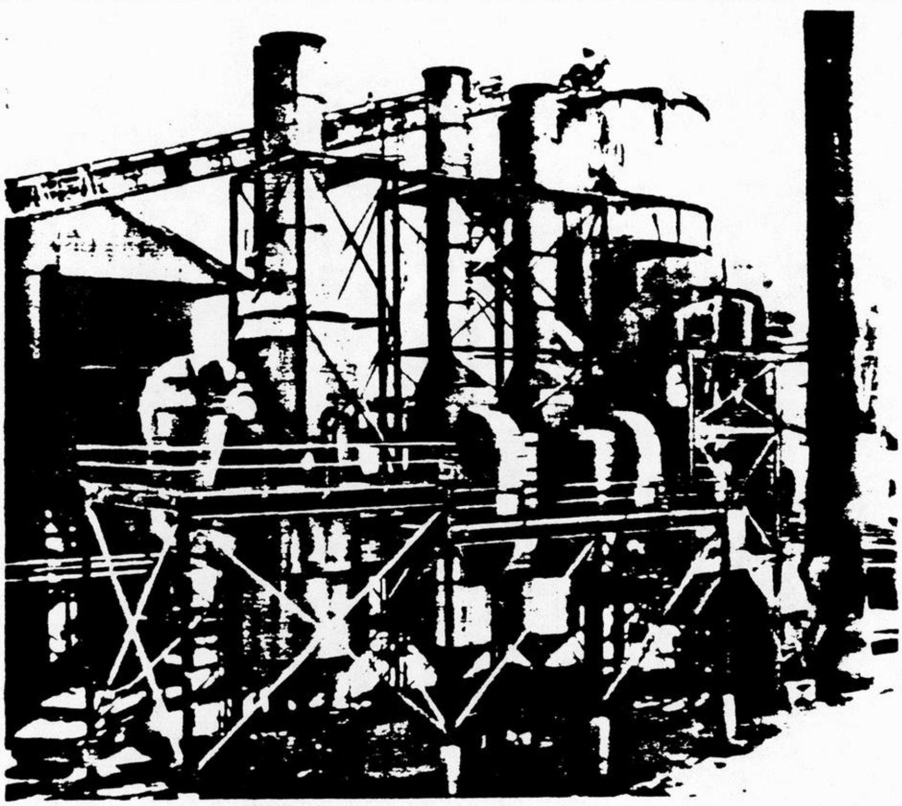
5. Thoroughly wetted fan greatly reduces normal problems of condensation, solids build-up and/or abrasion.

6. No wet/dry areas in system and no small openings to plug.

7. Minimum water usage since scrubbing liquid can be recycled.

8. Instantaneous start-up and shutdown are possible because no water level must be maintained.

9. Low maintenance.



Features

The Ducon Dynamic Scrubber, Type UW-4, has proved to be the most reliable and dependable choice for all drying and calcining kiln applications, pelletizing and sintering plants and for control of all types of material handling such as conveyor transfer points, screens, bins crushers and mills. It is also used in fluid bed processing and in cooling, classifying and general dust ventilation operations.

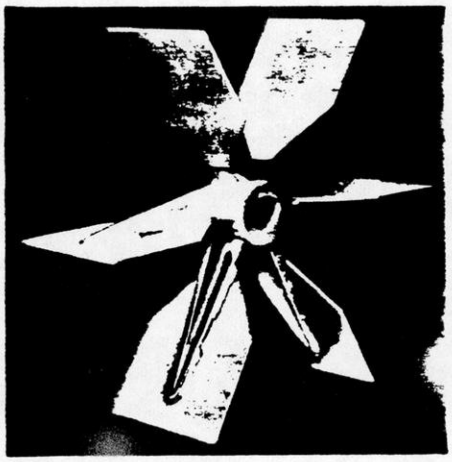
The wide acceptance of Ducon's Dynamic UW-4 Scrubber can be attributed as much to its maintenance-free operation as to its highly efficient performance. On-line performance is maintained even under severe or adverse operating conditions. On rotary limestone kilns, lime hydrators, and lime slakers, which are recognized as being very difficult applications, this unit is used extensively because it has proved to require less maintenance than other scrubber designs.

Two-Stage Pre-Cleaner

The pre-cleaner section of the Dynamic UW-4 scrubber provides several immediate advantages for the system. By eliminating up to 90% of the dust load before the fan section and causing particle growth through cooling and condensation on the remaining suspended particles, it promotes higher operating efficiencies in the two remaining stages.

The wide open design of the pre-cleaner section assures trouble-free, non-plugging operation. Its efficiency and dependability have been proven in hundreds of difficult applications. Complete liquid flushing of the scrubbing vane in the UW-4 scrubber is another important factor in the elimination of build-up and plugging problems.

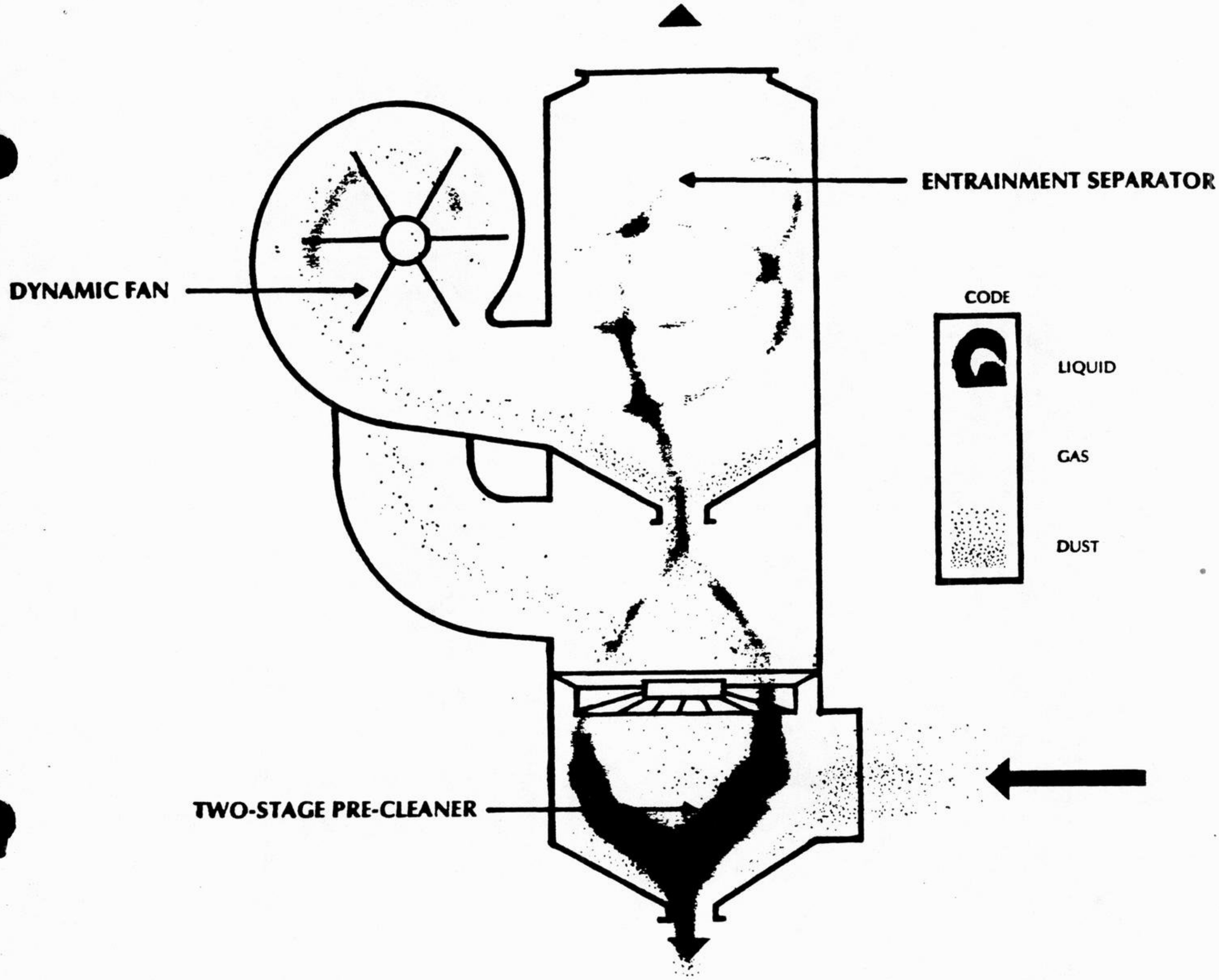
Fan Impeller



The wet "Dynamic Fan" combines the functions of exhaust system prime mover, atomization of scrubbing liquid and agglomeration of atomized liquid with suspended particulate matter. It not only promotes maximum scrubbing efficiency but it also eliminates the problems associated with exhaust fans installed in systems before or after gas scrubbers. When a fan is located on the high temperature inlet side of a scrubber, the fan is subject to considerable abrasion. Fans on the scrubber outlet side on the other hand, are subject to condensation and/or solids build-up on impeller blades with resulting wheel imbalance and in some case, corrosion. The UW-4 scrubber integral fan, however, never comes in contact with a mass of dry abrasive dust and is kept constantly and thoroughly wetted to protect against build-up and minimize the effects of corrosion.

Unique Vane Design

The wide open design of the conoidal impingement vane assures troublefree, non-plugging operation. Its efficiency and dependability has been proven in hundreds of difficult applications. Complete flushing of the vane in the UW-4 is another important factor in the elimination of build-up and plugging problems.



Two-Stage Pre-Cleaner

Dust-laden gases enter the lower part of the scrubber tangentially, resulting in a cyclonic flow thoroughly intermixed with scrubbing liquid. This forces the larger and more abrasive dust particles into the swirling liquid film on the surfaces and then, through the slurry outlet at the bottom. The gases pass through the scrubbing vane which provides: 1. Increased wetted surface area for particle impingement and 2. a swirling action for the mass of gas and liquid in the cylindrical section above. Here, intermediate size particles are collected and then flushed through the vane to the slurry discharge.

Dynamic Fan

The gases which are now conditioned, essentially saturated with water vapor and substantially free of large dust particles, are drawn into the interconnecting fan duct riser along with sufficient liquid from the bottom sections to flush clean the duct internal surfaces and to promote growth by agglomeration, of the remaining fine particles with liquid droplets.

All of the scrubbing liquid for the unit is introduced into the "eye" of the fan, causing complete flushing (cleaning) of all the fan internal surfaces. Fine dust particles are then captured by:

1. Turbulent mixing of gases, liquid and dust particles causing liquid atomization and further particle "growth".
2. Impingement of fine dust particles on rotating wetted blades.
3. Centrifugal forces resulting from high fan wheel tip speeds causing impingement of dust particles and "agglomerates" on the moving film of water which completely covers the fan housing inside surfaces.

Entrainment Separator

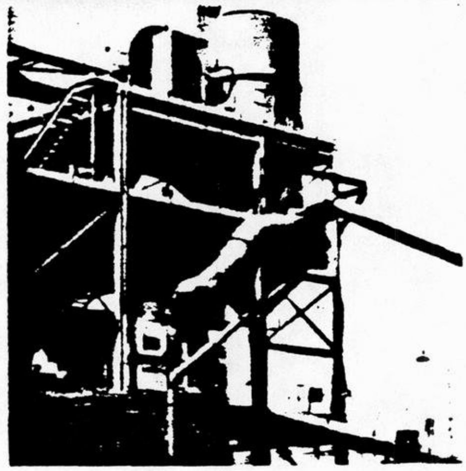
The collected dust and liquid discharge from the fan tangentially into the final section of the scrubber where cyclonic action causes separation of slurry from the gas stream.

The entrainment separator increases gas velocity and directs gas flow so that entrained liquid droplets are thrown against the scrubber wall to descend and discharge through an intermediate cone orifice by gravity to become the liquid feed for the scrubbing vane below. Gases free of liquid droplets, discharge vertically through the scrubber gas outlet.

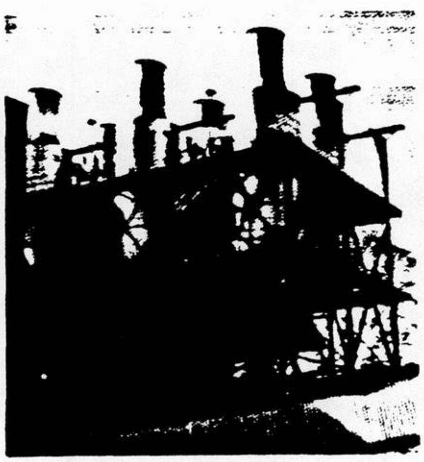
Capabilities

The Dynamic Scrubber, Type UW-4, Model IV is available with two performance capabilities, a standard and a high efficiency design.

The Dynamic Scrubber Type UW-4, Model IV High Efficiency, is an improved design which decreases outlet dust loadings up to 60% as compared to those obtained with prior standard efficiency models of the Dynamic Scrubber. As an example, in performance tests on talc dust, an average outlet dust loading of 0.016 gr/SCFD obtained with a standard Model IV Type UW-4 Scrubber was reduced to 0.006 gr/SCFD using the Model IV HE scrubber. This represents a reduction of 62%.



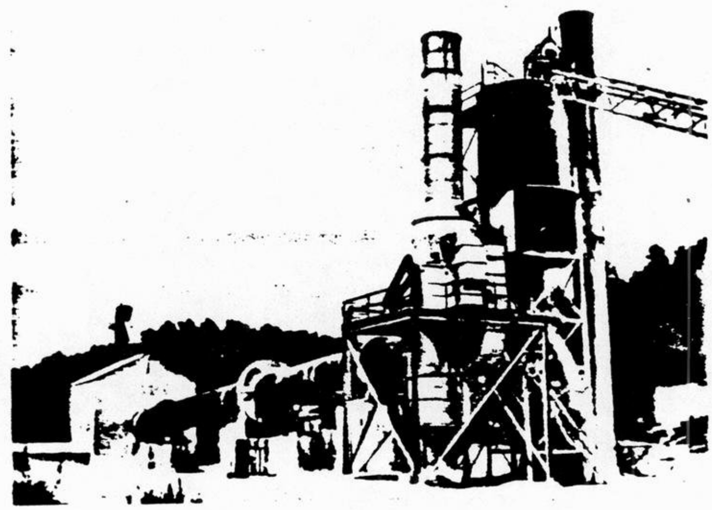
The improved performance of the Dynamic Scrubber, Type UW-4, Model IV HE results from improvements in configuration of unit internals and operating characteristics. The latter includes an increase in horsepower requirement (20-30%) and, in some instances, an increase in scrubbing liquid rate. However, the percentage increase in horsepower and scrubbing liquid requirements are far less than would be anticipated for the degree of improvement attained in scrubber performance.



A Dynamic Scrubber, Type UW-4, Model IV Standard, handling exhaust gases from an expanded aggregate drying kiln, had outlet dust loadings averaging 0.101 gr/SCFD. After upgrading to a Model IV HE Dynamic Scrubber, the average outlet loadings were 0.026 gr/SCFD, a reduction of 75%.

Applications

A partial list of applications includes: calcium hypochlorite • carbon black • clay • copper concentrate dryers • dyes • fertilizer • fluorspar dryers • lime hydrators • limestone • paper grinding • pelletizing • phthalic anhydride • plastics • potash • silica flour • sintering • soda ash • titanium dioxide pigments



SIZE AND HORSEPOWER SELECTION CHARTS FOR DYNAMIC SCRUBBER TYPE UW-4 MODEL IV

STANDARD DESIGN (UW-4S)

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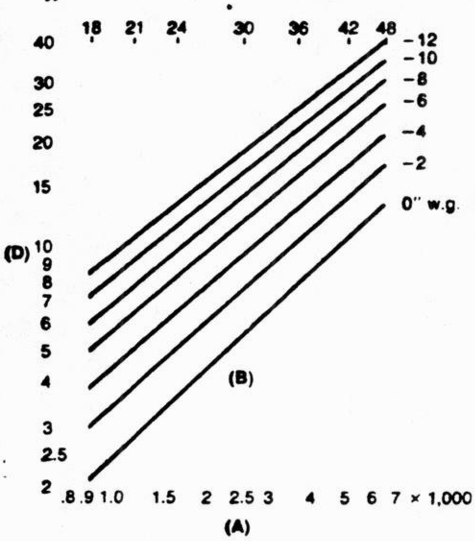

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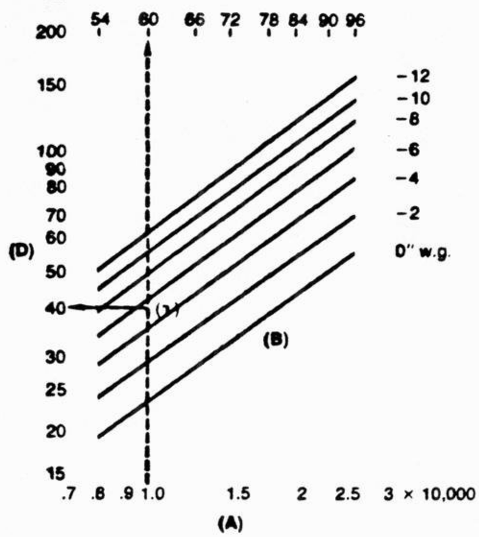

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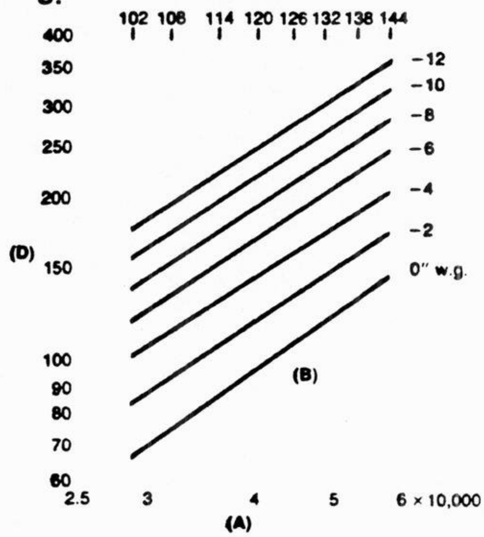
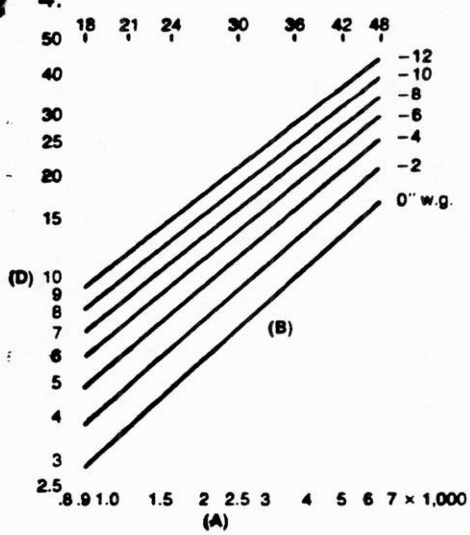


HIGH EFFICIENCY DESIGN (UW-4HE)

4.



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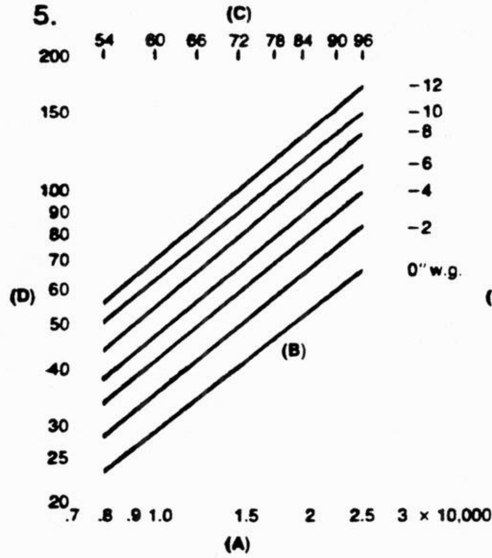

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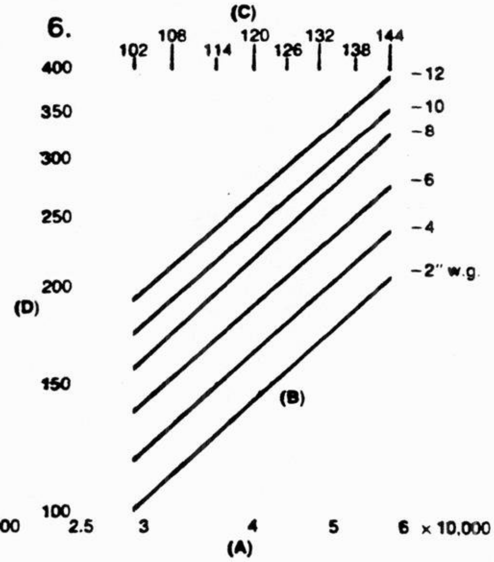

Scale (A) Saturated Gas Volume, ACFM (Scrubber Outlet Conditions)
Curve (B) Inlet Static Pressure converted to standard conditions
Scale (C) Scrubber Size
Scale (D) Brake Horse Power (Gas Density—0.075 #/ft³)

HOW TO USE THE CHARTS

Example (see chart #2)
12,000 acfm at 300°F and −5" wg inlet static pressure and containing 15% water vapor by volume. Barometer −29,92" Hg.

1. Calculate adiabatically saturated gas volume (scrubber outlet) —9,800 acfm at 138°F (gas density = 0.062 #/ft³)
2. Correct −5" wg inlet static pressure for density.
   $-5x \frac{.075}{.062} = -6.0$ wg at standard conditions (at fan inlet)
3. Enter chart on Scale A at 9,800 acfm.
4. Move vertically to 6.0" wg (Curve B-Point 1).
5. From Point 1 move vertically to Scale C and read scrubber Size 60.
6. From Point 1 move left to Scale D and read 42 B.H.P. (Density 0.075 #/ft³)
7. Select 50 H.P. motor.

Size and horsepower selection approximate.

Ducon Service

The Ducon Company has been solving dust control and air pollution problems for more than 40 years. In addition to supplying a broad range of control equipment, including the most versatile and complete selection of scrubbing equipment offered to industry, cyclones and pneumatic conveying systems, Ducon can supply the necessary system engineering and construction management for total engineered and/or installed systems.

Ducon maintains a large staff of sales and service engineering personnel experienced and capable of solving virtually any air pollution or dust control problem. service engineers are available for system services, start-ups, and troubleshooting assignments.

For expert engineering assistance and the highest quality of dust control and air pollution control products available, contact Ducon Mineola or our local representative.

DUCON

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Subsidiary of U.S. Filter Corporation

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MikroPul-Ducon Ltd., Shoeburyness, England
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ENVIRONMENTAL PROTECTION AGENCY	SECTION NEDS	SECTION 3	CHAPTER 7	SUBJECT 0
NATIONAL AIR DATA BRANCH	CHAPTER Source Classification Codes and Emission	DATE 1/3/76		PAGE 5
VOLUME V. AEROS MANUAL OF CODES	SUBJECT Factors			

		POUNDS EMITTED PER UNIT						
		PART	SOX		NOX	HC	CO	UNITS
INTERNLCOMBUSTION -ELECTRIC GENERATN								
DISTILLATE OIL								
2-01-001-01	TURBINE	5.00	190.	S	67.8	5.57	15.4	1000 GALLONS BURNED
2-01-001-02	RECIPROCATING		190.	S				1000 GALLONS BURNED
NATURAL GAS								
2-01-002-01	TURBINE	14.0	990.	S	413.	42.0	115.	MILLION CUBIC FEET
2-01-002-02	RECIPROCATING		940.	S				MILLION CUBIC FEET
DIESEL								
~~2-01-003-01~~	~~RECIPROCATING~~	~~13.0~~	~~190.~~	~~S~~	~~370.~~	~~37.0~~	~~225.~~	~~THOUSANDS OF GALLONS~~
~~2-01-003-02~~	~~TURBINE~~	~~5.00~~	~~190.~~	~~S~~	~~67.8~~	~~5.57~~	~~15.4~~	~~1000 GALLONS BURNED~~
RESIDUAL OIL								
2-01-004-01	TURBINE		159.	S				1000 GALLONS BURNED
JET FUEL								
2-01-005-01	TURBINE		6.20					1000 GALLONS BURNED
CRUDE OIL								
2-01-006-01	TURBINE		196.	S				1000 GALLONS BURNED
PROCESS GAS								
2-01-007-01	TURBINE		950.	S				MILLION CUBIC FEET
OTHER/NOT CLASIFD								
2-01-999-97	SPECIFY IN REMARK							MILLION CUBIC FEET BURNED
2-01-999-98	SPECIFY IN REMARK							1000 GALLONS BURNED
INTERNLCOMBUSTION -INDUSTRIAL								
DISTILLATE OIL								
2-02-001-01	TURBINE	5.00	190.	S	67.8	5.57	15.4	1000 GALLONS BURNED
2-02-001-02	RECIPROCATING	33.5	199.	S	469.	37.5	102.	1000 GALLONS BURNED
NATURAL GAS								
2-02-002-01	TURBINE	14.0	990.	S	413.	42.0	115.	MILLION CUBIC FEET
2-02-002-02	RECIPROCATING		940.	S				MILLION CUBIC FEET
GASOLINE								
2-02-003-01	RECIPROCATING	6.50	5.30		102.	161.	3,940.	1000 GALLONS BURNED
DIESEL FUEL								
2-02-004-01	RECIPROCATING	33.5	199.	S	469.	37.5	102.	1000 GALLONS BURNED
2-02-004-02	TURBINE	5.00	190.	S	67.8	5.57	15.4	1000 GALLONS BURNED
RESIDUAL OIL								
2-02-005-01	TURBINE		159.	S				1000 GALLONS BURNED
JET FUEL								
2-02-006-01	TURBINE		6.20					1000 GALLONS BURNED
CRUDE OIL								
2-02-007-01	TURBINE		196.	S				1000 GALLONS BURNED
PROCESS GAS								
2-02-008-01	TURBINE		950.	S				MILLION CUBIC FEET
2-02-008-02	RECIPROCATING		950.	S				MILLION CUBIC FEET BURNED
OTHER/NOT CLASIFD								
2-02-999-97	SPECIFY IN REMARK							MILLION CUBIC FEET BURNED
2-02-999-98	SPECIFY IN REMARK							1000 GALLONS BURNED

'A' INDICATES THE ASH CONTENT, 'S' INDICATES THE SULFUR CONTENT OF THE FUEL ON A PERCENT BASIS (BY WEIGHT)

Response:

Fugitive dust emissions resulting from construction of the access road are included in the estimated total provided for the mine/mill site in Table 1.1 of the January 24, 1984 letter on the air permit application. Clearing of trees, brush and other materials within the access road 30.5 m (100 ft) corridor will occur over approximately 15 ha (37.1 acres). The access road from shoulder to shoulder will encompass an estimated 12.2 m (40 ft) of this corridor; therefore, construction activities for this area including excavation were assumed to be approximately half of the 15 ha (37.1 acres), or 8 ha (19.8 acres). For the railroad spur, the cleared area estimate is for a 30.5 m (100 ft) corridor totalling 18 ha (44.5 acres). The actual railroad spur excavation construction activity was assumed to be approximately half of this area, or 9 ha (22.2 acres). Similarly for the mine/mill site, the cleared area is approximately 46 ha (113.7 acres), but the excavation construction activities were estimated to involve approximately 25 ha (61.8 acres).

Therefore, the estimated excavation construction activities total approximately 42 (25 + 8 + 9) ha or 104 acres (42 x 2.47 acres/ha). This acreage estimate incorporating the access road and railroad spur was utilized in the calculations for the response to Comment No. B1 of the January 24, 1984 letter on the air permit application.

Comment No. 6:

Provide information describing the baghouse used for emissions control on preproduction ore crushing.

Response:

The baghouse presently included in our design will be similar to a DCE Vokes Model DLM 1/3/10 with 315 sq ft of 16-oz dacron filter material and an air to cloth ratio of 5.6 (cfm) per 1.0 (ft^2). The vendor supplied brochure in the response to Comment No. 1 describes the principles of operation and other detailed specifications.

Comment No. 7:

Describe derivation of particle size ranges used for determination of settling rates for mine blasting emissions.

Response:

The particle size range used for mine blasting TSP emissions was <30 um as stated in EPA AP-42, Table 8.24-2 for surface blasting (May 1983). Emissions in this size range were then compared with EPA Appendix A, Table A-1, p. A-3, dated February 1972 (attached) for Mineral products, Stone quarrying and processing-Crushing in which the percentage distribution by particle size is:

Table A-1. PERCENTAGE DISTRIBUTION BY SIZE OF PARTICLES FROM SELECTED SOURCES WITHOUT CONTROL EQUIPMENT

Type of source	Particles by size range, %				
	<5 μ	5 to 10 μ	10 to 20 μ	20 to 44 μ	>44 μ
Stationary combustion					
Bituminous coal					
Pulverized	15	17	20	23	25
Cyclone	65	10	8	7	10
Stoker	4	6	11	18	61
Anthracite coal	35	5	8	7	45
Fuel oil	50	NA[a]	NA	NA	0
Natural gas	100	-	-	-	-
Solid waste disposal					
Refuse incineration	12	10	15	18	45
Mobile combustion					
Gasoline-powered motor vehicles	100	-	-	-	-
Diesel-powered motor vehicles	63	NA	NA	0	0
Aircraft	100	-	-	-	-
Chemical process					
Phosphoric acid	100	-	-	-	-
Soap and Detergents	5	15	40	30	10
Sulfuric acid	100	-	-	-	-
Food and agriculature					
Alfalfa dehydrating	Average size 2 to 10 μ		-	-	-
Cotton ginning	NA	NA	NA	NA	40
Feed and grain	5	15	20	45	15
Fish meal	1	1	3	8	87
Phosphate fertilizer	6	6	10	8	70
Metallurgical					
Primary aluminum	13	12	12	13	50
Primary zinc	14	17	40	NA	NA
Iron and steel					
Sintering	0	0	0	15	85
Blast furnace	NA	NA	NA	NA	70
Open hearth	46	22	17	10	5
Basic oxygen	99.5	0.5	0	0	0
Bessemer converter	-	-	-	100	-
Secondary aluminum	34	30	23	10	3
Brass and bronze	100	-	-	-	-
Gray iron foundry	18	8	12	14	48
Secondary lead	95	3	2	0	0
Secondary steel	60	14	11	9	6
Secondary zinc	100	-	-	-	-
Mineral products					
Asphalt batching	35	25	17	20	3
Asphalt roofing	100	-	-	-	-
Ceramic clay	36	NA	NA	40	6
Castable refractories	100	-	-	-	-
Cement	22	25	25	20	8
Concrete	13	21	27	25	14
Frit	45	15	15	15	10
Glass	26	NA	NA	NA	0
Gypsum	95% <10 μ		NA	NA	NA

- Attachment for Comment No. 7 -

Table A-1 (continued). PERCENTAGE DISTRIBUTION BY SIZE OF PARTICLES FROM SELECTED SOURCES WITHOUT CONTROL EQUIPMENT

Type of source	Particles by size range, %				
	<5 μ	5 to 10 μ	10 to 20 μ	20 to 44 μ	>44 μ
Mineral products (continued)					
Lime	2	8	24	38	28
Mineral wool	0.5	2.5	10	27	60
Perlite	32	10	10	13	35
Phosphate rock	80	15	5	0	0
Stone quarrying and processing					
Crushing	5	5	5	10	75
Conveying and screening	30	20	20	18	12
Petroleum refinery					
Catalyst regenerator	50	15	NA	NA	NA
Wood processing					
Fiberboard	NA	NA	NA	NA	25

[a]NA = no further breakdown of particle distribution available.

Particles by Size Range %

<5 um	5 to 10 um	10 to 20 um	20 to 44 um	>44 um
5	5	5	10	75

Since blasting produces emissions <30 um, the 20 to 44 um percentage of 10 was halved, leaving four size ranges with equal percentages. Therefore, the four predominate particle size ranges used for estimating the TSP emissions included the following distributions:

Particles by Size Range %

<5 um	5 to 10 um	10 to 20 um	20 to 30 um
25	25	25	25

Comment No. 8:

Describe how the estimate of 20 stope blasts per year was determined.

Response:

The estimate of 20 stope blasts per year was determined by dividing the estimated peak tonnage of ore extracted from the mine in any given year (3,276,000 t [3,611,000 st]) by the tonnage contained within a typical designed stope block blast (163,400 t/blast [180,100 st/blast]). The 163,400 t/blast is one-half of the total tonnage contained in a typical stope block. The design stope height is 120 m (395 ft), which is halved to allow for drilling (for blasting) from two mine levels. Separation of a stope block blast is necessary because of the drilling equipment limitations. Therefore, approximately 20 stope blasts or 10 complete stope blocks are estimated to be blasted for the estimated peak tonnage in any given year.

Comment No. 9:

Provide the source used for determination of the vertical gravity settling velocities in the mine.

Response:

The settling velocities used to determine gravity settling parameters in the mine were obtained from a TRC Environmental Consultants, Inc. 1981 publication titled "Coal Mining Emission Factor Development and Modeling Study." In the study, settling velocities were derived by an analytical procedure based upon field acquired dustfall data. Determination of actual settling velocities are presented in Part 1, pp. 13-23, Table 3.2 of the report. The data presented on p. 20 (Attachment 1) were used and extrapolated/interpolated for a density of 3.0 g/cm^3 (i.e., the density of Crandon rock to be blasted). The calculated settling velocities are presented in Attachment 2.

Attachment No. 1 for Comment No. 9

TABLE 3.2

STOKES LAW SETTLING VELOCITY (m/sec)

PARTICLE DIAMETER (μm)	PARTICLE DENSITY (g/cm^3)		
	ρ = 1.5	ρ = 2.0	ρ = 2.5
2	.00018	.00024	.00030
10	.0046	.0061	.0076
25	.0286	.038	.048
40	.073	.097	.122
55	.138	.184	.230
65	.193	.257	.322
70	.224	.298	.373
85	.330	.44	.55
90	.370	.49	.62
100	.457	.61	.76
115	.604	.81	.1.01
130	.772	1.03	1.29

NOTE: ρ = 1.5 was utilized for Coal Dump Samples;

ρ = 2.0 was utilized for Coal Haulroad Samples; and

ρ = 2.5 was utilized for All Other Tests.

Attachment No. 2 for Comment No. 9

CRANDON PROJECT

Modified Stokes Law Settling Velocities (m/sec)
(In response to Comment No. 9)

Particle Diameter (um)	Particle Density (g/cm^3) P = 1.5	P = 2.0	P = 2.5	P = 3.0
2	.00018	.00024	.00030	.00036*
5[a]	.00184*	.00244*	.00304*	.00364*
7.5	.00322*	.00427*	.00532*	.00637*
10	.0046	.0061	.0076	.0091*
15	.0126*	.0167*	.0211*	.0254*
25	.0286	.0380	.048	.0580*
30	.0434*	.0577*	.0727*	.0877*
40	.0730	.097	.122	.147*

*Extrapolated/interpolated values.

a. Example Calculation:

1) Determine the 2 um particle settling velocity at 3.0 g/cm^3

	P = 1.5	P = 2.0	P = 2.5	P = 3.0
	.00018	.00024	.00030	
Difference:	.00006	.00006	+.00006 = .00036	

2) To determine the 5 um particle settling velocity at 3.0 g/cm^3 density

a) First, derive the particle settling velocity at 3.0 g/cm^3 density for 10 um as in 1) above.

b) Next, determine the difference between 2 and 10 um particle settling velocities at 3.0 g/cm^3 density (i.e., 0.0091 - 0.00036 = 0.00874)

3) Then, multiply that difference by a proportion determined from

$$\frac{5\text{ um} - 2\text{ um}}{10\text{ um} - 2\text{ um}} = 3/8 \times 0.00874 = 0.00328$$

4) Add 0.00328 to 0.00036 = 0.00364 m/sec at 5 um

Comment No. 10:

Provide the manufacturer's brochure for the insertable dust collectors used for control of dust emissions near the primary crusher in the mine. Also provide the source of particle sizes for mine emission sources.

Response:

The responses submitted in our January 24, 1984 letter on the air permit application stated that emissions from coarse crushing and subsequent transfer operations will be controlled with insertable dust collectors similar to DCE Vokes Model No. DLM-V 45/15 F1. The manufacturer's brochure provided in response to Comment No. 1 of this letter describes the principles of operation and other detailed specifications.

The particle size distributions for rock handling presented in the January 24, 1984 letter were as stated from EPA AP-42, Appendix A, Table A-1, p. A-3, Stone quarrying and processing-Crushing. (See also the response to Comment No. 7 of this letter.)

Comment No. 11:

Will all mine air heating be performed on the surface at one location by direct fired heaters. What is the estimated peak hourly and annual fuel usage?

Response:

Mine air heating will be performed at two separate locations on the surface. They are: 1) the main shaft, and 2) the intake air shaft. No additional heating of mine air is planned underground other than that provided indirectly from sources such as the rock mass, equipment, and adabiatic compression of air as it descends the intake air shafts. The two heaters located at the intake shaft collars require a maximum of 91,800 SCF/hr of natural gas on a -25°F day; however, the units will be capable of consuming 100,000 SCF/hr (i.e., the combined total rated capacity). Yearly maximum consumption of natural gas for mine air heating is estimated to be 110,600,000 SCF.

Comment No. 12:

The estimated TSP emissions for the mine/mill site in-plant gravel roads for heavy duty diesel vehicles in response to Comment No. D5 of the January 24, 1984 air permit letter should be 1.9 st/yr instead of 1.6 st/yr and the total estimated TSP emissions for employee and plant operation traffic should be 49.2 st/yr instead of 48.9 st/yr.

Response:

Because of a rounding difference, the emission factor used for the heavy duty diesel vehicles (HDDV) was 0.5 instead of 0.6 lb/veh-mile. The estimated TSP emissions for HDDV should be 1.9 st/yr. Therefore, the total estimated TSP emissions (uncontrolled) should be 11.3 instead of 11.0 st/yr. The total estimated TSP emissions (controlled) should be 5.7 instead of 5.5 st/yr, and the total for employee and plant operation traffic should be 49.1 instead of 48.9 st/yr. The revised air permit application will include these changes. (See also Revised Table 1.1 in the response to Comment No. 13 of this letter.)

Comment No. 13:

Tabulation of the emission estimates beginning on p. 62 of the January 24, 1984 response letter shows TSP emissions from MWDF construction of 71.8 st/yr. Where is this number included in Table 1.1?

Response:

The 71.8 st/yr TSP estimate was included in the estimated 96.3 st/yr for construction of each tailing pond. The derivation of the 96.3 st/yr estimate is as follows.

Hauling emissions to and from the MWDF as well as excavated till hauling emissions were calculated based on soil material volumes presented in the air permit application. These soil material volumes were based on a 2-1/2 year construction period for each pond with 40%, 40% and 20% completed in the first, second and third years, respectively. Construction of each pond is now scheduled to be completed in 2 years rather than 2-1/2. Therefore, the 71.8 st/yr hauling emissions estimate was increased by 5/4 to 89.75 st/yr. The estimate also included wind-blown TSP emissions of 6.53 st/yr as shown in Table 2.6 of the air permit application. The estimated combination of hauling and wind-blown TSP emissions was 96.3 st (89.75 + 6.53 st) as shown on Table 1.1 of the air permit response letter of January 24, 1984.

Emissions from other MWDF construction related activities such as site clearing, surface excavation and scraping were included in the 112.8 st/yr estimate shown on Table 1.1 for site preparation.

Since the review meeting with the DNR on February 29, 1984, we have recalculated the MWDF construction emissions to account for several factors: 1) use of the latest EPA AP-42 emission factors for loading and dumping, and 2) to further incorporate current design criteria into our calculations; e.g., a 2 year construction period instead of 2-1/2, the inclusion of emission calculations for each pond rather than assuming equal emissions from each pond, the use of the current estimated excavated soil material volumes and haul miles traveled, and a revised wind-blown emission factor as presented in the January 24, 1984 air permit response letter. .

Site preparation TSP emissions are the same as those shown in Table 1.1 of the January 24, 1984 air permit response letter. Revised estimates for the waste rock handling and individual tailing ponds construction are shown on the attached table (Revised Table 1.1). The attached table (Revised Table 1.1) also includes estimates of the other construction related activities for the tailing ponds such as hauling, loading and dumping, and wind-blown TSP emissions in the total number. The calculations for the revised TSP estimates are presented following the revised Table 1.1. Till excavation is now assumed to occur equally over two years. Other activities such as loading and dumping, and hauling of other construction soil materials (i.e., drain layer, liner) were conservatively assumed to be completed in the second year of each pond construction which represents the difference (see Revised Table 1.1) between the emissions in the first and second year for construction of each pond.

Revised Table 1.1 (In response to Comment Nos. 12, 13, 14, 15, 17, 20, 21, 24 and 25)

Schedule associated with Project activities during construction and operation phases and the estimated TSP air emissions from proposed sources (st/yr).

	CONSTRUCTION				OPERATION																	
Project Activities ( )**	1986	1987	1988	1989	1990	1991-92	1993	1994	1995	1996	1997	1998-2000	2001	2002	2003	2004	2005-06	2007	2008	2009	2010	2011-15
Site Preparation (trees & brush)																						
1. Mine Shafts (A1)	17.6																					
2. Mill/Mill Site (A3, B1)	77.3																					
3. MWDF Area (14)		112.8***					112.8					112.8[a]					112.8[b]					
4. Access Road/Powerline (A3, D5, D7)	2.7	3.2	3.24	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5. Railroad Spur (A3, D4)	4.2	0.14	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
6. Haul Road (B1)	4.0																					
7. Water Discharge Pipeline (B5)	10.2																					
8. In-Plant Roads (B2, D5) (12)	4.8	49.1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
9. Mobile Sources (Table 2.3)	8.0	*	*	*																		
10. Concrete Batch Plant (Table 2.3)	2.7	*	*	*																		
Construct Mine Support Facilities																						
1. Sink Main Shaft (15)	5.9	2.7																				
2. Sink and equip air intake shaft (15)	2.6	2.1																				
3. Construct east exhaust shaft (15)			2.0																			
4. Construct west exhaust shaft (15)				2.0																		
5. Power Generation (A2, C3)	4.2	0.2	*	*																		
Construct Major Surface Facilities																						
1. Construct Reclaim Pond R1 (17)	59.3																					
2. Construct Reclaim Pond R2 (17)		18.0	18.0																			
3. Construct Temporary Ore Storage Pad	Included in Mine Shafts																					

Project Activities ( )**	CONSTRUCTION				OPERATION																	
	1986	1987	1988	1989	1990	1991-92	1993	1994	1995	1996	1997	1998-2000	2001	2002	2003	2004	2005-06	2007	2008	2009	2010	2011-15
Construct MWDF Facilities																						
1. Construct Tailing Pipeline (21)			6.0	6.0																		
2. Install Liner (E4)	1.0		1.0	1.0				1.0	1.0				1.0	1.0				1.0	1.0			
a. Hauling of bentonite to MWDF (E1)			0.9	0.9	0.9			0.9	0.9				0.9	0.9				0.9	0.9			
3. Waste Rock Handling (13)																						
a. Loading and Dumping		0.01	0.07	0.1	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
b. Hauling	0.35	2.1	23.7	35.6	9.23	9.23	9.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23	4.23
4. Construct Tailing Pond T1 (13)			46.8	57.2																		
5. Construct Tailing Pond T2 (13)								66.8	79.6													
6. Reclaim Tailing Pond T1 (17)										49.0	49.0											
7. Construct Tailing Pond T3 (13)													55.8	65.6								
8. Reclaim Tailing Pond T2 (partial) (17)															64.8							
9. Construct Tailing Pond T4 (13)																		73.1	83.9			
10. Reclaim Tailing Pond T3 (17)																				60.5	60.5	
Underground Mine Development																						
1. Develop Drifts and Stopes (15)	0.01	0.09	1.7	3.7																		

Project Activities ( )**	CONSTRUCTION				OPERATION																	
	1986	1987	1988	1989	1990	1991–92	1993	1994	1995	1996	1997	1998–2000	2001	2002	2003	2004	2005–06	2007	2008	2009	2010	2011–15
Mine Production																						
1. Initial (15)					4.2																	
2. Full (C1)																						
a. Blasting						13.6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
b. Rock handling						7.9	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
c. Mobile equipment						5.5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d. Mine air heating						0.6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Mill/Concentrator Operations																						
1. Coarse Ore Transport (20)		0.3	4.7	3.4	10.0	*																
2. Crushing and Screening (24)					8.4	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3. Fine Ore Loading (Table 2.4)					0.7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4. Fine Ore Unloading (Table 2.4)					1.1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5. Concrete Batch Plant (D3)					0.1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
6. Facility Heating (25)					0.9	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
7. Emergency Diesel Generators (C3)					0.2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
TOTAL	204.9	201.4	168.3	173.3	88.2	110.7	213.5	164.4	177.2	144.7	144.7	208.5	153.4	163.2	160.5	95.7	208.5	170.7	182.0	156.2	156.2	95.7

* Means previous annual estimate is used for this year.

** Number within parentheses identifies January 24, 1984 air permit response letter, this letter, or the air permit application source for the information.

*** ___ This letter is the source of the information.

[a] In the year 2000 only.

[b] In the year 2006 only.

Example Calculations: MWDF Construction Emissions (TSP)

MWDF construction activities are separated into four categories for calculation of TSP emission estimates.

1. General construction: This includes clearing the land and surface earthwork (excavation to approximately 10 ft). This estimate uses the primary emission factor from AP-42 for construction activities for project facilities. However, where deep excavation (greater than 10 ft) and major hauling of soil material within the excavated area is involved, the TSP emissions from hauling, and loading and dumping of the soil material was calculated separately (i.e., in addition to the general construction emissions).

Emission Factor and Source: 1.2 st/acre/month; EPA AP-42, Section 11.2.4

Clearing and excavation (i.e., heavy construction):

Assume: Based on largest surface area disturbed in one year - Tailing Pond T1 - 94 acres

Duration: 12 months (94 ÷ 12 = 7.83 acres/month)

TSP = 1.2 st/acre/month x 7.83 acres/month x 12 months/yr = 112.8 st/yr

2. Hauling: TSP emissions generated by hauling excavated till within the pond construction area, within the MWDF boundary, and between the mine/mill site and MWDF.

Emission Factor and Source: EPA AP-42, Section 11.2.1

$$TSP\text{-}EF = (0.8)(5.9)(s/12)(S/30)^2(W/3)^{0.7}(w/4)^{0.5}(d/365) = \text{lb/veh-mile}$$

TSP-EF = suspended particulates - lb/veh-mile

s = silt content of road material - %
S = vehicle speed (mph)
W = average vehicle weight - st
w = number of wheels on vehicle
d = dry days/year - 230

Assume: Pond with largest quantity of soil material (till) excavation - Tailing Pond T4 (i.e., average excavation is 40 ft - upper 10 ft included in emissions from general construction). Therefore, 75% of excavated till haulage is within the pond area.

$$TSP\text{-}EF = (0.8)(5.9)(15/12)(15/30)^2(63/3)^{0.7}(4/4)^{0.5}(230/365)$$
$$= (4.72)(1.25)(0.25)(8.42)(1)(0.63) = 7.82 \text{ lb/veh-mile}$$

Emissions (controlled) = 7.82 lb/veh-mile x 34,434 miles x st/2000 lb x 0.5*
= 67.3 st

See also attached Table 13-2.

---

*50% control with watering.

3. Loading and Dumping:

Emission Factor and Source: EPA AP-42, Section 11.2.3

$$TSP\text{-}EF = (k)(0.0018)\,\frac{(s/5)(U/5)(H/5)}{(M/2)^2(Y/6)^{0.33}} = \text{lb/st}$$

TSP-EF = emission factor - lb/st

k = particle size multiplier (dimensionless) - 0.73
s = silt content - %
U = wind speed (mph) - 7.2 mph (Crandon Project EIR, p. 2.1-17)
H = drop height - ft
M = material moisture content - %
Y = capacity of dumping device (yd^3)

Assume: Construction of Tailing Pond T-4:

$$TSP\text{-}EF_{(Loading\ Till)} = (0.73)(0.0018)\,\frac{(15/5)(7.2/5)(3/5)}{(2/2)^2(4.5/6)^{0.33}} = 0.0037\ \text{lb/st}$$

Emissions (uncontrolled) = 0.0037 lb/st x 82,800 yd^3 x 2970 lb/yd^3 x st/2000 lb x st/2000 lb = 0.23 st

See also attached Table 13-3.

4. Wind-blown:

Emission Factor and Source: Guide for Wind Erosion Control on Cropland in Great Plains States, Craig and Turelle, USDA-SCS, July 1964, in: Evaluation of fugitive dust emissions (PEDCo, 1976).

TSP-EF = aIKCLV

TSP-EF = st/acre/yr

a = total of wind erosion losses measured as suspended particulates (0.01 for ponds and storage area and 0.025 for haul roads)

I = soil erodibility factor (st/acre/yr) (134 for ponds and storage areas and 38 for haul road)

K = surface roughness factor - 1.0

C = climate factor; 0.05 for Crandon site area

L = unsheltered field width; 0.7 to 1.0 for Crandon site area

V = vegetative cover factor - 1.0

See Air Permit Application

Source	Acreage	Control*	Emission Factor	Emission (st/yr)
Haul Road	16	0.85	0.03325 st/acre[a]	0.18
Storage Area	20	0.85	0.0469 st/acre	0.14
Ponds	119	--	0.0469 st/acre	5.58
				5.80

*85% control with watering and chemical stabilization.

a. Factor of 0.3325 listed in air permit application was a typographical error. (See also air permit response letter of January 24, 1984.)

Table 13.1 Summary of Estimated MWDF Construction Emissions (TSP) - st/yr*

		Year 1	Year 2
Tailing Pond T-1 (1988-1989)	Hauling	41	49.6
	Loading and Dumping	--	1.8
	Wind-blown	5.8	5.8
		46.8	57.2
Tailing Pond T-2 (1994-1995)	Hauling	61	71.1
	Loading and Dumping	--	2.7
	Wind-blown	5.8	5.8
		66.8	79.6
Tailing Pond T-3 (2001-2002)	Hauling	50.0	57.71
	Loading and Dumping	--	2.1
	Wind-blown	5.8	5.8
		55.8	65.6
Tailing Pond T-4 (2007-2008)	Hauling	67.3	75.7
	Loading and Dumping	--	2.4
	Wind-blown	5.8	5.8
		73.1	83.9

*See Revised Table 1.1

5. Waste Rock Handling (See also 6. in Table 13-2)

Hauling

$$\text{TSP-EF} = (0.8)(5.9)(6/12)(15/30)^2(51/8)^{0.7}(6/4)^{0.5}(0.63) = 3.3 \text{ lb/veh-mile}$$

Emissions (controlled) = 3.3 lb/veh-mile x 1400 veh-miles x st/2000 lbs x 0.15*
= 0.35 st/yr

Year	Waste Rock Hauled (k-st)	Miles Traveled (k)	Controlled Emissions (st/yr)**
1986	1,144	1.4	0.35
1987	66	8.3	2.1
1988	761	95.7	23.7
1989	1,144	143.8	35.6
1990-1993	297	37.3	9.23
1994-2015	136	17.1	4.23

*85% control with watering and chemical stabilization.

Loading and Dumping

$$\text{TSP-EF}_{(\text{Loading})} = (0.73)(0.0018)\frac{(1.6/5)(7.2/5)(4/5)}{(4/2)^2(7/6)^{0.33}} = 0.00012 \text{ lb/st}$$

$$\text{TSP-EF}_{(\text{Dumping})} = (0.73)(0.0018)\frac{(1.6/5)(7.2/5)(4/5)}{(4/2)^2(28/6)^{0.33}} = 0.000073 \text{ lb/st}$$

Combined = 0.000193 lb/st for loading and dumping

Year	Waste Rock (k-st)	Emissions (st/yr)**
1986	11	---
1987	66	0.01
1988	761	0.07
1989	1,144	0.11
1990-1993	297	0.03
1994-2015	136	0.01

**See also Revised Table 1.1

Table 13-2. Source Inputs for Emission Factor in Estimating Hauling Emissions of Tailing Pond T-4

Source	s	S	w	W	d	Emission Factor lbs/veh-mile	Control Efficiency	Soil Material Moved k-yd^3	Miles Traveled	Emissions (st)
1. Hauling excavated till within pond	15	15	4	63	230	7.82	50%[a]	1,913[c]	34,434	67.3
2. Bentonite/soil to pond	6	15	6	30	230	2.27	85%	90[d]	5,012	0.85
3. Underdrain to pond	6	15	6	30	230	2.27	85%	264[d]	12,375	2.11
4. Filter material to pond	6	15	6	16	230	2.27	85%	383[d]	20,826	3.55
5. Rip-rap to pond	6	15	6	16	230	2.27	85%	237[d]	11,109	1.89
6. Waste rock to MWDF	6	15	6	51	230	3.31	85%[b]	108.8	17,097	4.2

a. 50% control with watering.

b. 85% control with watering and chemical stabilization.

c. Each of the two years of construction.

d. All in second year of T-4 construction.

Table 13-3. Source Inputs for Emission Factor in Estimating Loading and Dumping Emissions

Source	s	U	H Loading	H Dumping	M	Y Loading	Y Dumping	Soil Material (k-st)	Emission Factor (lb/st) Loading	Emission Factor (lb/st) Dumping	Emissions (st) Loading	Emissions (st) Dumping
1. Till at batch plant	15	7.2	3	3	2	4.5	8	122	0.0037	0.0031	0.23	0.19
2. Underdrain	1.6	7.2	3	3	4	4.5	9.6	330	0.0001	0.00008	0.017	0.013
3. Rip-rap	1.6	7.2	3	3	4	4.5	9.6	296	0.0001	0.00008	0.015	0.012
4. Filter	15	7.2	3	3	2	4.5	8	569	0.0037	0.0031	1.05	0.88

Table 13.4 Input to Hauling Emissions Calculations for MWDF

Activity	Vehicle Size	Material Bulk Density	Round Trip Distance/Haul	Volume of Material Moved by Area (k-yd^3) T-1	T-2	T-3	T-4
1. Excavation	25 yd^3	2970 lb/yd^3	0.45 mi	3,068	4,652	3,750	5,100
2. Soil/Bentonite mixture	12 st	2970 lb/yd^3	0.45 mi	95	99	82	90
3. Underdrain	12 st	2500 lb/yd^3	0.45 mi	288	296	234	264
4. Filter material	12 st	2900 lb/yd^3	0.45 mi	280	460	357	383
5. Rip-rap	12 st	2500 lb/yd^3	0.45 mi	353	318	222	237

Comment No. 14:

How was the MWDF area TSP estimate of 112.8 st derived?

Response:

The surface area of construction disturbance for Tailing Pond T1 is estimated to be approximately 94 acres. Using the emission factor of 1.2 st/acre from EPA AP-42, the estimated TSP emissions are 112.8 st assuming these construction activities occur in one year. (See also the response to Comment No. 13 of this letter.) Because many areas of the additional tailing ponds are part of the previous construction activities (i.e., common embankment sections), it was assumed that 94 acres represents the additional surface area disturbance for the other ponds. Therefore, the estimated TSP emissions of 112.8 st was used for the early construction activities for the other tailing ponds. (See also Revised Table 1.1 in the response to Comment No. 13 of this letter.)

Comment No. 15:

Provide a description of the method used in determining construction emissions from sinking of the main shaft, intake air shaft, east exhaust shaft, west exhaust shaft and general underground development.

Response:

The procedure used to estimate TSP emissions from the different shaft sinkings (i.e., main, intake air) and general underground development is presented under its respective heading below. The estimated yearly TSP emissions for the different shaft sinkings were presented in Table 1.1 of the January 24, 1984 air permit response letter under the heading Construct Mine Support Facilities. The general underground development TSP emission estimates were presented in Table 1.1 under the heading of Underground Mine Development. However, these numbers have been recalculated based on the current design criteria. Therefore, revised Table 1.1 (See the response to Comment No. 13 of this letter) presents the estimated TSP emissions as calculated below.

Underground Blasting Emissions - Blasting using dynamite

Emission Factor and Source: AP-42, Table 8.24-2, Blasting - Surface Coal Mining

TSP-EF for emitted particles of less than or equal to 30 um

$$\text{TSP-EF} = \frac{344\ (A)^{0.8}}{(D)^{1.8}(M)^{1.9}}$$

where:

A = area blasted - m^2
D = hole depth - m
M = material moisture content - %

Main Shaft Sinking

A = $(8.5\ m/2)^2 \times 3.14 \div 2 = 28.36\ m^2$ (i.e., one half of area/blast)
D = 2.12 m
M = 15%

$$TSP\text{-}EF = \frac{344(28.36)^{0.8}}{(2.12)^{1.8}(15)^{1.9}} = 7.5\ kg/blast \times 2\ blasts/day = 15.1\ kg/d$$

Process Rate:

2 blasts/day, 30 blast days/month and 514 blast days/17 months

Example Calculation:

514 blast days/17 months x 15.1 kg/day x t/1000 kg = 7.8 t/17 months

Total TSP (Sink Main Shaft) = 8.6 st/17 months (1986-87) - (see also Revised Table 1.1 in Comment No. 13 of this letter)

Sink and Equip Air Intake Shaft

A = $(6.1\ m/2)^2 \times 3.14 \div 2 = 14.6\ m^2$ (i.e., one half of area/blast)
D = 2.12 m
M = 15%

$$TSP\text{-}EF = \frac{344(14.6)^{0.8}}{(2.12)^{1.8}(15)^{1.9}} = 4.4\ kg/blast \times 3\ blasts/day = 13.3\ kg/d$$

Process Rate:

3 blasts/day, 75 blast days/month and 326 blast days/10 months

Example Calculation:

326 blast days/10 months x 13.3 kg/day x t/1000 kg = 4.3 t/10 months

Total TSP (Air Intake Shaft) = 4.7 st/10 months (1986-87) - (see also Revised Table 1.1 in Comment No. 13 of this letter)

Construct East Exhaust Shaft (Raise) - EER

A = $(6.1\ m/2)^2 \times 3.14 - (1.83\ m/2)^2 \times 3.14 = 26.6\ m^2$
D = 2.12 m
M = 15%

$$TSP\text{-}EF = \frac{344(26.6)^{0.8}}{(2.12)^{1.8}(15)^{1.9}} = 7.2\ kg/blast \times 3\ blasts/day = 21.6\ kg/d$$

Process Rate:

3 blasts/day, 21 blast days/month, 85 blast days/total (yr)

Example Calculation:

85 blast days/total x 21.5 kg/day x t/1000 kg = 1.8 t/yr

Total TSP (EER) = 2.0 st/yr (1988) - (See also Revised Table 1.1 in Comment No. 13 of this letter)

Construct West Exhaust Shaft (Raise) - WER

TSP-EF = Same as EER

Total TSP (WER) = 2.0 st/yr (1989) - (see also Revised Table 1.1 in Comment No. 13 of this letter)

Underground Mine Development - Blasting of irregular sized openings of varying dimensions

TSP-EF = .0013 kg/t (for blasting overburden and coal)

From AMC report on "Fugitive Dust Emission Factors for the Mining Industry," Appendix p. D-3 - Colorado Fugitive Emissions.

Year	Waste Rock (k-st)	Ore (k-st)	Total (k-st)	st/yr*
1986	11	--	11	0.01
1987	66	--	66	0.09
1988	763	532	1295	1.7
1989	1146	1700	2846	3.7
1990	396	2814	3210	4.2

*See Revised Table 1.1 in the response to Comment No. 13 of this letter.

Example Calculation:

2,846,000 st/yr x 0.0026 lb/st x st/2000 lbs = 3.7 st/yr

Total TSP (Underground Mine Development) = 3.7 st/yr

The Colorado fugitive emissions reference is attached.

COLORADO DEPARTMENT OF HEALTH — Attachment for Comment No. 15

Division or Section of APCD

INTER-OFFICE COMMUNICATION

TO : All Interested Parties
THROUGH: COLORADO DEPARTMENT OF HEALTH, APCD
FROM: Thomas Tistinic, Public Health Engineer

DATE : September 30, 1981
SUBJECT: FUGITIVE DUST EMISSIONS

Attached find a compilation of fugitive dust emission factors the Division will be using to estimate emissions from sources of fugitive dust wishing to operate in the State of Colorado.

Unfortunately, agreement between sampling methods and between identical methods operated by different groups may show errors of degrees of magnitude. For this reason some general assumptions are needed to determine how the equations should be used and what the numbers mean.

Generally speaking:

1. The factors were developed based on those particles collected by the hi-vol sampler, considered to be mostly less than 30 microns in size.

2. The factors are not corrected for fallout. Until such time a fallout function may be incorporated into our dispersion model, we will assume:

   a. Maximum uncorrected distance of impact = 5 km (approximately 3 miles)

   b. Average wind speed in the State = 5 m/sec = μ

   c. Average stability class = D (see reference 9)

   Therefore, multiply factors by 0.24 or $0.24^{5/\mu}$ to get impact past 5 km.

3. EPA approved emission factors were used where possible.

4. Total annual emissions should be calculated for the estimated year of the greatest activity. Naturally some factors should be used in conjunction with total annual work days such as crushing, and some factors should be used in conjunction with 365 days per year such as wind erosion.

5. None of the factors, other than vehicle traffic and the wind erosion equation, appear to take into account emissions on days with .01 inches or more of rainfall (W). Multiplying the chosen emission factor by the quantity $(1-\frac{W}{365})$ will result in a modified emission factor corrected for wet days. See Appendix G for values of W.

We accept all comments to these factors and assumptions. This compilation will be updated regularly, probably every six months. Due to the large number of requests, it will be difficult to update any sooner than that, however, major changes will be given priority.

Signature

TT/na

AD BUS-29 (10-29-100)

TABLE D-1.
COLORADO FUGITIVE EMISSION PROJECT

PROCESS OPERATION	UNCONTROLLED FACTOR	CONTROL - EST. EFFICIENCY
Topsoil Removal - a combined factor which includes removal, haulage, and placement into storage area.	16 lb/scraper hour (5) or .38 lb/yd^3 (5) If no information provided we will assume: yd^3 topsoil = 1.5 tons (12) Average depth of topsoil = 1.5 feet (9) Capacity of scraper = 25 yd^3 (6)	Controls usually not practiced or required due to the relative moistness of the soil.
Topsoil Stockpile - once topsoil is placed in storage it is not worked continuously like product stockpiles. Therefore, once the surface fines have blown away, the topsoil will most likely show an ability to crust over making it resistant to all but very high wind velocities. However, unless the applicant can cite unusual soil conditions, to be conservative we will not apply a "natural crusting efficiency" for topsoil storage areas, but will assume a 5% monthly reduction due to loss of surface fines.	$E_s = .01\ [a\ I\ K\ C\ L^1\ V^1]$ (15) Es = emission factor tons/acre/yr a = portion of total wind erosion losses that would be measured as suspended particulates I = soil erodibility in tons/acre/yr K = surface roughness factor (demensionless) C = climatic factor (dimensionless) L^1 = unsheltered field width factor (dimensionless) V^1 = vegetative cover factor (dimensionless) To calculate surface area of pile see Appendix A To obtain C values, see Appendix B and C To obtain a, I, K, L^1, and V^1 values, see Appendix D.	Chemical supressants - normally a synthetic polymer or copolymer - 85% (5) Mulch - 85% (5) Rapid revegetation - 75% (5) Wind breaks=height of pile - 50% (6) Wind breaks <height of pile - 30% (23) Frequent watering (twice a day) - 50% (8) Water as needed - 25% (6) Chemical/vegetative stabilization - 93% (20)
Drilling: Overburden or uranium ore Coal Rock	1.5 lbs/hole (5) .22 lbs/hole (9) .0013 lb/ton quarried (10) Plans reviewed indicate from 75 to 200 (29) tons of broken granite produced per hole. Assuming 200 tons per hole would make the rock drilling emission factor = .26 lb/hole	Bag Collector - 90% (6) Chemical Suppresants - 90% (6 & 11) Water Injection - 75% (6 & 11)
Blasting: Overburden or uranium ore Coal and/or Rock I will equate blasting of rock with the blasting of coal mainly because extremely wide variation in emission factors for blasting rock, i.e. from 2.2 to 4200 lbs per blast.	0.0026 $\frac{\text{lb}}{\text{ton}}$ blasted (9)(5)(6) This figure was derived using the highest EPA recommended emission factors for blasting, i.e. 85.3 lbs/blast and 78.1 lbs/blast for overburden and coal respectively. These factors were obtained from Reference 9 which also provided scant data on frequency of blasting and amounts of material mined. With this data the above factor of 0.0026 $\frac{\text{lb}}{\text{ton}}$ blasted was calculated.	Water filled plastic bags -50% (11) (controls rarely used during lasting, and control efficiency is highly speculative.)

Comment No. 16:

Table 1.1 does not include all of the sources from the original air permit application.

Response:

We have reviewed the tables in the original air permit application with the sources identified in the submittal of Table 1.1 of the air permit response letter of January 24, 1984. Some sources identified in the original air permit application have been eliminated in the current design as was indicated in the air permit letter of January 24, 1984 and others have been combined under a more general heading for Table 1.1. In other cases, sources emitting contaminants other than TSP were not repeated in Table 1.1 since they were not included in the annual estimates. All TSP emitting sources in the original air permit application were included in Table 1.1. If the DNR could indicate the specific sources from the tables of the original air permit application from which TSP estimates are not included in Table 1.1, we will review them immediately.

As also agreed at the meeting in Madison on February 29, 1984, we will provide in an additional table in the revised air permit application, all of the Project sources for all of the estimated air emissions. This table will follow the format provided to us by the DNR at the meeting. We will also include a separate table or tables for annual TSP emissions for the construction, operation and reclamation phases. This table will be similar to Tables 1.1 and 1.2 of the air permit response letter of January 24, 1984.

Comment No. 17:

What is the source for the estimated TSP emissions for the reclaim ponds?

Response:

Reclaim Ponds R1 and R2 are estimated to have construction activities including excavation over approximately 49.4 and 29.6 acres, respectively. Using the TSP emission factor of 1.2 st/acre from EPA AP-42 results in calculated total TSP emissions of approximately 59.3 and 36 st, respectively. Since Reclaim Pond R2 is constructed over two years, the estimated TSP emissions of 36 st are approximately 18 st/yr as presented in Table 1.1 of the January 24, 1984 air permit response letter.

Comment No. 18:

Provide the manufacturer's brochure describing the insertable collectors planned for use on emissions produced from handling of ore and waste rock in the headframe. Will the collector be ducted?

Response:

The insertable collectors planned for use to control TSP emissions produced from handling of ore and waste rock in the headframe will not be ducted to the atmosphere and will be similar to a DCE Vokes Model No. DLV-M 45/15 Fl. The manufacturer's brochure is provided in response to Comment No. 1 of this letter.

Comment No. 19:

Will the cement silos for the backfill system be ducted to the insertable collectors and where will these collectors discharge?

Response:

The cement silos for the backfill system will be located inside the concentrator building which encloses the backfill surface operations and will not be vented (i.e., discharged) to the atmosphere. Each cement silo will have an insertable collector mounted on top of the silo which is similar to the other DCE Vokes models being used in the facility. (See also the response to Comment No. 1 of this letter.) The insertable collector will discharge the collected particles to the silo.

Comment No. 20:

It appears that the emissions estimate for preproduction ore handling is listed twice on Table 1.1.

Response:

The emissions listed on Table 1.1 of the air permit response letter of January 24, 1984 for preproduction ore handling (see Mine Production - Initial and Coarse Ore Transport) are listed twice. This has been changed in the revision to Table 1.1. (See Revised Table 1.1 in the response to Comment No. 13 of this letter.) Although the ore will be handled twice (i.e., initial loading at the mine, hauling and dumping at the preproduction ore storage pad; then reloaded from storage, and hauling and dumping into the crusher), initial ore storage will occur over a period of several years. Preproduction ore crushing will occur in 1990. The estimated emissions of 12.7 st are as shown on Table 1.1. This estimate has been revised using the latest emission factor from AP-42 for loading and dumping resulting in a reduction in total emissions to 10.0 st. (See also Revised Table 1.1 in the response to Comment No. 13 of this letter.) The maximum year for preproduction ore crushing is still 1990 with estimated TSP emissions as follows:

Activity	TSP emissions (st/yr)
Hauling of preproduction ore	6.4
Loading and dumping of preproduction ore	0.1
Wind-blown emissions*	0.2
Crushing and handling of preproduction ore*	3.3
	10.0

---

*See response to Comment No. A4 of the January 24, 1984 air permit letter.

PREPRODUCTION ORE HANDLING

1. Hauling - from main shaft to storage pad in 35 st dump truck

   Haul distance = to storage - 1.2 mile round trip
   from storage - 1.0 mile round trip

$$\text{TSP-EF} = (0.8)(5.9)(s/12)(S/30)^2(W/3)^{0.7}(w/4)^{0.5}(d/365) = \text{lb/veh-mile}$$
$$= (4.72)(6/12)(15/30)^2(51/3)^{0.7}(6/4)^{0.5}(230/365)$$
$$= 3.31 \text{ lb/veh-mile uncontrolled}$$

Example Calculation:

Emissions (controlled) = 3.31 lb veh-mile x 436 veh-miles/yr x st/2000 lbs x 0.15*
= 0.1 st/yr

Year	Volume Hauled (k-st) To Storage	Volume Hauled (k-st) From Storage	No. of Hauls	Miles Traveled	Emission (tons)
1986	---	---	---	---	---
1987	11	2**	371	446	0.1
1988	524	---	14,971	17,965	4.4
1989	366	---	10,457	12,548	3.1
1990		898	25,657	25,657	6.4

---

* 85% control with watering and chemical stabilization.

**Haul distance to pilot plant is the same as to storage (i.e., 1.2 miles round trip).

2. Loading and dumping (L&D):

   Loading: Cat 988B - 7 yd^3 bucket

$$\text{TSP-EF} = (0.73)(0.0018)\frac{(1.6/5)(7.2/5)(4/5)}{(4/2)^2(7/6)^{0.33}} = 0.00012 \text{ lb/ton}$$

   Dumping: 35 st dump truck - 35 st ÷ 2,500 lb/yd^3 x 2,000 lb/st = 28 yd^3

$$\text{TSP-EF} = (0.73)(0.0018)\frac{(1.6/5)(7.2/5)(4/5)}{(4/2)^2(28/6)^{0.33}} = 0.000073 \text{ lb/st}$$

   Combined emission rate = 0.000193 lb/st loaded and dumped

Year	Volume Loaded and Dumped (k-st)	Emissions (st/yr)
1987	13	0.00
1988	524	0.05
1989	366	0.04
1990	898	0.09

Total Preproduction Ore Handling Emissions

Year	Hauling	L&D	Crushing	Wind-Blown	Total (TSP - st/yr)
1986	---	---	---	---	---
1987	0.1	0.0	---	0.2	0.3
1988	4.4	0.05	---	0.2	4.7
1989	3.1	0.04	---	0.2	3.4
1990	6.4	0.1	3.3	0.2	10.0

Comment No. 21:

What is the source for the estimated TSP emissions for the tailings pipeline construction?

Response:

The estimated acreage disturbed for construction of the tailings pipeline including excavation is approximately 10 acres. Using the TSP emission factor of 1.2 st/acre from EPA AP-42 results in calculated total TSP emissions of 12 st. Since the tailings pipeline is constructed over two years, the estimated TSP emissions of 12 st are approximately 6 st/yr as presented in Table 1.1 of the January 24, 1984 air permit letter.

Comment No. 22:

Table 1.1 shows 96.3 st/yr particulate emissions from MWDF construction. What was the input to this rate.

Response:

The derivation of this rate is explained in the response to Comment No. 13 of this letter. Note, however, that MWDF construction emissions have been revised to incorporate use of different emission factors for loading and dumping as requested by the WDNR and to provide more specific estimates for individual ponds. (See also Revised Table 1.1 in response to Comment No. 13 of this letter.)

Comment No. 23:

Where are the emissions calculations for drift development found?

Response:

The estimates for TSP emissions produced during mine drift development prior to and leading into mine operation are presented in the response to Comment No. 15 of this letter. Operations drift development TSP emission estimates are presented in the response to Comment No. C1 of the January 24, 1984 air permit letter.

Comment No. 24:

What is the source for the estimated TSP emissions for the crushing and screening in Table 1.1 of the January 24, 1984 air permit response letter.

Response:

The estimated TSP emissions for ore crushing and screening were recalculated after receipt of the revised EPA AP-42, Section 8.23 dealing with mining operations. The revised emission factors were obtained from Table 8.23-1 on p. 8.23-4. The calculations are as follows:

Fine Ore Crushing and Screening - Crushing and screening of high moisture ore

Emission Factors and Source: AP-42, Table 8.23-1

TSP-EF = 0.03 kg/t secondary and tertiary crushing
0.005 kg/t handling

Duration: 24 hr/day, 365 days/yr

Process Rate: 620 t/hr, 14,880 t/day, 3,629,000 t/yr

Example Calculation:

TSP = 3,629,000 t/yr x 0.03 kg/t x 2 (crushing and screening) x (1-.979) ÷ t/1000 kg = 4.6 t/yr
4.6 t/yr x 1.1 st/t = 5.1 st/yr

TSP = 3,629,000 x 0.005 x 8 (handling) x (1-.979) ÷ 1000 = 3.0 t/yr
3.0 t/yr x 1.1 st/yr = 3.3 st/yr

Total estimated TSP emissions from crushing and screening are 8.4 st/yr as presented in Table 1.1 of the January 24, 1984 air permit response letter.

Comment No. 25:

Provide the calculations used to determine the TSP emissions from combustion of natural gas for Facility Heating shown in Table 1.1.

Response:

Natural gas is used for three purposes in the surface facilities. They are: 1) heating the buildings, 2) water heating and 3) water treatment (brine crystallizer). Each of these processes are described in the following under its respective heading.

Heating Buildings - Use of natural gas unit heaters. Heat content is 1000 BTU/SCF for natural gas.

Emission Factors and Source: EPA-NEDS, Appendix C, p. C-3, December 1975 - <10 M BTU/hr (see attached)

TSP-EF = 10.0 lb/10^6 SCF of natural gas

SO_x-EF = 0.6 lb/10^6 SCF of natural gas

NO_x-EF = 120.0 lb/10^6 SCF of natural gas

CO-EF = 17.0 lb/10^6 SCF of natural gas

HC-EF = 3.0 lb/10^6 SCF of natural gas

Process Rate: 17,350 SCF/hr, 416,400 SCF/day and 33,960,000 SCF/yr of natural gas

Duration: As required by weather conditions

Control Method and Efficiency: Use of natural gas

TSP = (33,960,000)(10.0/1,000,000)/2000 = 0.17 st/yr

Water Heating - Heating of water in the concentrator building for the process using a 42,000 BTU/hr boiler. Also, heating water in the plant services building for washrooms and showers using a 1,005,000 BTU/hr water heater.

Emission Factors and Source: Same as building heating

Process Rate: 1,047 SCF/hr, 25,128 SCF/day and 9,172,000 SCF/yr of natural gas

Duration: 24 hrs/day, 365 days/yr

Control Method and Efficiency: Use of natural gas

TSP = (9,172,000)(10.0/1,000,000)/2000 = 0.05 st/yr

Water Treatment - Use of a boiler for VCE (i.e., initial) and brine crystallization operations in the vapor compression evaporator process. Boiler will consume 14,600,000 BTU/hr of natural gas.

Emission Factors and Source: Same as for heating buildings

Process Rate: 14,600 SCF/hr, 350,400 SCF/day and 127,900,000 SCF/yr of natural gas

Duration: 24 hrs/day, 365 days/yr

Control Method and Efficiency: Use of natural gas

TSP = (127,900,000)(10.0/1,000,000)/2000 = 0.64 st/yr

Total Estimated Facility Heating TSP Emissions

	TSP (st/yr)
Heating Buildings	0.17
Water Heating	0.05
Water Treatment	0.64
Total	0.86

NATIONAL EMISSION DATA SYSTEM
SOURCE CLASSIFICATION CODES

POUNDS EMITTED PER UNIT

		PART		SOX		NOX	HC	CO	UNITS
EXCOMB BOILER	-ELECTRIC GENERATN								
****************	****************								
LIQ WASTE-SPECIFY									
1-01-013-01	>100 MMBTU/HR								1000 GALLONS BURNED
1-01-013-02	10-100 MMBTU/HR								1000 GALLONS BURNED
1-01-013-03	<10 MMBTU/HR								1000 GALLONS BURNED
OTHER/NOT CLASIFD									
1-01-999-97	SPECIFY IN REMARK								MILLION CUBIC FEET BURNED
1-01-999-98	SPECIFY IN REMARK								1000 GALLON (LIQUID) BURNED
1-01-999-99	SPECIFY IN REMARK								TONS BURNED (SOLID)
EXTCOMB BOILER	-INDUSTRIAL								
****************	****************								
ANTHRACITE COAL									
1-02-001-01	>100MMBTU/HR PULV	17.0	A	38.0	S	18.0	0.03	1.00	TONS BURNED
1-02-001-02	>100MMBTU/HR STKR	2.00	A	38.0	S	10.5	0.20	6.00	TONS BURNED
1-02-001-03	10-100MMBTU PULVD	17.0	A	38.0	S	18.0	0.03	1.00	TONS BURNED
1-02-001-04	10-100MMBTU STKR	2.00	A	38.0	S	10.5	0.20	6.00	TONS BURNED
1-02-001-05	<10MMBTU/HR PULVD	17.0	A	38.0	S	18.0	0.03	1.00	TONS BURNED
1-02-001-06	<10MMBTU/HR STKR	2.00	A	38.0	S	6.00	0.20	10.0	TONS BURNED
1-02-001-07	<10MMBTU/HR HNDFR	10.0		36.0	S	3.00	2.50	90.0	TONS BURNED
1-02-001-99	OTHER/NOT CLASIFD	17.0	A	38.0	S	18.0	0.03	2.00	TONS BURNED
BITUMINOUS COAL									
1-02-002-01	>100MMBTU PULVWET	13.0	A	38.0	S	30.0	0.30	1.00	TONS BURNED
1-02-002-02	>100MMBTU PULVDRY	17.0	A	38.0	S	18.0	0.30	1.00	TONS BURNED
1-02-002-03	>100MMBTU CYCLONE	2.00	A	38.0	S	55.0	0.30	1.00	TONS BURNED
1-02-002-04	>100MMBTU SPDSTKR	13.0	A	38.0	S	15.0	1.00	2.00	TONS BURNED
1-02-002-05	10-100MMBTU OFSTK	5.00	A	38.0	S	15.0	1.00	2.00	TONS BURNED
1-02-002-06	10-100MMBTU UFSTK	5.00	A	38.0	S	15.0	1.00	2.00	TONS BURNED
1-02-002-07	10-100MMBTU PULWT	13.0	A	38.0	S	30.0	0.30	1.00	TONS BURNED
1-02-002-08	10-100MMBTU PULDY	17.0	A	38.0	S	18.0	0.30	1.00	TONS BURNED
1-02-002-09	10-100MMBTUSPDSTK	13.0	A	38.0	S	15.0	1.00	2.00	TONS BURNED
1-02-002-10	<10MMBTU OFD STKR	2.00	A	38.0	S	6.00	3.00	10.0	TONS BURNED
1-02-002-11	<10MMBTU UFD STKR	2.00	A	38.0	S	6.00	3.00	10.0	TONS BURNED
1-02-002-12	<10MMBTU PULV DRY	17.0	A	38.0	S	14.0	0.30	2.00	TONS BURNED
1-02-002-13	<10MMBTU SPD STKR	2.00	A	38.0	S	6.00	3.00	10.0	TONS BURNED
1-02-002-14	<10MMBTU HANDFIRE	20.0		38.0	S	3.00	20.0	90.0	TONS BURNED
1-02-002-99	OTHER/NOT CLASIFD	13.0	A	38.0	S	15.0	0.30	2.00	TONS BURNED
LIGNITE									
1-02-003-01	>100MMBTU PULVWET	6.50	A	30.0	S	13.0	0.30	1.00	TONS BURNED
1-02-003-02	>100MMBTU PULVDRY	6.50	A	30.0	S	13.0	0.30	1.00	TONS BURNED
1-02-003-03	>100MMBTU CYCLONE	6.50	A	30.0	S	17.0	0.30	1.00	TONS BURNED
1-02-003-04	>100MMBTU OFSTKR	6.50	A	30.0	S	13.0	1.00	2.00	TONS BURNED
1-02-003-05	>100MMBTU UFSTKR	6.50	A	30.0	S	13.0	1.00	2.00	TONS BURNED
1-02-003-06	>100MMBTU SPDSTKR	6.50	A	30.0	S	13.0	1.00	2.00	TONS BURNED
1-02-003-07	10-100MMBTU DYPUL	6.50	A	30.0	S	13.0	0.30	1.00	TONS BURNED
1-02-003-08	10-100MMBTU WTPUL	6.50	A	30.0	S	13.0	0.30	1.00	TONS BURNED
1-02-003-09	10-100MMBTU OFSTK	6.50	A	30.0	S	13.0	1.00	2.00	TONS BURNED
1-02-003-10	10-100MMBTU UFSTK	6.50	A	30.0	S	13.0	1.00	2.00	TONS BURNED
1-02-003-11	10-100MMBTUSPDSTK	6.50	A	30.0	S	13.0	1.00	2.00	TONS BURNED
1-02-003-12	<10MMBTU PULV DRY	6.50	A	30.0	S	13.0	3.00	10.0	TONS BURNED
1-02-003-13	<10MMBTU OFSTOKR	6.50	A	30.0	S	13.0	3.00	10.0	TONS BURNED
1-02-003-14	<10MMBTU UFSTOKR	6.50	A	30.0	S	13.0	3.00	10.0	TONS BURNED
1-02-003-15	<10MMBTU HANDFIRE	6.50	A	30.0	S	13.0	20.0	90.0	TONS BURNED
1-02-003-16	<10MMBTU SPDSTKR	6.50	A	30.0	S	13.0	3.00	10.0	TONS BURNED
RESIDUAL OIL									
1-02-004-01	>100MMBTU/HR	23.0		157.	S	60.0	3.00	4.00	1000 GALLONS BURNED
1-02-004-02	10-100MMBTU/HR	23.0		157.	S	60.0	3.00	4.00	1000 GALLONS BURNED
1-02-004-03	<10MMBTU/HR	23.0		157.	S	60.0	3.00	4.00	1000 GALLONS BURNED
DISTILLATE OIL									
1-02-005-01	>100MMBTU/HR	15.0		142.	S	60.0	3.00	4.00	1000 GALLONS BURNED
1-02-005-02	10-100MMBTU/HR	15.0		142.	S	60.0	3.00	4.00	1000 GALLONS BURNED
1-02-005-03	<10MMBTU/HR	15.0		142.	S	60.0	3.00	4.00	1000 GALLONS BURNED
NATURAL GAS									
1-02-006-01	>100MMBTU/HR	10.0		0.60		600.	3.00	17.0	MILLION CUBIC FEET BURNED
1-02-006-02	10-100MMBTU/HR	10.0		0.60		230.	3.00	17.0	MILLION CUBIC FEET BURNED
1-02-006-03	<10MMBTU/HR	10.0		0.60		120.	3.00	17.0	MILLION CUBIC FEET BURNED
PROCESS GAS									
1-02-007-01	REFINERY >100								MILLION CUBIC FEET BURNED
1-02-007-02	REFINERY 10-100								MILLION CUBIC FEET BURNED
1-02-007-03	REFINERY <10								MILLION CUBIC FEET BURNED
1-02-007-04	BLAST FNC >100								MILLION CUBIC FEET BURNED
1-02-007-05	BLAST FNC 10-100								MILLION CUBIC FEET BURNED
1-02-007-06	BLAST FNC <10								MILLION CUBIC FEET BURNED

'A' INDICATES THE ASH CONTENT, 'S' INDICATES THE SULFUR CONTENT OF THE FUEL ON A PERCENT BASIS (BY WEIGHT)

Comment No. 26:

Where are the estimated TSP emissions for the pilot plant activities?

Response:

Most of the pilot plant activities are currently designed for completing the program within the core storage building. The equipment will not be vented to the atmosphere and there will be no stack releasing emissions from this facility. The only activity producing air emissions is the temporary portable crusher outside the core storage building. The crusher will have a baghouse collector with an estimated efficiency of 99% as presented in the response to Comment No. A4 of the January 24, 1984 air permit response letter. The estimated TSP emissions for crushing and handling of all of the preproduction ore (898 k-st) is 3.3 st/yr as presented on p. 26 of the Janaury 24, 1984 letter. The pilot plant is estimated to process approximately 2 k-st (see p. 22 of the Janaury 24, 1984 letter) of preproduction ore. This represents 0.2% of the preproduction ore and 0.007 st of the calculated TSP emissions from crushing the 898 k-st of this ore. These TSP emissions were included in the 12.7 st/yr provided in Table 1.1 for Mine Production - Initial in 1990. They are now included in the 10.0 st/yr estimate provided in Revised Table 1.1 (see response to Comment No. 13 of this letter) for Mill/Concentrator Operations - Coarse Ore Transport (i.e., preproduction ore in 1990).

Comment No. 27:

How was the burning TSP emission estimate for forest residues determined? How will this material be burned - in one pile or several piles? Do you intend to apply for permits for the burning for each occurrence?

Response:

The TSP emission estimate for burning unspecified Forest residues was determined by using the available harvestable timber estimate provided in the report entitled, "Forest Inventory Timber Appraisal and Forest Management Recommendations on 3,474 Acres of the Crandon Mine Project," prepared by E. F. Steigerwaldt and Sons (1982), Tomahawk, Wisconsin (previously provided to the DNR) and the emission factors presented in EPA AP-42, Table 2.4-2, p. 2.4-3. The Steigerwaldt report provides a harvestable timber estimate for the acres to be cleared for construction of 12,677 total cords. Approximately 1.75 st/cord (3,500 lbs/cord) is the air dry weight (see Attachment 1) of this timber with brush and waste (i.e., unspecified Forest residues) an estimated 65% of the harvestable timber (see Attachment 2). See also Comment Nos. 129 (EIR letter of October 3, 1983) and 86 (Mine Permit letter of November 17, 1983). These estimates were used to calculate the tons (st) of unspecified Forest residues for the various areas of the Project facilities as follows:

1) The MWDF and reclaim ponds cover 614 acres with estimated harvestable timber of 8603 total cords (Steigerwaldt, 1982). The acreage for construction of the initial tailing and reclaim ponds

is approximately 136 acres or 22% of the total 614 acres. Therefore, approximately 1900 cords (8603 x 0.22) of timber will be harvested for construction of the initial tailing and reclaim ponds. The estimated air dry weight of these 1900 cords is 3325 st (1900 x 1.75) with approximately 2161.25 st (3325 x 0.65) of brush (i.e., unspecified Forest residues). The estimated brush tonnage of 2161.25 st was used with the emission factors of AP-42, Table 2.4-2 to calculate the estimated contaminant air emissions from burning. (See Comment No. 160 of the EIR response letter submitted to the DNR on October 3, 1983.)

2. The construction zone for the mine/mill site was estimated to be approximately 104 acres for the air permit response letter of January 24, 1984. This estimated acreage included approximately 14.7 and 89 acres from clearing the pad areas (see response A1 of the January 24, 1984 air permit letter) and the mine/mill site, respectively. (See also Comment No. 86 of the Mine Permit letter submitted to the DNR on November 17, 1983.) The estimated harvestable timber for the 89 acre mine/mill site is 1215 cords (Steigerwaldt, 1982). The estimated unspecified Forest residues for this 89 acres is approximately 1382 st (1215 x 1.75 x 0.65). Using the AP-42 TSP emission factor of 17 lb/st x 1382 st x st/2000 lbs, gives an estimate of 11.8 st/yr for TSP air emissions for burning of unspecified Forest residues at the mine/mill site. By proportion for the 89 to 104 acres, an estimated 1420 (1215 ÷ 89 x 104) cords of harvestable timber was calculated for the total 104 acres. Approximately 205 cords would be harvested from the pad areas (i.e., 14.7 acres). This 14.7 acres would also have approximately 233 st of unspecified Forest residues. Using the AP-42 TSP emission factor of 17 lb/st x 233 st x st/2000 lbs, gives an estimate of 2.0 st/yr for burning the unspecified Forest residues of the pad areas.

3. Similarly for the access road and railroad spur current estimates for cords of harvestable timber are 272 and 411 cords, respectively. Estimated unspecified Forest residues are 309 and 468 st, respectively. (See also Comment No. 129 of the EIR letter submitted to the DNR on October 3, 1983.) The revised air permit calculations for estimated TSP air emissions are 2.6 and 4.0 st/yr, respectively.

4. The slurry pipeline and haul road is estimated to have 87 cords of harvestable timber on the 8 acres for construction clearing. Approximately 99 st of Forest residues are estimated to be burned with TSP air emissions of approximately 0.8 st/yr. The revised air permit application will include these calculations.

Although we intend to utilize much of the unspecified Forest residues for mulching, we have conservatively assumed that all of it will be burned for the air permit application. Actual burning will occur periodically during the year as portions of the Project areas are cleared for construction

RECEIVED
MAR 12 1984
EXXON MINERALS

Wood for Home Heating
LOCATING, CUTTING, AND GATHERING WOOD

Gordon R. Cunningham and Arlan L. Wooden

You can buy wood for home heating from firewood dealers, or you can gather it (with permission, of course) from national, state, county, community, industrial, farm, and small private woodlands.

Nature makes most fuel wood available—trees die, and wind blows them over. Storms, fires, insects and diseases damage trees. Sometimes we cut healthy trees to leave more room for others to grow.

Most of the public forest managers, many industrial forest owners, and some private forest owners will give permission for harvesting wood for personal home heating. Locations of some of these forests, and regulations for harvesting fuel wood from them, are given at the end of this publication.

If the private woodland is your own, your concerns are to (1) figure how much wood you need for heating each year, (2) know how much your woodland will grow, and (3) plan how to gather and store wood for burning.

FIGURE HOW MUCH WOOD YOU NEED

The easiest way to figure how much fuel wood you will need for a heating season is to covert your present fuel consumption to wood equivalents. Or, you can estimate the heat loss and fuel needs for your house.

Below are figures to help convert your present fuel to wood equivalents. A standard cord of wood is a stack 4' x 4' x 8'; it includes 80 cubic feet of solid wood. The heavier (better) hardwoods weigh, per standard cord, between 3000 to 4000 pounds (1361 to 1814 kilograms) when air-dry, so you can use an average of 3500 pounds (1587 kg.) per cord for your estimate.

1 gallon of #2 fuel oil = 22.2 pounds of wood
1 therm (100 cubic feet) of natural gas = 14.0 pounds of wood
1 gallon of propane gas = 14.6 pounds of wood
1 kilowatt-hour of electricity = 0.59 pounds of wood
1 pound of coal = 1.56 pounds of wood.

Using #2 fuel oil as an example, if you burn 1000 gallons of fuel oil then 1000 x 22.2 = 22,200 pounds of wood. Dividing 22,200 by 3,500 means you would need 6 1/3 standard cords of wood. For a more accurate estimate, and information on how much you can afford to pay for wood compared to other fuels, see Publication G2874—Wood for Home Heating: WOOD AS FUEL.

The second method to figure how much fuel wood you need for a heating season is to calculate heat loss and fuel consumption for your house. Circular A1844 "How to Calculate Heat Loss and Fuel Consumption" will help you estimate heat losses through walls, ceilings, windows, doors and various kinds and amounts of insulation. Let's assume your calculations show your house is losing about 200 million Btu's per heating season. (A Btu, British thermal unit, is the heat needed to raise the temperature of one pound of water one degree Fahrenheit). A pound of air-dry wood provices about 5800 Btu's of heat, so 200,000,000 divided by 5800 equals 34,483 pounds of wood needed. And 34,483 divided by 3500 equals 9.8 standard cords of wood you need.

HOW MUCH WOOD WILL A WOODLAND GROW?

The average woodland in Wisconsin grows about 38 cubic feet of wood usable for fuel on each acre annually. This is about 1/2 a standard cord. Intensive management can double this growth rate. With careful selection of trees harvested for fuel wood, the remaining trees in a woodland will grow more vigorously, because they will have more soil moisture, nutrients, and sunlight. Removing some trees to favor others is called Timber Stand Improvement, or TSI as foresters abbreviate it.

A Department of Natural Resources forester, or a consulting or industrial forester, can mark the trees to cut. The forester will know how many trees can be removed without taking more than the woodland will grow.

Oneida Co. FD, Rhinelander 54501	W	RA	Maps	Lr T	PU 10 Cds.		Yes	6/1 - 11/15
Price Co. FD, Phillips 54555	W	RA	Ld	Lr D	PU		No	1 year
Rusk Co. FD, Ladysmith 54848	V	RA	Sales areas	Lr D T		No	No	
St. Regis Paper Co., Rhinelander 54501	W	RA	Ld	Lr D	PU	No	No	30 - 60 days
Sawyer Co. FD, Hayward 54843	W	RA	Map	Lr DD		Yes $1	No	Annual
Vilas Co. FD, Eagle River 54521	W	LOR	Ld & Map	Lr D T	PU	No	No	1 year - date issued
Washburn Co. FD, Spooner 54801	W	RA		Lr D		Yes $2.50	No	6 mos.
Wood Co. FD, Wisconsin Rapids 54494	W	RA	Ld	Lr D	PU	No	Yes	90 days

* For address information: Ask county Extension agent or forester.
** For standing marked trees. No charge for Lr/DD.

This publication is slightly revised. Earlier edition may be used.

COOPERATIVE EXTENSION PROGRAMS UWEX

Gordon R. Cunningham and Arlan L. Wooden are professor of forestry and extension forestry project assistant respectively, College of Agricultural and Life Sciences, University of Wisconsin-Madison, and Division of Economic and Environmental Development, University of Wisconsin-Extension.

UNIVERSITY OF WISCONSIN–EXTENSION/MADISON

University of Wisconsin-Extension, Gale L. VandeBerg, director, in cooperation with the United States Department of Agriculture and Wisconsin counties, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress; and provides equal opportunities in employment and programming including Title IX requirements. This publication is available to **Wisconsin residents** from county Extension agents. **It's available to out-of-state purchasers** from Agricultural Bulletin Building, 1535 Observatory Drive, Madison, Wisconsin 53706. **Editors,** before publicizing, should contact the Agricultural Bulletin Building to determine its availability. **Order by serial number and title;** payment should include price plus postage.

JULY 1979

15¢

G2873 WOOD FOR HOME HEATING

The total of unharvested annual growth for each county was reduced by a proportion equal to the forest industry land ownership for that county, therefore factoring in the unavailability of forest industry timber. The remainder is considered available for use on a sustained basis. The figures in the next-to-last column represent roundwood volumes only, and do not include the weight of branches and tops. If branches and tops are added, the total tonnage would be increased by about 45 percent. The Forest Residues Energy Program report also adds cull trees, which would increase the estimated amount by about another 19 percent. The addition of these forest residues is accounted for in the last column of Table 5.

3.1.3.2 Mill Residues

Additional amounts of fuel are available in the form of mill residues (such as bark, sawdust, slabs, and edgings). Data for 1972 and 1973 on residue production from primary processing and unused residues are summarized in Table 6. Since that time, however, demand and use have increased. Currently, there are at least five major users of wood residues:

- Superior Power - at Ashland, Wisconsin
- Weyerhaeuser Mills - at Marshfield and Rothschild, Wisconsin
- Owens-Illinois - at Tomahawk, Wisconsin
- Champion International - just starting at Iron Mountain, Michigan
- Mead Mill - at Escanaba, Michigan

There is also a public school in Park Falls, Wisconsin, that heats with wood chips, and several other mills are discussing conversion to burning residue and chips.

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*Dames & Moore, 1981. Wood-fired Power Plant Siting Study. Conducted for Wisconsin Public Service Corporation. Excerpt is p. 2 of the report. Dames & Moore, Park Ridge, IL activities. Therefore, burning will be completed with several piles on the ground surface.

As agreed at the meeting in Madison with the DNR on February 29, 1984, we would coordinate each of these burnings with the North Central District DNR office in Rhinelander, Wisconsin. We would also apply for any necessary open burning permits required by local governments.

Comment No. 28:

Provide a copy of the memorandum from Mr. Charles A. Collins, Wyoming Department of Environmental Quality, which was referenced on p. 23 of your January 24, 1984 air permit response letter. This was used as the citation for squaring the vehicle speed correction factor ratio when calculating emission factors for transportation on unpaved roads.

Response:

A copy of the subject memorandum was provided to Mr. Steve Klafka at a review meeting in Madison, Wisconsin on March 1, 1984. Another copy of this memorandum is attached.

Comment No. 29:

It was assumed that the haul road and surface access roads had a silt content of 6%. Unless a gravel surface will be used on unpaved roads the silt content of native soil should be used.

Response:

Gravel obtained from local suppliers will be used on the haul road and unpaved surface access roads.

Comment No. 30:

The emission control factor used in Exxon's emission calculations for the haul road is 85% based on use of chemical stabilization. Please provide a reference for this control factor as AP-42 shows a control factor of 50% for chemical stabilization.

Response:

An excerpt of a letter from EPA Region VIII, December 10, 1979 is provided which shows a control factor of 85% for chemical stabilization of mine haul roads.

The control factor of 50% shown in AP-42 is a factor based on chemical stabilization only (no watering) of public unpaved roads. The reference from which that control factor was cited, also gives a control factor for

MEMORANDUM

TO: Whom It May Concern

THROUGH: Randolph Wood
Administrator

FROM: Charles A. Collins
Air Quality Supervisor

SUBJECT: Fugitive Dust Emission Factors

DATE: January 24, 1979

Attached to this memorandum is a guideline for fugitive dust emission factors which the Division will be using to evaluate all future and pending applications regarding major sources of fugitive dust. The attached guideline will supercede a previous guideline dated November 14, 1978. The Division had proposed to use the November 14, 1978 guideline in conjunction with a fallout function for dispersion modeling purposes and has since determined that the use of a fallout function as presented by PEDCo in reference 1 of the attached material is not a workable tool.

The Division will be using the attached guideline emission factors as input to a CDM dispersion model (rural version) assuming no fallout or deposition of particles 30 um in size and smaller. The emission factors as presented and adjusted account only for that portion of emissions which are 30 um in size and smaller.

Certain selected emission factors and accompanying 30 um cut off factors were selected from the 1978 PEDCo report. To arrive at presented emission factors, the Division went to Tables 4-1 through 4-7 of subject report to obtain average apparent emission rates and then selected the 30 um particle size fraction by reviewing data in Table D-1 and composite size distribution curves on figure 4-2. A fugitive dust emission rate diagram is presented following this memorandum to illustrate the Division's assumptions in extracting data from the PEDCo report for the following mine specific operations:

1. Overburden Removal
   Dragline, Mine B
   Truck/Shovel, Mine E
2. Product Removal
   Coal-Truck/Shovel, Mine B
3. Product Dumping
   Coal Truck Dump, Mine B
4. Stockpiles (wind erosion)
   Stockpile, All Mines

25

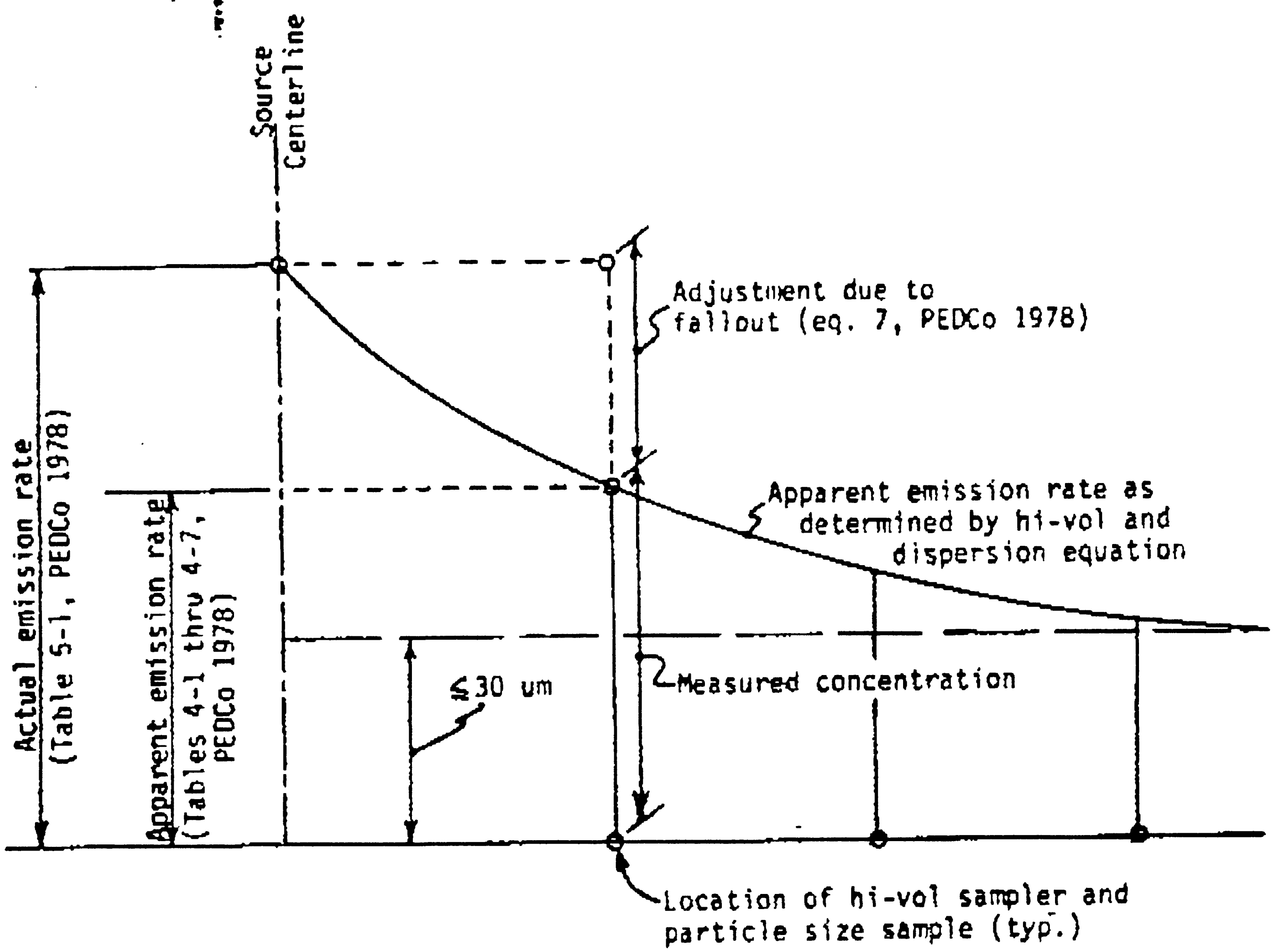

Figure C-1. Determination of apparent emission rate for fugitive dust source (after WDEQ 1979)

3/5

TABLE C-1.

STATE OF WYOMING
DIVISION OF AIR QUALITY
GUIDELINE FOR FUGITIVE DUST EMISSION FACTORS
FOR MINING ACTIVITIES

, January, 1979

(Particulate size 30 um and smaller, no fallout function required)

Mining Activity	(note) Emission Factor (Ref) x % Suspended	Control Technique	Control Efficiency
1. Overburden Removal			
Dragline	0.04 lb/yd³(1) x 0.75	——	——
Truck/Shovel	0.02 lb/ton(1) x 0.75	——	——
Scraper	[1]32 lbs/hr(2)	watering	50%
2. Haul Roads	[2]E = 0.81s(S/30)((365-W)/365)lb/VTH(3) x 0.62	a. watering [3]b. oil or chemical dust suppressant	50% 60%
Access Roads	[2]E = 0.81s(S/30)((365-W)/365)lb/VTH(3) x 0.62	a. asphalt paving or equal b. stabilization of base with chip and seal surface	85% 70%
3. Haul Road Repair and Construction			
Graders	[1]32 lbs/hr(2)	watering	50%
Scrapers	[1]32 lbs/hr(2)	watering	50%
4. Wind Erosion	[4]E = AIKCL'V' ton/acre/yr(4)	——	——
5. Product Removal			
Coal-Truck/Shovel	0.003 lb/ton(1) x 0.70	——	——
~~Coal-Frontend Loader~~	[5]0.003 lb/ton x 0.70	——	——
Uranium-Frontend Loader	[6]0.003 lb/ton	——	——
6. Product Dumping			
Coal-Truck Dump	0.017 lb/ton(1) x 0.75	a. coal-water sprays b. coal-negative pressure collection system	50% 85%
Uranium	[7]0.017 lb/ton		
7. Stockpiles (wind erosion)			
Coal	[8]1.2 u lb/acre/hr x 0.75	Enclosure	99%
Uranium	[9]E = 0.05(s/1.5)(d/235)(f/15)(D/90)lbs/ton(5)	watering	50%
8. Blasting			
Overburden	50 lb/blast(1) x 0.75	prevent overshooting	——
Coal	35 lb/blast(1) x 0.75	prevent overshooting	——

Notes:

1. If applicant's estimate of grader and scraper hours includes wet days, then reduce emissions by the factor $\frac{365-W}{365}$ where W = no. of days where rain or snow precipitation is 0.01" or greater

2. From Reference 3 $E = 0.81s(S/30)\left(\frac{365-W}{365}\right)$ lbs/VHT

   where s = silt content of road surface material(%)
   S = vehicle speed in mph
   W = no. of days with 0.01" precipitation or more
   S/30 factor should be squared for speeds less than 30 mph
   Apply correction for number or width of tires compared to light vehicles

3. Frequency and rate of application as per manufacturer's recommendation or as justified by applicant for site, specific road materials and experience.

4. From Reference 4 E = AIKCL'V' ton/acre/yr
   where A = portion of losses which become suspended
   I = soil erodibility
   K = surface roughness factor
   C = climatic factor
   L'= unsheltered field width factor
   = 0.7 for 1000' & 1.0 for 2000' and greater
   V'= vegetative cover factor (use V' = 1.0)

Soil Type	A	I, ton/acre/yr
Rocky, Gravelly	0.025	38
Sandy	0.010	134
Fine	0.041	52
Clay Loam	0.025	47

   K - Varies from 0.5 to 1.0; 1.0 is normally used.
   C - Table 3.11 of reference or $C = 0.345\,(u^3) \div (P-E)^2$
   where u = average wind velocity (mph)

5. It was felt that given the similarity of operation of a frontend loader to a shovel that measured emissions from Reference 1 of 10 to 20 times more (loader vs. shovel) were not reasonable, thus the selection of 0.003 lbs/ton.

6. Given the usual wetness of observed uranium ore in surface mines this factor is probably conservative. Factor estimate only - not measured. No correction is made for % suspended material as data is not available.

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TABLE C-1 (completed).

GUIDELINE FOR FUGITIVE DUST EMISSIONS (con't)

Notes:

7. Estimate only - not measured. No correction is made for % suspended material as data is not available.

8. 1.2 u lb/acre/hour where u is wind speed in m/sec. Factor includes some equipment activity around and on piles. Total emission should include truck dumping, etc. Adjust by ratio of dry days to total days in existence.

9. From Reference 5 E = 0.05(s/1.5)(d/235)(f/15)(D/90)lbs/ton throughput through pile
   where s = silt content of material (%)
   d = no. of dry days/yr
   f = percentage of time wind speed exceeds 12 mph
   D = duration of material in storage (days)

References:

(1) EPA-908/1-78-003, "Survey of Fugitive Dust from Coal Mines", by PEDCo Environmental, Inc., February, 1978.

(2) EPA-908/1-76-009, "Wyoming Air Quality Maintenance Area Analysis", by PEDCo Environmental, Inc., May, 1976.

(3) AP-42 "Compilation of Air Pollutant Emission Factors (Supplements 1-8)", May, 1978.

(4) PEDCo 1976, "Evaluation of Fugitive Dust Emissions from Mining", by PEDCo Environmental, Inc., April, 1976.

(5) C. Cowherd and R.V. Hendriks, "Development of Fugitive Dust Emission Factors for Industrial Sources", Paper No. 78-55.4, Annual Meeting Air Pollution Control Association, Houston, Texas (June, 1978).

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Attachment for Comment No. 30

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER, COLORADO 80295

DEC 10 1979

REF: 8AH-A

Dear Colleague:

In January, 1979, the Environmental Protection Agency (EPA) Region VIII distributed an Interim Policy Paper on the Air Quality Review of Surface Mining Operations. This paper attempted to present guidelines on the review of surface mining operations pursuant to the Prevention of Significant Deterioration of Air Quality (PSD) regulations, 40 CFR 52.21.

Two hundred people attended a public meeting to discuss this paper on February 6, 1979. We are today distributing a revised document entitled "Compilation of Past Practices and Interpretations by EPA on the Air Quality Review of Surface Mining Operations." This paper is being distributed today in full awareness of the June 1979 Alabama Power Company v. EPA opinion of the District of Columbia Circuit, U. S. Court of Appeals, and the September 5, 1979, EPA reproposal of the PSD regulations (44 FR 51924) in response to the above decision. This distribution is being made for the following reasons:

1. Potential permit applicants have asked for guidance on what control methods constitute BACT. This attached paper provides information on past BACT decisions.

2. The final Alabama Power v. EPA decision and final PSD regulations may be several months away in time.

3. The existing PSD regulations (40 CFR 52.21 (1978)) are still being implemented at this time.

4. This document will provide guidance to States in Region VIII whose PSD regulations closely resemble 40 CFR 52.21 (1978). SIP revisions to incorporate the next revision of the federal PSD regulation may not be formally approved until late 1980 or early 1981.

5. The EPA Region VIII Energy Policy Statement indicates that efforts will be made to provide industry and the concerned public with a better understanding of EPA policies.

This office fully expects to make all necessary revisions to this document when the next set of PSD regulations are finalized.

If you have any questions on this document please refer them to Norman Huey or David Joseph of the Air Programs Branch, Air and Hazardous Materials Division, at (303) 837-3763.

Roger L. Williams
Regional Administrator

Attachment

Compilation of Past Practices and Interpretations by EPA Region VIII on Air Quality Mining

I. Background

On December 5, 1974, EPA promulgated regulations under the 1970 version of the Clean Air Act for the prevention of significant deterioration of air quality (PSD). These regulations established a program for protecting areas with air quality cleaner than the national ambient air quality standards (NAAQS). The primary mechanism for implementation of that program was a preconstruction review program applicable to specific categories of major stationary sources. Nineteen source categories were listed in those regulations. Under that new source review program which has been implemented by EPA, a proposed major facility was reviewed according to the following criteria:

(1) The combined impacts of that source and other new sources in the area could not exceed prescribed ambient air quality increments. Increments for total suspended particulates (TSP) and sulfur dioxide were established and in a given area are a function of the PSD classification of the area; and

(2) The new or modified source must utilize best available control technology (BACT).

On August 7, 1977, Congress amended the Clean Air Act and Part C of the new Act contains specific requirements for the prevention of significant deterioration.

For the most part the 1977 Amendments were a codification of the EPA regulations. However, some additional requirements were included. A few of these additional requirements are:

(1) The source category list was expanded to 29 and the Amendments added a general provision requiring applicability to any new or modified source which will have potential emissions of 250 tons per year;

(2) The air quality increments were revised;

(3) Certain areas were established as mandatory Class I areas and the Federal Land Managers for these areas were given specific responsibilities to protect the air quality related values of the areas; and

(4) One calendar year of ambient air quality monitoring data may be required to accompany a PSD application.

The expansion of the applicability of the PSD program has resulted in the inclusion of fugitive dust sources in the PSD coverage. In fact, because of the nature of fugitive dust sources, such as surface mines, the 1977 Amendments have applied the preconstruction review program to relatively many small operations.

Because of the differences between point (stack) sources and fugitive dust sources in terms of control technology, as well as localized versus regional air quality impacts, it was necessary for EPA to develop unique criteria in the review of preconstruction applications for operations which cause fugitive dust. These provisions were codified in regulations published on June 19, 1978, (43 FR 26388). Since promulgation of those regulations, EPA Region VIII has received more than 40 permit applications from companies planning operations which would cause fugitive dust emissions. During that period, because of the complexity of the PSD program, particularly with respect to the unique provisions for fugitive dust sources, numerous questions have surfaced which need immediate resolution. The following discussions are intended to address these questions and the manner in which they were resolved, and are intended to provide insight as to the interpretations by Region VIII staff regarding some portions of the PSD regulations. Four general areas are addressed:

(1) General - Discussions of the interpretation of certain definitions as they apply to fugitive dust sources and interpretations of other general provisions of the PSD regulations.

(2) Monitoring - Region VIII interpretation of the intent of the preconstruction/postoperation monitoring requirements as they apply to operations which cause fugitive dust, and the design of monitoring programs which have been approved by Region VIII.

(3) BACT - Region VIII interpretaton of the applicability of the BACT requirement with respect to fugitive dust and control practices considered in reviewing pending applications.

(4) Modeling - Region VIII's current thinking regarding available models for fugitive dust sources.

II. General Interpretations

During the consideration of permit applications received to date a number of clarifications and interpretations of the intent of the PSD regulations with respect to fugitive dust have been necessary. Some of these involved clarification of the definitions contained in the 40 CFR 52.21(b) of the PSD regulations. Others involved clarification of other portions of the regulations and their application to fugitive dust sources. The following is a discussion of some of the issues that have needed resolution and the interpretation which was implemented by Region VIII.

(1) Fugitive Dust - Included in this category are overburden and topsoil removal, grading, exposed soils, and haul roads. Not included are operations involving the processing of product or product ore (i.e., coal, uranium ore). The processing of product includes the emissions resulting from the actual removal of the product from the earth (e.g., blasting, and removal of coal from the seam), as well as emissions resulting from the conveying, crushing, screening, storage and transfer of the product.

(2) Best Available Control Technology - This is usually expressed as a numerical emission limitation. However, for operations which cause fugitive dust it is expressed as a set of work practices designed to minimize, to the maximum extent practicable, emissions of fugitive dust.

(3) Potential Emissions - Total uncontrolled emissions, including fugitive dust.

(4) Allowable Emissions - Total controlled emissions. Depending upon the application of allowable emissions, it may either include or exclude fugitive dust (See Item II-5).

(5) Review Criteria - Any source (i.e. mine) with potential emissions greater than 250 tons per year is subject to PSD review. Potential emissions are computed for all facilities within an operation, including fugitive dust. BACT is required of all facilities if the total allowable emissions from all facilities are greater than 50 tons per year or 1000 pounds per day. In this portion of the review, controlled fugitive dust emissions would be included in the determination as to whether the allowable emissions exceed 50 tons per year or 1000 pounds per day. Air quality review, including monitoring, modeling, and additional impact analyses, is required if allowable emissions (excluding fugitive dust emissions) exceed the above criteria given for BACT. As described in 40 CFR 52.21(k)(5), the allowable emissions would not include fugitive dust and the air quality review could exclude impacts of fugitive dust.

(6) Boundaries - The air quality review need not consider impacts within the applicant's boundaries or within the boundaries of neighboring industrial operations. The source boundary is

generally defined as the permitted area (or area owned by the applicant) as specified in an approved mining plan. On certain occasions it may be necessary to define the boundaries in terms of the leased area. If a well defined mine plan Boundary does not exist, then a case-by-case determination of such boundaries must be made during the permit review.

(7) Modifications - A modification is referred to as a change in the operation which would increase potential emissions by 250 tons per year. In the case of a mining operation an applicable modification would usually consist of an increase in the production rate above that which existed on August 7, 1977, or above that which is stipulated in a PSD or State new source permit. Changes in the areas of an operation can also be considered a modification if there is a net increase in emissions of more than 250 tons per year. Specifically, for an operation which has a PSD permit, that permit will stipulate those areas which can be mined without being considered a modification.

(8) Emission Factors - The state-of-art for emission factors for fugitive dust is extremely limited at present, and additional field studies are absolutely necessary. Those factors which Region VIII believes best represent particulate emissions from mining operations are shown in Section IV of this paper. However, this list is not all inclusive and other representative emission factors can be used after consultation with Region VIII staff. EPA has recently contracted Midwest Research Inc. and Pedco-Environmental to perform a joint study to develop better emission factors for western surface mining operations. This guideline document will be updated to incorporate the new emission factors when they become available in early 1980.

(9) Emission Categories - While the major facilities within a operation which causes fugitive dust are taken into account when determining the total potential emissions from the overall source, clarification is required concerning a few categories.

(a) Mobile Sources - Tail pipe emissions are ignored for PSD purposes.

(b) Construction Emissions - These emissions are not considered in determining whether a new or modified source is subject to the PSD regulation. However, if a PSD permit is required, the construction phase emissions of an operation is subject to the BACT requirements.

(c) Secondary Emissions - In computing potential emissions, all on-site reentrained dust traffic emissions are included. In addition, off-site reentrained dust from hauling product or product ore are considered. However, reentrained dust from off-site employee traffic is ignored.

III. Monitoring

Section 52.21(n) of the PSD regulations provides the opportunity for EPA to require ambient air quality monitoring both prior to submission of a PSD application and during the operation of the source. This requirement applies only to a major source whose allowable emissions, excluding fugitive dust, exceed 50 tons per year or 1000 pounds per day.

The main purpose of this requirement is to assess the air quality impact of the source and to determine if the source is contributing to a violation of a national ambient air quality standard. The extent of air quality data which must be collected is determined by EPA on a case-by-case basis depending upon the need for data and the representativeness of the air quality data already being collected or previously collected in the vicinity of the proposed operation. Considerations which EPA has used in the review of PSD ambient air monitoring network reviews are discussed in Appendix A. This internal checklist may provide useful information for prospective applicants.

As an example, the type of ambient monitoring which is being performed for various reasons by a few large surface mines in the west is described below:

Preconstruction

For baseline levels, TSP data is collected for one year using hi-vol samplers at one or more sites in the vicinity of the proposed mining operations. To provide statistical confidence in the monitored results, a sampling frequency of once-every-third day should be utilized. State schedules which prescribe some other frequency, representativeness of data collected on other less frequent sampling schedules, availability of electrical power and manpower, and costs are considerations which influence the choice of an optimum monitoring frequency. In addition to TSP, one air monitor should be equipped to provide information on particle size distributon. These data could provide some insight to the general contribution of very large particles to high concentrations of TSP. If sophisticated "level two" diffusion modeling (as described in Section V) will be utilized to predict ambient impacts, it would be to the applicant's advantage to collect continuous meteorological data at one location to collect data needed as input to the model. Also "event-triggered" precipitation dat would be extremely useful for computing annual emissions where prediction of emissions is dependent upon precipitation.

Operational

In order to determine the variability of air quality impacts from mining activities, TSP data could be recorded on a more frequent basis than during the baseline program at three locations (two in the prevailing downwind direction and one upwind). One of the two downwind sites should also collect particle size data. In addition, meteorological data similar to that collected in the preconstruction phase should be recorded. Collection of these data should allow the mine operator to be able to better demonstrate the contribution which his operations are making toward recorded air quality concentrations.

IV. Modeling

The PSD regulations (40 CFR 52.21(1), (k) and (b)(6) require an air quality impact analysis on the non-fugitive dust portion of the particulate matter emissions resulting from mining activities if the allowable emissions (excluding fugitive dust) from these sources exceed 50 tons per year or 1000 pounds per day, whichever is more restrictive. EPA recommends that the impact analysis make use of existing atmospheric dispersion models such as those discussed in the "Guidelines on Air Quality Models" (EPA-450/2-78-027). If the applicant has access to a model, or models, which are equivalent to or an improvement over those listed in the guidelines document, for a specific application, and can demonstrate their equivalence or improvement, the applicant may use such models pursuant to the requirements of 40 CFR 52.21(m). Departures from the Guideline models must be subject to public notice and opportunity for public comment.

Because model applications for particulate matter with an appreciable settling, and model verification studies for such applications, have not reached the same degree of acceptance as for gaseous pollutants, it is recommended that two levels of sophistication be considered. The first level would be a rather simple approach which would make use of screening techniques using acceptable models in which the particulate matter would be assumed to behave much the same as gaseous pollutants. This approach would make use of the commonly acceptable dispersion models which are applicable for screening techniques as referenced in the "Guidelines." This simple technique would be expected to provide conservative estimates. If this analysis demonstrates that the mining operation causes an insignificant impact (e. g. one-half the controlling increment or less), no additional anal would be required. If the analysis shows a significant impact (e. g. greater than one-half the controlling increment), additional, more sophisticated modeling techniques may be necessary.

Simple Gaussian models which consider both point and area sources would be appropriate for this first level of review. Past practice at EPA Region VIII has been to often use the EPA Valley Model. The usual limitations which restrict the use of atmospheric dispersion models (see Guideline on Air Quality Models) should be taken into consideration in the impact analyses on mining activitie.

The second level of sophistication would require using models not provided in the referenced guidelines document. Models appropriate for this more refined analysis should consider fall velocity and deposition velocity of particles. This approach requires emissions data not commonly available; i.e., particle size of the point or area emissions. This information must be provided by the applicant.

Because more sophisticated models are not referenced in the Guidelines, it will be necessary for the applicant to review model use with EPA Region VIII and comply with the public review provisions of 40 CFR 52.21(m) and (r). Those models may range from Gaussian types such as the Industrial Complex Source Model, ERTAQ, or others, to numerical models such as Systems Applications, Inc., IBM, IMPACT, Lawrence Livermore Lab, SRI, or others.

Finally as discussed in Section II of this policy paper, air quality impacts will be assessed beyond the mine "permitted area" boundary. Long term and short term simulation models will be required. Application of the models will limit prediction of concentrations out to a maximum distance of 50 kilometers and/or when the TSP concentration becomes less than 1 ug/m^3 for 24 hour average. However, any reasonably expected impacts (such as greater than ten percent of the Class I increment) must be considered for Class I areas regardless of the above distance and significant criteria.

V. Best Available Control Technology (BACT)

BACT on all emissions from mining activities, both fugitive and non-fugitive, is required pursuant to 40 CFR 52.21(j) if allowable emissions (fugitive plus non-fugitive) exceed 50 tons per year or 1000 pounds per day. Under the Clean Air Act Amendments of 1977 and the revised PSD regulations (43 FR 26388), BACT is to be determined on a case-by-case basis rather than automatically applying an applicable federal New Source Performance Standard (NSPS) as was the case under the previous PSD regulation.

EPA has published general guidelines for determining BACT. (This guideline document appears as Appendix B.) Case-by-case determinations of BACT must take into account several factors including cost, energy and technical feasibility. The procedure for determining BACT requires first, that the applicant propose in its PSD application air pollution control systems which the applicant believes represents BACT. EPA reviews the proposed controls and may request supporting information and/or considerations of alternative control systems prior to making a final decision on BACT. Pre-application meetings between EPA Region VIII and potential applicants have proven to be a useful tool in helping applicants to define BACT for their particular source or operation.

Suggested factors that may be considered in a BACT impact analysis include, but are not limited to: energy consumption; air, water and solid waste pollution; economic costs; capital availability; geographical and climatic factors; or the physical characteristics of the product (e.g., high moisture content).

Economic ratios such as the ratio of total control costs to total investment costs, cost per unit of pollutant removed, and unit production costs may prove helpful in defining the point at which a given control measure becomes economically infeasible. The Appendix B guideline discusses the above ideas in more detail.

In response to numerous questions during pre-application meetings concerning what control practices would constitute BACT for surface mining operations, we include Table 1. This table summarizes EPA Region VIII's past practices and experiences with BACT determinations for previously permitted large surface coal mines (greater than 4 MM tons per year) and open pit uranium mines. Deviations from this list of BACT practices may well be expected for smaller operations, operations in other geographical areas, various precipitation conditions, and other types of surface mining operations. Again, we stress the importance of determining BACT on a case-by-case basis considering environmental, energy and economic factors. TAble 1 does not constitute a definition of BACT for all surface mining operations. Rather, it provides a concrete illustration of what Region VIII has accepted as BACT for certain operations in areas of the western United States. For example, baghouses and enclosed storage piles may be economically infeasible for the small coal mine operator. The BACT determination can reflect this and allow for alternate schemes of control.

Table 1 also lists the emission factors and control efficiencies used in past BACT analyses. The EPA Region VIII office will consider the use of other emission factors if the applicant can demonstrate their appropriateness.

Table 1

Summary of Past BACT Determinations Made by Region VIII for Large Surface Coal and Uranium Operations

Process Operation	BACT Practice	Uncontrolled Emission Factor: Range	Uncontrolled Emission Factor: Best Estimate	BACT Control Efficiency
1. Topsoil removal		16 #/scraper hr. (4) or 0.38 #/yd3 (1)		
2. Topsoil stock pile	Stabilization via either			
	a. rapid revegetation or,			75%
	b. mulch or,			85%
	c. chemical dust suppressant* or,			85%
	d. establish wind breaks			50%
3. Drilling	Use of bag type collector on air drill, or water injected			90%
a. coal			0.22 #/hole (1)	
b. overburden			1.5 #/hole (1)	
4. Blasting	a. Minimize area to be blasted			f(area blasted)
	b. Prevent overshooting			f(amount of blasting)
a. overburden		14.2 - 85.3 #/blast (1)		
b. coal		25.1 - 78.1 #/blast (1)		
5. Overburden removal	a. Minimize fall distance of material			
a. dragline		.0056 - .053 $\#/yd^3$ (1)		
b. truck/shovel			.037 #/ton (1)	
c. scraper			16 #/scraper hr. (4)	
6. Overburden stockpile	Stabilization via either			
	a. Temporary vegetation or,		Soil loss equation	75%
	b. Mulch or,		** (3)	85%
	c. Chemical dust suppressant*			85%

Table 1

BACT - Mining

Process Operation	BACT Practice	Uncontrolled Emission Factor: Range	Uncontrolled Emission Factor: Best Estimate	BACT Control Efficiency
7. Overburden shaping	a. Leave ridges with K = 2 - 5		soil loss equation** (3)	
	b. Establish wind breaks			
	c. Orient piles perpendicular to prevailing wind			
	d. Rapid revegetation (i.e. within one growing season)			
	e. Minimize spoil pile area			
8. Product removal	Minimize Fall Distance			
a. Coal-Truck/shovel		0.0035-0.014 #/ton(1)		
Coal-Front end loader			0.12 #/ton (1)	
b. Uranium			0.05 #/ton (4)	
9. Product dumping	a. Negative pressure or,			85%
	b. Spray system on dumped material			50%
a. Coal-bottom dump		0.005-0.027 #/ton (1)		
Coal-end dump			0.007 #/ton (1)	
b. Uranium-end dump			0.04 #/ton (4)	
10. Product storage				
a. Coal wind erosion from open pile	a. Enclosed		1.6 u #/acre hr (1) where u = wind speed, m/sec	99%
b. Uranium	a. Pile wetting		****	50%

Table 1

BACT - Mining

Process Operation	BACT Practice	Uncontrolled Emission Factor: Range	Uncontrolled Emission Factor: Best Estimate	BACT Control Efficiency
11. Product loading				
a. Coal load into silo Coal load out from silo	a. Baghouse on silo,		0.0002 #/ton (1)	95%
	b. Retractable chute on load out,			
	c. Minimize no. of openings			
	d. Spraying of coal in cars			
b. Uranium	————		0.05 #/ton (4)	
12. Haul roads			$E = \frac{(0.6)(0.81s)}{30} S \left(\frac{365-w}{365}\right)$** (2)	
	a. Speed control, and			f(speed)
	b. Chemical stabilization worked into road*			85%
	c. Restrict off road use			100%
13. Access roads				
a. if public	————	————	————	————
b. if controlled by operator	a. Paving or equivalent stabilization		$E = \frac{(0.6)(0.81s)}{30} S \left(\frac{365-w}{365}\right)$** (2)	85 - 100%
	b. Speed control, and			f(speed)
	c. Restrict off road use			100%
14. Road maintenance	a. Removal of loose debris, grading		32 #/road grader hour (4)	
	b. Chemical stabilization of roadbed after grading*			
15. Disturbed areas	Stabilization via either		Soil loss equation** (3)	
	a. Chemical dust suppressant*, or			85%
	b. Mulch, or			85%
	c. Revegetation within one growing season, or			75%
	d. Minimize area disturbed			f(area)

Table 1

BACT - Mining

Process Operation	BACT Practice	Uncontrolled Emission Factor: Range	Uncontrolled Emission Factor: Best Estimate	BACT Control Efficiency
16. Conveyors	Fully Covered		0.2 #/ton (4) for all conveyors and transfer points	
a. Fully covered				100%
b. Partially covered				90%
17. Transfer points	a. Enclosed and vent to baghouse or equivalent			99% 20% opacity
	b. Ducting to a central baghouse			99.0% and 0.01 gr/acf 20% opacity
18. Uranium Crushing and Screening	Baghouse or equivalent	@9-10% H_2O,E = 0.002 #/ton (5) @8% ",E= 0.040 #/ton @6% ",E= 0.16 #/ton		99.0% and 0.01 gr/acf
19. Coal crushing	Baghouse or equivalent			
a. Primary			0.02 #/ton (4)	99.0% and
b. Secondary			0.06 #/ton (4)	0.01 gr/acf
20. Coal Screening	Baghouse or equivalent		0.1 #/ton (4)	99.0% and 0.01 gr/acf
21. Coal Cleaning				
a. Thermal dryer			0.031 gr/dscf	NSPS
b. Pneumatic cleaning			0.018 gr/dscf	NSPS
22. Transportation	Bus service			f(VMT)
23. Construction	a. Chemical dust suppression of all roads and disturbed areas			50%
	b. Gravel parking lots			50%
	c. Confine traffic to specified roads			100%
	d. Minimize area of land disturbed			100%
	e. Prewater areas to be disturbed			50%

Table 1

BACT - Mining

Process Operation	BACT Practice	Uncontrolled Emission Factor: Range	Uncontrolled Emission Factor: Best Estimate	BACT Control Efficiency
24. Miscellaneous	a. Extinguish smoldering or burning areas in the mine			100%
	b. Chipping and mulching of vegetative material;removal from mine site rather than open burning			f(amount burned)
	c. Minimize all haulage distances			f(VMT)
	d. Prevent overloading of trucks			f(present practice)
	e. Covered haul trucks if haulage is on a public highway			f(VMT)

* Note -- Dilution ratio of dust suppressant, rate of application, and frequency of application is important. An example for Coherex is shown. This example is provided for guidance only. Mention of trade names does not mean endorsement of any material. Use of other suppressants shall meet equivalent specifications. Deviations from the specifications below shall be justified on a case-by-case basis, based upon data submitted by the applicant. Also, it is anticipated that the PSD permit condition may need to be revised upon adequate showing by the applicant or by the permitting authority.

	Dilution of Coherex	Rate of application	Frequency of Application
Haul roads preparation	1:4	1 gal/yd^2	Initial
Access roads preparation	1:4	1 gal/yd^2	Initial
Road maintenance	1:10	1/2 gal/yd^2	Once per month when the number of days when rainfall does not exceed 0.01 in. = 10 days
Disturbed areas not subject to vehicles	1:10	1/2 gal/yd^2	Initial

** Note -- From Reference 3 Universal soil loss equation is $E = 0.025\ IKCLV$
where E = tons of suspended particulate per acre per year
I = soil erodibility factor
K = soil ridge roughness factor
C = localized climate factor
L = field width
V = vegetative cover

*** Note -- From Reference 2 $E = 0.6(0.81s)\left(\frac{S}{30}\right)\left(\frac{365-W}{365}\right) = \left(\frac{sS}{60}\right)\left(\frac{365-W}{365}\right)$

where s = silt content of road in percent
S = vehicle speed in mph
W = mean annual (number of days with > 0.01 inches of rain)

Corrections may be applied for vehicle speed and number of vehicle tires.

An alternative method is to use the following:

$$E = 5.9\left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.8}\left(\frac{d}{365}\right)$$ Reference 6

where E = #/VMT
s = silt content in percent
S = average vehicle speed, mph.
W = average vehicle weight, tons
d = dry days per year (number of days less than 0.01 inches of rain)

****

$$E = 0.05\left(\frac{s}{1.5}\right)\left(\frac{d}{235}\right)\left(\frac{f}{15}\right)\left(\frac{D}{90}\right) \text{ \#/ton}$$ Reference 6

where s = silt content in percent
d = dry days per year
D = duration of material storage, days
f = % of time wind speed exceeds 12 mph.

References

(1) Survey of Fugitive Dust from Coal Mines, EPA 908/1-78-003, February 1978, EPA Region VIII, Denver, Colorado

(2) Compilation of Air Pollutant Emission Factors, AP-42, Second Edition

(3) Guide for Wind Erosion Control on Cropland in the Great Plains States, Craig and Turelle, USDA-SCS, July 1964

(4) Evaluation of Fugitive Dust Emissions from Mining, prepared by PEDCO for EPA-IERL-Cin, June 1976

(5) ORNL-TM-4903 "Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing as Low as Practicable Guides Milling of Uranium Ores" by Oak Ridge National Laboratory, May 1975

(6) Fugitive Emissions From Integrated Iron and Steel Plants, EPA - 600/2-78-050, March 1978 by R. Bohn, et al, Midwest Research Institute

watering alone of 50%. However, it notes that watering is impractical for a public road (not to be confused with a mine haul road), and therefore, no additional control efficiency was listed for watering. The combination of well maintained chemical stabilization, supplemented with watering, if needed, results in the control factor of 85% shown in the EPA Region VIII policy memorandum.

Comment No. 31:

Please use the emission factor from EPA AP-42, May 1983 for loading and dumping emissions.

Response:

The emission factor from EPA AP-42, May 1983 was used to recalculate emissions from loading and dumping. Revised emissions are incorporated in the revision to Table 1.1. (See Revised Table 1.1 in the response to Comment No. 13.)

Input used in developing the respective emission factors are as follows:

Particle size multiplier	- 0.73
Material silt content	- Till - 18%; Waste rock and ore - 1.6%*
Mean wind speed	- 7.2 mph (Crandon Project EIR, p. 2.1-17)
Drop height	- 3 ft for small loader and trucks (12 ton); 4 ft for large loader and trucks (35 ton)
Moisture content	- 2% for till; - 4% for waste rock and ore
Dumping device	- varies from 7 to 28 yd^3

*There should be no silt in this material. However, the percent shown in Table 11.2.3-1 of AP-42 for Stone Quarrying was used to provide a conservative estimate.

Comment No. 32:

Provide the source used to determine the particle size distributions presented on p. 35 of the January 24, 1984 letter to the DNR.

Response:

The methodology used for determination of particle size distributions and the reference source is presented in Comment No. 7 of this letter.

Comment No. 33:

Were emissions from tire wear included in the emissions in Table 1.1 of the January 24, 1984 air permit response letter. If not, use the emission factor in AP-42, Section 3.1.4 of $0.2\frac{\text{number of tires}}{4}$ g/mile.

Response:

Because of the way the particulate emission factor equations were developed, tire wear emission rates should already be included in the estimates generated for inclusion in Table 1.1 of the January 24, 1984 air permit response letter. However, since the subject references do not verify this, the emission factor from AP-42, Section 3.1.4 was used to generate tire wear TSP emissions. The TSP emissions for the maximum year of hauling is based on activity estimated for 1989. The following result indicates that tire wear TSP emissions are a very small contribution to the atmosphere.

Activity for 1989	Miles Traveled	$(\frac{T}{4})$	Emissions st/yr
Waste rock hauling	143,817	1.5	0.050
Bentonite hauled	1,148	4.5	0.001
Employee traffic	103,250	1	0.022
Service truck traffic	3,000	4.5	0.003
			0.076

These calculations will be provided in the revised air permit application.

Comment No. 34:

We could not find the formula presented for wind-blown emissions in the reference cited in your air permit application and the letter of January 24, 1984. Where in the reference is this discussion?

Response:

During our meeting in Madison on February 29, 1984, we provided Mr. Steve Klafka with the cited report so that DNR could copy those pages describing the formula for estimating wind-blown TSP emissions as discussed in the report beginning on p. 68.

The full citation for the report is:

PEDCo - Environmental Specialists, Inc. 1976. Evaluation of Fugitive Dust Emissions from Mining. Task 1 Report. Identification of fugitive dust sources associated with mining. Contract No. 68-02-1321. Task No. 36. April 1976. U.S. Environmental Protection Agency. Cincinnati, Ohio.

Comment Nos. 35 and 36:

What are the short-term emission rates for the annual estimates presented in the response to our Comment No. F1 of the February 24, 1984 air permit letter? The emission rates used for the 24-hour modelling efforts need to be defined for the fugitive dust sources. The emission rates presented for the mobile and stationary sources appear to be satisfactory for the 24-hour model calculations.

Response:

As discussed at our meeting in Madison on March 1, 1984, the emission rates for the 24-hour modeling calculations will be presented to the DNR in a separate letter by the end of March. We agreed with the DNR that the mobile and stationary source emission rates as presented are to be used in the modeling efforts. However, the fugitive dust sources annual emission rates are to be reviewed by EMC and adjusted to account for peak daily activity to the extent possible. These adjusted emission rates would be discussed and presented in a letter to the Bureau of Air Management by the end of March. After the DNR reviews these adjusted emission rates, we would meet and discuss them during the second week in April (tentative), after which the DNR would provide final approval of the modeling conditions.

Comment No. 37:

Further modeling efforts for the other criteria pollutants such as SO_x and NO_x are not required for the revised air permit application. However, revised estimates for the annual emissions and a discussion of these estimates related to the original air permit application should be completed with the revision document submittal. Further, this revision document should also include a discussion of the estimated emissions for the metals presented in our September 12, 1983 letter. Additional calculations for Pb are to be included as well as a discussion relating these estimated concentrations to TLV criteria.

Response:

As agreed at the meeting in Madison on February 29, 1984, we will review and discuss all of the criteria pollutants in our revised air permit application. We will also include the metals (i.e, aluminum, arsenic, cadmium, copper, lead, mercury and zinc) mentioned in the DNR's September 12, 1983 letter and a discussion relating them to TLV criteria.

Comment No. 38:

We would appreciate a copy of all building elevation drawings that you have available from your current engineering design.

Response:

Copies of our current engineering design for the Project buildings were presented for your review at our meeting in Madison on February 29, 1984. We agreed to provide an additional figure in the revised air permit application which would show the relation of stack heights to building dimensions and location. This would likely be a profile drawing through the mine/mill site since this is the area with major sources having stack emissions.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

April 11, 1984

File Ref: 1630 (Exxon)

Dear Librarian:

A copy of Exxon's response (dated March 1, 1984) to the Department's second detailed Environmental Impact Report (EIR) review letter (dated December 29, 1983) is enclosed.

Please place this item along with the rest of the correspondence kept with the Exxon EIR material.

Thank you for your assistance.

Sincerely,
Bureau of Environmental Impact

Carol Nelson

Carol Nelson
Environmental Specialist

CN/bjb

Enc.

Comment No. W1

The areas proposed for development appear reasonable based on the wetland acreage minimization criterion outlined in ch. NR 132. Further discussion is needed, however, to justify wetland impacts of the preferred access road corridor, since it is not the least acreage alternative.

Response:

The difference in wetland area affected by the proposed access road (2.6 ha [6.6 acres]) versus Alternative E (1.0 ha [2.5 acres]) is 1.6 ha (4.1 acres) (see EIR Table 4.4-2). Alternative E is aligned with the existing road system from STH 55 to the mine/mill site (EIR Figure 4.1-14). Alternative A would have a greater effect by 2.4 ha (5.9 acres) on wetlands than would the proposed action.

The main reason Alternative E was not selected is because a portion of this route passes through the Mole Lake Indian Reservation. This route also requires traffic to and from the mine/mill site to pass through the Sokaogan-Chippewa Community on STH 55. An increase in traffic of approximately 46 percent over current levels would occur if Alternative E is selected as the preferred route. Because of the potential impacts associated with increased traffic through the Sokaogon-Chippewa Community by using Alternative E, this alternative was not selected as the proposed route. The minor increase in disturbance of wetland vegetation (1.6 ha [4.1 acres]) associated with the proposed route was judged to be less of an impact than those associated with Alternative E.

In addition to the above factors, when the impacts to wetlands are reevaluated using a 30 m (100 feet) rather than a 60 m (200 feet) corridor width for the access road, as requested by the DNR, the area disturbed will be considerably reduced (see response to comment No. 46).

Comment No. W2

It is predicted that the only wetland to be affected by mine dewatering is Z17 (EIR 4.2-26), identified as the only water table wetland within the expected cone-of-depression. Yet there is some reduction in flow to certain surface waters even beyond the expected zone of influence. Since these surface waters possess associated wetlands, it would appear that some wetland impacts may also be expected. Also, the extent of groundwater connected wetland impacts may be influenced by further refinement and modification of groundwater models by Exxon and the Department. We will have to review this new information as it relates to wetlands as it becomes available.

Response:

Comment acknowledged. After additional ground water modeling has been completed to address specific DNR verification needs, as identified in comment No. 25, the potential impacts to water table wetlands, including those associated with surface water bodies (e.g., Swamp and Hemlock creeks), will be reevaluated. The results of this reevaluation will be presented in the revised EIR.

Comment No. W3

Wetlands were identified as being perched or water table linked without explanation of how this was determined for each wetland. Explanation of how this condition was determined for each wetland inventoried within the expected zone of influence of mine dewatering is necessary to evaluate impacts to these wetlands. In your explanation please refer to the presence of spring seeps in the vicinity of wetlands that have been classified as perched (Figure 2.3-17 of the EIR).

Response:

The determination of perched versus water table hydrologic position for wetlands was based upon the following: The surficial geological map prepared by Simpkins et al. (1981) was examined to determine if the wetland in question occurred in an area of stratified sand and gravel or in an area of glacial till. Stratified sand and gravel were considered to have a higher potential to be water table wetlands than perched. The opposite was considered for wetlands on glacial till. The piezometric surface map prepared by Golder Associates was also reviewed. Wetlands which had a ground surface elevation similar to that of the piezometric level were considered to be water table wetlands. Those wetlands which occurred in till areas that had an elevation above the piezometric surface were considered perched. Each wetland was examined in the field and an opinion was formed based upon characteristics such as vegetation, open water, inflow-outflow differences, springs, and observed surficial geology. Spring seeps shown on Figure 2.3-17 of the EIR were not used in the determination of perched versus water table wetlands. Presence of spring seeps alone does not prove conclusively that a wetland is a water table wetland. Spring seeps can be caused by a large number of hydrogeologic features. In areas of dense till, spring seeps are commonly associated with perched wetlands caused by soil interflow occurring at the interface between weathered and unweathered till (i.e., piping and long joints in till).

Comment No. W4

In testing the consultants' wetland evaluation models on a sample of wetlands, both with our own field data as well as theirs, we had difficulty in achieving the same results. While the size of the differences are not substantial, the number of differences are. The number of differences can affect the relative rankings and the model means which are used in the impact analysis. This problem needs to be reconciled.

Response:

The DNR review of the model results consisted of two parts: Calculation of model scores using the data contained on the consultants' wetland inventory reports and comparison of those scores with the consultants' scores, and field verification of the models by DNR staff and comparison of those scores with the consultants' scores. Review of these score differences with the DNR personnel performing these checks showed that in all cases the consultants' scores were mathematically correct and the models properly applied. Differences between DNR calculated scores using the consultants' data and scores calculated by the consultants were a result of the DNR not fully understanding all of the elements used in the model and the application of those elements to the models. In addition, some mathematical errors and possible computer errors were identified in the DNR data, which created differences in scores. Also, the DNR used a draft wetland inventory report, whereas the consultants used the final wetland inventory report in their data calculations. The final wetland inventory report included additional elements which were not included in the draft inventory report. This caused misinterpretation on the part of the DNR regarding data on the geologic deposits of the wetland versus those of the watershed.

Other differences in data collection resulted from the DNR staff spending more time in the field in the 12 wetlands they investigated compared to the time spent in these same wetlands by the consultants. This resulted in more lengthy plant species lists; however, this did not affect the model results. Discrepancies between DNR and the consultants' estimates of ecological elements, such as vegetative density, were attributed to differences in professional judgment and were within the variations expected by the consultants.

In summary, the consultants' model scores were correct. Actual differences between the DNR field data and the consultants were minor and did not affect the relative rankings and the model means used in the impact analysis.

Comment No. W5

We have not been able to normalize the wetland scores to achieve the same results as the consultant. We understand, from an inquiry by the Department (R. Read) to the consultant, that the normalization process described in Appendix L of the Wetland Assessment Report was not used. Instead a scaling process was utilized. However, we have still not been able to achieve the same "normalized" results that are presented in Table 6.2-2 of the Assessment Report and Table 5.2-2 of the Supplemental Assessment Report. This problem needs to be reconciled.

Response:

The model scores of the 127 wetlands presented in the August 1982 Wetlands Assessment Report were normalized using the method contained in Appendix L of that report. The model scores of the 31 wetlands in the August 1983 Supplemental Wetlands Assessment Report were not normalized using the method in Appendix L, but were normalized by using a scaling procedure. Minor changes will be made in wetland inventory data resulting from combining additional DNR wetland observations since 1979 with those of the consultants. These changes will affect the unnormalized scores of 15 wetlands. Once these unnormalized scores are computed, all 158 wetlands will be normalized using the method defined in Appendix L. Table 5.2-2 of the Supplemental Wetlands Assessment Report will be revised using the new normalized scores.

Comment No. W6

1) Based on the known geographical distribution of the following species, we believe that they may have been misidentified by the consultants. Examination of vouchers by the consultants should be made to determine the correct identification. Should they prove to be correctly identified, the presence of these species in studied wetlands would indicate special biotic values.

2) Picea rubens (Red Spruce) — Not recognized as a native Wisconsin species.

3) Kalmia angustifolia (Sheep Laurel) — An eastern species not yet recognized as a native Wisconsin species.

4) Vaccinium corymbosum (Highbush Blueberry) — An exceedingly uncommon species in Wisconsin, not known to occur in northeastern Wisconsin.

5) Quercus muehlenbergii (Chinquapin Oak) — Quercus muehlenbergii occurs in Wisconsin on dry prairie sites in southwestern Wisconsin.

6) Scirpus atrocinctus (Bulrush) — Considered synonymous with S. cyperinus (Wool-grass), which is also listed as occurring in the same wetland (Z1) (plus cf. 3.1 - 2, Supplemental Assessment Report).

7) Fraxinus pennsylvanica var, subintegerrima and Fraxinus nigra -- Our field investigations found that F. nigra was by far the most prevalent ash species in wetlands, while the consultants found green ash to be most common. We think black ash is the common wetland ash species.

Response:

1) If there were species misidentifications, this had no effect on the results of any of the models or the relative rating or ranking of the wetlands. One case involved confusion between two nearly identical species having different distributions (e.g., Spiraea latifolia mistaken for S. alba). In two other cases, the problems involve a typing error (the species name for bur oak) or differences in the proportions of two similar species (green and black ash).

2) Picea rubens (Red Spruce) -- Foliage samples collected from specimens that appeared different during the field examination from typical black spruce were examined in the laboratory (based upon descriptions in Grays Manual and Britton and Brown) and had characteristics inconsistent with black spruce and more nearly matching those of red spruce. Lacking mature cones at the time of the investigations, conclusive identification was not possible. A statement will occur on the errata sheet that red spruce on the field inventory report should be Picea sp.

3,4) Kalmia angustifolia (Sheep Laurel) and Vaccinium corymbosum (Highbush Blueberry) -- A statement will also be included on the errata sheet that sheep laurel and highbush blueberry on the field inventory reports are to be revised to Kalmia sp. and Vaccinium sp., respectively.

5) Quercus muehlengergii (Chinquapin Oak) — A statement will occur on the errata sheet noting this change in species name to Q. macrocarpa on the field inventory report.

6) Scirpus atrocinctus (Bulrush) — Considered a separate species in Grays Manual, and readily distinguished from S. cyperinus on the basis of (1) spikelete pedicelled and (2) base of involucre and involucels black. In S. cyperinus spikelets are sessile, base of involucre and involucels brownish.

7) Fraxinus pennsylvanica var. subintegerrima and Fraxinus nigra (Green Ash and Black Ash) -- It is acknowledged that black ash may be more prevalent in some areas of the site area than others. Differences in opinion may be based on (1) the wetlands and portions of wetlands visited and (2) difficulties in distinguishing these species during early spring without examination of the buds, which was usually not possible. Since both species have been positively identified in the site area by the DNR and EMC wetlands consultants, their relative proportions are not important with regard to the results of the investigations.

Comment No. W7

We would like to know how the element describing the surficial geologic material of the wetland bank (Storm and Flood Water Storage Function Model) was distinguished from "surficial material of watershed" element for the same model. There is no place on the field data collection sheet for recording of "wetland bank surficial material."

Response:

The element "Surficial Geologic Material of the Wetland Bank" in the Storm and Flood Water Storage Function Model is obtained primarily from the element "Surficial Material." In most cases they are identical. "Surficial Material" is that geologic material which underlies the wetland. "Surficial Geological Material of the Wetland Bank" is that geologic material which constitutes the wetland's immediate banks (upland area). Occasionally they are different when the wetland-upland boundary is also a surficial geologic boundary. The surficial geologic map of Simpkins et al. (1981) was used for these determinations as well as field observations by the geological consultant. "Surficial Material of the Watershed" is the dominant (>50 percent) surficial geological material which is found within the wetland's watershed and is not always the same as the "Surficial Material" under the wetland nor the "Surficial Material of the Wetland Bank."

Comment No. W8

Table 6.1-1 in the Assessment Report, and Table 5.1-1 in the Supplemental Report, summarize the major elements used to describe and evaluate the wetlands. These are qualitative descriptors, and are not explained in the text. It is not clear how they were derived from the field data sheets. The derivation of most of these elements can be surmised, such as: "Water Storage" in the tables apparently summarizes "Dominant Hydrologic Type" on the field inventory sheets. A discussion of what these descriptive elements are, and how they achieved, would be useful. For example, what exactly is meant by "Living Filter Capacity"?

Response:

The following information describes the major qualitative elements in Table 6.1-1:

Dominant Wetland Type - Synonymous with "Dominant Wetland Class" in the wetland inventory report. This assignment is made at the end of the wetland visit after all of the wetland subclasses and their relative proportions are known.

Amount of Edge - "Wetland Class Richness", "Subclass Richness" and "Vegetative Interspersion" are the elements in the wetland inventory report that are the basis for this qualitative element. The number of different wetland classes and subclasses and their degree of interspersion are the factors controlling the amount of edge in the wetland. This determination is made from aerial photographs and wetland visits after all the classes and subclasses and their shapes and distributions have been established.

Water/Cover Ratio - This element is based entirely on "Cover Type" in the wetland inventory report, and denotes the relative proportions of vegetative cover and water in a wetland and their degree of interspersion. This is determined from aerial photographs and wetland visits after an overview of the wetland has been completed.

Surrounding Habitat Variability - This element is synonymous with "Surrounding Habitat Variability" in the wetland inventory report, and denotes the number of different landscape elements comprising the surroundings. A wetland surrounded by an upland mixed forest would be assigned to the second designation under this element, whereas one bordered by a forest on one side and a lake or open field on another would be considered to be surrounded by "90 percent of 2 or more of the listed types." The types are not actually listed in the inventory report, but this terminology refers to any landscape elements which are predominantly non-urban. This determination would be made from aerial photographs following the wetland field reconnaissance.

Percent Bordering Open Water - Synonymous with "Percent Wetland Bordering Open Water" in the wetland inventory report. This determination is made from aerial photographs following the wetland field reconnaissance.

Recharge Potential - Elements that were considered to qualitatively assess a wetland's ability (i.e., potential) to recharge surface water to the underlying ground water were "Surficial Geologic Material," "Dominant Hydrologic Type," "Hydrologic Position," and "Ground Water Outflow" with "Surficial Geologic Material" being the dominant element. These elements were determined using available geologic and hydrogeologic data and field observations.

Water Storage - This element is an estimate of a wetland's ability to detain and retain surface water. The inventory elements which were used to estimate qualitatively a wetland's water storage potential were "Topographic Configuration," "Wetland Gradient," "Topographic Position in Watershed," "Organic Material," "Dominant Hydrologic Type," "Water Level Fluctuation," and "Surficial Geologic Material of the Watershed." The dominant element considered was dominant hydrologic condition. These elements were determined by using geologic and topographic maps, available hydrogeologic data, and field observations.

Discharge To Downstream Aquatic Systems - This is an estimate of a wetland's ability to maintain downstream water quality and quantity. Inventory elements used in this qualitative assessment were "Topographic Configuration," "Topographic Position in the Watershed," "Hydrologic Position," "Dominant Hydrologic Type," "Hydrologic

Connection" and "Outlet." Available hydrologic data, topographic and geologic maps, and field inspection were used to obtain this data.

Living Filter Capacity - This element denotes pollution attenuation capacity of the wetland and is assessed on the basis of best professional judgment applied to the vegetation and soil characteristics observed in the wetland, and the wetland's geologic setting. The length of time that a unit of water spends in the wetland, the wetness of the substrate, physical characteristics of the substrate as they relate to cation exchange capacity, life form of the vegetation as it relates to the uptake of nutrients, metals and other elements, and vegetative density are all factors that determine the wetlands' "Living Filter Capacity." "Dominant Wetland Class," "Cover Type," "Vegetative Density," "Topographic Configuration," and "Dominant Hydrologic Type" are the major elements in the wetland inventory report that determine the "Living Filter Capacity." These elements are determined from aerial photographs and from wetland visits after an overview of the geological and biological conditions has been completed.

Size - After a wetland's acreage has been measured, it is assigned to a size category. These categories are established after the size distribution of all wetlands in the area of interest has been determined.

Comment No. W9

Inventory Report Format: The dominant class listings on the field data sheets do not conform to the six classes described in the text. Deciduous and coniferous swamps are lumped together on the front page of the inventory, yet are distinguished elsewhere in the report. Conversely, though "Wet Meadow" and "Shallow Marsh" are considered identical in the report, they are presented as two distinct categories on the cover page of the inventory report form.

Response:

The inventory report cover sheets should have divided wooded swamp into deciduous and coniferous components. The inventory data contained on the second page in Appendix G and on the wetland maps all divided wooded swamp into coniferous and deciduous parts. Conversely, wet meadows and shallow marsh are both listed on the cover and on the second page. The information on the front page is summary information and is not used in calculating the model scores. The data shown on the front page have no influence on the model scores or the ranking of wetlands.

Comment No. W10

Throughout the Assessment Report there are disagreements about the dominant wetland class of various wetlands. We have used the field data sheets as the final word on any questions about wetland type, but the high number of these presumably typographic errors needs to be pointed out. There are numerous discrepancies among the inventory reports, Table 3.5-1, Table 6.1-1, and Appendix G. For example:

Wetland	Inventory Report	Table 3.5-1	Table 6.1-1	Appendix G
D3	D.S.	D.S.	D.S.	C.S.
D3	D.S.	D.S.	D.S.	C.S.
F60	C.S.	D.S.	C.S.	C.S.
B4	C.S.	C.S.	C.S.	C.S.

D.S. = Decidous Swamp
C.S. = Coniferous Swamp

When the field data sheets are used to correct these discrepancies, summary tables, such as Table 6.3-1 in the Assessment Report, are significantly changed (seven wetlands out of forty-six are shifted into different categories in Table 6.3-1.

Response:

The dominant wetland class shown on the wetland inventory reports is used when entering data into the models for the purpose of calculating model scores. The discrepancies noted by the DNR in the tables of the report are typographical errors and do not affect the model scores. The typographical errors will be addressed in an errata sheet and Table 6.3-1 of the Wetland Assessment Report will be revised and submitted as part of the errata sheet.

Comment No. W11

Comments on Specific Wetlands:

The following specific comments apply to wetlands in the vicinity of the proposed mine which were identified in the Supplemental Wetlands Assessment Report (SWAR) and Wetland Assessment Report (WAR). The comments are listed here as examples of differences between Department and Exxon's consultant's observation of wetland classification and function. While some of these differences may not be significant in terms of wetland evaluation or impacts to them, others may be significant. Please review the following comments and address those which could be significant in altering wetland scoring or facility placement, or significantly alter projections of impacts.

Response:

During a meeting on January 24, 1984 with DNR (G. Egtvedt, R. Read and J. Welch), EMC and EMC's wetlands consultants (IEP, Inc. and Normandeau Associates, Inc.) discussed each of the following specific comments. The results of this meeting provided the basis for the responses to comments No. W12 through W42. Some of the changes in the biological and hydrological characteristics of the wetlands that were agreed upon during the meeting may affect the model results. The inventory reports for the affected wetlands and the model results presented in tables in the Wetlands Assessment reports will be revised. An errata sheet listing the revisions and revised copies of the tables and inventory reports for the Wetlands Assessment reports will be issued to the DNR when completed.

Comment No. W12

Wetland Z-2 - There is an open water area located along this wetland's southern edge not identified in the SWAR. Also, separate from this wetland is a small pond. The pond appears to discharge to Z-2 during high water periods.

Response:

Following a discussion of this comment with the DNR, it was concluded that the small pond referenced is separate from wetland Z2. Although the pond may discharge to wetland Z2 under high water conditions, during average conditions it does not. This comment does not affect the model results.

Comment No. W13

Wetland Z-5 - The field inspection and the vegetation list provided in the SWAR indicate this wetland should be classified a "shallow marsh" rather than a "shrub swamp".

Response:

The acreage indicated on the cover page of the inventory report was improperly labeled "Shrub Swamp" rather than "Shallow Marsh"; however, on the second page of the report the data were correctly presented in the shallow marsh category. Data presented on the second page of the inventory report are used in calculating model results; therefore, no change in model results is necessary. The error on the cover page of the inventory report will be corrected and a revised report will be included with the errata sheet containing revisions to the Wetlands Assessment reports.

Comment No. W14

Wetland Z-6 - This wetland does not have an inlet from Wetland Z-10, as indicated in the SWAR (see direction on Wetland Z-10 for details).

Response:

The DNR's observation that wetland Z10 discharges to Z9 rather than Z6 is correct. The inventory report for Z6 will be changed to remove the inlet from Z10. This change will affect the Hydrologic Support, Storm and Flood Water Storage, Ground Water, and Water Quality Maintenance function models by decreasing their scores by 1, 1, 2 and 2 points, respectively. These changes do not affect the ranking of this wetland.

Comment No. W15

Wetland Z-7 and Wetland Z-9 - These wetlands are the headwaters of streams 24-14 and 24-15 T35N R12E. Department surveys have determined both of these streams pass through Wetland W-2 before reaching Swamp Creek. The original "Wetlands Assessment Report" indicates Wetland W-2's outlet is located "off site". Wetland W-2's inventory report should be completed now that it is included in the wetland study area.

Response:

The EMC wetlands consultants observed these streams in the field and agree with the DNR's observations. The study area for the original Wetland's Assessment Report did not include both streams within the area assessed for wetland W2. However, the study area for the Supplemental Wetlands Assessment included both of these streams as part of wetland W2. One perennial inlet will be added to W2's inventory report which will increase the Hydrologic Support function by 2 points, Ground Water by 3 points, Storm and Flood Water Storage by 2 points and Water Quality Maintenance by 4 points. This will not greatly change this wetlands ranking.

Comment No. W16

Wetland Z-9 - The SWAR does not indicate that this wetland receives surface water flow from Wetland Z-10 (see Wetland Z-10 discussion for details).

Response:

The DNR's observation that wetland Z10 discharges to Z9 is correct. The inventory report for Z9 will be corrected and the models recalculated. The Hydrologic Support function will increase by 2 points, Ground Water by 3 points, Storm and Flood Water Storage by 2 points and Water Quality Maintenance by 4 points. This wetland's ranking will not change.

Comment No. W17

Wetland Z-10 - This wetland discharges to Wetland Z-9 via a culvert under the logging road that separates the two wetlands. Creek 24-4, T35N, R12E, originates in Wetland Z-10. A channel approximately two feet wide is present immediately downstream from the culvert. There was a flow of approximately one-half cfs during a July 26, 1983, field inspection. Wetland Z-10's outlet is incorrectly identified as flowing to Wetland Z-6 in the SWAR.

Response:

As discussed in the response to comments No. W14, W15 and W16, discharge from wetland Z10 is to Z9. This correction results in no change to the inventory or model results for wetland Z10.

Comment No. W18

Wetland Z-15 - Though not indicated in the SWAR, water from this wetland appears to follow its historical route to Z-11 during high water periods passing over the town road that separates the two wetlands. No culvert could be found connecting the two wetlands.

Response:

Comment acknowledged. Both the EMC wetlands consultants and the DNR are in agreement that ephemeral discharge from wetland Z15 occasionally occurs; however, this surface water flow disappears before it reaches another wetland and thus no outlet occurs. No change in the model results is necessary.

Comment No. W19

Wetland Z-16 - The SWAR lists this wetland as having no outlet. However, a District field inspection determined the wetland intermittently drains to the south through a culvert under Keith Siding Road to Wetland T-4. The open water portion of the wetland identified in the SWAR is listed in "Surface Waters of Forest County" as Lake 17-16, T35N, R13E.

Response:

During detailed inspection by DNR staff a culvert was located which intermittently drains water from wetland Z16 to T4. Wetland Z16 will be given an ephemeral outlet. This will add 32 points to the Hydrologic Support function model score, 2 points to Ground Water, minus 1 point from the Storm and Flood Water Support Model and minus 2 points from the Water Quality Maintenance function model. A minor change in the ranking of this wetland probably will occur. Wetland T4 which has three inlets on the inventory sheet will be credited with a fourth inlet and its scores will increase similar to those described for Z9 (see response to comment No. W16); however, the ranking of this wetland should not change. We acknowledge the fact that the open water portion of wetland Z16 is listed in the "Surface Waters of Forest County."

Comment No. W20

Wetland Z-18 - The SWAR does not recognize that this wetland complex is listed as Hoffman Spring in the "Surface Waters of Forest County."

Response:

Comment acknowledged.

Comment No. W21

Wetland Z-20 - Our inspection of this wetland determined the forested portion has primarily "conifer" rather than "deciduous" tree species as listed in the SWAR.

Response:

Based on a discussion of wetland Z20 with the DNR staff, it was agreed that this wetland would remain as a deciduous swamp. No change in the model results is necessary.

Comment No. W22

Wetland Z-21 - This wetland discharges to Z-20 during periods of high water, contrary to being listed as having no outlet in SWAR. Wetlands Z-20 and Z-21 appears to be contiguous on their north ends during high water periods.

Response:

Based on a discussion of wetlands Z20 and Z21 with the DNR staff, it was agreed that these wetlands should remain separate. No change in the model results is necessary.

Comment No. W23

Wetland Z-22 - This wetland drains south through a culvert under Little Sand Lake Road to Wetland Z-20 during high water periods. This is contrary to the "absent" outlet listing in the SWAR. The open water area portion of the wetland identified in the SWAR listed as Lake 25-11, T35N, R12E, in the "Surface Waters of Forest County".

Response:

The DNR staff located a culvert under Little Sand Lake Road between wetlands Z22 to Z20. The inventory reports for both of these wetlands will be revised to include an outlet for Z22 and an inlet for Z20. The model scores for these wetlands will be recalculated and included in an errata sheet containing the revisions to the Wetland Assessment reports. We acknowledge the fact that the open water portion of wetland Z22 is listed in the "Surface Waters of Forest County."

Comment No. W24

Wetland Z-23 - The drainage characteristics of this wetland have not yet been determined. However, recent information indicates that the wetland discharges to both Rolling Stone and Mole Lakes rather than having Mole Lake as its outlet. Our inspection of this wetland determined the primary tree species are black spruce and tamarack. Black spruce is listed in the SWAR as only an "occasional" species and tamarack is not listed at all.

Response:

Based on a discussion of wetland Z23 with DNR staff, it was agreed that surface water flow occurs in both a northerly and southerly direction in this wetland. It is also acknowledged that black spruce and tamarack are dominant species in this wetland. These conclusions have no impact on the model results.

Comment No. W25

Wetland F-10 - While this wetland is for the most part contiguous with Little Sand Lake, it is doubtful if waterflow is perennial as listed in WAR.

Response:

Wetlands contiguous with a surface water body (i.e., lakes) were defined as having a perennial outlet because of year-round exchange of water between the two systems.

Comment No. W26

Wetland F-15 - The WAR did not identify the ephemeral surface water discharge in this wetland's southwest corner. In addition, the WAR does not identify the large portion of Wet Meadow within this wetland.

Response:

A well defined connection between wetland F15 and Skunk Lake is not evident as discussed in the response to comment No. W18. The EMC wetlands consultants agree that a portion of this wetland is wet meadow, but this has no impact on the model scores.

Comment No. W27

Wetland F-17 - This wetland's ephemeral surface water discharge to Wetland F-16 was not identified in the WAR.

Response:

Although the EMC wetlands consultants did not observe an outlet from wetland F17 during the 1982 field inventory, the DNR's observations confirm such an outlet. The wetland inventory report will be revised to include an ephemeral outlet, and the model scores for wetland F17 will be recalculated. The score changes will be similar to those discussed in the response to comment No. W19 for wetland Z16 and a minor change in ranking probably will occur.

Comment No. W28

Wetland F-19 - Water depth in the portion of this wetland adjacent to Deep Hole Lake would be sufficient to require a classification of Deep Marsh. This was not recognized in the WAR.

Response:

Following a discussion of this comment with the DNR, it was agreed that no change in the inventory report of wetland F19 is necessary.

Comment No. W29

Wetland F-33 - The WAR did not identify this wetland's ephemeral surface water discharge to the north during high water conditions. It is not an isolated wetland and could be included in the water balance study.

Response:

EMC wetlands consultants and the DNR agreed that wetland F33 does not have an outlet. Field observations have not confirmed that surface water from wetland F33 does reach another wetland. No change in the inventory report for wetland F33 is needed.

Comment No. W30

Wetland F-60 - The WAR lists this wetland's inlet as originating in F-68. There is no F-68 wetland.

Response:

The inlet for wetland F60 originates in F61. This typographical error will be listed in the errata sheet containing revisions to the Wetlands Assessment reports.

Comment No. W31

Wetland F-62 - This wetland is listed as a zero summer discharge, however, it has been observed flowing during and after rainy periods.

Response:

The inventory report lists an ephemeral outlet for wetland F62 which is in agreement with the DNR observations. No change in the model results is required.

Comment No. W32

Wetland F-70 - Our investigation of this wetland resulted in a classification of Shallow Marsh. The WAR classified the wetland as Wooded Swamp.

Response:

The wetland maps (WAR Figures 4.3-1 and 4.3-11) indicate wetland F70 is predominately a shallow marsh. The inventory report will be revised and the model results recalculated. Ranking of this wetland should not be affected. The corrected model scores will be included in the errata sheet containing revisions to the Wetlands Assessment reports.

Comment No. W33

Wetland F-72 - The WAR did not identify this wetland's ephemeral surface water discharge to Wetland F-60.

Response:

Discussion of this comment between the EMC wetlands consultants and the DNR resulted in an agreement that an outlet did not exist and changes in the model results for wetland F72 are not necessary.

Comment No. W34

Wetland F-81 - This small pond intermittently drains south across the road via a steel pipe. This surface discharge was not identified in the WAR.

Response:

The EMC wetlands consultants acknowledge that a culvert does exist but flow from this culvert does not reach another wetland and thus wetland F81 does not have an outlet. The DNR staff agreed with this observation and no change in the model scores is needed for F81.

Comment No. W35

Wetland F-114 - The WAR did not identify this wetland's ephemeral surface water discharge to the southwest.

Response:

Based upon the DNR's longer record of observations of this wetland, an ephemeral outlet will be assigned to F114 and the wetland model scores will be revised. These revisions will be similar to those made for wetland Z16 (see response to comment No. W19) and a minor change in ranking probably will occur.

Comment No. W36

Wetland F-119 - We identified a portion of this wetland as Shallow Marsh in addition to the WAR classification of Wooded Swamp.

Response:

The inventory report for wetland F119 includes shallow marsh as a subtype but the area of this wetland type was too small to phototype and measure. No change in the model scores for F119 is required.

Comment No. W37

Wetland H-1 - The WAR did not identify this wetland's ephemeral surface water discharge to the east.

Response:

Following discussion with the DNR staff, it was agreed that there is no outlet for wetland H1. No change in the model results is necessary.

Comment No. W38

Wetland K-4 - We classified this wetland as Shallow Marsh, while the WAR made the classification of Shrub Swamp.

Response:

After discussing this comment with the DNR staff, it was agreed that shallow fresh marsh would be added as a subtype and the model scores recalculated. Minor changes will occur in this wetland's score; however, its ranking should not be altered. The corrected scores and ranking will be included in the errata sheet containing revisions to the Wetland Assessment reports.

Comment No. W39

Wetland K-5 - The WAR did not identify this wetland's ephemeral surface water discharge to the northeast.

Response:

The EMC wetlands consultants and the DNR agreed that ephemeral surface water flow from wetland K5 does not reach another wetland; therefore, no outlet exists. No change in the model results is required.

Comment No. W40

Wetland M-4 - The WAR did not identify this wetland's ephemeral surface water discharge to the north.

Response:

Based on a discussion of the hydrological characteristics of wetland M4 with the DNR staff, it was agreed that no outlet exists. No change in model results is necessary.

Comment No. W41

Wetland R-7 - The WAR did not identify this wetland's ephemeral surface water inlet across the road to the north from Wetland R-7A.

Response:

There is no culvert under the road dividing wetlands R7 and R7A. Because the DNR has observed intermittent water flow over the road for a number of years, this wetland will be assigned an ephemeral outlet and its model results will be revised. The revisions will be similar to those for wetland Z16 (see response to comment No. W19) and a minor change in ranking probably will occur.

Comment No. W42

Wetland R-8 - The WAR did not identify this wetland's ephemeral surface water outlet to Wetland R-7A.

Response:

Based on a discussion of the hydrological characteristics of wetland R8 with the DNR staff, it was agreed that no ephemeral outlet exists. No change in the model results is necessary.

CHAPTER 1

Comment No. A1

In the May 11 letter to Exxon, there were four questions on manpower needs. The questions were aimed at clarifying peak manpower needs and identifying the skills required for the construction and operations work forces. When we know what Exxon's specific hiring needs are, they can be compared to the availability of skills of the local work force. From this comparison an estimate of local hires can then be made. All other hires are assumed to be non-local, thereby requiring worker immigration. Immigration is a key variable in determining socioeconomic impacts, including impacts on local facilities and services, schools, housing, taxes and others. Exxon's responses did not provide sufficiently detailed information (for example, mine technical, mine operation, mill technical, operation and maintenance) for us to estimate whether the jobs could be filled locally. Please provide us with explicit descriptions of the essential skills required for each type of Exxon construction and contract construction and operations workers to be hired. Each type of work position should also be identified by the appropriate 4-digit Standard Occupational Classification Code (SOC) of the U.S. Department of Commerce. This explicit description should include the skills and knowledge required for each SOC code as a prior condition for employment at the project.

Response:

The attached tables (A1-1 and A1-2) summarize the current employee estimates that will be required for construction and operation of the Crandon Project. The 4-digit Standard Occupational Classification Code (SOC) from the U.S. Department of Commerce has been listed for each job category along with the number of employees, general educational level required and an indication of whether the position requires previous experience. The job category identifies the general skills necessary for the employees (i.e., cement mason) expected to be hired.

These tables represent only general guidelines for education and experience. The hiring and job interview process will balance the education and experience levels. In actual practice some deviation from the education and experience requirements, as indicated in the attached tables, will probably occur through the employment process.

Comment No. A2

Exxon has frequently stated they are committed to preferentially hiring local people to the extent allowable under applicable laws. To which federal and state laws does this refer and what are the implications? Are there any existing or planned agreements with local governments or Indian tribes relating to proposed hiring practices? What activities does Exxon plan in cooperation with local educational institutions to support training of local workers in order to increase local hiring? Would Exxon financially support a locally organized van or bus transportation system between outlying areas, including Indian reservation lands, and the mine site to encourage local hires?

(Table A1-1 for the Response to Comment No. A1)

NON-EMC EMPLOYEES

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCE[d]
Mine Construction				
Pipefitters	6450	3	V	Y
Welders	7710	3	V	Y
Electricians	6430	6	V	Y
Millwrights	6178	6	V	Y
Mechanics	6140	24	H	Y
Equipment Operators	8310	25	H	Y
Ironworkers	6472 & 6473	12	V	Y
Carpenters	6420	6	H	Y
Laborers	8710	33	H	N-Y
Cement Masons	6463	18	H	Y
Shaft and Drift Miners/ Rock Drillers	6530	102	H	Y
Hoistmen	8314	12	H	Y
Surveyors	1640	4	V	Y
Supervisors	6310	22	H-C	Y
Engineers	162 & 163	5	C	Y
Surface Facilities Construction				
Boilermakers	6814	90	V	Y
Carpenters	6420	160	H	Y
Electricians	6430	120	V	Y
Laborers	8710	145	H	N-Y
Operating Engineers	8310	145	H	Y
Millwrights	6178	60	V	Y
Painters	6440	15	H	Y
Pipefitters	6450	120	V	Y
Ironworkers	6472 & 6473	200	V	Y
Teamsters/Mechanics	6140	40	H	Y
Cement Masons	6463	20	H	Y
Surveyors (Rodmen)	1640	5	V	Y
Finishers	6463	5	H	Y
Supervisors	6310	100	H-C	Y
Engineers	162 & 163	25	C	Y

a Standard Occupational Classification Code (SOC) - U.S. Department of Commerce.

b Numbers reflect employment needs within job categories. Due to timing differences, totals may not agree with Project employment totals.

c Education: H - High School
V - Vocational Technology
C - College

d Y - yes; N - none required; N-Y - some employees will need prior experience and others will be trained on the job.

(Table A1-2 for the Response to Comment No. A1)

EMC EMPLOYEES

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCE[d]
	Administration	86		
Secretaries/Clerks	46-47	22	H	N-Y
Janitors	5240	7	H	N-Y
Security	5140	8	V	Y
Accountants	1412	2	C	Y
Warehouse	8724	11	H	N-Y
Purchasing	1449	1	H	Y
Paramedics	5236	3	V	Y
Employee Relations/ Safety/Training	1430	15	C	Y
Public Affairs	3320	1	C	Y
Environmental	1849	3	C	N-Y
Supervision	12-13	9	C	Y
Engineers	162 & 163	4	C	Y
	Mine Technical	35		
Supervisors/Engineers	162 & 163	10	C	N-Y
Geologists	1847	6	C	N-Y
Draftsmen	3720	3	V	N-Y
Engineers/Geology Technicians	3710	8	V	N-Y
Surveyors	1640	6	V	Y
Clerks	46-47	2	H	N-Y
	Mine Operations	276		
Secretaries/Clerks	46-47	4	H	N-Y
Miners	6530	87	H	N-Y
Equipment Operators	6540	108	H	N-Y
Laborers	6560	41	H	N
Supervisors	6320	32	V	Y
Hoistmen	8314	4	H	Y

[a] Standard Occupational Classification Code (SOC) - U.S. Department of Commerce.

[b] Numbers reflect employment needs within job categories. Due to timing differences, totals may not agree with Project employment totals.

[c] Education: H - High School
V - Vocational Technology
C - College

[d] Y - yes; N - none required; N-Y - some employees will need prior experience and others will be trained on the job.

(Table A1-2 for the Response to Comment No. A1 [continued])

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCED[d]
	Mine Maintenance	85		
Equipment Mechanics	6110	40	H	N-Y
Pump/Fan Mechanics	6130	3	H	Y
Welders	7710	3	V	Y
Electricians	6430	9	V	Y
Maintenance	6179	19	H	N-Y
Clerks	46-47	3	H	N-Y
Supervisors	6000	7	V	Y
	Mill Operations	60		
Secretaries/Clerks	46-47	2	H	N-Y
Mill Operators	6960	43	H	N-Y
Laborers	8650	8	H	N-Y
Supervisors	6320	7	H	Y
	Mill Technical	26		
Lab Technicians	3831	13	V	N-Y
Metallurgists/Chemists/ Engineers	162 & 163	10	C	N-Y
Technicians	3710	2	V	N-Y
Typist/Clerks	46-47	1	H	N-Y
	Mill Maintenance	30		
Supervisors	6000	2	V	Y
Mechanics/Oilers	6140	20	H	N-Y
Welders	7710	4	V	Y
Instrument Repairs	6170	4	V	Y

(Table A1-2 for the Response to Comment No. A1 [continued])

JOB CATEGORY	SOC[a]	NO. OF EMP.[b]	EDUCATION[c]	EXPERIENCED[d]
	Central Maintenance	68		
Supervisors	6000	8	V	Y
Machinists	6813	2	V	Y
Electricians	6430	18	V	N-Y
Mobile Equip Maintenance	6110	27	H	N-Y
Draftsmen	3720	1	V	N-Y
Welders/Fabricators	7710	6	V	Y
Carpenters	6420	1	H	Y
Secretaries/Clerks	46-47	2	H	N-Y
Maintenance Planners	4750	2	H	Y
Engineers	162 & 163	2	C	Y
	Construction Management	26		
Engineers	162 & 163	7	C	Y
Purchasing	1449	2	H	Y
Accounting	1412	3	C	Y
Secretaries/Clerks	46-47		H	N-Y
Supervisors	6320	14	H	Y

Response:

To the extent allowed by the state and federal anti-discrimination laws, Exxon has an announced policy of preferentially hiring qualified local people during the construction and operation phase of the Crandon Project. As presently interpreted, the state and federal anti-discrimination laws do not prohibit the granting of local preferential treatment in the hiring decision provided the hiring is conducted in a nondiscriminatory manner within the local area. There are no existing or currently planned agreements with local governments or Indian tribes relating to proposed hiring practices.

We will outline job skills required for various positions at the Crandon Project and review curricula developed by the local schools if requested. We currently see no need to support an organized van or bus system to encourage local hires.

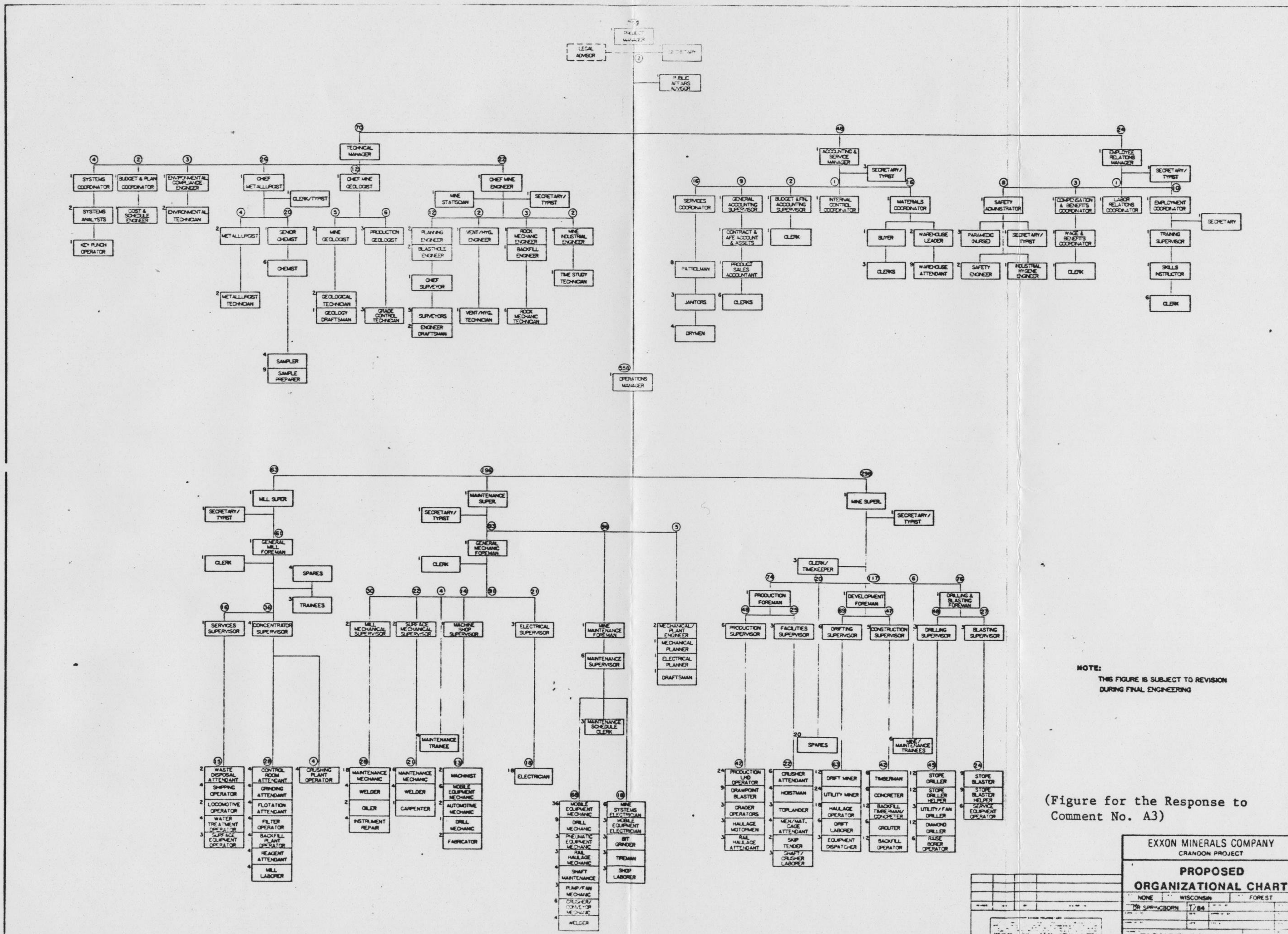
Comment No. A3

At the November 18, 1983 meeting in Madison, when the Future Conditions Report was discussed by Exxon, the subject of local hiring rate was raised. Exxon stated that a skills analysis of the local study area had been performed and had been used as the basis for determining that the local hiring rate for operations workers could be as high as 60%. That figure was used for calculating impacts in the three scenarios used in the Future Conditions Report - minimum, most likely, and maximum impact scenarios. Please provide us with that skills assessment and any other data used to calculate the local hiring rate so we can verify your approximations of local hiring rates.

Response:

The draft organization diagram proposed for the Crandon Project with job category titles for the employees in various departments is presented in the attached figure. Recently, a compilation of the Rhinelander Applicant Counts for the occupations listed by Exxon Minerals Company for the Crandon Project was developed by the Department of Industry, Labor and Human Relations. These data are presented in the attached Table A3-1.

The permanent (operations-and-maintenance) work forces of large mining projects and similar resource developments generally are comprised largely of craftsmen-technicians, equipment operators, and mechanics. Because wages paid by mines are generally higher than those in most other rural area jobs demanding similar skills, many of the local workers with appropriate skills typically are interested in obtaining employment at a new mine (Leholm et al., 1975; Murdock and Leistritz, 1979). Thus, even in areas with relatively sparse population (and thus small local labor pools), mining firms have often been able to achieve high rates of local recruitment. For example, a survey of workers at seven coal mines and seven power plants in the Northern Great Plains indicated that local workers made up 62 percent of the overall work force (Wieland et al., 1977; Wieland et al., 1979). Substantial variations in the rates of local hiring were found among these projects, with higher rates of local hiring usually occurring where the local (area) labor pool was larger in relation to the project's labor requirements. The local hire rate was less than 60 percent at only two of the seven mines surveyed.



(Figure for the Response to Comment No. A3)

(Table A3-1 for the Response to Comment No. A3)

NORTH CENTRAL WISCONSIN JOB SERVICE APPLICANTS FOR SELECTED OCCUPATIONAL CODES December 22, 1983	Total	Active	Inactive
Total All Occupations	13,623	6,788	6,835
SELECTED DOT CODES	-	-	-
010061.....Mining Engineer	-	-	-
011061.....Metallurgists	-	-	-
016187.....Surveyor, Mine	-	-	-
019167.....Project Engineer	3	-	3
020162.....Programmer, Business	2	1	1
022061.....Chemist	2	1	1
024061.....Geologist	4	3	1
075374.....Nurse, Staff, Occupational Health	11	5	6
079374.....Emergency Medical Technician	36	17	19
097227.....Instructor, Vocational Training	2	1	1
110107.....Lawyer	-	-	-
160167.....Accountant	37	15	22
162157.....Purchasing Agent	15	8	7
165067.....Public-Relations Representative	5	2	3
166117.....Manager, Personnel	7	1	6
166167.....Manager, Labor Relations, Employment	1	-	1
166227.....Training Representative	1	1	-
166267.....Employment Interviewer	10	4	6
169167.....Clerk, General Assistant	45	28	17
181117.....Mine Superintendant	2	2	-
189117.....Project Director	6	3	3
201362.....Secretary, Legal Secretary, Medical Sec.	138	54	84
203582.....Data Typist	27	13	14
209562.....Clerk, General	189	80	109
213362.....Computer Operator	13	8	5
216482.....Accounting Clerk	38	18	20
219362.....Administrative Clerk	358	144	214
222387.....Inventory Clerk	43	20	23
372167.....Guard, Chief	1	1	-
372667.....Guard, Security	44	19	25
408662.....Hydro-Sprayer Operator	-	-	-
409683.....Farm-Machine Operator	5	2	3
454683.....Tree-Shear Operator	3	-	3
454687.....Chainsaw Operator	2	2	-
519687.....Laborer, General	14	6	8
562662.....Log-Chipper Operator	-	-	-
564662.....Log-Chipper Operator	-	-	-
603685.....Bit-Sharpener Operator	5	3	2
620261.....Mine-Machinery, Heavy Equip., Truck Mechanic	147	69	78
630381.....Conveyor-Maintenance Mechanic	-	-	-
638281.....Maintenance Mechanic	49	23	26
710281.....Instrument Mechanic	2	-	2
801361.....Structural-Steel Worker	25	17	8
805261.....Boilermaker I	4	3	1
805381.....Boilermaker II	-	-	-
819384.....Welder, Combination	76	50	26
824261.....Electrician	63	40	23
840381.....Painter	60	27	33
844364.....Cement Mason	57	40	17
849663.....Concrete-Pump Operator	-	-	-
850663.....Motor-Grader Operator	1	1	-
850683.....Bulldozer Operator	13	9	4
859682.....Earth-Boring-Machine Operator	1	-	1
859683.....Operating Engineer	136	81	55
860381.....Carpenter	328	167	161
861381.....Bricklayer	33	14	19
862381.....Pipe Fitter	95	45	50
869664.....Construction Worker 1	281	152	129
869665.....Auxillary-Equipment Tender	-	-	-
869683.....Compactor	2	1	1
869687.....Construction Worker 11	244	143	101
900683.....Concrete-Mixing Truck Driver	3	2	1
902683.....Dump-Truck Driver	25	15	10
903683.....Tank-Truck Driver	1	1	-
904383.....Tractor-Trailer Driver	181	74	107
905663.....Truck Driver, Heavy	181	102	79
905683.....Water-Truck Driver	3	3	-
906683.....Truck Driver, Light	77	43	34
913663.....Chauffeur	1	1	-
921663.....Hoist Operator	22	6	16
921683.....Front-End Loader Operator	73	34	39
929137.....Warehouse Supervisor	2	2	-
929683.....Tractor	26	12	14
930382.....Driller, Machine	3	2	1
930682.....Core-Drill Operator	-	-	-
936687.....Company Laborer	-	-	-
939281.....Miner 1	-	-	-
939667.....Cager	4	3	1
955585.....Wastewater-Treatment Plant Attendant	-	-	-

More recent surveys of operations work forces indicate rates of local hiring similar to those previously cited. For example, a survey of workers at two coal mines near Sheridan, Wyoming indicated that about 60 percent of the work forces had been recruited locally (Hooper and Branch, 1983). Similar results were reported from a survey at the Jim Bridger power plant in southwestern Wyoming (Browne, Bortz, and Coddington, 1981). Large-scale development projects can strain the local labor supply, however. For instance, a survey of 15 companies developing coal mines in Campbell County, Wyoming indicated that only 40 percent of the 523 workers hired during 1981 had lived in the county for six months or more prior to their employment by the energy firm (Browne, Bortz, and Coddington, 1982).

Considering the Crandon Project specifically, several factors would suggest that a relatively high rate of local recruitment can be expected. These include: the large local labor force (relative to project labor requirements), the substantial percentage of local workers possessing skills consistent with Project employment requirements, the general stock condition of the local labor market (as evidenced by a persistent trend of moderate to substantial unemployment), and the fact that no other major projects are anticipated to be developed in the area during the period when the major hiring for Crandon will occur. Thus, the 60 percent rate of local hiring assumed in the impact assessment could prove to be conservative.

CITATIONS

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Leholm, A. G., Leistritz, F. L., and Wieland, J. S. 1975. Profile of North Dakota's Coal Mine and Electric Power Plant Operating Work Force. Ag. Econ. Rpt. No. 100. Fargo: North Dakota Ag. Exp. Station.

Murdock, S. H. and Leistritz, F. L. 1979. Energy Development in the Western United States: Impact on Rural Areas. New York: Praeger Publishers.

Wieland, J. S., Leistritz, F. L., and Murdock, S.H. 1979. "Characteristics and Residential Patterns of Energy-Related Work Forces in the Northern Great Plains." Western Journal of Agricultural Economics 4:57-68.

Wieland, J. S., Leistritz, F. L., and Murdock, S. J. 1977. Characteristics and Settlement Patterns of Energy-Related Operational Workers in the Northern Great Plains. Agricultural Economic Report No. 123. Fargo: North Dakota Agricultural Experiment Station.

Comment No. A4

The following data are from Exxon's Forecast of Future Conditions Report (1983); Scenario I (minimum impact) identifies that in 1989 there would be 1,410 workers on site; Scenario II (most-likely impact) identifies 1680 workers on site; Scenario III (maximum impact) has 1830 workers on site. These are approximate staffing levels needed during peak hiring in the final year of construction (p. 17).

In Exxon's response to comment number 154, a peak hiring number of slightly more than 1,400 employees would occur as the construction and operations workers overlapped. Which number of peak total workers is correct and why?

Response:

The response to the earlier EIR comment No. 154, showing a peak hiring number of slightly more than 1,400 employees, is correct based on current engineering design basis and plan (see also response to comment No. 1 of this letter). As explained in the response to the earlier EIR comment No. 30, this projection is based on new construction estimates developed in early 1983. We believe that this new peak (1,417 employees per response to earlier EIR comment No. 30) is a more accurate representation of the most likely peak number of construction/operations people because it is based on current Project design.

The data contained in the Forecast of Future Conditions for Scenario I (1,410 workers), Scenario II (1,680 workers), and Scenario III (1,830 workers) were based on earlier Project design information. As indicated in the Forecast of Future Conditions, the different scenarios were an attempt to bracket the expected range of construction phase personnel for the Project since the actual number of people employed will vary somewhat from any forecast. To the extent that Scenario I approximates current estimates for Project employees, a review of its information will provide projected effects.

Comment No. A5

Exxon has indicated to the Department of Industry, Labor and Human Relations that for planning purposes for the septic system at the mill, 1,400 workers was the peak employment. If the peak employment is 1,680 workers as indicated in the Future Conditions Report's, most-likely scenario, would the septic tank and soil absorption field be adequately sized? Please explain.

Response:

As explained in the response to comment No. A4, Exxon Minerals Company's current estimate of peak employment is approximately 1400 people. At that point during the construction period approximately 10 percent are contractor personnel for shaft and underground construction, 33 percent are Exxon employees and the remainder (57 percent) are contractor personnel for surface facilities construction.

The sanitary sewage soil absorption field was sized following DILHR guidelines based on the current estimate of the operations phase work force of 703 people. With allowance for visitors and approximately 10 percent contingency, 800 people were used for estimating sanitary sewage waste generation.

In following Wisconsin Administrative Code H63.15(3)(C)2, a total per day per person sanitary sewage waste generation rate of 0.13 m^3 (35 gallons) (20 gallons sanitary waste and 15 gallons for showers) was assumed. The 35 gallon per person per day is conservative because most employees and visitors will not shower in Exxon facilities. However, using these criteria and adding 2.84 m^3 (750 gallons) per day of base flow (per code), the total daily sanitary sewage flow is estimated to be 108.8 m^3 (28,750 gallons) which is equivalent to an approximate average flow rate of 4.54 m^3/h (20 gallons per minute).

Assuming one-half of the shaft and underground construction personnel (i.e., 70) and one-fourth of the Exxon permanent employees (i.e., 116) shower during the temporary construction peak, the sewage flow would be:

Those showering:

0.10 x 1400 x 0.5 x 35 gal/day = 2450 gal/day
0.33 x 1400 x 0.25 x 35 gal/day = 4043 gal/day

Those not showering:

0.10 x 1400 x 0.5 x 20 gal/day = 1400 gal/day
0.33 x 1400 x 0.75 x 20 gal/day = 6930 gal/day
0.57 x 1400 x 1.00 x 20 gal/day = 15960 gal/day
30783 gal/day

Although this temporary peak construction flow rate is approximately 7 percent greater than the soil absorption field design flow rate, it is within the variations of flow the DILHR design criteria (area loading rate) are meant to tolerate. For the septic tank, which is sized for a one-day retention time for the sewage flow rate, the retention time would also be shortened by about 7 percent during this construction peak. This would have no effect on the operation of the system.

Comment No. A6

Are there any federal requirements and regulations relating to training, mine safety, or other prerequisites for underground miners which could impact Exxon's local hiring? Are there any other barriers to local hiring? Please discuss.

Response:

Initially a core of experienced underground miners must be hired (i.e., approximately 70 people) to begin early mine level (i.e., drifts) construction. To our knowledge, there are no laws that will impact Exxon's local hiring practices, as long as the preferential hiring of local people does not result in a violation of state or federal civil rights. There are MSHA training requirements which must be fulfilled prior to assigning an employee to work underground. This training will be conducted after employment and will be given to all underground employees regardless of experience levels. Therefore, this training requirement should not impact hiring.

Comment No. A7 (Comment #45)

Exxon's response indicates that an inventory of all private water wells and systems within the 1 meter potential groundwater drawdown area was undertaken. However, the appropriate drawdown area must be defined by the 0-meter contour and under a worst-case scenario analysis. These data are required so that impact to all potentially affected wells can be evaluated.

Response:

An inventory of private water wells in the environmental study area was completed in 1978 as part of the baseline evaluation and the results are reported in EIR subsection 2.3.3.7. The inventory included those wells located in the area of potential ground water drawdown.

The current hydrogeology program will provide information on the extent of the ground water potentiometric surface drawdown defined by the 0-meter contour under a worst-case analysis. These data will provide the basis for evaluating the impact to potentially affected wells in the site area. When this field and laboratory program has been completed, we will discuss the results with the DNR. These results will also provide the basis for an inventory of private water wells and systems within the drawdown area. The scope of this inventory, including the inventory area, schedule and field and laboratory data to be collected, will be determined jointly with the DNR.

Comment No. A8 (Comment #72)

Please identify classes or "typical" chemicals which may be used as dewatering agents.

Response:

Dewatering agents are chemicals used to lower the surface tension of water and/or flocculate mineral particles so that they can be filtered more easily. The mining industry uses these chemicals to aid in filtering mineral concentrates. Dewatering agents that are currently marketed are sulfo-succinate surfactants. A particular dewatering agent has not been identified for use at Crandon, nor has the absolute need for a dewatering agent been established. It is unlikely that they will be needed. Operating experience with pressure filters on sulfide concentrates at other operations has not shown the need for dewatering agents.

Comment No. A9 (Comment #102)

Surface fuel storage facilities would be surrounded by dikes to contain accidental spills. Please provide details on how precipitation would be permitted to run off the site while accidental fuel spills would be contained.

Response:

The two main fuel oil storage tanks and the two subsidiary downhole measuring tanks, together with their containment dikes, are shown on Drawing No. 051-1-G-003 (Attachment No. 1). The dikes surrounding both storage areas have been sized to contain the combined volume of the tanks in each facility. This drawing is subject to revision during final engineering.

Under normal circumstances the sluice gate valves, shown in Section C (see Attachment No. 1), will be closed at all times. Rainwater will thus be contained within the berm. Periodically or after each storm and assuming no fuel oil spills have occurred, the gate valves would be opened and the water allowed to drain into the surrounding area.

In the event of minor contamination of the water within the dike, the oily water would be pumped to a tanker truck and transported to the industrial sewer system, which is equipped with an oil/water separator, for disposal.

The transfer pumps are located in a small pump house outside of the dike for fire safety reasons. The pumps also will be surrounded by a concrete wall 0.25 m (0.8 feet) high to contain any spills which might occur in the pump house.

In the unlikely event of a tank rupture, the spilled fuel would be totally contained within the dike. If such an event should occur, the spilled fuel would be pumped to a tanker truck for disposal at an approved disposal location off-site or to a reprocessor if appropriate. Similarly, any major spills less than a tank rupture could be handled in the same way.

Comment No. A10 (Comment #104)

Our comment was erroneous. Since there will be no permanent residences the potable water supply system will be classified as a noncommunity water supply. As such, the approval for well construction and chemical treatment are governed by NR 112, Wisconsin Administrative Code.

Response:

Comment acknowledged and construction and chemical treatment of the potable water supply well will be completed in accordance with NR 112, Wisconsin Administrative Code.

Comment No. A11 (Comment #176)

Please provide either plan elevation drawings or a schematic representation showing dust collection points and duct work to the dust collector(s).

Response:

Drawings No. 051-5-G-002, 051-1-M-001, 051-5-G-005, and 051-5-G-004 showing the dust collectors and their locations were provided with the air permit response letter sent to the DNR on January 24, 1984. Please review the response to comment No. 3 of the January 24, 1984 letter for this information.

Comment No. A12 (Comment #186)

Please discuss the potential for generation of hydrogen sulfide from the concentrator.

Response:

There are no process conditions that are conducive to the production of hydrogen sulfide. Sodium sulfide will be added to the primary grinding circuit for stringer ore. This is used to precipitate any soluble metals, particularly copper, in the stringer ore slurry. Since this reagent is expensive, its use will be closely controlled to avoid excess use. Assuming 250 g of sodium sulfide are added per ton of stringer ore and that the pH of the ground ore slurry is 10.3, the theoretical concentration of hydrogen sulfide in air just over the slurry would be less than 1 ppm. This assumes that 5 percent of the added sulfide exists as unreacted sulfide in the ore slurry and that all excess hydrogen sulfide reaches the air. Any hydrogen sulfide formed will react with soluble metals to form an insoluble metal sulfide. Hydrogen sulfide will also react with polythionates in recycle process water to form thiosulfate according to the following reaction:

$$2H_2S + 4S_4O_6^{=} + 3H_2O \text{ -----> } 9S_2O_3^{=} + 10H^+$$

Because these mechanisms prevent hydrogen sulfide from being emitted, hydrogen sulfide generation has not been identified as a problem in massive sulfide concentrators.

CHAPTER II

Comment No. A13 (Comment #5)

The most accurate characterization of the Department's role in air monitoring would be to state that the Department certified Exxon's air monitoring data.

Response:

Comment acknowledged and the EIR will be revised to state that the Department certified Exxon Minerals Company's air monitoring data.

Comment No. A14 (Comment #9)

The equation provided for calculating the geometric mean value is incorrect, perhaps due to a typographical error. Please provide the correct equation.

Response:

Comment acknowledged. The correct expression of the equation is:

$$\log (G.M.) = \frac{1}{n} \sum_{i=1}^{n} \log x_i$$

Our calculations are correct; however, the equation was incorrect because of a typographical error.

Comment No. A15 (Comment #16)

Please identify the locations of test wells and soil borings which have been abandoned and describe the abandonment methodology.

Response:

Figure 2.2-5 of the EIR shows the location of all test wells and soil borings in the environmental study area. Borings in which piezometers have been installed are marked by solid black circles. All others have been abandoned.

The following description from a drilling contract outlines abandonment methodology:

"Grouting of Boreholes

Upon satisfactory completion of each boring which does not contain a ground water observation well, and acceptance thereof by Exxon, the contractor shall refill the borehole with grout.

All boreholes are to be grouted. The grout mix shall consist of seven (7) gallons of water and two (2) pounds of powdered bentonite per sack (94 pounds) of Type I Portland cement. The contractor, at his option, may use an accelerating agent in the grout to achieve a rapid set and hardening of the grout. Exxon reserves the right to adjust the grout mix proportions in order to provide a grout consistency which is in Exxon's judgment better suited to the project needs.

The grout shall be pumped into the borehole through a pipe or hose. Pumping shall be initiated with the pipe or hose extended to the bottom of the borehole. The grout pipe or hose shall then be withdrawn in a tremmie fashion until the casing or hole is full. Casing where used shall then be removed from the borehole in no more than ten (10) foot increments with the grout level in the remaining casing re-established to the top of the hole after each increment of casing is removed. The grout added after the initial pumping may be poured down the casing rather than being pumped. It is estimated that the grout mix specified herein, without an accelerating agent, will require 12 to 24 hours to achieve its initial set. If at any time prior to completion of the refilling operation the borehole is left unattended, it shall be suitably capped and protected."

Comment No. A16 (Comment #21)

This response does not address the potential for contamination of the samples from drilling fluids.

Response:

At the selected sampling depth, a split spoon sampler is attached to the end of the drill string and lowered to hole bottom. By hammering on the drill rods, the split spoon sampler is driven into the undisturbed glacial soil material for approximately 457 mm (18 inches). The split spoon sampler is opened after removal from the hole. Generally, only the upper 25 to 51 mm (1 to 2 inches) of the sample have been disturbed by the rotary bit and drilling fluids. That portion of the sample is discarded. To further insure an undisturbed sample and a sample free of contamination by drilling fluids, only the lowermost 152 mm (6 inches) are logged and saved in a plastic container for laboratory testing.

Comment No. A17 (Comment #23)

We feel that additional testing for asbestiform materials is warranted. While the bulk analyses performed to date indicate a general absence of asbestiform minerals, even trace amounts of asbestiforms fibers can be a potential health hazard. Since asbestiform fibers would tend to be concentrated in the tailings and the concentrate fines, it is necessary to investigate these materials using trace techniques. Similar analyses could also be conducted on waste rock and glacial till samples.

The fines fractions should be analyzed as if they were air particulates obtained by special sampling techniques. The analysis should conform with that specified in the U.S. EPA document "Electron Microscope Measurement of Airborne Asbestos Concentrations; A Provisional Methodology Manual", EPA - 600/2-77-178 (Revised June, 1978). Please consult with our Bureau of Air Management before initiating this program.

Response:

A preliminary test program has been developed to determine if asbestiform minerals are present in tailings resulting from pilot testing of Crandon ores. We intend to review this proposed program and all previously acquired data with the DNR to determine (1) if further asbestiform testing is indeed necessary, and (2) the details of a test program if it is required. A meeting will be scheduled within the next 30 days with the Bureau of Air Management to discuss and resolve the program for additional testing of asbestiform materials.

Comment No. A18 (Comment #25)

This response does not provide the requested information. Please provide quality control data collected when Exxon's samples were analyzed and describe the evaluation of these data.

Response:

We do not maintain contractor quality control data in our files. It is the responsibility of our contractors to maintain these data files.

Because these contractors have several clients and analyze many samples each year, it is time consuming and costly to retrieve quality control data. These data are generally maintained in laboratory files which have EMC data interspersed with other client data and a technician must search the entire file to retrieve specific quality control data. We recently experienced this in providing Aqualab, Inc. quality control data which the Department requested.

We will provide these data, however, the DNR must make their request as specific as possible. We need to know the type of samples analyzed and the specific time the samples were analyzed (i.e., June 1979). Once this information is received, it will take us approximately 90 days to provide the data.

Comment No. A19 (Comment #34)

Please provide interpretive lithologic logs for the exploration holes drilled to evaluate the mineral potential of sites 40 and 41. Discuss the degree of bedrock fracturing, weathering, and permeability of these two sites.

Response:

The requested information will be included as part of a forthcoming report to the DNR entitled "Bedrock Hydrology." The contents of this report were discussed at the January 11, 1984 meeting with the DNR in Madison, Wisconsin.

Comment No. A20 (Comment #33)

Please provide the results of the analyses for the 6 till samples cited in this response.

Response:

Permeability estimates for three till samples were completed at two different densities (i.e., 125 and 135 pounds per cubic foot [pcf] dry weight) using the published Federal Highway Administration (FHWA) nomograph. The relevant data required for the analysis are as follows:

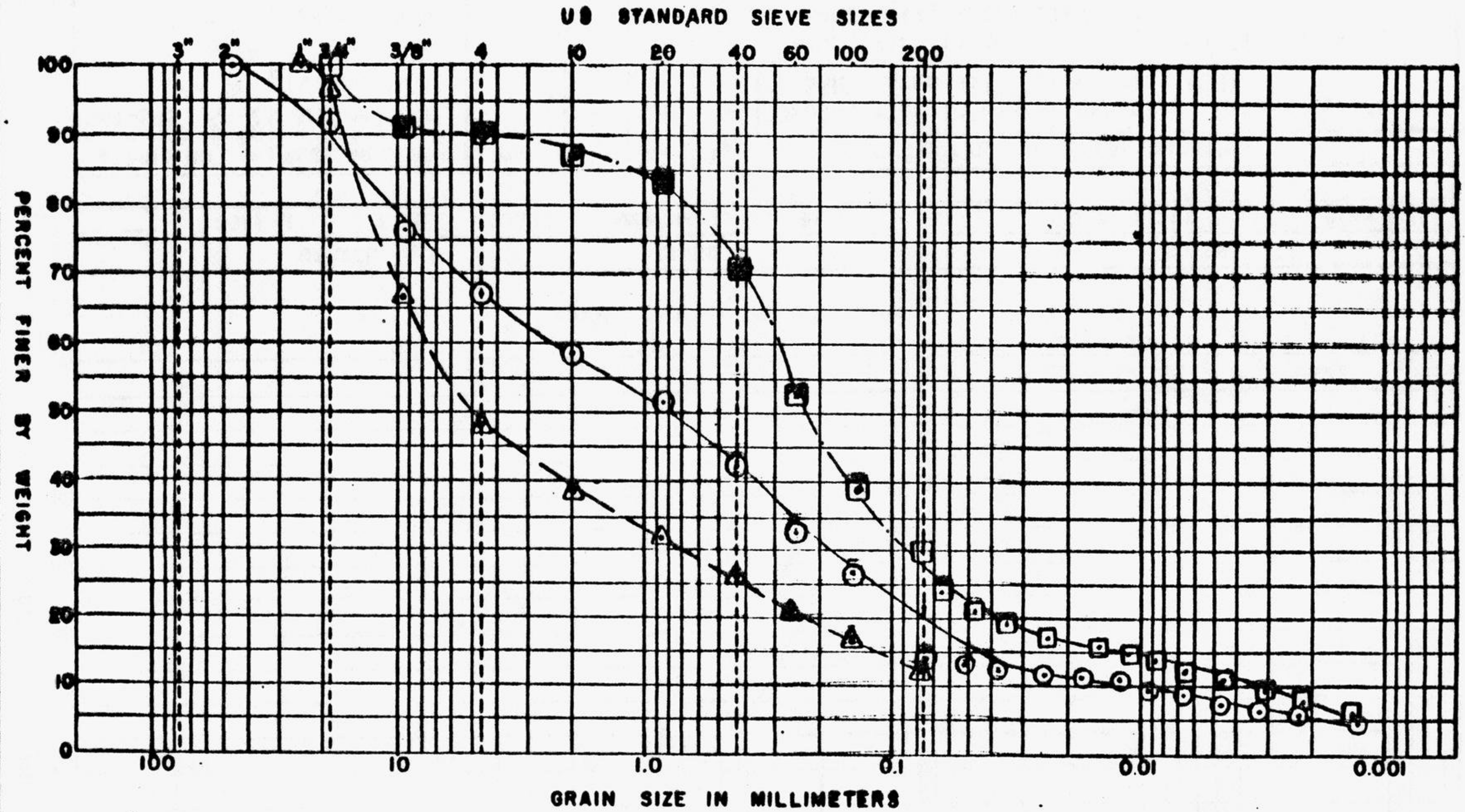
Boring	Sample	Depth (m)	D10 (mm)	%-200*	Unit Dry Weight (pcf)	Coefficient of Permeability (cm/sec)
G41-G15	SA 5A & 5B	20	.003	27	125	1.4×10^{-6}
			.003	27	135	2.1×10^{-7}
G41-L19	SA-2	3	.017	18	125	1.0×10^{-5}
			.017	18	135	1.7×10^{-6}
G41-E13	SA-9	12.5	.06	11	125	1.0×10^{-4}
			.06	11	135	1.5×10^{-5}

Grain size curves for the referenced samples and the nomographs illustrating the analyses are provided on the attached figures (A20-1 through A20-6).

*Percentage of soil passing a No. 200 mesh sieve on a dry weight basis -- commonly referred to as the percentage of fines.

GRAIN SIZE DISTRIBUTION

(Figure A20-1 for Response to Comment No. A20)



COBBLES	GRAVEL		SAND			FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	W_n	W_L	W_p	I_p	DESCRIPTION OR CLASSIFICATION
G41-G15 SA-1 —○—	13.11m-13.41m (43.0'-44.0')	-	-	-	-	Brown, fine to coarse gravelly, fine to coarse SAND, some silt, trace clay (SM)
SA-3 – –△– –	16.46m-16.61m (54.0'-54.5')	-	-	-	-	Brown, fine to coarse GRAVEL and fine to coarse SAND, some silt (GM)
SA-5A&B –·–□–·–	19.96m-20.27m (65.5'-66.5')	-	-	-	-	Red-brown, silty, fine to coarse SAND, some fine gravel, trace clay (SM)

Date 6/7/79
Job No. 786035

Golder Associates

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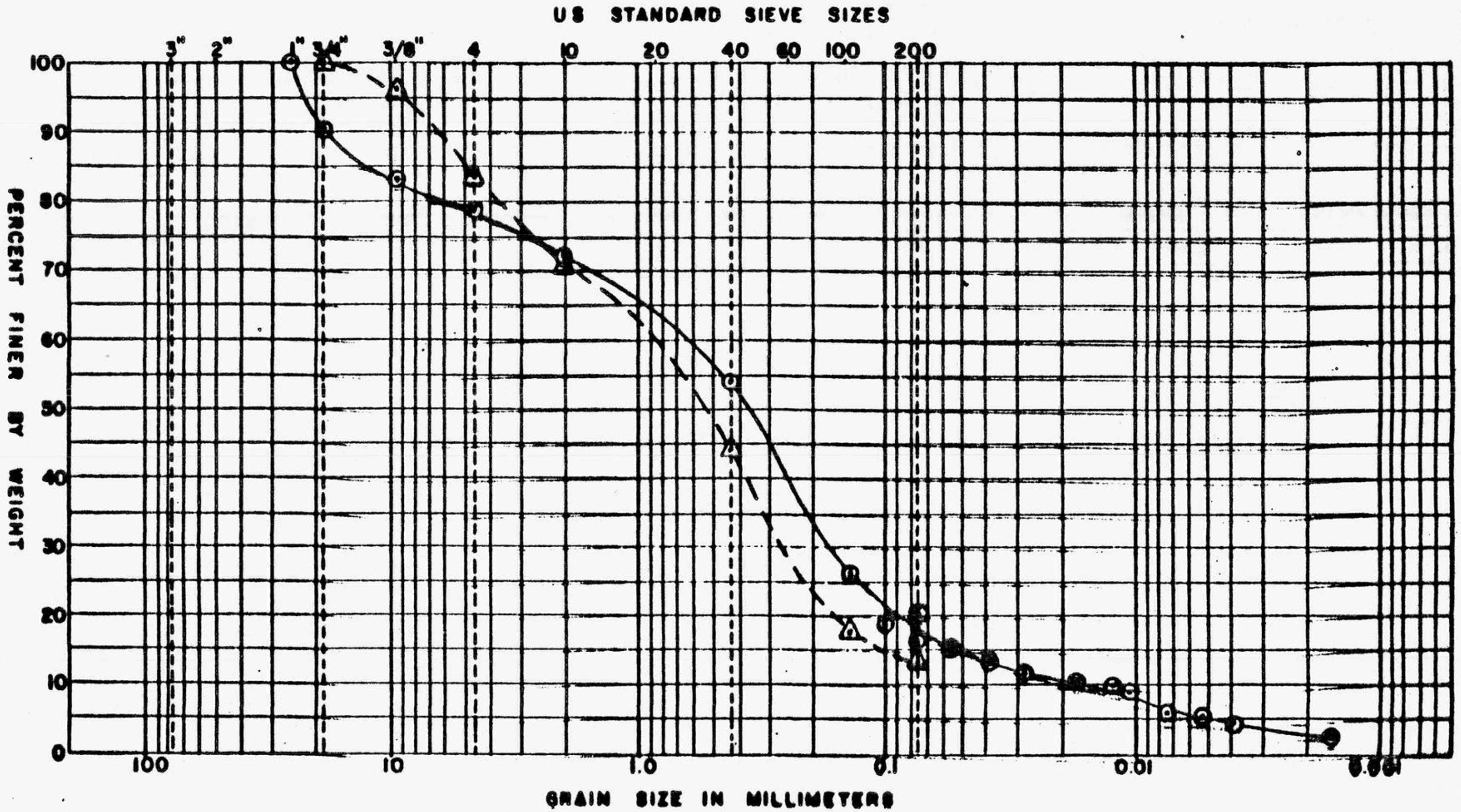
Approved JFC

GRAIN SIZE DISTRIBUTION

(Figure A20-2 for Response to Comment No. A20)



COBBLES	GRAVEL		SAND			FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	W_n	W_L	W_p	I_p	DESCRIPTION OR CLASSIFICATION
G41-L19 SA-2 —o—	2.74m-3.20m (9.0'-10.5')	-	-	-	-	Brown, fine to coarse gravelly, fine to coarse SAND, some silt, trace clay (SM)
SA-5 - -Δ- -	7.32m-7.77m (24.0'-25.5')	-	-	-	-	Brown, fine to coarse SAND, some fine gravel, some silt, trace clay (SM)

Date 6/14/79
Job No. 786035

Golder Associates

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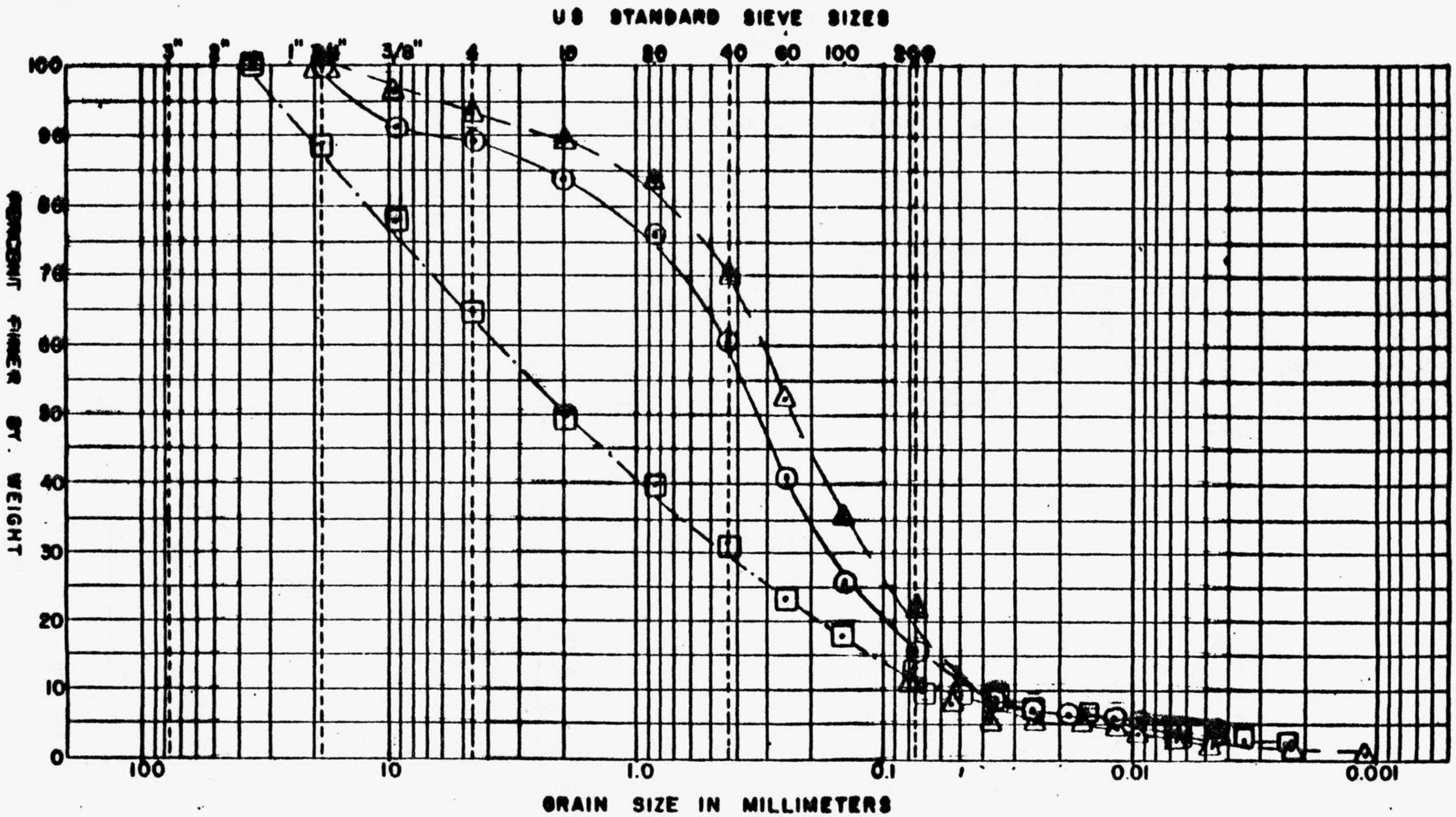
Approved JFC

GRAIN SIZE DISTRIBUTION

(Figure A20-3 for Response to Comment No. A20)



COBBLES	GRAVEL		SAND			FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	W_n	W_L	W_p	I_p	DESCRIPTION OR CLASSIFICATION
G41-E13 SA-3 —⊙—	3.05m-3.51m (10.0'-11.5')	-	-	-	-	Red-brown, fine to coarse SAND, some fine gravel, some silt, trace clay (SM)
SA-5 - -△- -	6.10m-6.55m (20.0'-21.5')	-	-	-	-	Light brown, fine to coarse SAND, some fine gravel, some silt, trace clay (SM)
SA-9 — -⊡- -	12.19m-12.65m (40.0'-41.5')	-	-	-	-	Red-brown, fine to coarse SAND and fine GRAVEL, trace silt, trace clay (SM)

Date 6/7/79
Job 785085

Golder Associates

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JFC

G41-G15 (SA-5A+B) 65-66'

USCS	P_{200}	D_{10}
SM	27%	.003mm

γ_d-125pcf-135pcf
k-1.4 x 10^{-6} to 2.1 x 10^{-7} cm/sec

$$k = \frac{6.214\times10^{5}(D_{10})^{1.478}(n)^{6.654}}{(P_{200})^{0.597}} \text{ (ft./day)}$$

$$n = \text{Porosity} = \left(1 - \frac{\gamma_d}{62.4G}\right)$$

G = Specific Gravity
(Assumed = 2.70)

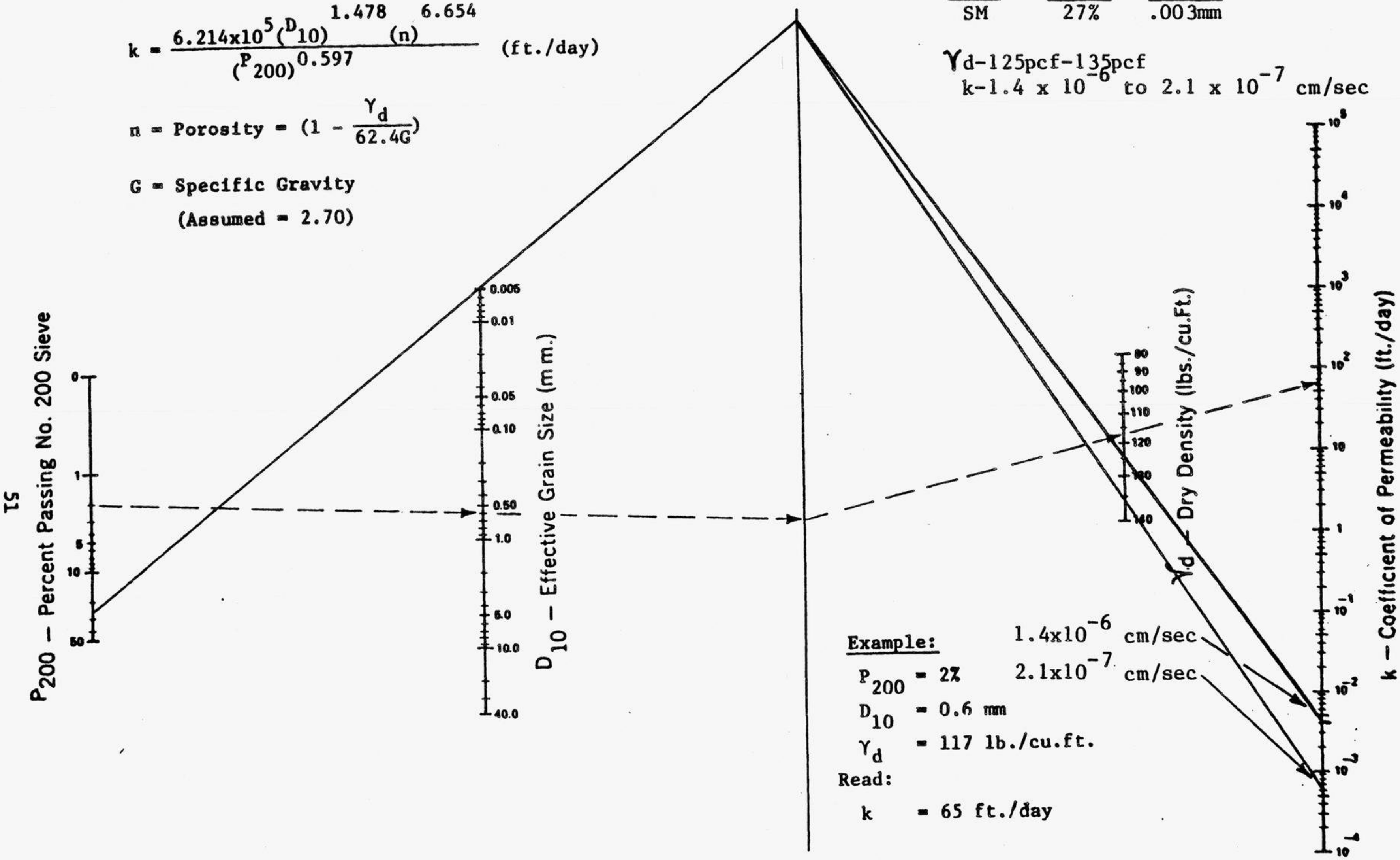


Figure 28. Chart For Estimating Coefficient of Permeability of Granular Drainage and Filter Materials (Source: Federal Highway Administration Report No. FHWA-TS-80-224, August 1980)

—— EMC
– – – Federal Highway Administration

(Figure [illegible]-4 for the Response to Comment No. A20)

	USCS	P_{200}	D_{10}
G41-L19 (SA-2)	SM	18%	.017

γ_d-125-135

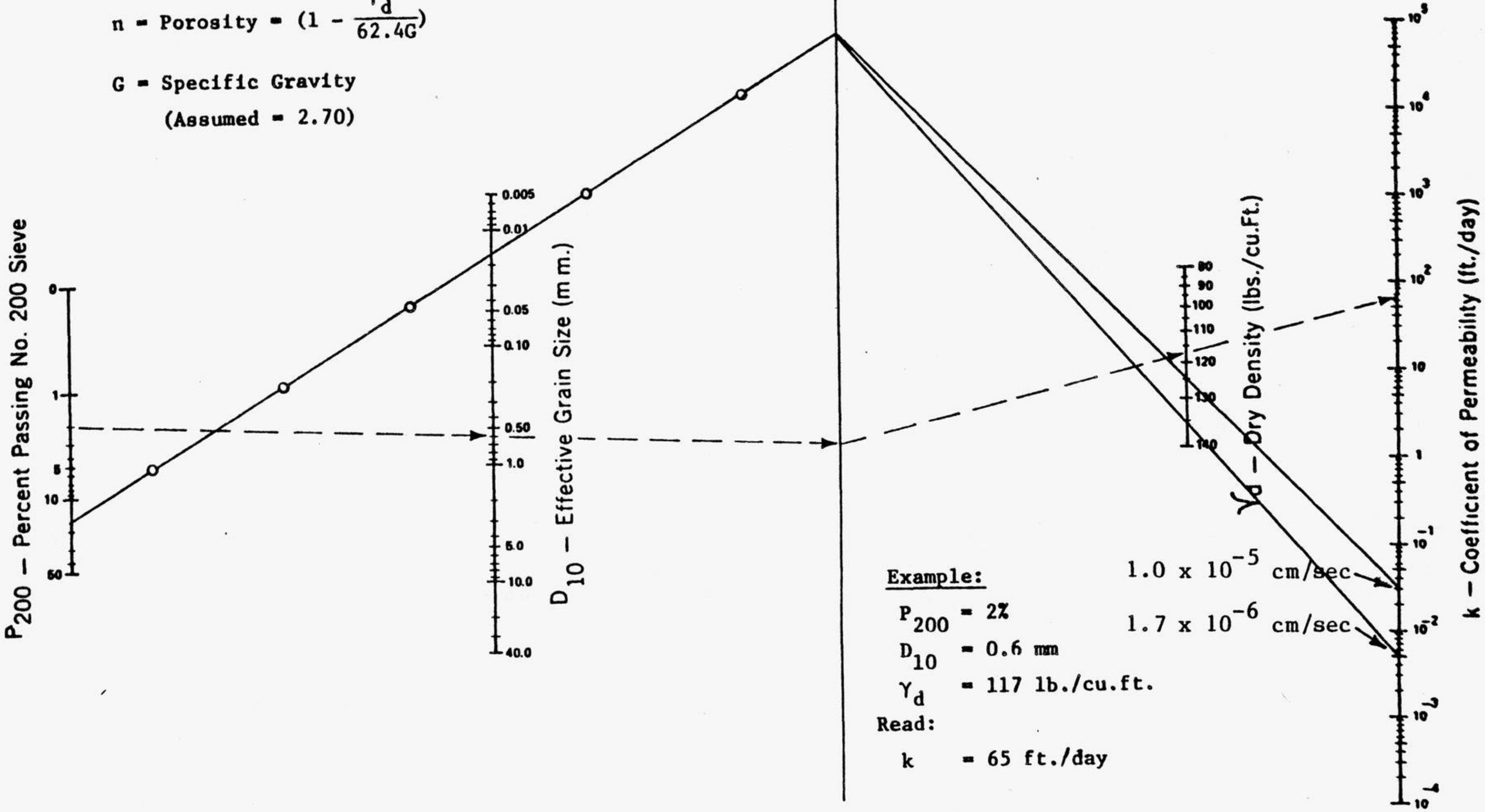
k-1.0 x 10^{-5} to 1.7 x 10^{-6} cm/sec

$$k = \frac{6.214\times10^{5}(D_{10})^{1.478}(n)^{6.654}}{(P_{200})^{0.597}} \quad \text{(ft./day)}$$

$$n = \text{Porosity} = \left(1 - \frac{\gamma_d}{62.4G}\right)$$

G = Specific Gravity

(Assumed = 2.70)



Example:

P_{200} = 2%

D_{10} = 0.6 mm

γ_d = 117 lb./cu.ft.

Read:

k = 65 ft./day

Figure 28. Chart For Estimating Coefficient of Permeability of Granular Drainage and Filter Materials (Source: Federal Highway Administration Report No. FHWA-TS-80-224, August 1980)

——— EMC

– – – Federal Highway Administration

(Figure A20-5 for the Response to Comment No. A20)

G41-E13 (SA-9) 40-41.5'

USCS	P_{200}	D_{10}
SM	11%	.06

$$k = \frac{6.214\times10^5 (D_{10})^{1.478} (n)^{6.654}}{(P_{200})^{0.597}} \quad \text{(ft./day)}$$

$$n = \text{Porosity} = \left(1 - \frac{\gamma_d}{62.4G}\right)$$

G = Specific Gravity

(Assumed = 2.70)

γ_d= 125-135pcf

k- 1.0×10^{-4} to 1.5×10^{-5} cm/sec

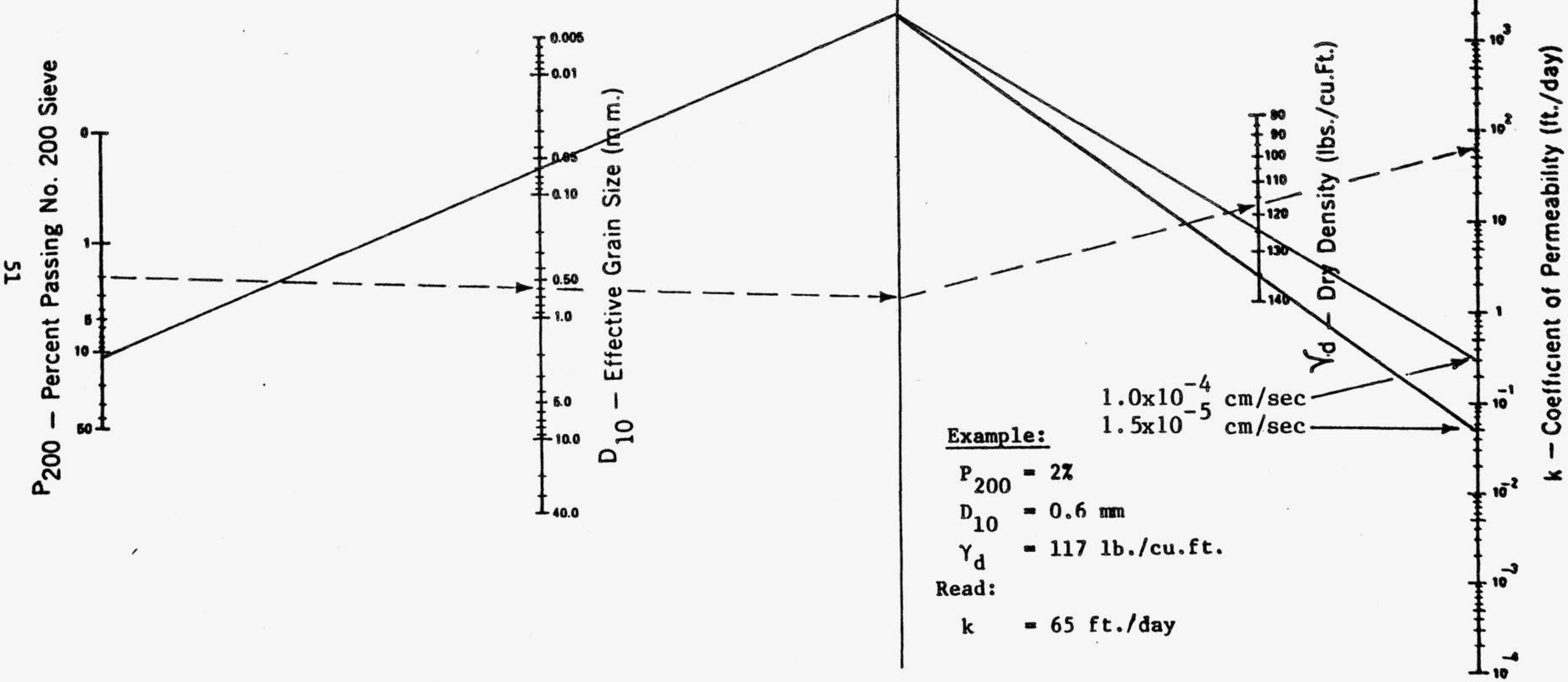


Figure 28. Chart For Estimating Coefficient of Permeability of Granular Drainage and Filter Materials (Source: Federal Highway Administration Report No. FHWA-TS-80-224, August 1980)

——— EMC

– – – Federal Highway Administration

(Figure A●6 for the Response to Comment No. A20)

Comment No. A21 (Comment #44)

Please provide noninterpretive lithologic logs which address bedrock weathering and fracturing for the deep exploration holes used in the packer tests and the data obtained from these tests. Attachment 2, submitted in support of response 18, should be amended to indicate which holes had been subjected to the packer tests.

Response:

Noninterpretive lithologic logs which address weathering and fracturing for the deep exploration holes used in the packer tests and the data obtained from these tests will be presented in an Exxon Minerals Company report entitled "Bedrock Hydrology." This report is in preparation and will be submitted to the DNR when completed.

Attachment No. 2 which was submitted in support of response to comment No. 18 in the May 11, 1983 DNR letter will be amended to indicate which holes were subjected to packer tests. This amended attachment will be provided within 30 days.

Comment No. A22 (Comment #58)

Please indicate the ground water divides on Figure 2.3-4.

Response:

A dotted line as shown on the attached figure will be added to EIR Figure 2.3-4 to indicate the approximate axis of the ground water table "ridge." There is no other defined ground water divide, although a ground water mound occurs northeast of Little Sand and Duck lakes.

Comment No. A23 (Comment #61)

Provide at least one illustrative comparison of a selected groundwater hydrograph with piezometer data or a stream hydrograph, and precipitation data to substantiate this response.

Response:

Limited precipitation data in the site area are available. However, a long-term precipitation record is available from Nicolet College in Rhinelander, Wisconsin. These data indicate that the maximum precipitation occurs from May through September (see attached Table 2.4-14). From May through September rainfall is approximately 63 percent of the annual precipitation which occurs.

The USGS stream gage at State Highway 55 above Rice Lake is the nearest sampling station to the site area with a long-term record of surface water flow rates. As indicated in attached EIR Appendix Table C-1, the months with highest surface water flow rates are from April to October. This record closely follows the average monthly precipitation totals summarized in Table 2.4-14. With the exception of April, the surface water flow rate data suggest a lag time of approximately one month between increased precipitation and higher flow rates.

TABLE 2.4-14

AVERAGE MONTHLY PRECIPITATION AT
NICOLET COLLEGE, RHINELANDER, WISCONSIN
1908 THROUGH 1977[a]

MONTH	AVERAGE PRECIPITATION (mm)[b]	PERCENT OF ANNUAL PRECIPITATION
October	59.4	7.6
November	47.8	6.1
December	28.2	3.6
January	26.9	3.4
February	25.4	3.3
March	38.4	4.9
April	59.4	7.6
May	85.3	10.9
June	115.6	14.8
July	97.3	12.4
August	102.6	13.1
September	95.2	12.2
Total	781.6	100

[a]Black, 1978.

[b]25.4 mm = 1 inch.

TABLE C-1

USGS DAILY STREAM DISCHARGE RECORD
FOR SWAMP CREEK ABOVE RICE LAKE AT HIGHWAY 55 NEAR MOLE LAKE, WISCONSIN
AUGUST 1977 TO SEPTEMBER 1980
USGS STATION NUMBER 04074538

DAILY DISCHARGE (cfs)

	1977					1978								
DAY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
1	--	43	40	28	26	27	17	16	25	37	57	27	37	36
2	--	44	38	29	26	25	17	16	29	32	53	46	37	33
3	12	43	36	37	26	24	17	16	27	34	46	68	35	34
4	--	40	33	46	25	24	17	16	34	31	41	61	32	32
5	--	37	34	42	25	24	17	16	41	30	38	49	30	29
6	--	36	34	38	25	24	17	17	49	30	36	50	28	29
7	--	36	32	38	25	23	17	17	57	29	35	49	26	29
8	--	34	41	43	25	22	17	17	56	31	39	41	25	28
9	12	31	51	42	25	22	18	17	54	40	37	37	23	27
10	16	28	50	41	25	22	18	17	66	42	34	34	22	26
11	14	25	48	39	26	21	18	17	74	37	32	31	24	24
12	13	25	49	37	26	21	18	17	69	36	32	28	22	27
13	13	27	47	33	26	21	18	17	66	36	31	28	21	39
14	13	25	45	31	26	21	18	17	58	53	31	27	20	59
15	11	23	45	30	26	21	18	17	51	60	43	25	25	64
16	17	27	38	28	26	21	18	17	47	51	40	24	64	54
17	19	31	38	27	27	21	18	17	44	42	37	22	72	45
18	16	32	35	26	30	21	18	18	45	37	35	41	61	42
19	12	54	33	24	31	21	17	18	58	35	32	72	54	44
20	11	63	31	26	31	21	17	18	64	34	30	64	49	43
21	12	58	29	36	29	21	17	19	62	34	31	50	43	40
22	13	50	29	33	29	20	17	19	56	31	31	51	39	36
23	11	45	29	30	28	20	16	19	54	30	29	90	43	33
24	10	48	28	33	28	20	16	19	58	29	28	98	59	30
25	8	55	28	30	29	20	16	20	56	28	27	81	60	28
26	14	55	28	28	29	20	16	21	52	29	26	68	52	26
27	31	55	25	27	29	20	16	21	48	35	26	61	50	32
28	43	50	26	26	29	19	16	21	44	53	24	53	54	33
29	35	46	27	26	29	19	--	22	43	56	24	48	52	35
30	27	43	29	26	28	19	--	23	40	60	22	43	45	40
31	33	--	28	--	28	18	--	24	--	55	--	39	39	--
Total (cfs)	--	1,209	1,104	980	843	663	480	566	1,527	1,194	1,027	1,506	1,243	1,077
Mean (cfs)	--	40.3	35.6	32.7	27.2	21.4	17.1	18.3	50.9	38.5	34.2	48.6	40.1	35.9
MONTHLY STREAM DISCHARGE														
Acre-feet	--	2,398	2,189	1,946	1,672	1,316	950	1,125	3,029	2,367	2,035	2,988	2,466	2,136
Inches of Runoff	--	0.97	0.89	0.79	0.68	0.53	0.39	0.46	1.23	0.96	0.83	1.21	1.00	0.87

Notes: 1978 Water year = October 1, 1977 to September 30, 1978.
Total stream discharge, 1978 water year = 24,219 acre-feet (9.83 inches of runoff).
Mean daily stream discharge, 1978 water year = 33.5 cfs.
Location: See Figure 2.4-1.
Drainage Area: 119.7 km^2 (46.2 square miles).
Period of Record: August 1977 to current year.
To convert to m^3/s, multiply cfs by 0.02832.
Source: USGS, 1979.

TABLE C-1 (continued)

DAY	1978 OCT	1978 NOV	1978 DEC	1979 JAN	1979 FEB	1979 MAR	1979 APR	1979 MAY	1979 JUNE	1979 JULY	1979 AUG	1979 SEP
	DAILY DISCHARGE (cfs)											
1	37	19	17	21	21	26	67	55	43	40	38	31
2	35	18	17	21	21	26	62	55	41	37	32	43
3	35	18	17	21	21	27	57	57	40	38	29	43
4	35	18	18	20	21	27	56	53	36	42	27	39
5	35	18	18	20	21	27	57	50	35	39	26	35
6	38	18	18	19	21	28	62	53	34	35	25	32
7	34	17	17	19	22	28	54	62	36	33	23	31
8	30	17	17	19	22	28	53	69	41	32	22	26
9	27	18	17	19	22	28	51	82	39	35	21	22
10	26	18	18	19	22	27	48	91	61	34	24	21
11	26	18	18	19	22	26	46	81	78	34	25	20
12	26	18	19	19	22	27	47	74	60	79	24	23
13	26	19	19	19	22	27	59	65	47	87	25	30
14	24	23	19	19	22	27	67	64	41	94	25	29
15	22	23	19	18	21	26	69	62	39	83	22	25
16	22	20	18	18	21	28	[illegible]5	53	43	66	18	21
17	22	22	18	19	21	29	[illegible]3	47	117	57	20	19
18	21	31	18	19	21	30	25	44	128	44	22	17
19	21	26	19	19	22	33	137	58	90	38	25	16
20	21	24	20	20	23	42	151	82	70	36	24	15
21	21	21	21	21	23	47	149	75	80	35	22	15
22	20	19	21	21	23	54	131	63	78	33	24	15
23	21	18	21	21	25	68	113	55	66	31	38	13
24	21	18	21	21	25	92	102	52	54	30	41	17
25	21	18	21	21	24	90	96	47	48	38	36	19
26	21	18	21	21	23	80	91	43	46	42	29	17
27	20	18	20	21	24	76	80	43	45	38	29	17
28	20	18	20	21	25	72	68	42	42	37	30	14
29	18	19	21	21	--	68	61	40	43	34	29	14
30	18	18	21	21	--	65	58	39	41	32	27	15
31	19	--	21	21	--	65	--	41	--	40	25	--
Total (cfs)	783	588	590	618	623	1,344	2,395	1,797	1,662	1,373	827	694
Mean (cfs)	25.3	19.6	19.0	19.9	22.3	43.4	79.8	58.0	55.4	44.3	26.7	23.1
	MONTHLY STREAM DISCHARGE											
Acre-feet	1,556	1,166	1,168	1,224	1,238	2,669	4,748	3,566	3,297	2,724	1,642	1,375
Inches of Runoff	0.63	0.47	0.47	0.50	0.50	1.08	1.93	1.45	1.34	1.11	0.67	0.56

Notes: 1979 Water year = October 1, 1978 to September 30, 1979.
Total stream discharge, 1979 water year = 26,373 acre-feet (10.70 inches of runoff).
Mean daily stream discharge, 1979 water year = 36.4 cfs.
Source: USGS, 1980.

TABLE C-1 (continued)

DAY	1979 OCT	1979 NOV	1979 DEC	1980 JAN	1980 FEB	1980 MAR	1980 APR	1980 MAY	1980 JUNE	1980 JULY	1980 AUG	1980 SEP
	DAILY DISCHARGE (cfs)											
1	15	57	20	23	19	17	32	33	49	31	24	47
2	17	45	20	22	18	17	33	32	42	29	24	47
3	17	36	22	21	18	17	35	32	37	26	25	40
4	16	34	24	19	18	17	32	30	27	24	26	41
5	16	32	26	19	18	17	36	30	35	23	32	39
6	15	39	27	19	19	17	46	29	61	33	30	34
7	18	37	28	18	18	17	59	29	62	29	29	29
8	20	33	27	18	18	17	78	28	64	23	36	26
9	19	29	28	18	18	17	107	26	52	23	40	25
10	17	27	28	18	18	18	91	25	42	23	34	24
11	17	22	28	20	19	17	70	32	35	23	30	22
12	17	27	25	20	19	17	61	32	30	24	27	21
13	18	26	24	20	19	17	53	35	28	23	24	26
14	16	25	23	21	18	17	46	35	28	21	22	31
15	15	25	23	23	18	17	42	34	35	20	21	28
16	15	22	22	27	18	17	40	31	32	21	19	28
17	15	25	21	30	18	18	40	28	28	25	18	27
18	14	26	21	32	18	19	43	28	31	25	17	24
19	15	28	21	30	19	20	46	28	45	27	16	22
20	19	32	22	28	20	22	47	27	50	31	17	25
21	23	33	24	27	21	22	46	25	41	35	21	68
22	48	36	24	26	22	20	47	26	34	31	22	95
23	86	36	25	25	21	20	44	25	31	26	21	77
24	74	35	26	24	20	21	40	23	29	21	23	56
25	49	33	25	23	19	20	37	22	27	21	31	45
26	38	35	25	22	19	22	34	20	26	20	36	41
27	33	40	23	21	20	23	32	22	27	19	49	34
28	37	35	22	21	19	22	33	39	48	18	47	31
29	37	32	23	19	18	24	34	42	45	25	39	28
30	34	22	22	19	--	27	34	54	37	25	37	28
31	33	--	22	19	--	31	--	60	--	24	37	--
Total (cfs)	823	964	741	692	547	604	1,418	962	1,158	769	874	1,109
Mean (cfs)	26.5	32.1	23.9	22.3	18.9	19.5	47.3	31.0	38.6	24.8	28.2	37.0
	MONTHLY STREAM DISCHARGE											
Acre-feet	1,629	1,912	1,470	1,373	1,085	1,198	2,813	1,908	2,297	1,525	1,734	2,200
Inches of Runoff	0.66	0.78	0.60	0.56	0.44	0.49	1.14	0.77	0.93	0.62	0.70	0.89

Notes: 1980 Water year = October 1, 1979 to September 30, 1980.
Total stream discharge, 1980 water year = 21,144 acre-feet (8.58 inches of runoff).
Mean daily stream discharge, 1980 water year = 29.2 cfs.
Source: USGS, 1981 (provisional).

The increase in April surface water flow rates are a result of increased precipitation (i.e., 4.9 to 7.6 percent from March to April) and surface water drainage from melting snow.

Similarly, the piezometer hydrographs for boring locations DW-1A, DW-1U, and DW-1L (see attached EIR Figure B-2) indicate an increase in ground water elevation in June, July and August of 1978. An increase is also evident in 1977 for hydrograph DW-1L. The increase in the ground water elevation also appears to occur from 1 to 2 months later than the melting snow or precipitation percolation to the main ground water table. This pattern is more evident in hydrograph DW-1L than in DW-1A and DW-1U during 1977.

Comment No. A24 (Comment #62)

Provide an illustrative demonstration of the comparability of data recorded by continuous and intermittent water level recorders.

Response:

The attached ground water hydrographs from wells TW-1 (EIR Figure 2.3-11) and DW-2U (EIR Appendix Figure B-3) show the comparability of data recorded continuously (TW-1) and on a monthly basis (DW-2U). These wells are located within 1.6 km (1 mile) of each other and are screened in approximately the same aquifer zone. Over the common period of record, October 1977 through October 1978, the hydrographs exhibit almost identical response.

Comment No. A25 (Comment #83)

Please note that the same methodology for total sulfur analysis should be used in future analysis to insure comparability of data.

Response:

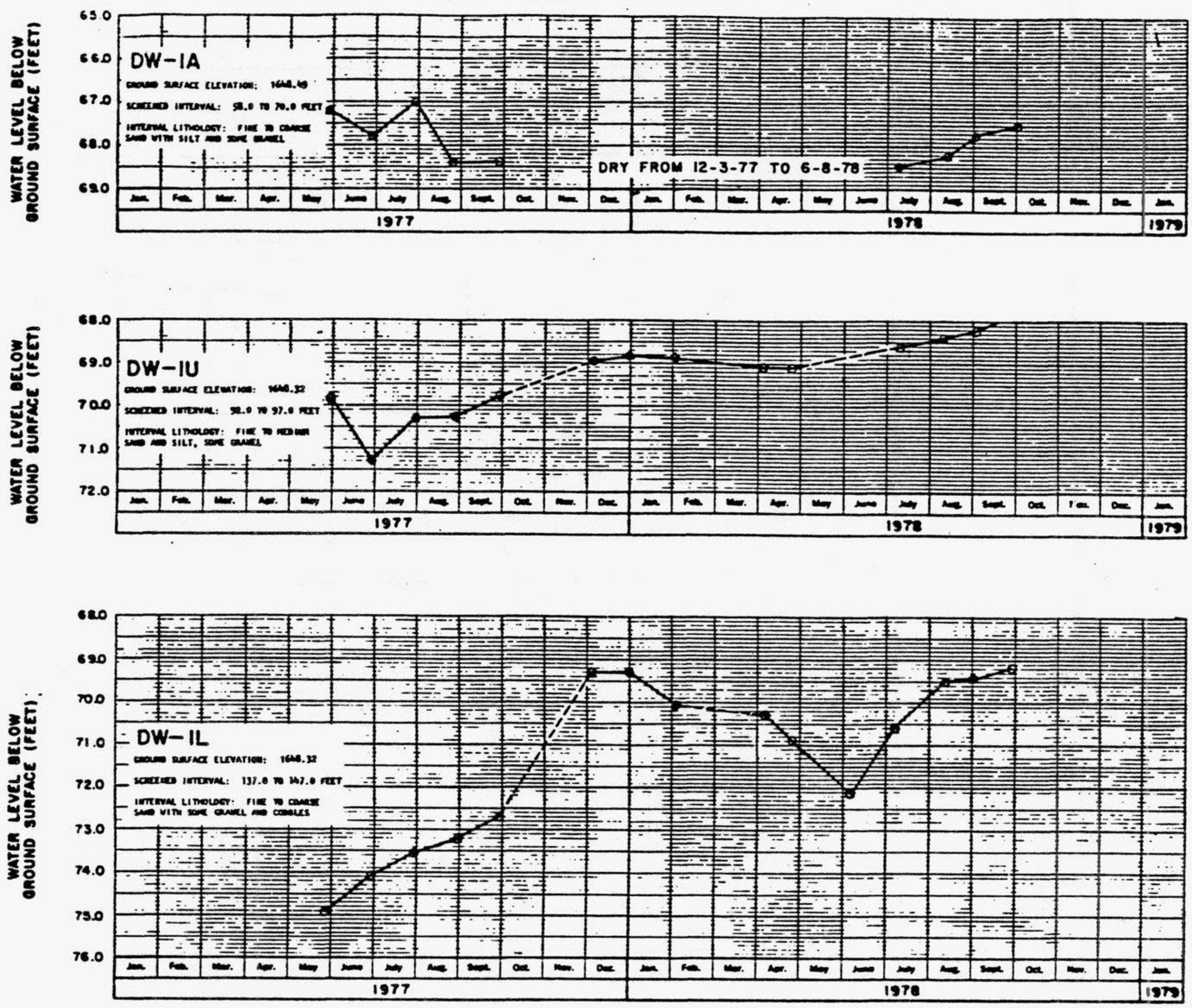
Comment acknowledged and the same methodology for total sulfur analysis used during the baseline monitoring program will be employed for any future analyses of this parameter.

Comment No. A26 (Comment #84)

This response does not address the comment. Please explain how total sulfur data can be reported to a greater number of significant figures than the sulfate data from which it is partially derived.

Response:

As stated in EMC's response to earlier EIR comment No. 84 in the DNR's May 11, 1983 letter, the analytical detection limit for sulfate is 1 mg/l. If total sulfur is being reported from sulfate analytical results, then the detection limit is correspondingly S/SO_4 = 32/96, or 0.3 mg/l. The detection limit value of 0.01 mg/l for total sulfur which was originally reported in EIR Table 2.4-10 was incorrect and will be corrected in the revised EIR. Thus, as the DNR correctly stated, total sulfur values can only be reported to the nearest mg/l.



KEY:

⊙ GROUND WATER LEVEL MEASUREMENTS

--- INFERRED WHEN DATA MISSING

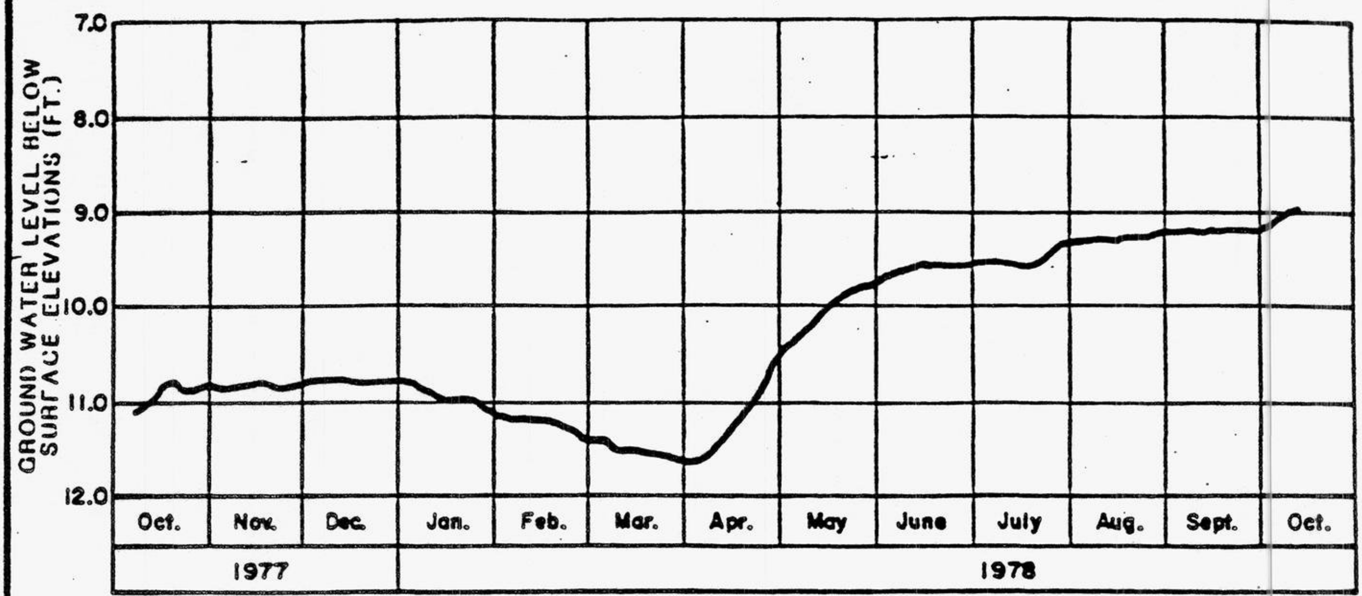
EXXON MINERALS COMPANY

CRANDON PROJECT

PIEZOMETER HYDROGRAPHS

DAMES & MOORE

FIGURE B-2



TW-1

GROUND SURFACE ELEVATION: 1601.19

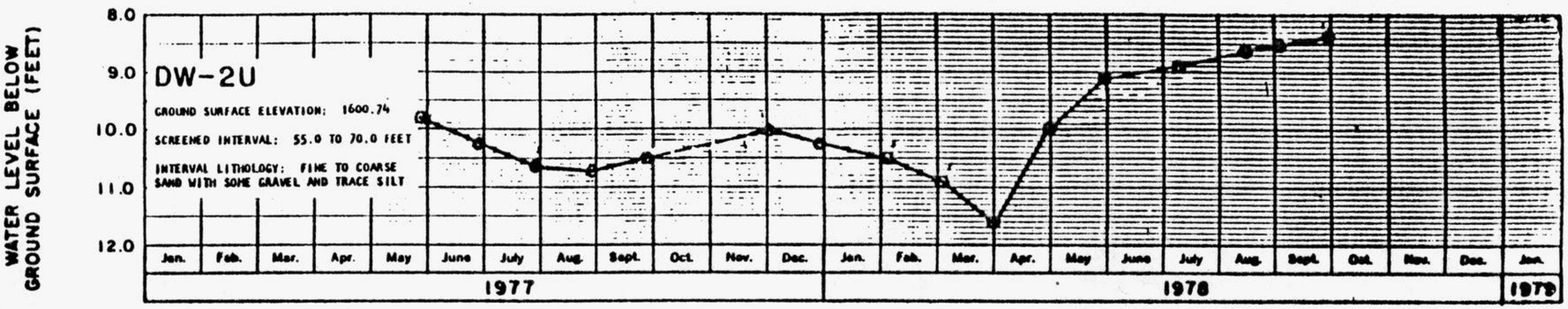
SCREENED INTERVAL: 40.0 TO 55.0 FEET

EXXON MINERALS COMPANY
CRANDON PROJECT

GROUND WATER HYDROGRAPHS
FOR TW-1

DAMES & MOORE

FIGURE 2.3-11



KEY:

⊙ GROUND WATER LEVEL MEASUREMENTS

--- INFERRED WHEN DATA MISSING

EXXON MINERALS COMPANY
CRANDON PROJECT

PIEZOMETER HYDROGRAPHS.

DAMES & MOORE

FIGURE B-3

Comment No. A27 (Comment #87)

Is the 0.01 mg/l detection limit for Cr^{+6} listed in Table 2.4-10 correct?

Response:

The detection limit for Chromium (VI) as listed in Table 2.4-10 is 0.01 mg/l.

Comment No. A28 (Comment #119)

Analysis of the most recent surface water quality samples collected from Duck Lake revealed that baseline conditions have not been reestablished since the 1980 pumping test. Values for conductivity, alkalinity and pH remain elevated. Exxon must continue monitoring Duck Lake on a periodic basis until baseline conditions are reestablished.

Response:

Comment acknowledged and Exxon Minerals Company will monitor Duck Lake on a quarterly basis for pH, alkalinity, total hardness, total dissolved solids, and specific conductance (conductivity) until baseline conditions are reestablished or agreement with the DNR that continued monitoring is not required.

Comment No. A29 (Comment #123)

We believe that the low dissolved oxygen levels at Station Z are attributable to aquatic plant communities in that segment of the Wolf River rather than inputs of low dissolved oxygen water from Swamp Creek, Spider, and Pickerel Creeks.

Response:

In our response to comment No. 123 in the DNR's May 11, 1983 comment letter, we provided a possible explanation for the low dissolved oxygen levels at Station Z in the summer of 1978. We acknowledge the presence of aquatic plant communities in this segment of the Wolf River and it could be speculated that these communities affected dissolved oxygen concentrations in the water during this period.

Comment No. A30 (Comment #128)

Contrary to your response, there are sediment metal concentrations significantly outside the expected range of values (e.g. Cr and Pb in sediment at Station D). Please provide a discussion and explanation for these unusually high concentrations.

Response:

Chemical analyses on stream sediment samples in the Swamp Creek drainage basin in March 1978 indicate a mean of 43.5 ppm with a standard deviation of 21.4 ppm for chromium, exclusive of Station D. Station D in Swamp Creek had a single reported value of 180.8 ppm which is six standard deviations from the above mean of the chromium values reported for the Swamp Creek drainage basin.

The lead concentration in the sediment sample at Station I, Little Sand Lake in the Pickerel Creek drainage basin, was 156 ppm which was approximately 10 standard deviations from the mean, 16.9 ppm ($\pm$13.3 ppm), of the nine samples exclusive of Station I.

These chromium and lead values are anomalously high compared to other analyzed concentrations during the sampling period and appear to be non-representative of the sediments for the drainage basins. In EIR Appendix 2.4L, Tables L5 and L6 more recent chemical analyses are presented of sediment samples collected at two stations on Swamp Creek in May 1982. The total chromium concentrations measured were lower than those reported in 1978 and had less statistical variance. Possible explanation for the earlier reported unusually high concentrations in the sediment samples may be contamination from a nearby corroding lead sinker (fishing equipment), stainless steel tool or machine part and would thus not be representative of the drainage basin.

Comment No. A31 (Comment #137)

Rather than selecting a representative species from each trophic level, it is only necessary to sample a top level predator (i.e., walleye, bass, or northern) and a bottom feeder (i.e. carp or suckers).

Response:

Comment acknowledged. Analysis of metal concentrations in fish tissue has been completed as part of the 1983 Aquatic Monitoring Program in Swamp Creek. Fish species representative of a bottom feeder (white sucker) and a top predator (northern pike) were included in the analyses. Rock bass were also included in the analyses as an example of a diverse feeder consuming plant material, insects and fish. Any additional analyses of fish tissues will include only samples from top level predators and bottom feeders.

Comment No. A32 (Comment #138)

As a point of clarification, metal analysis of bullheads and catfish should be conducted with skin-off fillets.

Response:

Comment acknowledged.

Comment No. A33 (Comment #146)

The statement that "The fish community structure upstream and downstream of Rice Lake is similar" is inaccurate since a native brook trout fishery (Class II) exists in Swamp Creek above Rice Lake but is nonexistent downstream of Rice Lake.

Response:

In Swamp Creek the fish community trophic structure upstream and downstream of Rice Lake is considered similar. Insectivorous, omnivorous and piscivorous species are present in both segments of the creek. There are differences in species composition in fish communities upstream and downstream of Rice Lake and these are discussed in detail in subsection 4.1 in Ecological Analysts' "Final Report on the Aquatic Biology of Swamp Creek" dated August 1983 (report previously provided to the DNR).

CHAPTER III

Comment No. A34 (Comment #2)

Please provide a discussion of the likelihood and ramifications of ore reserves significantly exceeding the current estimate.

Response:

There is little likelihood of finding ore reserves "significantly" exceeding the current estimated reserve of 68.7 million metric tons (75.7 million short tons). Drilling from the surface has defined the extent of the orebody along the east/west strike and perpendicular across the deposit into the hanging wall and footwall.

The Crandon ore deposit has not been definitively defined at depth. However, the deep orebody drilling indicates that the deposit thins rapidly below the 710 m level. The current mine plan assumes the recovery of ore down to the 830 m level.

The decision by Exxon Minerals Company to recover additional reserves, should they be found, would be based on a detailed study that would consider the technical, environmental, and economic parameters at the time of mining. Based on this study a "mine" or "do not mine" decision would be made.

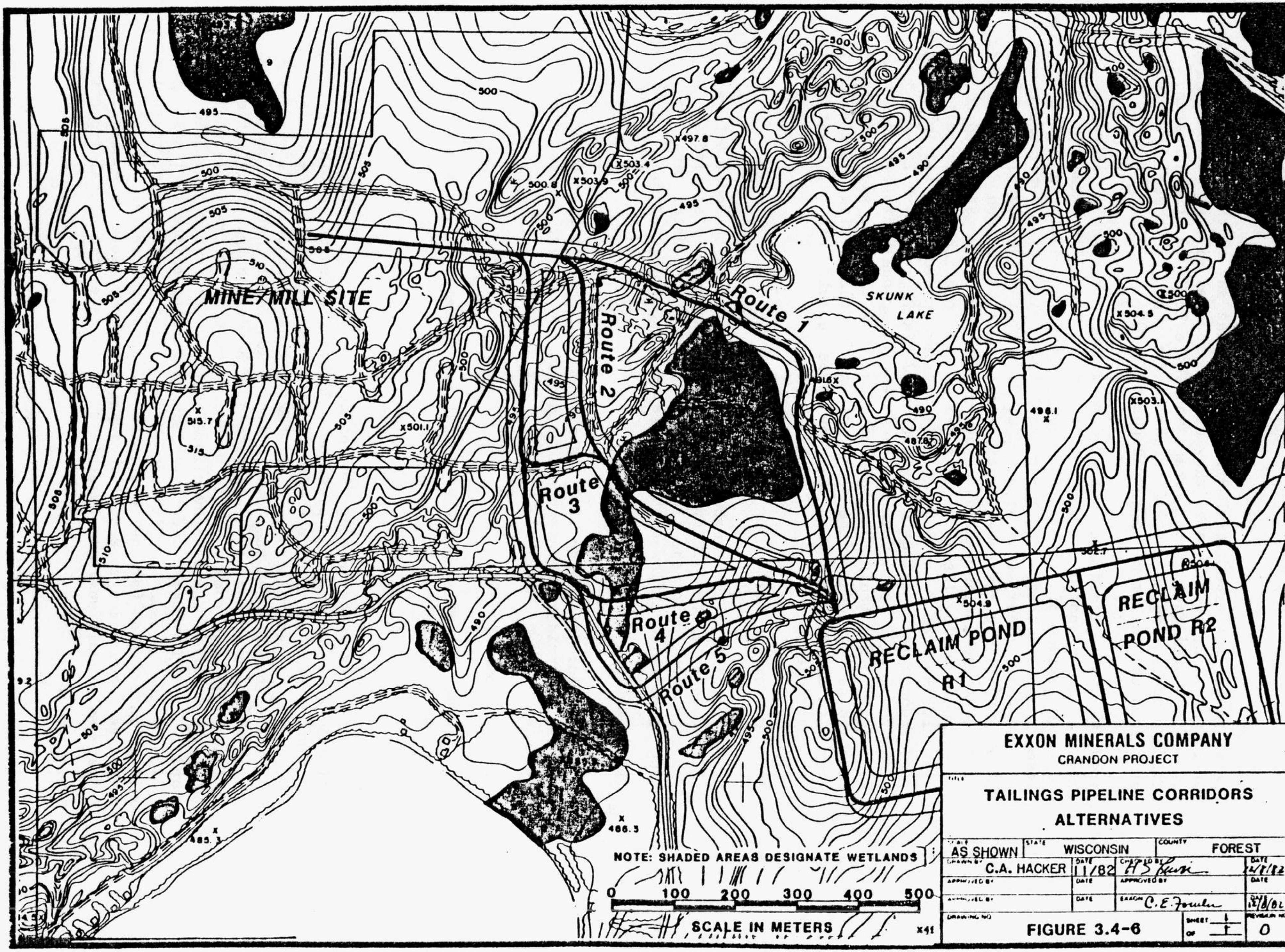
The ramifications of the unlikely event of finding "significantly" more ore and recovering these reserves would probably result in an extended mine life beyond the present forecast of 20 years of production. The current facilities design and the constraints of underground mining limit the daily production from Crandon to a normalized 9100 t/d (10,033 short tons per day). With the exception of the MWDF, the extended operation would have the same impact as the normal operations. The additional tailings that would be generated would simply fill the contingent capacity allowed for in the current design of the MWDF.

Comment No. A35 (Comment #10)

Due to the lack of an adequate buffer zone between Skunk Lake and the proposed slurry pipeline and haul road corridor, we recommend consideration of a more southern route as an alternative.

Response:

Exxon Minerals Company originally considered four potential routes from the mine/mill site to the MWDF area and a fifth "no-wetlands" alternative was identified in response to an earlier EIR comment No. 10 in the May 11, 1983 DNR letter. All five of the routes are presented in the attached revised Figure 3.4-6.



(Figure for Response to Comment No. A35)

While there are not substantial differences among any of the five routes, we favor routes 1, 2, or 3 because they are not located adjacent to Sand Lake Road. This avoids having to relocate Sand Lake Road and eliminates any potential adverse impact on traffic use of the road. Of these three routes, we prefer route 1 as proposed in EIR Chapter 1.0.

Alternative routes 1 and 2 are aligned to maximize the use of existing corridors. The proposed route and Alternatives 2 and 3 are each projected to effect a maximum of 0.5 ha (1.3 acres) of wetland vegetation. The proposed route also has a greater probability of impacting waterfowl use of Skunk Lake than either Alternatives 2 or 3. Alternative routes 2 and 3 cross wetland F11 at the same location and the total wetland disturbance is the same over the entire length of both alternatives. Construction of the proposed route would disturb wetland F11 at two locations on its perimeter, whereas Alternatives 2 and 3 cross this wetland and would divide it into two segments connected by culverts (see attached EIR Figure 3.4-6). Alternatives 2 or 3 would have a greater effect on the hydrologic functions of wetland F11 than would the proposed route. If there is additional evidence to support one of the alternatives, we would review and discuss it further with the DNR to ensure that the route selected has the least impact on the environment.

Comment No. A36 (Comment #24)

Localized pumping of the overburden aquifer appears to be under active consideration by Exxon. If so, this proposal should be discussed in the appropriate sections of the EIR and mining plan with greater detail on pumping rates, mine inflow control and excess water discharge.

Response:

Although overburden pumping is a possible method of mine dewatering, we are not actively considering using this method in the current design of mine operations.

Comment No. A37 (Comment #29)

Please discuss the alternative of installing a second tailings transport pipeline as a backup system.

Response:

During preliminary engineering studies for the tailings transport system, we considered a backup tailings pipeline. However, based on continuing study and planning of the system a single pipeline was selected. The design and construction procedures proposed for the tailings transport system reduce the risk of an unplanned shutdown to such a low level that the additional cost of a backup system is not justified. The design and installation procedures are more comparable to an underground water transmission line installation rather than a conventional tailings transport line laid above ground. These procedures reduce the susceptibility of the tailings transport line to damage or failure. If a failure would occur, operations would be interrupted for the repair period. Repair materials will be stockpiled and procedures established prior to operations to ensure repairs are made as expeditiously as possible to minimize environmental impacts.

An increase in pipeline length over that currently being proposed would increase the overall probability of a leak. Even though a backup pipeline would only be used in the event of failure in the main line, it would double the pipeline length and likewise increase the potential risk of failure.

Comment No. A38 (Comment #33)

Will the synthetic membrane system alternative require a 6 inch bentonite liner? Also, no seepage collection systems are included for alternatives 2 and 3. If seepage collection systems are components of these alternatives, the cost estimates should be modified accordingly.

Response:

The three liner systems discussed in the earlier response to comment No. 33 were not presented for purposes of directly comparing one system to another. The first liner system was proposed for seepage control in the tailing ponds (underdrain plus bentonite modified soil liner); the second was proposed for use in the water reclaim ponds (bentonite modified soil liner beneath a membrane liner); and the third system was a 1.5 m (5 feet) thick native clay liner that could be used in either application.

The use or function of a pond is a key factor in the selection of a seepage control system. For example, if there is no requirement to actually maintain water in the pond (i.e., the tailing ponds as opposed to the water reclaim ponds) and if the water can be effectively removed, then removing water from the pond becomes a primary means of ultimately controlling seepage. In that case, a combination underdrain and liner system becomes the best overall system. The underdrain, as used in the tailing ponds, is the drainlayer overlying the liner which collects and removes water leaching from the tailings, thereby removing the pressure head on the liner and reducing the quantity of water which could seep through the liner.

For a pond designed to contain water, such as the water reclaim ponds, the primary liner must contain the water, so there is no use for an underdrain component similiar to the concept used in the tailing ponds. However, for a water containing pond, use of a secondary liner for added protection to the primary liner assures minimal risk in the event of primary liner failure.

Using the data presented in the response to comment No. 33, the following alternative seepage control systems for use in a tailing ponds are estimated to cost:

1) <u>Bentonite Modified Soil Liner and Underdrain Seepage Control System (the proposed system)</u>

a.	0.15 m (6 inch) thick bentonite modified till liner - (4 percent bentonite)	-	$\$0.29/ft^2$
b.	0.46 m (18 inch) thick underdrain layer of processed till	-	$0.31/ft^2$
c.	0.46 m (18 inch) thick filter layer of unprocessed till	-	$0.10/ft^2$
	Total cost	-	$\$0.70/ft^2$

2) <u>Membrane Liner and Underdrain Seepage Control System</u>

a.	synthetic liner - 36 mil Hypalon	-	$0.55/ft^2$
b.	0.46 m (18 inch) thick underdrain layer of processed till	-	$0.31/ft^2$
c.	0.46 (18 inch) thick filter layer of unprocessed till	-	$0.10/ft^2$
	Total cost		$0.96/ft^2$

3) <u>Native Clay Liner and Underdrain Seepage Control System</u>

a.	1.5 m (5 foot) thick native clay liner hauled from Fence area in Florence County	-	$3.70/ft^2$
b.	0.46 m (18 inch) thick underdrain layer of processed till	-	$0.31/ft^2$
c.	0.46 m (18 inch) thick filter layer of unprocessed till	-	$0.10/ft^2$
	Total cost	-	$4.11/ft^2$

However, in these alternative seepage control systems the important component is the underdrain. When the underdrain performs its function of reducing the pressure head (i.e., by collection and removal of water) acting to cause seepage through the liner, then the primary factor causing seepage has been eliminated and minimal seepage will have been achieved.

<u>APPENDICES</u>

Comment No. A39 (Comment #A4)

Attachment number A2 does not provide data from Northern Lakes Services. Please provide these data if they are available.

Response:

Mr. Ronald Krueger, Northern Lakes Services has conducted a complete search of their files and no additional Duck Lake data are available. EMC has provided DNR with all of the available Duck Lake water quality data.

CHAPTER 1

Subsection 1.1.2.3 Project Schedules

Comment No. 1

The EIS indicates that over 4 years are required to construct the mine and mill complex, about 3 years to reach full production, and 26 years of operation. The Future Conditions Report, however, indicated an operations life of 21 years. Please explain why the estimated operation life was shortened by 5 years. Are the other schedules accurate? Will the operating duration change result in any project construction or operation changes?

Response:

The current Project basis and plan are:

1) A construction period of about 3-1/2 years;

2) A mine production buildup period of about 3 years to full production -- 1 year during the construction phase (1989) and 2 years during the early operation phase (1990-1991); and

3) A full production period (operation phase) of about 20 years.

The 20 year full production period represents our current plan based on revised mine ore reserve calculations of 68.7 million metric tons (75.7 million short tons). The 26 year full production period in the EIR contained a contingency factor to allow for a larger ore reserve and processing more ore than the current estimate. The 20 year full production period contains no contingency.

The current Project basis and plan supercede all previous schedules. The operating duration change has no effect on other Project construction or operations plans. EMC will provide a Project basis and plan schedule in March 1984.

Section 1.2.1.2.1 Main Shaft

Comment No. 2:

Construction of the main shaft will require blasting of consolidated bedrock material for the proper placement of the shaft collar and headframe foundation. Discuss the potential for bedrock fracturing during blasting which could increase the rate of ground water flow into the mine. Will grouting be capable of minimizing these inflows?

Response:

Shaft advance by drill-blast-muck methods is anticipated to produce a 10 percent overbreak in the bedrock beyond the design rib "neat" line. The overbreak rock material will be removed during the normal course of rib scaling and mucking cycles. Beyond the overbreak boundary, it is anticipated that a zone about 0.5 to 1 m (1.6 to 3.3 feet) thick will be loosened by blasting, reflecting an increase in aperture of existing discontinuities. Undisturbed rock will be present beyond the loosened zone.

Temporary "construction" support estimates include the use of grouted rock bolts, approximately 2.7 m (9.0 feet) in length, placed in a 1.2 m (4.0 feet) center to center pattern. The temporary support will probably be located within 4 m (13.1 feet) of the shaft bottom and is expected to maintain the integrity of the loosened zone and minimize further loosening with time.

Tentative construction plans indicate that the final support will probably consist of slipform concrete which will be located approximately 15 m (50 feet) behind the advancing shaft bottom. The concrete will be placed against the rock rib generally without voids between the rock and concrete.

Pressure grouting will be employed to control point sources of ground water inflow which are large enough to hinder sinking operations. Grouting as a general practice is not anticipated to be necessary below the interface of the shaft collar, bedrock and overburden. This is primarily a result of the clay filling of discontinuities in the weathered rock zone which extends from 18 to 30 m (59 to 98 feet) below the overburden-bedrock contact. Also, the bedrock displays a general and a rapid reduction in fracture frequency and discontinuity aperture, respectively, with depth.

The loosened zone around the shaft is expected to perform somewhat like a thin sand backfill for a standpipe piezometer installed in clay. Water will migrate from the intact rock zone to the loosened zone and drain towards the shaft bottom or behind the final support. However, the amount of migrating water will depend upon the amount of water in the intact rock zone, which is expected to be small, based on packer test results.

Also see subsection 1.3.1.4.2, Shafts and Collar, in the construction section of the EIR.

Section 1.2.1.2.4 Stopes

Comment No. 3

Supergene weathering of the hanging wall and the Crandon formation has created a very deep weathering slot that extends as deep as 230 m. Figure 1.2-4 indicates that mining will occur between 140 m. and 230 m. Describe in greater detail the precautions that will be taken to minimize groundwater inflows and mine gallery collapse in these weathered bedrock areas.

Response:

The EMC response to EIR comment No. 61 in the May 11, 1983 DNR letter describes in detail the precautions that will be taken to minimize ground water inflows.

Exploratory diamond drilling techniques will be employed to identify active water courses prior to advance of the mine face. Flows encountered on the uppermost mine level will be captured in interceptor drill holes and contained to avoid contamination by the mining processes at levels below.

Mine water control drifts will be developed ahead of production entry in the upper mine areas to maintain the ability to intercept ground water prior to contamination and entry into the active mining areas. Ultimately, the ground water interceptor system would function as shown on the conceptual Mine Inflow Control cross-section (see attached figure). Cement grouting of rock may be used for local inflow control or diversion.

As the mine progresses upward from the 230 m level, the required mine water control drifts will simply be normal production access drifts developed prematurely and dedicated for exploration and interception of ground water.

The exploration diamond drill holes, in fact, become part of the ground water interception system. As is common practice in other mines, the diamond drill hole collars will be packed and fitted with pipe connections.

Support of the mine workings in these areas is not expected to present any major problems. Rock strength in the weathered zone that will be mined is expected to be in the range of 5,000 to 10,000 psi. The planned mining methods for the upper portions of the mine (modified cut and fill) have been developed with the recognition of lower rock strength. These mining methods will maintain the overall rock mass integrity and prevent the collapse of the mine entries.

Section 1.1.3.6 Requirements for Governmental Service

Comment No. 4

Could sludge from sewage treatment be disposed in the tailings pond or on site as a fertilizing amendment?

Response:

There are no plans for disposal of sewage sludge in an operating tailings pond or as a soil fertilizing amendment. We believe disposal in a facility specifically designed for that purpose, and handled by personnel specifically trained and experienced in that activity is the proper method for disposal of this material.

Section 1.2.1.2.14 Fuel Handling and Storage

Comment No. 5

Will the fuel handling storage facilities in the mine have a liner as well as retaining walls to contain spilled fuels? How will spilled fuels be collected and disposed/recycled? What equipment will be used and will each level with a fuel storage area have this equipment available?

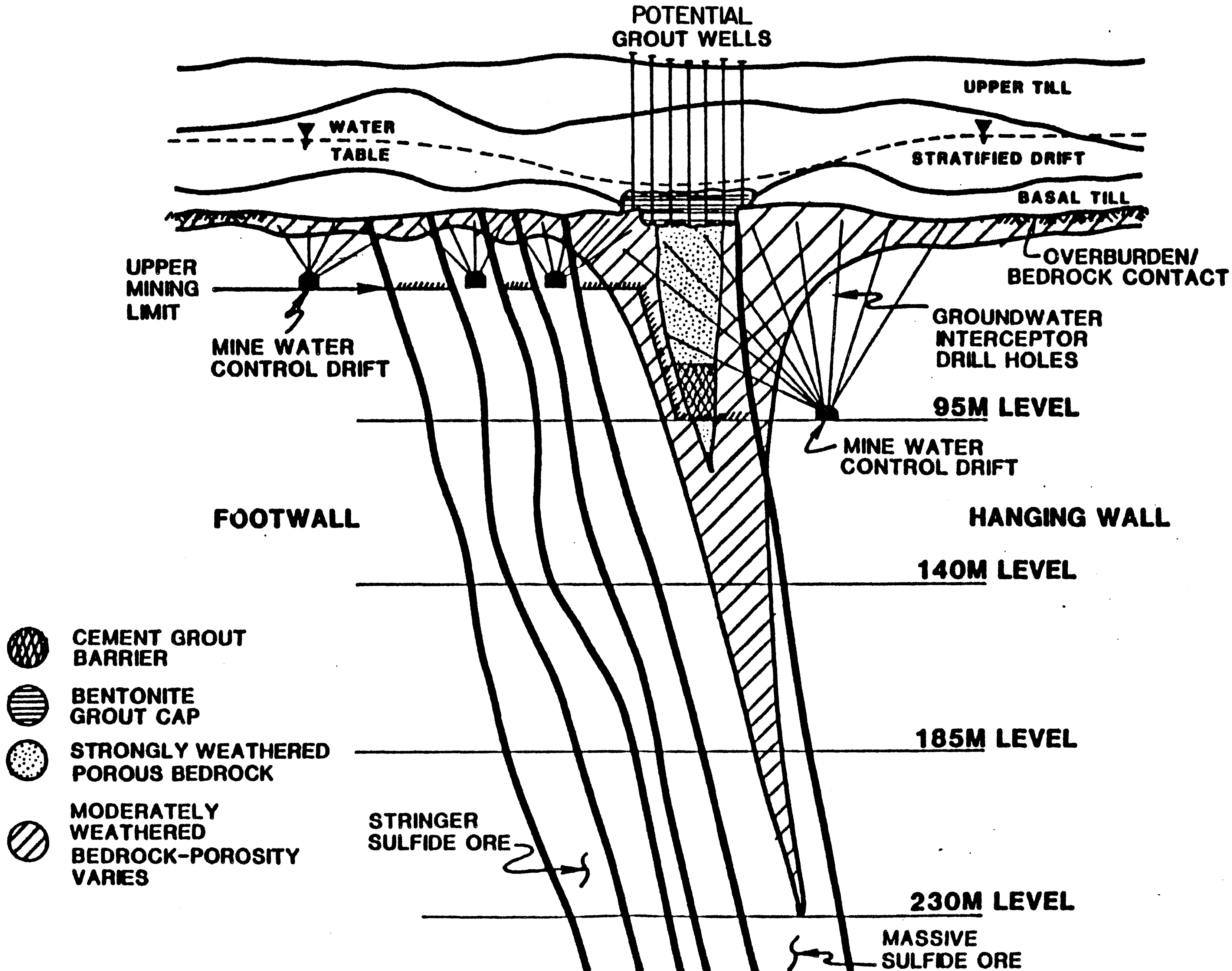
Response:

As specified in the EMC response to Mining Permit Application comment No. 44 in the October 10, 1983 DNR letter, the floors of the fuel spill retention areas will be bedrock behind the cement retaining walls. Spilled fuel will be collected with a sump pump, filtered, and recycled to the fuel tank. Two fuel stations will be located underground on the 350 m and 695 m levels. These stations will contain the same equipment which includes: (1) 1 -

EXXON MINERALS CO.
CRANDON PROJECT

MINE INFLOW CONTROL METHODS

(CONCEPTUAL X-SECTION)



(Figure for Response to Comment No. 3)

4,000 gallon tank; (2) fuel pump, valving, and piping; (3) sump pump, valving, and piping; (4) foam generator for fire suppression; and (5) fire doors and sensors.

Section 1.2.2.3 Concentrating

Comment No. 6

The EIR states that "floors will drain to separate sump pumps which return the various product spills to appropriate feed points". Will there be general floor drains to remove cleanup or rain waters that enter the building? Will spilled material be recyclable without treatment?

Response:

The sump pumps used to handle any spills will also be used for general clean-up. Sumps have not been provided specifically for rain water; the building is designed to prevent entrance of precipitation. Spilled material can be recycled without any treatment; this is common practice in mineral processing plants.

Section 1.2.2.10 Spill Control Facilities

Comment No. 7

What capacity will the spill control surge tank have? If multiple spills occur for different process lines can the materials be safely mixed? If recovered spills cannot be recycled where will they be stored pending disposal?

Response:

The spill control surge tank referred to in subsection 1.2.2.10, Spill Control Facilities, was intended for spills in the reagent preparation area. Current engineering does not incorporate the concept of using a common tank to collect all liquid reagent spills so the spill control surge tank has been deleted. Rather, curbing will be provided around the reagent mixing tanks. Any spills will be confined within the curbing for a given mixing tank. If multiple spills were to occur, they could not mix with each other. Spills will be collected in a blind sump provided within each curbed area. The spill will simply be pumped back into the respective mixing tank using a portable sump pump. Available details for the reagent preparation areas have been provided to the department.

There will be four process lines in the concentrator:

1) Grinding stringer ore and flotation for copper recovery;

2) Grinding massive ore and flotation for copper and lead recovery;

3) Copper-lead separation and lead upgrading; and

4) Zinc flotation.

The sump system is designed to keep potential spills from these areas separated. Allowing spills to mix would not be a safety hazard; however, from the standpoint of process control it is not desirable.

There is no reason that process slurry spills cannot be recovered and pumped back into the process. There is also no reason why reagent spills cannot be recovered for use as intended.

Section 1.2.4.2 Access Road

Comment No. 8

The EIR states that the access road will be two paved lanes (12 feet each) with 8 feet shoulders. For the projected traffic load (600-780 vehicles/day) two paved lanes (11 feet each) with 6 feet shoulders should be adequate.

Response:

During the preliminary engineering design work for the access road, consideration was given to a lower design class or standard for the roadway. An 11-foot paved lane and a 6-foot shoulder width would be the next lower standard. However, the higher standard affords some safety and operating improvements that are worthwhile but admittedly are difficult to quantify.

In winter weather additional roadway and shoulder width improves snow plowing operations and ability to maintain an open road. Also, with a stalled vehicle or an accident, traffic can be more easily maintained with the wider road. While these considerations would be less important for other roads with our traffic load and more normal traffic patterns, most of our traffic will occur during the three shift changes each day. An interruption to traffic flow during one of the shift changes might affect operations. During final engineering of the access road, the lane and shoulder widths will again be considered.

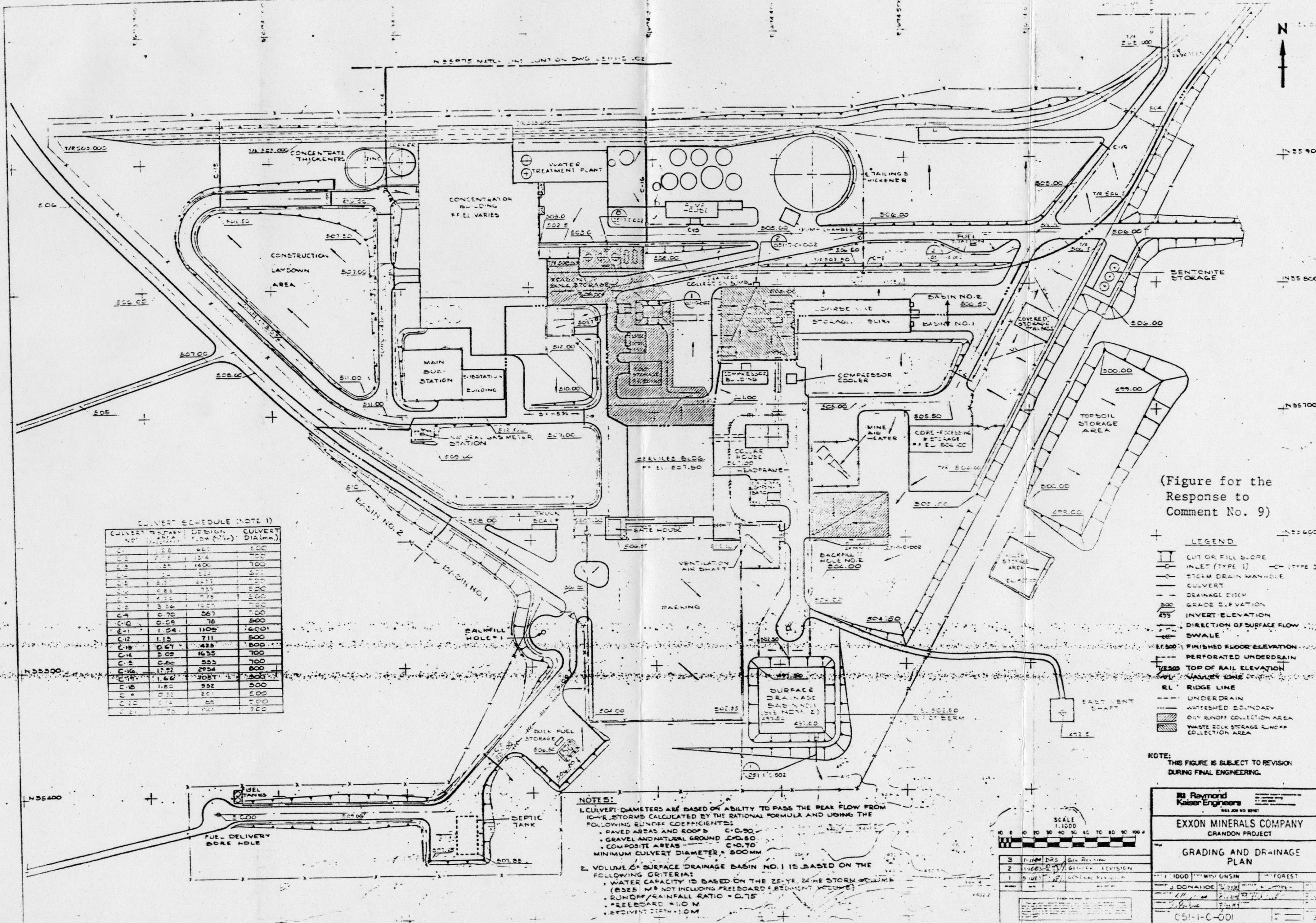
Section 1.2.4.3 Parking and Gate House

Comment No. 9

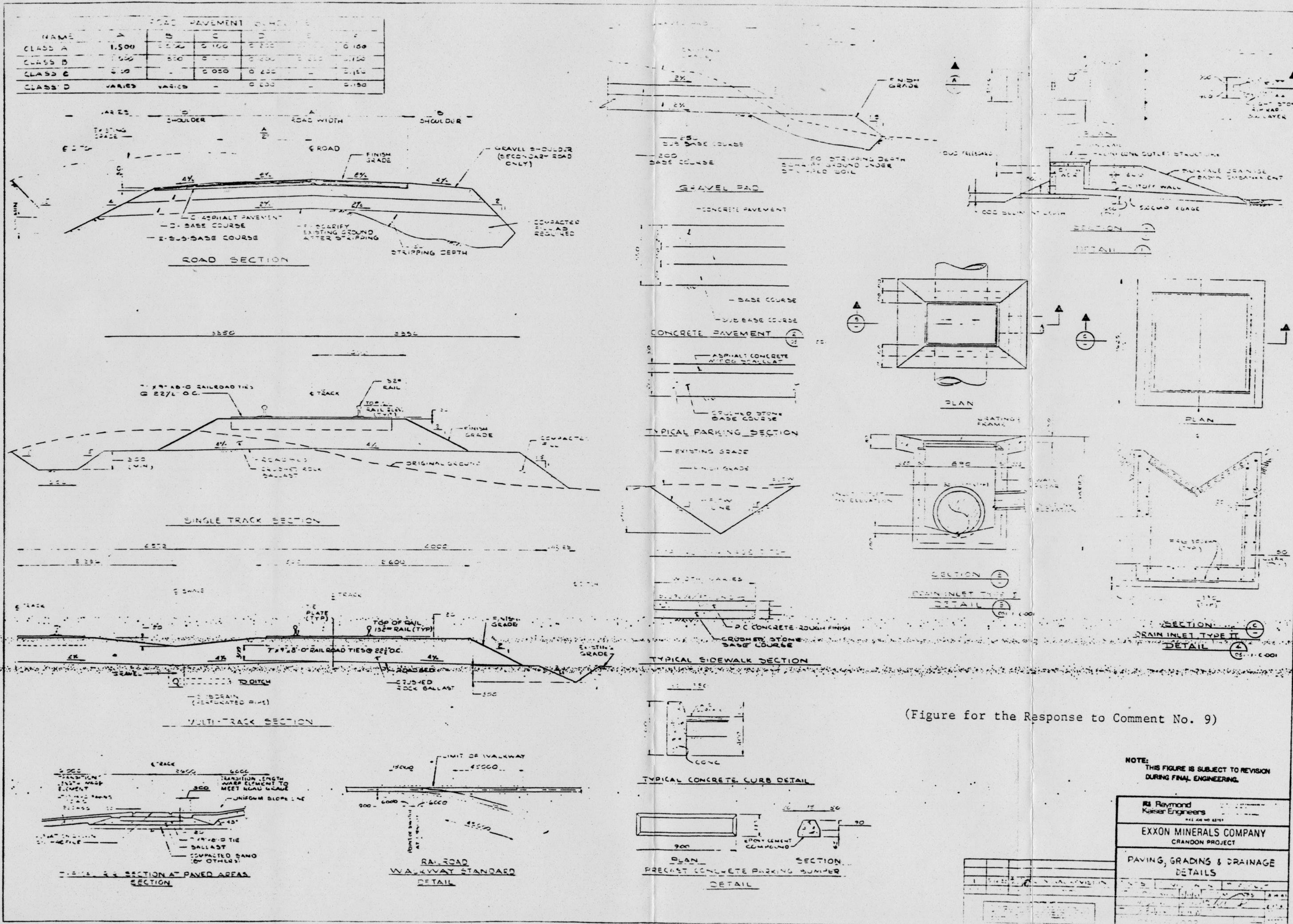
Describe in greater detail the two water retention basins on the site. If basin siltation requires dredging, where will the dredged materials be dumped? Estimate the quality of the water leaving these basins. To which streams will this water flow?

Response:

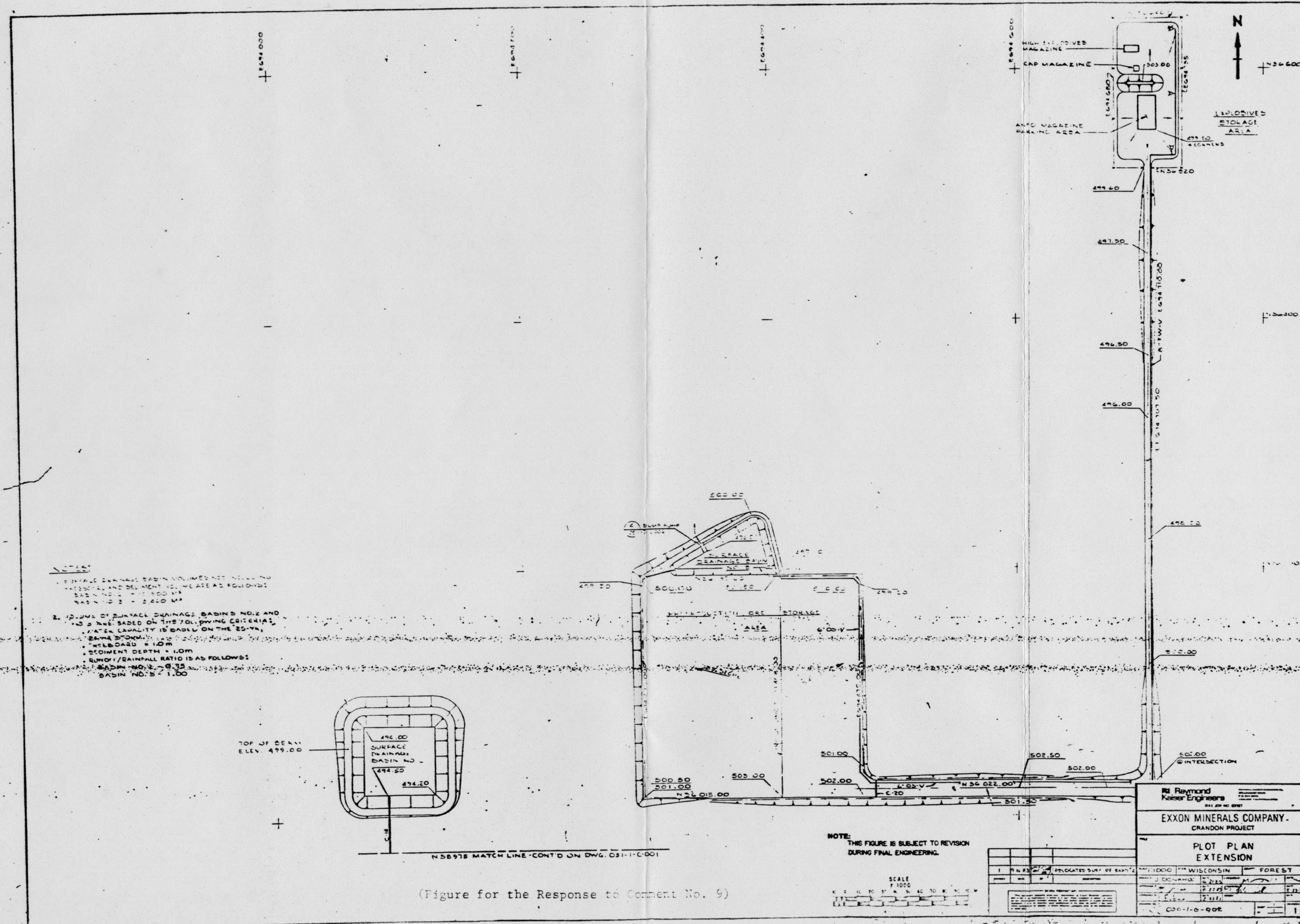
The three attached figures show the current mine/mill site layout, including the locations of the two water drainage basins used for collection, retention, and release of all uncontaminated surface waters in the mine/mill area. Details of the drainage basins and the other surface water drainage facilities, the drainage area for each basin, and the basin sizing criteria are all included on the figures. These figures are subject to revision during final engineering.



(Figure for the Response to Comment No. 9)



(Figure for the Response to Comment No. 9)



(Figure for the Response to Comment No. 9)

If the basins collect sediment in excess of their design, the sediments will be removed (excavated) and hauled to the topsoil stockpile or one of the soil material stockpiles at the MWDF. Separate basins (e.g., surface drainage basin No. 3) are provided in the mine/mill site to collect and transfer for treatment any surface waters that could potentially be contaminated from mining operations.

Except for possible contaminants from parking lots and roadways and slightly higher suspended solids content, the surface runoff water quality should be comparable to current surface drainage water quality in the site area.

Water from drainage basin No. 1 will be discharged to the south of the mine/mill site into wetland F11 between Skunk and Little Sand lakes. Ultimately, this water would enter Little Sand Lake.

Basin No. 2 will discharge surface water into wetland P2 north of the mine/mill site. Ultimately, this water would enter Swamp Creek.

Section 1.2.4.5 Combustible Storage Building

Comment No. 10

What measures will be taken to contain, control, and clean up spills (e.g. contingency plans, liners, berms, recycling, disposal, safety equipment)?

Response:

Combustible materials will be stored in a separate building now designated as the lubricant storage building. Lubricants, paints, and cleaning materials for the mine and mill will be stored in this building. The building floor will be concrete without floor drains. There will be no long-term storage of large quantities of these materials. the building and contents will be inspected daily and any spills will be cleaned manually as required.

Section 1.3.1 Facilities Construction

Comment No. 11

Please provide a list of nonmetallic minerals needed for construction purposes. This would include gravel for all road and facility construction, the ballast for the railroad spur, and materials for road/facility surfacing. Include the processing plants associated with these activities if appropriate, and indicate quantity of materials needed, estimated cost, and likely source.

Response:

The primary nonmetallic minerals needed for construction of the Crandon Project along with estimated quantities and costs are summarized below:

Item	Quantity	1982$/Unit
Concrete (includes surface and underground)	46,900 m^3	34.40
Base Course (includes access road and in-plant roads)	24,400 m^3	6.68
Subbase (includes access road and in-plant roads)	28,800 m^3	3.92
Asphalt Pavement	7,400 m^3	29.73
Railroad Ballast (includes spur and siding)	37,900 t	3.86
Railroad Subbase	12,400 t	3.92
Bentonite	7,700 t	117.16

Sand and aggregate for the above items could be supplied from a number of local sand and gravel pits. The bentonite to be used primarily for the MWDF probably will be obtained from out of state and will be delivered by rail tank cars.

Two separate batch plants will be used on or near the Project construction site. Descriptions of the batch plants and their estimated air emissions have been included in the air permit application. The first, a temporary concrete batch plant, will be located to the southeast of the main shaft. This facility will provide most of the concrete for the surface buildings and for underground mine construction.

A second processing plant will be located in the tailing ponds construction area. This batch plant will mix the bentonite with native soils to provide liner material for the tailing ponds, reclaim water ponds, and the temporary ore storage pad.

Section 1.3.1.3 Access Road Construction

Comment No. 12

Please provide additional details on access road construction activities including topsoil stockpile areas, location and design of erosion control methods such as sediment basins, and deposition of peat removed from wetlands.

Response:

Existing topsoil will be stripped and saved from all cleared and grubbed areas along the access road right-of-way. Based on preliminary engineering for the access road, approximately 12.1 ha (29.9 acres) of right-of-way will be cleared and grubbed. Assuming a depth of suitable topsoil of 0.15 m (6 inches) throughout the cleared area, a total volume of 18,150 m^3 (23,700 cubic yards) of topsoil would be available for stockpile and reuse. Suitable areas along the right-of-way would be chosen to temporarily stockpile the topsoil. If temporary protection (control of surface water runoff) was required, it would also be provided.

Construction of the access road includes topsoiling, fertilizing, and seeding of all disturbed areas along the right-of-way. Most salvaged topsoil will be applied to the road side slopes prior to seeding. However, at the completion of access road construction any unused topsoil will be hauled to the permanent topsoil stockpile at the mine/mill site.

The plan and profile and detail drawings from the plan set of preliminary engineering drawings for the access road depict the entire alignment from STH 55 to the mine/mill site interface point (see Attachment No. 10 included with the response to EIR comment No. 129 in the DNR's May 11, 1983 comment letter). Drainage structure locations, typical sections showing revegetation, and settling basin details are included. The plan sheets also show the approximate slope intercept lines along the entire route, including limits of revegetation after construction. These drawings are subject to revision during final engineering.

Locations of the temporary erosion control facilities to be utilized during construction, such as the straw bale or filter fabric silt traps and the sheet piling at the Swamp Creek crossing, will be determined during final engineering. These temporary facilities will be subject to further minor adjustments in the field depending upon actual conditions and performance.

The total estimated amount of wetland soil materials removed along the access road during construction is approximately 4800 m^3 (6275 cubic yards). No separate estimate of peat materials within this volume has been made. These soil materials will be used as a top dressing on the roadway side slopes outside the edges of the aggregate base course.

Section 1.3.1.9 Railroad Construction

Comment No. 13

Please provide additional details for railroad construction and associated activities, including topsoil stockpile location, retention basin details, and deposition of wetland organic soils.

Response:

The construction activities planned for the railroad spur are similiar to those for the access road. In the preliminary engineering work for the railroad spur, an estimated 13.6 ha (33.6 acres) will be cleared and grubbed within the right-of-way. Assuming 0.15 m (6 inches) of suitable topsoil throughout the cleared area, approximately 20,400 m^3 (26,700 cubic yards) of topsoil would be stripped and saved. In the preliminary engineering study an estimated 11,000 m^3 (14,400 cubic yards) of topsoil will be used during railroad spur construction for reclaiming disturbed areas and embankment or cut slopes. Any excess topsoil will be relocated to the topsoil stockpile at the mine/mill site.

The permanent drainage and erosion control structures for the railroad spur are shown in the plan and profile and detail drawings (see Attachment No. 10 included with the response to EIR comment No. 129 in the DNR's May 11, 1983 comment letter). The temporary erosion control measures will include the same measures as suggested for the access road construction (see response to comment No. 12). Tentative locations (subject to final verification in the field at the time of construction) for the temporary erosion control facilities will be established during final engineering for the railroad spur. Also, depending upon actual performance of the temporary facilities, modifications may also be made in the field.

Wetland soil materials excavated for construction of the railroad spur will be used as top dressing along the railroad spur embankment or cut side slopes. For the railroad spur the volume of wetland excavation was estimated to be 12,700 m^3 (16,600 cubic yards).

Section 1.4.2.3 Ventilation and Air Heating

Comment No. 14

How will controlled amounts of clean air be withdrawn for each level?

Response:

Early mine development will be performed with air being supplied from the surface through ducting to each active heading. In-line fans will be used to establish the required air volume necessary to remove combustion products produced by diesel engines and detonation of explosives. Similar methods of air movement will be used for heading advance after primary ventilation circuits are operational.

Movement of air down the main and intake air shafts will be accomplished by operation of the main mine exhaust fans located on the surface at the east and west exhaust raises. The intake shafts will act as common free splitting plenums; each level in the mine will receive a predetermined volume of air necessary to conduct work activities on that level. Mine level air splits will be achieved with the aid of "regulators" (used on levels nearer the surface), air doors, and booster fans (required for those levels farthest from the air flow created by the main mine exhaust fans). These devices or combination of devices will be located at the primary exhaust points of each level.

A "regulator" is simply a device which restricts flow and induces the air along its path of least resistance. In an operating mine a regulator is a blockage (bulkhead) in an airway with an adjustable opening. The opening is adjusted as required to accommodate changes in the required mine air movement.

Air doors are large doors which physically separate sections of the mine while allowing passage of large mining equipment via mechanical opening and closing methods. Generally, air doors are installed in pairs to form an air lock and to minimize leakage.

Booster fans are used as energy additions to a mine ventilation system. Generally they are found in locations most distant from the main mine exhaust fans. These types of fans are much smaller in size than the main surface units and act in conjunction with them. Location of these units will generally be the same as for the regulators.

The use of these devices serves to control and direct air movements on each mine level. The underground environment is constantly changing with the relocation of primary work areas. Acceptable air movement conditions will be achieved through constant attention and monitoring by mine management.

The planned techniques for ventilation control are those in common use throughout the industry for underground mining. These techniques have been refined and proven through many years of use by the industry.

Section 1.4.7 Operations Traffic

Comment No. 15

This section estimates a total of 623 vehicles used to transport 782 operations workers on a daily basis, with an occupancy rate of 1.25 persons per vehicle. In section 1.3.3.4 on construction traffic, only 550 vehicles are needed to transport over 1,450 construction workers and staff in the peak year of construction. Please explain why fewer vehicles would be needed for a greater number of workers during construction than during operations.

Response:

The Socioeconomic study report entitled, "Forecast of Future Conditions" provides an early estimate of vehicle traffic for the construction and operation phases of the Project. Based on an occupancy rate of 1.6 persons per vehicle and approximately 1,400 employees during the peak construction year, an estimated 875 vehicles would be required to transport these people to and from the mine/mill site. The number of employee vehicles currently estimated for the operation phase with 703 employees is approximately 440 (703/1.6).

Section 1.5.1 Facilities Removal

Comment No. 16

The EIR states that drifts, raises, and shafts will not be backfilled. Why shouldn't they be filled with tailings and plugged with concrete or bentonite to minimize surface subsidence and maximize the amount of waste rock returned to the mine? What is the volume of mine drifts, raises and shafts that would not be backfilled? How does this compare with the volume of the stopes which will be backfilled?

Response:

During the operational life of the mine and mill, an attempt will be made to maximize the amount of material returned underground to be used as fill. However, at the completion of the milling operation the current plan is to reclaim the tailings that have been deposited in the tailing ponds. Consideration of several factors have led to this decision.

First, not all of the tailings could be returned underground. Through the mining and milling process, the density of a cubic meter (1.30 cubic yards) of rock decreases from 3.32 t/m^3 (2.80 short tons per cubic yard) to a tailings density of 1.73 t/m^3 (1.46 short tons per cubic yard). This is approximately double the volume of space required for disposal of the tailings compared to the mined ore tonnage.

Second, the amount of tailings that could be readily accessed would be limited to those contained in the last active pond. The tailings in the other ponds would have been reclaimed in previous years.

Third, to move the tailings from the disposal ponds to the mine would require repulping of the tailings. This would be done by mechanical agitation and/or by the use of water jets. Both of these methods have the potential to disrupt the liner system.

Finally, there is an additional cost to remove and transport the tailings from the disposal ponds to the mine. For these reasons tailings in the final pond will be reclaimed and not backfilled upon completion of mine and mill operations.

The total volume of excavation underground, including ore and waste rock, will be approximately 23.3 M m^3. Of this volume, approximately 21.3 M m^3 will be backfilled during mine operation, leaving less than 10 percent of the mine entries open after mine closure.

The question of surface subsidence has been addressed in the response to comment No. 54 of the DNR's earlier comments on Chapter 1.0 of the EIR (EMC letter dated October 3, 1983) and again in the response to comment No. 41 of the comments on the Mining Permit Application (EMC letter dated November 11, 1983).

CHAPTER 2

Section 2.4.1.2 Stream Flow Rates

Comment No. 17

There are a number of streams which may be impacted by lowering the groundwater potentiometric surface. However, the information presented in the EIR does not indicate the maximum worst-case scenario if mine inflow is greater than 2,000 gpm. When this information is available, we will be able to determine whether additional streams may be impacted. An example of streams which could be impacted are the five unnamed streams tributary to the north and east sides of Rolling Stone Lake. Three of these contain brook trout populations and are Class I trout streams. For these or other streams within the ultimate groundwater drawdown zone of influence, we may require water quality, low flows, and biotic data gathering as necessary to document premining conditions.

Response:

We believe that the analysis presented in the EIR of the impacts of the mine inflow of 0.126 m^3/s (2,000 gallons per minute) is an accurate assessment of the worst-case scenario. We are currently working with the DNR in securing additional data and performing additional analyses to verify the maximum extent of potential ground water impacts from mine operation. The results of this activity should address the concerns stated in this comment.

Comment No. 18

For all streams within the area potentially impacted by mine dewatering, low flows (7-day Q_{10}) must be determined. Please include information on how stream low flows are determined. Low flow information is required to adequately assess the potential drawdown impacts on these streams. The analyses of flow reductions based on average total flow or average base flow are inadequate.

Response:

Extreme stream low flow estimates (Q7,10) were completed for nine locations in the Crandon Project environmental study area (Golder Associates, 1982). All of these locations are within the Swamp Creek and Pickerel Creek drainage basins and are shown on EIR Figure 2.4-1.

Q7,10: The Q7,10 (7 day - 10 year recurrence) extreme low flow discharge rate is defined as that average statistical low flow rate over a 7 day period for which the flow will be less than an average of once in 10 years (10 year recurrence) (Gebert and Holmstrom, 1977).

Stream Low Flow Periods: Two stream low flow periods occur annually in the Crandon Project environmental study area. The annual extreme low flow period occurs during late summer (August through September). The winter low flow period occurs between late November and early March and is virtually all base flow. The annual seven consecutive day extreme low flow period may be determined by comparing the daily variations in stream flow exhibited during annual low flow periods. Periods with relatively constant flow rates are controlled by base flow, while periods with variable flow rates show that relatively constant base flow is augmented with surface runoff.

Inspection of the flow records of the USGS maintained stream gage on Swamp Creek at STH 55 (August 1977 to 1983) indicated that while the extreme low flow occurs during late summer, the winter period low flow (late winter/early spring) is virtually all base flow. This was based on the daily flow variation in the late summer and the near constant flow during the late winter. Therefore, the 7 day, 10 year low flow estimates were prepared considering flow during the entire year.

Methodology: The annual low flow analysis was performed using the USGS procedures and equations presented in Holmstrom (1980) which use the longer stream flow records of surrounding basins. The procedures are considered to be applicable in Forest and Langlade counties (Golder Associates, 1982). Equations are presented which allow estimates of the 7 day, 10 year low flows to be made based on watershed characteristics. Holmstrom (1980) presented a correlation procedure for both ungaged basins and for basins with limited stream flow data. Details of this application are presented in Golder Associates (1982). The attached table presents the results of this analysis.

References

Gebert, W. A. and B. K. Holmstrom, Low Flow Characteristics at Gaging Station on the Wisconsin, Fox and Wolf Rivers, Wisconsin, U. S. Geological Survey, Water Resources Investigation 77-27, June 1977.

Holmstrom, B. K., Low Flow Characteristics of Streams in the Menominee-Oconto-Peshtigo River Basin, Wisconsin, U.S. Geological Survey, Open File Report 80-749, August 1980.

Golder Associates, Inc., Geohydrologic Site Characterization, Exxon Minerals Company, Crandon Project, Chapter 5 - Surface Water Hydrology, pp. 50-79, Atlanta, Georgia, 1982.

Section 2.5.2.1 Drainage Lakes and Associated Streams (Aquatic Ecology)

Comment No. 19

Page 2.5-37, - Baetis, in particular, is a very common mayfly in Swamp Creek that was not identified to species. Because of the numerical importance of this genus, species identifications should be made. As a general guideline, species identification should be made on all future Exxon benthos specimens, when possible, with the exception of biotic index samples which may not require species identification for tolerance assessment.

Response:

During the 1983 Swamp Creek Aquatic Monitoring Program, Baetis pygmaeus was identified at Stations 3, 4 and 5 in macroinvertebrate collections to determine Hilsenhoff's biotic index values. No other mayfly species of this taxon was identified, which is consistent with NCD-DNR identifications completed to date (February 1, 1984) in samples from Swamp Creek (personal communication from R. Young NCD-DNR to H. Lewis, EMC). The final report of the 1983 Aquatic Monitoring Program will be provided to the DNR within 60 days.

During the pre-construction aquatic monitoring program, all benthos identifications of numerically important species will be to the lowest positive taxonomic level. We acknowledge the comment that biotic index samples may not require species identifications for tolerance assessment.

(Table For Response to Comment No. 18)

Statistical Extreme (Q7,10) Low Flow Analysis Results

Station or Location	Estimated Annual (Q7,10) m^3/s	cfs
Swamp Creek Drainage Basin		
Swamp Creek at County Road K (USGS)	0.895	31.55
Swamp Creek at County Road M Below Rice Lake (USGS)	0.45	16
Swamp Creek at Highway 55 Above Rice Lake (USGS)	0.34	12
SG 3 on Swamp Creek below confluence of Outlet Creek	0.319	11.27
Swamp Creek below confluence with Hemlock Creek (ungaged)	0.028	1.0
SG 6 on Hemlock Creek below Ground Hemlock Lake	0.008	0.29
Pickerel Creek Drainage Basin		
SG 19 on Pickerel Creek into Rolling Stone Lake	0.015	0.53
SG 23 on Creek 12-9 into Rolling Stone Lake	0.016	0.56
SG 22 on Pickerel Creek at East Shore Road	0.097	3.44

Section 2.5.2.1 Drainage Lakes and Associated Streams (Aquatic Ecology)

Comment No. 20

With regard to Table 2.5-13, the practice of "lumping" or "splitting" taxonomic groups for data presentation affects our ability to review and compare data sets. If many taxonomic groups are "lumped" as in Table 2.5-13, it makes DNR's verification of the data cumbersome and time consuming. Rather than requiring a complete remake of this and other similar tables, please send raw data and/or unpublished copies of the necessary data for review purposes.

Response:

We recognize the inherent problems associated with summary tables and their limitations for comparison with other data sets. However, to minimize the number and length of tables used in EIR Section 2.5, it was necessary to consolidate and summarize the raw data sheets rather than present the detailed genus and species classification and enumeration data. The raw data that provided the basis for Table 2.5-13, as well as for other macroinvertebrate tables presented in Section 2.5, are presented in Appendix 2.5D. The data used in developing Table 2.5-13 are cited on EIR page 2.5-39; these are Appendix 2.5D, Tables D-58 through D-64. Classifications were completed in all cases to the lowest positive taxonomic category possible.

Section 3.5.6.1 Water Treatment Systems

Comment No. 21

Compare the expected quality of the sodium sulfate byproduct from the water treatment process with the commercially available sodium sulfate presently used in the paper making industry. If the reclaimed sodium sulfate is not of commercial quality please discuss the alternatives for purifying the sodium sulfate versus land disposal.

Response:

As a result of a telephone survey conducted in the spring of 1982, there are two sources of salt cake used by the Kraft mills in Wisconsin -- Saskatchewan Minerals in Chaplin, Saskatchewan, Canada and Green Bay Packaging in Green Bay, Wisconsin. The salt cake produced by Saskatchewan Minerals is from natural brines and a typical chemical analysis of this product is presented in the attached table.

Green Bay Packaging, a pulp and paper mill, is the only reported source of sodium sulfate within the state of Wisconsin. Green Bay Packaging produces a byproduct sodium sulfate, which is recovered from sulfide pulp waste liquor. This byproduct sodium sulfate is known in the trade as Copeland sulfate and is typically a mixture of sodium sulfate and sodium carbonate. Green Bay Packaging's Copeland sulfate is reportedly 79.4 percent sodium sulfate, 20.1 percent sodium carbonate, and 2.9 percent insolubles.

Salt Cake

CHAPLIN, SASKATCHEWAN, CANADA

TYPICAL ANALYSIS

CHEMICAL ANALYSIS

	%
Insolubles	.40
Moisture	0.00
$CaSO_4$	.06
$MgSO_4$	.25
Na_2CO_3	.06
$NaHCO_3$	.22
NaCl	.08
Na_2SO_4	98.93

pH 8.3-9.5

SCREEN ANALYSIS

Screen Number Tyler	Screen Number U.S.	Opening Size in Inches	% Retained
14	16	.0469	1.1
20	20	.0328	3.4
28	30	.0232	3.0
35	40	.0165	2.6
48	50	.0116	3.1
60	60	.0098	2.1
80	80	.0070	7.3
100	100	.0059	8.2
150	140	.0041	20.1
200	200	.0029	24.0
Pan (Thru 200)			25.1

Bulk Density 74-80 lbs./cu. ft.
Whiteness 60

This information is believed to be reliable but is not to be construed as a warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of the product described herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE.

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(Table for the Response to Comment No. 21)

The purity of sodium sulfate consumed in the chemical treatment of wood pulp in a Kraft mill is not well defined. It is normally based more on what is cheaply available. The expected quality of the sodium sulfate byproduct from the Project water treatment process for recycle is expected to be similar to that produced by Saskatchewan Minerals. Both recovery methods would use crystallization from sodium sulfate brines.

The processing steps will ensure a high purity, 99+ percent, sodium sulfate. The proposed post VCE brine treatment system, which includes brine soda ash softening, sodium sulfate crystallization and a wash centrifugation, has the inherent flexibility to achieve essentially any level of purity required.

Section 3.5.2 Process Alternatives

Comment No. 22

Due to the environmental hazards associated with the use of cyanide compounds please discuss the use of alternative reagents in the copper beneficiation process.

Response:

In the recovery of copper minerals from massive ore, sodium cyanide along with zinc sulfate and lime is used to control and prevent the activation and premature flotation of zinc minerals which would otherwise be a contaminant in the copper-lead bulk product. It also serves to depress the flotation of pyrite. The sodium cyanide is added to the process as a zinc cyanide complex $[Zn(CN)_4^{=}]$ which is formed in a mixture of sodium cyanide, zinc sulfate and lime. Hydrogen cyanide is not involved in the process. Cyanide is not required in the treatment of the stringer ore.

Researchers have been attempting to develop alternatives to sodium cyanide as a depressant or as a component of a depressant scheme. No reagent has been identified as a universal replacement for sodium cyanide. During the development of the process for treating the Crandon massive ore, many alternatives to sodium cyanide were investigated, none of which were sufficiently effective.

Sodium sulfite (Na_2SO_3) and sodium sulfide (Na_2S) were investigated as replacements for the sodium cyanide-zinc sulfate mixture. The combination of sodium cyanide-zinc sulfate allows for higher recovery of copper and lead while keeping the amounts of pyrite and sphalerite in the copper-lead rougher scavenger concentrate at a minimum.

The proposed processing flowsheets utilize the lowest practical amounts of cyanide.

Section 3.5.2 Process Alternatives

Comment No. 23

Briefly discuss the feasibility of heap leaching the tailings to enhance metal recovery.

Response:

Heap leaching of finely ground tailings from massive sulfide flotation is not practiced at any mining operation. Heap leaching of Crandon tailings is impractical for the following reasons:

1) Low residual metal value and complex mineralogy (e.g., copper, lead and zinc).

2) Insoluble nature of the copper, lead, and zinc remaining in the tailing; a strongly oxidizing leaching solution would be required;

3) Low permeability of the tailings which would allow for only very slow percolation rate of the leaching solution; and

4) Any solution resulting from the oxidative leaching of the tailing would be high in iron content but low in copper and zinc content; recovery of copper and zinc from this solution would be impractical, if not impossible.

Heap leaching is generally done on low-grade overburden removed during the open-pit mining of porphyry copper ores in the west and southwest regions of the United States. Some of these overburden materials contain recoverable amounts of copper as mixed oxides and sulfides and, in some cases, gold. Since the overburden material consists of blasted rock (i.e., not ground to a fine size like flotation tailings), it has a permeability suitable for leaching. The Crandon Project is an entirely different situation and heap leaching of tailings is not planned.

CHAPTER 3

SECTION 3.5.6.3 Water Treatment Waste Disposal

Comment No. 24

This section states that water treatment wastes could potentially be sold to Kraft paper mills in Wisconsin, or transported to and disposed of in a secure landfill site. One of the tailings ponds could be used for the storage of this waste if a separately bermed area was provided. If this alternative were chosen, would it require any modifications to the size of the tailings ponds? How would sodium sulfate be handled and disposed in the tailings ponds?

Response:

The water treatment process will produce up to 10.2 t/d (11.2 short tons per day) or 8.5 m^3 (300 cubic feet) per day of anhydrous sodium sulfate. Disposal of this sodium sulfate in a bermed portion of a tailing pond would require 76,500 m^3 (2.7×10^6 cubic feet) for a mine life of 20 years (assuming the water treatment plant operates for 25 years). This total volume of sodium sulfate represents only 1 percent of the storage capacity of the first tailing pond (6.0×10^6 m^3) or a fraction of 1 percent of each of the other three ponds. Thus, the tailing ponds should not require a modification to their design size to include sodium sulfate disposal.

The salt cake for disposal would be removed from the covered storage bunker at the water treatment plant with a front-end loader and transferred to a dump truck for transportation to the MWDF. The sodium sulfate would need to be covered progressively as it is dumped into the tailing pond. Sodium sulfate is very water soluble, its disposal in the separate bermed area in the tailing pond would require a synthetic liner to hydrostatically isolate it from the water in the tailings and in the underdrain system. (See also the response to comment No. 21 for marketing of sodium sulfate.)

III. Chapter 4, Comments on Environmental Consequences

Comment No. 25

Introduction

The following comments pertain to Exxon's EIR Chapter 4, Environmental Consequences. The first group of comments is referenced to the corresponding EIR section for your convenience. The second group of general comments has no corresponding section in Chapter 4.

These comments represent our initial review of Chapter 4. We have incorporated the appropriate concerns identified by local units of government, the general public, Indian tribes, state and federal agencies and our Department staff into these comments. As additional comments on the EIR are received, they will be transmitted to you as appropriate.

We have not provided complete comments on several sections in Chapter 4 of the EIR, especially those sections on impacts to surface waters and groundwater. Discussions on these issues between the Department and Exxon are currently underway to determine additional field data requirements and further analytical modeling needs. The Department's position on information needs was detailed in the November 14, 1983 letter to Exxon, hereby incorporated by reference. The specific data needs and analyses which must be addressed by Exxon include:

1) a worst-case analysis of the mine inflow rate;

2) the extent of the ultimate groundwater potentiometric surface drawdown which must be identified by the 0-meter contour interval;

3) acceptable low flow (7-day Q_{10}) data on streams, rather than average flows, on which to calculate flow changes due to mine dewatering.

4) quantified impacts to surface water (lake, streams, springs and wetlands) quality and quantity due to lowering the groundwater potentiometric surface and from altered surface drainage;

5) impacts to water wells from groundwater potentiometric surface drawdown;

6) potential impacts to groundwater and surface water quality due to contaminant movement out of the mine and the mine waste disposal facility after closure; and

7) mitigation strategies for potentially impacted water wells, groundwater, and surface waters.

We will continue to work with Exxon toward resolving these issues by developing a comprehensive hydrogeological program.

Response:

Comment acknowledged.

Section 4.1.1.2 Ambient Air Quality

Comment No. 26

Page 4.1-2: The EIR states: "Since the estimated component air emissions rates for construction and operation sources are essentially equal, the results of the operation air quality impacts modeling are considered representative of impacts from construction." Though construction and operation emissions may be approximately equal, this does not mean the impact from these emissions will be equal. The emissions must be emitted in the same manner, over similar time intervals and from the same areas to have the same impact. However, during operation approximately 80 tons of particulate matter will be emitted from the concentrator building at heights ranging from 25 to 133 feet above the ground. Sixty of those tons will be emitted at 133 feet with an upward exit velocity of 20.8 m/s. By comparison, construction particulate emissions will be emitted near the ground. Since construction emissions will be released at ground level they will have greater impact closer to the facility than will operation emissions. Construction phase emissions may have less affect on air quality off Exxon's property. Please include a discussion of these differences.

Response:

We agree that construction air emissions will be emitted closer to the ground surface than operations emissions and that they will have less effect on air quality off our property. Further, construction activities will be of short duration as compared with emissions produced during the 20 year operations phase. That was one of the major reasons we performed air quality modeling for the operations activities. In our letter of January 24, 1984, submitted in response to DNR comments on the air permit application, revised estimates of Project air emissions were provided for the construction and operation phases. These estimates indicate a lower quantity of particulate emissions than what was previously provided. These revised estimates as well as conditions for the air quality modeling will be reviewed with the DNR to establish the basis for final air quality modeling.

Section 4.1.1.2 Ambient Air Quality

Comment No. 27

Tables 4.1-1, 2 and 3: Emissions are not estimated in Tables 4.1-1, 2, 3 for several air contaminant sources described or mentioned in the project description. Please include estimates for these sources:

1. Existing gravel access roads (page 1.3-3)

2. Temporary on-site diesel power generators (page 1.3-4)

3. Burning of stumps and brush during site clearing (pages 1.3-2, 1.3-5, and others)

4. Wind erosion from MWDF stockpiles (p. 1.3-13)

5. Screening and stacking plant to produce MWDF liner and underdrain materials (p. 1.3-15)

6. Primary crusher and related ore handling facilities during construction (p. 1.2-9)

7. Ore loading, hauling and dumping (p. 1.4-3)

8. Removal of rock from shaft during underground mine construction (p. 1.3-7)

Response:

Revised estimates, including all of the above sources, have been provided to the DNR in our letter of January 24, 1984 in response to comments on the air permit application. In particular, see responses B2, B3, A3, A4, E4, and C1 of the January 24, 1984 letter.

Section 4.1.2.2 Landscape

Comment No. 28

More discussion on the landscape changes caused by the MWDF are needed.

Response:

The total area disturbed for the MWDF and reclaim ponds will be approximately 248 ha (614 acres). As each tailing pond is developed, vegetation will be cleared for a distance of approximately 15 m (50 feet) from the toe of the outer embankments of each pond. No disturbance to the existing land forms or vegetation will occur outside this zone. When the grades of the embankments have been established, herbaceous plant species (grasses and legumes) will be planted to stabilize the soil surface. A fence will be erected around the perimeter of each pond and a road will be constructed between the toe of the embankments and the fence.

Detailed drawings of the MWDF and discussion of construction, including dimensions of the ponds, landscape disturbance and erosion control, are presented in EIR Chapter 1.0 and the Feasibility Report. The Reclamation Plan contains further documentation on the physical and vegetation aspects of reclamation of this facility during the construction phase. An assessment of the potential visual impacts of the MWDF in relation to the surrounding undisturbed environment and mitigative measures are presented in EIR subsection 4.2.9.2.

CHAPTER 4

Section 4.1.3.1 Groundwater Hydraulics

Comment No. 29

Figure 4.1-2: Percolation rates should be converted to volume measures.

Response:

The percolation rates on EIR Figure 4.1-2, "Project Facilities Schedule and Hydraulic Data" are only presented in millimeters per year (inches per year) since the area of each tailing or reclaim pond is different. However, EIR Table 4.2-5, "Projected Seepage Rate of MWDF," does present seepage rate data both as percolation rate per unit area and volume, m^3/s (gallons per minute).

Section 4.1.3.1 Groundwater Hydraulics

Comment No. 30

In the discussion on p. 4.1-8, it should be mentioned that wells in the area are also discharge points for local groundwater.

Response:

A statement will be added to subsection 4.1.3.1 (p. 4.1-8) of the revised EIR that wells in the site area are also discharge points for local ground water.

Section 4.1.3.2 Groundwater Quality

Comment No. 31

The redirection of groundwater flow which would occur during mine dewatering could result in water quality changes in nearby private water supplies. These changes could occur if the redirection causes wells to be down-gradient of contamination sources, such as septic systems or recharge areas with low pH water which may contain elevated levels of iron, manganese, and possibly hydrogen sulfide. In addition, there could be induced infiltration from groundwater discharge areas due to groundwater gradient reversal. These potential impacts on groundwater quality must be discussed in the EIR for both the drawdown of the groundwater potentiometric surface <u>and</u> its rebound following mine closure.

Response:

Computer simulations of the affected mining operations on the ground water regime have defined the extent of the cone of depression from mine dewatering. These simulations are described in Appendix 4.1A. A change in the direction of the gradient of ground water flow will occur in the immediate vicinity of the mine. This direction change is not predicted to affect the quality of private water supplies in this area. Properly designed septic systems within the affected area will discharge into the unsaturated zone which will not experience any flow reversal. Such discharges should be naturally purified before they reach the saturated zone. There are no other known sources of contamination such as those described, or discharge areas within the affected area, which might cause the effect hypothesized.

In areas outside the immediate vicinity of the mine, the gradients to discharge areas are not reversed, and therefore, there will not be induced infiltration from them. Furthermore, as stated in the EIR, we have committed to assure a reliable water supply to ground water users whose supply has been affected as a result of mining operations. The hydrogeologic system is projected to return to its pre-mining condition after mine closure.

Section 4.1.4.1.1 Surface Water Quantity - Streams

Comment No. 32

Since groundwater has different chemical and physical characteristics than surface runoff, any change in the proportion of groundwater and surface water going into a stream will result in changes in stream water quality. For example, during drought conditions, a loss of groundwater flow to a stream may increase stream temperatures and cause a possible reduction in available dissolved oxygen. Reduced groundwater flow into cold water streams could adversely affect cold water fisheries. Please discuss potential impacts to streams, especially Swamp Creek, due to the mine discharge.

Response:

The predicted base stream flow rate reduction to Swamp Creek is approximately 0.047 m^3/s (1.66 cubic feet per second) along segment BC for the unmitigated mine inflow case at year 33 of operation (see EIR Table 4.2-7A). This results in approximately a 4 percent reduction in the total average annual stream flow for the same period (see EIR Table 4.2-9). Water quality analyses for the Swamp Creek segment BC are shown in Table 2.3-10 of the EIR. The general quality classification of the stream is a moderately hard, neutral pH stream with an average dissolved oxygen content of approximately 9 mg/l. Water quality analyses from piezometers in the environmental study area indicate that the ground water is hard and has a neutral pH. Dissolved oxygen was not measured in the ground water samples. There are no predicted alterations to stream water chemistry from reduced stream flow as a result of mine dewatering. The percentage of stream flow reduction is small, and no measurable effects on stream water temperatures are expected.

We will reassess the mine dewatering impacts to streams following completion of the hydrogeology field and laboratory program.

Section 4.1.4.1.1 Surface Water Quantity - Streams

Comment No. 33

Increased flooding potential on the segment of Swamp Creek below the wastewater discharge should be discussed in this section.

Response:

The flood potential on Swamp Creek below the wastewater discharge is not increased as a result of the discharge. An outfall discharge of 0.126 m^3/s (2,000 gallons per minute) is less than 4 percent of the peak flood stream flow. Therefore, the outfall discharge will be less than 4 percent of peak flood flows on Swamp Creek.

Swamp Creek experiences peak flood flows as a result of thunderstorms and rain in combination with snowmelt and are most common in spring and early summer. The extensive lake and wetland areas associated with the Swamp Creek drainage basin further facilitate the storage of peak flows, thereby reducing the flood risk.

Flooding potential on the aquatic ecosystems downstream of the outfall is minor, consisting of a temporary water level increase from Swamp and Squaw creeks inflows. The hazard to human life and structures is negligible because the drainage areas are small, water level fluctuations are minor, and stream bank/wetlands storage is high.

Section 4.1.4.1.1 Surface Water Quantity - Streams

Comment No. 34

Estimates of impacts on stream water quality due to soil erosion from the various construction activities must be provided. Activities which could increase soil erosion include construction of tailings ponds, and reclaim ponds, slurry pipeline, haul road, mine-mill complex, access road, railroad spur, discharge pipeline, and topsoil stockpiling. Please provide soil sediment loading estimates for the impacted streams.

Response:

The Project erosion control plan presented in the Mining Permit Application will be used during construction and operation to minimize erosion potential and prevent any discernible increase in silt loading on affected streams and lakes. Large surface areas such as the mine/mill site will have surface water runoff patterns to the drainage basins. Other surface areas (i.e., access road, railroad) will have surface water drainage patterns through filter fabric (i.e., approximately 99% effective), which will ensure removal of residual sediment loadings. The areas where these and other erosion control procedures and facilities will be used are fully described in Appendix 2.1A of the Reclamation Plan submitted as part of the Mining Permit Application. Proper design and timely placement of these erosion control procedures and facilities should prevent any discernible increase in sediment loading to site area waters.

Section 4.1.4.1.1 Surface Water Quantity - Streams

Comment No. 35

The treatment system for the water discharge to Swamp Creek may be designed to meet WPDES permit limits; however, this does not guarantee that the system will always work as designed and that limits will always be met. Exxon must discuss potential impacts to Swamp Creek if the treatment system malfunctions. A reasonable range of possible malfunctions should be considered, with potential impacts on Swamp Creek flow rates and water chemistry calculated.

Response:

Water treatment system upsets could occur as a result of a number of conditions involving equipment malfunctions. The "worst-case" upset condition would be if the entire treatment system is off-line. As a result, it would not be possible to treat the wastewater. However, during partial or complete shutdown of the treatment system, water not meeting effluent limits would be held within the storage capacity of the treatment system (i.e., the treated water storage tank and the reclaim ponds), and/or the operating tailing pond. There is sufficient capacity above the normal operating level in the reclaim ponds alone to hold all anticipated discharge water for more than 40 days. This is based on using 75 percent of the total freeboard volume. Additional capacity is available in the operating tailing pond. Therefore, we do not anticipate upset conditions which would result in the need to discharge water not meeting WPDES permit limits.

To ensure that water is not discharged which does not meet WPDES limits, an automated monitoring system will be used to continuously monitor pH, turbidity and conductivity of the treated effluent and the uncontaminated mine water. In addition, chemical analyses of samples will be performed routinely for other critical constituents. The frequency and type of the chemical analyses and the exact constituents analyzed will be reviewed with the DNR Industrial Wastewater Section, Bureau of Wastewater Management, in conjunction with the development of the WPDES permit for this discharge. This monitoring system combined with sufficient storage capacity for any short-term upset will ensure that water is not discharged which would impair the integrity of Swamp Creek.

Subsection 4.1.4.1.1 Surface Water Quantity, Streams

Comment No. 36

Duration of the possible malfunctions should be identified, and a scenario based on low flow conditions should be calculated.

Response:

This information was previously provided in response to comment No. 169 of the DNR's Mining Permit Application letter of October 10, 1983.

Section 4.1.4.1.2 Lakes

Comment No. 37

P4.1-15: The impacts of stormwater runoff on surface water quality during both the construction and operation phases should be discussed in the EIR. Siltation could have significant impacts on aquatic habitat and water quality. Please provide quantitative estimates of siltation into lakes during construction.

Response:

See response to comment No. 34.

Section 4.1.4.1.4 Wetlands

Comment No. 38

Figures 4.1-13 through 4.1-19: The hydrologic connections between Wetlands F-57 and F-60, and F-64 and F-65 should be indicated. Were they disconnected because of road placement? (There are also roads between F-23 and F-25 and F-17, yet these connections were shown.) Waterflow networks of all affected wetlands should be shown.

Response:

The hydrological connections between wetlands F57 and F60, and F64 and F65 will be indicated on Figures 4.1-16 through 4.1-19 in the revised EIR. These connections were inadvertently omitted in the original EIR. Water flow networks will be shown on Figures 4.1-13 through 4.1-19 for all wetlands that could be affected during construction of Project facilities.

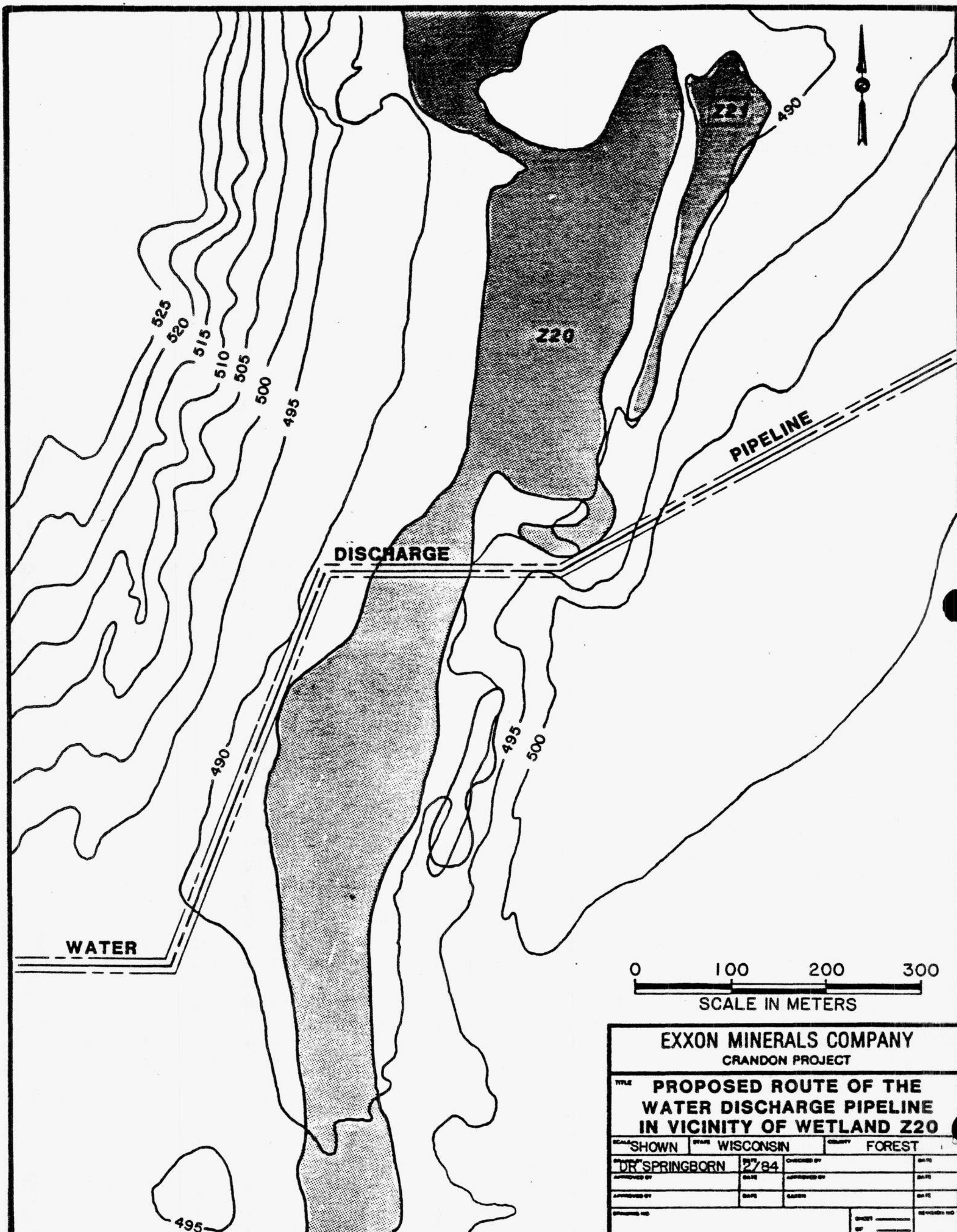
Section 4.1.4.1.4 Wetlands

Comment No. 39

Figure 4.1-13: The discharge pipeline crosses the drainage outlet of Wetland Z-20. The possible effects to this wetland and its outlet from the pipeline construction should be addressed.

Response:

The water discharge pipeline will be aligned to minimize impacts to wetland Z20. As shown in the attached figure, the pipeline will be routed so that wetland Z20 is crossed at a narrow point. During construction and installation of the pipeline, less than 0.03 ha (0.09 acre) of wetland Z20 will be affected. To ensure there are no long-term adverse impacts on the hydrologic characteristics of this wetland, as well as other wetlands that may be disturbed during construction of the pipeline, the trench will be backfilled with free draining granular fill materials and the organic soils originally removed during excavation. These materials will allow maintenance of existing surface and subsurface flow conditions through the wetland and there will be no long-term effects on the hydrology of the wetland or its outlet.



(Figure for Response to Comment No. 39)

Vegetation will be lost in the area disturbed during construction of the pipeline through wetland Z20. However, vegetation will be reestablished in the zone of disturbance following the construction period. Until vegetation becomes established a slight increase in the sediment load may occur in surface water flowing through the wetland. However, any increase in sediment load would be of short duration and may not occur because surface flow through wetland Z20 to wetland Z17 is intermittent. In summary, the effect of pipeline construction on wetland Z20 will be short-term and reversible and no long-term effects on the hydrologic and biological functions are expected.

Section 4.1.4.1.4 Wetlands

Comment No. 40

Figures 4.1-15: The wetlands along the east 1/4 of Alternate C should also be shaded. The osprey nest location is in error. It is further south - the correct location has previously been given to Exxon.

Response:

In Figure 4.1-15 of the revised EIR wetlands will be shaded along the east one-quarter of Alternative C for the railroad spur. The location of the osprey nest on Figure 4.1-15 will be designated at the correct site.

Section 4.1.4.1.4 Wetlands

Comment No. 41

Page 4-1-20: Standard construction methods for wetlands will be used..." What are these standard methods? In order to know what the impacts to adjacent wetlands will be, these construction activities (e.g., dredging, diversions, sediment pond construction and discharge, soil disposal, erosion potential, stockpiling, etc.) must be identified and the potential impacts to wetland hydrology specified. Even if these impacts are "short term and localized" (p. 4.1-21) they must be identified.

Response:

The various techniques or methods to be used for minimizing impacts to surrounding areas from construction in wetlands have been discussed in Section 1.3 of the EIR (e.g., see subsections 1.3.1.3, 1.3.1.7 and 1.3.1.9). Also, wetland construction techniques for use during installation of the water discharge pipeline are discussed in the EMC response to comment No. 163 in the May 11, 1983 DNR letter. We have not chosen specific construction methodology on a wetland by wetland basis. The specific construction methods for use in wetland areas will be determined during final engineering and these may be subject to field modification as differing conditions require.

For the MWDF, control of the surface water runoff in each area of construction has been planned on a phase-by-phase basis to minimize wetland impacts (see EIR Figures 1.3.3 through 1.3.8). Some method of siltation control (sediment pond, straw bale, or filter fabric trap) has been included for each surface drainage area. In the MWDF, all of the wetlands are perched above the main ground water aquifer, and most are connected through surface water drainage. As the MWDF is developed, wetland soil material removal will normally begin at the most up-gradient wetland or portion of a wetland and proceed down-gradient through the wetland's watershed. This construction sequence will keep surface water runoff through newly graded areas to a minimum thereby reducing the potential for siltation.

No wetlands are located within the limits of the mine/mill site. However, to eliminate the potential for siltation to nearby wetlands and lakes by surface water runoff from the mine/mill site, all mine/mill site drainage will be controlled by drainage basins. The drainage basins planned as part of the permanent mine/mill site facilities will be constructed early in the development sequence to provide the primary means of protection from siltation.

The remainder of the erosion control facilities are located within corridors for the access road, railroad spur, haul road/tailings transport system, and water discharge line. For the corridors, entire wetlands are not removed. Generally, the corridor crosses the wetland and a culvert or other means of maintaining wetland water drainage through the corridor is provided. The wetland soil materials are removed and replaced with select materials in the area of the corridor. The initial procedure will be to provide a temporary diversion ditch or channel to allow the wetland water flow to continue while the wetland soil is being removed and the culvert installed. The temporary erosion control measures (e.g., straw bales, filter fabric silt traps, siltation ponds) will be employed on a wetland-by-wetland basis as necessary. The detailed design and location for these temporary control measures will be developed during final engineering for the various corridors. However, these types of temporary control measures will also be subject to final adjustment in the field to accommodate actual conditions.

Construction within the water discharge corridor is slightly different than in the other corridors because no roadways or embankments are included and once the pipe is installed, drainage across or along the route will be allowed to return to initial conditions. The EMC response to comment No. 163 in the DNR's May 11, 1983 comment letter provides additional detail on wetland construction techniques for this pipeline system.

Section 4.1.4.1.4   Wetlands

Comment No. 42

Tables 4.1-16 and 4.1-17: Wetland #F-23 is incorrectly numbered. In the Normandeau Study, the correct number of the wetland is F-32.

Response:

Comment acknowledged and wetland F32 northeast of Duck Lake will be correctly numbered on Figures 4.1-16 and 4.1-17 in the revised EIR.

Section 4.1.4.1.4 Wetlands

Comment No. 43

Throughout the life of this project, erosion control "catch basins" will be constructed to trap soil particles and slowly release storm waters. Will the discharge be to wetlands adjacent to local surface water bodies? The discharges could result in physical and chemical changes within the wetlands. There needs to be further discussion on the impacts of siltation and runoff water quantity and quality on adjacent wetlands and surface waters.

Response:

As described in the response to comment No. 9, two surface drainage basins will be maintained and operated in the mine/mill site throughout the construction and operational life of the Project to collect, retain and release uncontaminated surface waters. Detailed characteristics of these basins are given in the figures included with the response to comment No. 9. Water from drainage basin No. 1 will be indirectly discharged to wetland F11, a coniferous swamp located between Skunk Lake and Little Sand Lake. Surface water from wetland F11 flows into wetland F10, also a coniferous swamp, associated with Little Sand Lake. Water that is discharged from surface drainage basin No. 2 will enter wetland P2, a coniferous swamp, and then flow northward to Swamp Creek.

Uncontaminated water from the mine/mill site will be collected and discharged from these drainage basins. Separate basins and transport facilities are provided in the mine/mill site to collect and transfer for treatment any surface waters that have potential to be contaminated from mining operations (e.g., surface drainage basin No. 3 will collect water from the preproduction ore storage area and from there it will be pumped to the water treatment facility).

Under average meteorological conditions, the quantity of water to be discharged from drainage basins No. 1 and 2 is estimated to be low if any. The basins are designed to contain a 25-year, 24-hour storm event using a runoff coefficient of 0.75. Only during prolonged periods of rainfall or unusual storm events would a major amount of water be discharged from these basins. During most months of the year, water collected in the basins will be retained and will either evaporate or seep from the basins.

During the 4-year construction phase of the mine/mill facilities when disturbed areas have not been completely stabilized with vegetation, suspended solids levels will be higher in surface water collected in the basins than during the operational phase when the disturbed areas have been stabilized and landscaped. Water discharged from the basins during the construction period may contain an elevated suspended solids level; however, the ponds are designed so that most suspended particles will settle prior to discharge. Only minor increases in sedimentation are expected during the construction period in the wetlands receiving discharge water, and no long-term adverse effects on the functions of these wetlands are projected. One of the major functions of wetlands is the removal of suspended sediment from water moving through them. A decrease in water velocity and the presence of vegetation in these wetlands will promote settling of suspended particles; therefore, no increase in suspended solids concentrations is expected in the surface water bodies (Little Sand Lake and Swamp Creek) ultimately receiving discharge from wetlands W10 and P2.

Other water quality characteristics of water collected from the mine/mill site and discharged via the drainage basins should be similar to existing surface water runoff in the site area. Therefore, no adverse effect on water quality in the wetlands receiving discharge water is projected to occur.

Section 4.1.5.2 Aquatic Biota

Comment No. 44

Table 4.1-14: Is the fish "brook silverside" correct or was "brook stickleback" intended? Are the capture locations known and voucher specimens available for verification?

Response:

The fish listed as brook silverside in Table 4.1-14 is incorrect and should be brook stickleback. Table 4.1-14 will be corrected in the revised EIR. The sensitivity of brook stickleback to turbidity and sedimentation is "intermediate" and will be presented accordingly in revised Table 4.1-14.

Section 4.1.6.1.2 Wetland Communities

Comment No. 45

Page 4.1-33: Pipeline placements do not necessarily "remove" acreage from wetlands (such as Z-20) if the buried pipeline does not involve wetland fill, and the corridor is allowed to revegetate as proposed.

Response:

Comment acknowledged. None of the wetland areas crossed during construction of the water discharge pipeline will be permanently removed. No wetlands will be filled and wetland as well as upland areas will be allowed to revegetate after construction activities have been completed. Subsection 4.1.6.1.2 will be revised to indicate that no removal of wetland acreage will occur during construction of the water discharge pipeline.

Section 4.1.6.1.2 Wetland Communities

Comment No. 46

Table 4.1-19: A 200 foot corridor width was used by Exxon to calculate wetland loss; figures should be revised using a width of 100 feet. Transmission lines and pipelines, for example, while constructed through wetlands, would not result in complete loss of those wetlands.

Response:

In the revised EIR, calculations of potential wetland impacts during construction will be revised based on a corridor width of 30 m (100 feet) for the access road/transmission line and 40 m (131 feet) for the haul road/tailings pipeline. The projected wetland losses presented in EIR Table 4.1-19 are based on a worst-case analysis using a corridor width of 60 m (200 feet) for both of these facilities. The analysis of potential wetland impacts associated with the water discharge pipeline will not change and will be based on a corridor width of 15 m (50 feet) even though the actual disturbed area in most segments of the corridor will be considerably less than this width. We acknowledge the fact that during construction a complete loss of wetlands will not occur in the corridors designated for transmission lines and pipelines.

Section 4.1.9.1.4 Residential

Comment No. 47

Exxon should indicate the number of summer cottages purchased (Little Sand Lake and others, if any) and discuss their eventual use.

Response:

Exxon Minerals Company currently owns 22 homes in the area of Little Sand Lake. These homes are in varying stages of construction and completeness, with approximately twelve being available for use on a year-round basis if properly renovated. Eventually, those homes which can be converted to year-round use will be available to the local housing stock on a lease basis. The remaining homes could possibly be utilized on a seasonal basis if justified by demand.

Section 4.2.1.1 Local Meteorology and Air Quality

4.2.1.1 Local Meteorology

Comment No. 48:

The EIR states: "Under some conditions the mine exhaust ventilation shafts will cause water vapor plumes." Additional information is needed on when water vapor plumes will be formed, their frequency, magnitude, and likely consequences.

Response:

The air physics experienced in mine exhaust shafts are similar to those for an ideal gas, as presented by the equation $PV = nRT$; where P = pressure, V = volume, n = weight of air in pounds (lbs), R = universal gas constant (i.e., 53.3), and T = temperature. In this equation the decrease in pressure and the increase in volume cause a decrease in temperature (i.e., 2°F per 1,000 ft rise); therefore, supersaturation occurs and water droplets form. These droplets begin to fall as they combine with other droplets. Some of the condensed moisture contacts the shaft walls as it falls and some is deposited at the shaft bottom or re-evaporated and distributed with the air as it rises in the exhaust shaft.

In the mine exhaust shafts only the smallest droplets remain in the air stream and eventually are discharged from the shaft. Once outside the shafts, the contained moisture will condense further (i.e., cold conditions) and deposit rapidly or evaporate (i.e., warm conditions). In general, these water vapor plumes will be visible when the atmospheric air temperature is at or below dew point temperature. This will mainly occur between late autumn and early spring. Water vapor plumes will be most prevalent in magnitude and frequency during the winter. There are no consequences except visibility of the water vapor plumes.

Comment No. 49:

Page 4.2-2 (Second paragraph): The EIR states that air quality constituent concentrations are expected to be below primary and secondary federal and state ambient air quality standards at the project boundary. However, the EIR does not identify the contribution to emissions by the handling, storage, and use of processing reagents. Please include such a discussion.

Response:

Current engineering design indicates no emissions from handling, storage and use of processing reagents will be vented to the atmosphere. As a result, they will not be an added source for atmospheric contributions and air quality constituent concentrations are expected to remain below primary and secondary federal and state ambient air quality standards. See also response to comment No. D6 of the air permit application letter submitted to the DNR on January 24, 1984.

Comment No. 50:

Table 4.1-1: Please revise or explain the total emission figures because they are not equal to the sum of the components.

Response:

Table 4.1-1 of the EIR presents the estimated air emissions per unit activity and for the annual usage. Many of the activities only occur periodically during the year and the annual estimate is not simply a summation of a daily estimate. For example, the daily estimate for blasting in Table 4.1-1 is 141.1 kg/d (311.1 pounds per day). However, these blasts do not occur every day. Therefore, the daily estimate cannot simply be multiplied by 365 to obtain the annual rate. Consequently, the total emission figures will not be equal to the sum of the components.

Revised estimates of emissions have been provided to the DNR in the air permit letter of January 24, 1984. Table 4.1-1 will also be revised in the EIR to be consistent with these estimates.

Comment No. 51:

Table 4.2-2: This table should include air emissions from the burnt pebble lime facility (p. 1.4-45).

Response:

There are no atmospheric air emissions from the lime facility.

Comment No. 52:

Table 4.2-4: This table should include SO_2 emissions from the SO_2 scrubber tower (Fig. 1.4-13).

Response:

Current engineering design has eliminated the SO_2 scrubber tower.

Section 4.2.1.1. Local Meteorology

Comment No. 53

Page 4.2-3 (Second paragraph): The EIR indicates that the control of 95% of dust emissions in the mine by gravity settling and the humid conditions has been documented. The reference should be provided.

Response:

The documented control efficiency addressed in the EIR is presented in AP-42, Appendix A, Table A-2 for a spray tower which has an overall control efficiency of approximately 95 percent. A complete discussion of the air physics present in the exhaust shafts resulting from humid mine conditions is presented in our letter of January 24, 1984 in response to DNR comments on our air permit application (see response to comment No. C1). In addition, a revised estimate of mine air emissions is presented in the response to comment No. C1 in which detailed calculations were performed for each mine TSP emission source and the path of air movement through the mine. Gravity settling conditions and calculations for revised TSP emissions were also included in the January 24, 1984 letter.

Section 4.2.3.2 Groundwater Quality

Comment No. 54

The data presented does not indicate whether the concentration gradients from the tailings ponds decrease in the future. The implication is that the concentration gradients will increase continuously such that concentration gradients at the top of the stratified drift and perhaps at the compliance boundary may exceed groundwater standards. There should be some explanation that the MWDF seepage quantity or quality will correct itself in the future.

Response:

The projected composition of the leachate in the tailing ponds underdrain system before seepage through the bentonite modified soil liner is presented in EIR Table 4.2-6, "Projected MWDF Tailings Pond Seepage Chemistry." The quality of this leachate improves after reclamation as depicted in this same table. The volume of the seepage per pond is presented in EIR Table 4.2-5, "Projected Seepage Rate of MWDF," and it also varies slightly with time.

This water quality and quantity information was used to calculate the normalized concentration (initial concentration = 1.0) of chemical constituents at the top of the water table, 15 m (49 feet) below the bottom of the pond in the glacial till. For those few chemical constituents assumed not to be totally chemically attenuated by the 15 m (49 feet) of partially-saturated till, such as sulfate and TDS, their concentration at the top of the water table immediately beneath the MWDF eventually (i.e., 200+ years) attains initial seepage concentrations (see EIR Figures 4.2-5, "Normalized Concentration at Different Depths for Various Times in Partially-Saturated Till," and A33, "Normalized Concentration at Top of Water Table for Various Times in Partially-Saturated Till)."

For the normalized concentrations of those chemical constitutents assumed as not totally chemically attenuated to attain initial seepage concentrations at the top of the stratified drift, typically an additional 20 m (66 feet) of saturated till, requires approximately 1,000 years assuming the seepage water quality remains unchanged. Therefore, the water quality directly beneath the MWDF at that time, 1,000+ years, would meet present federal and state drinking water standards, except for sulfate and TDS. The ground water quality at the compliance boundary will also meet drinking water standards for sulfate and TDS even if the initial seepage water quality and quantity continue indefinitely, which they will not. The modeling results to support this statement are presented in Attachment A.6, "Long-Term Ground Water Quality Analysis Adjacent to MWDF," Appendix 4.1A, EIR Volume VIII.

Section 4.2.4 Surface Water

Comment No. 55

Table 4.2-7A: The discrepancy between the reported difference in flow cfs for Rolling Stone Lake and lower portion of Pickerel Creek for Project Year 33 (reported as -0.04) versus the same value reported in Table 4.1-7 (reported as -0.35 cfs) should be explained.

Response:

The value shown for the Project Year 33 difference in the Pickerel Creek flow rate should be -0.04 cfs in Table 4.1-7. The value of -0.35 cfs shown is a typographical error and will be corrected in the revised EIR.

Section 4.2.4 Surface Water

Comment No. 56

Page 4.2-13 (Last Paragraph): Effects on the portion of Pickerel Creek above Rolling Stone Lake should also be summarized in this section.

Response:

The description of the effects of mine operations on Pickerel Creek summarized in the last paragraph on page 4.2-13 is for the entire length of Pickerel Creek, including the segment above Rolling Stone Lake. This segment is shown as DEF on Tables 4.2-7A, -7B, -8, and -9. The segment above Rolling Stone Lake is segment DE on these same tables and the segment below Rolling Stone Lake is EF.

Section 4.2.4.2 Surface Water Quality

Comment No. 57

Sources other than seepage from the MWDF must be considered in evaluating impacts to surface water quality. Additional factors include chemical and physical changes in Swamp Creek due to the wastewater inputs, reduced flows, altered temperatures in streams, and increased siltation.

Response:

The exact chemical and physical changes in Swamp Creek resulting from discharge of excess water will vary with stream flow, and discharge water characteristics. However, the water quality limits which will be imposed on the discharge by the DNR Bureau of Wastewater Management through the WPDES permit will ensure protection of existing stream uses. The limits imposed will be based on water quality standards being developed by the DNR to provide for the protection and propagation of fish and aquatic life. Therefore, the existing stream uses will not be changed or impaired by the proposed discharge.

For example, the effect on water quality will be primarily an increase in total dissolved solids (TDS). However, this is not expected to result in any predictable change in the aquatic ecosystem. The greatest increase in TDS is expected to occur during low stream flow conditions. Average TDS in Swamp Creek as measured during the 1982-1983 aquatic monitoring period* is 128 mg/l.

Under conservative assumptions of discharge flow rate and quality combined with low stream flow conditions the concentration of TDS in Swamp Creek at the discharge site would be approximately 330 mg/l which can be tolerated by the existing aquatic life.

Changes, if any, in Swamp Creek flow from ground water drawdown will be minor. As shown in EIR Appendix 4.1A, Table A-20, the projected percent reduction of Swamp Creek flow above Rice Lake is less than 3 percent, assuming a conservative mine inflow of 0.13 m^3/s (2,000 gallons per minute). This small stream flow reduction is well within the normal fluctuations in stream flow and should have no impact on aquatic life.

Upstream of the proposed water discharge site the stream flow rate varied during the 1982-1983 monitoring period from 15 to 120 cfs with an average 47 cfs (USGS gaging station at County Trunk Highway M). The proposed discharge of 0.13 m^3/s (2,000 gallons per minute) represents less than a 10 percent increase in the average flow rate which is within the range of normal stream flow rate variations and would not result in any detrimental physical effect on the stream environment.

The Project will be adding little if any heat load to the mine water or uncontaminated ground water which represents the only water proposed for normal discharge. This should result in a relatively uniform discharge temperature assumed to be approximately 9°C which will result in slightly

*Ecological Analysts final report, "Water and Sediment Chemistry and Hydrology in Swamp Creek for the Crandon Project," July 1983.

cooler stream temperatures during warmer months and warmer temperatures during the cooler months. The existing annual temperature range at the proposed discharge site is 0°-23.5°C. The proposed discharge temperature is near the mean of this range and should not result in any changes to aquatic life.

The proposed discharge will not cause a buildup of silt in Swamp Creek. The discharge water will be clarified and filtered as needed to remove suspended solids. The maximum effluent concentration is expected to be less than 30 mg/l and the average less than 20 mg/l total suspended solids. In actual operation, the TSS of the discharge should be comparable to pre-operational stream conditions.

Section 4.3.1 Meteorology and Air Quality

Comment No. 58:

The EIR should discuss fugitive dust and vehicle emissions which will occur during site decommissioning (removal of facilities), landscaping and other reclamation activities.

Response:

Estimates of the air emissions resulting from site decommissioning have been provided to the DNR in the air permit application letter of January 24, 1984 (see response to comment No. 17). The EIR will be revised to include this information.

Section 4.3.3 Ground Water

Comment No. 59

The EIR states that when the groundwater potentiometric surface has returned to its preconstruction level, the effects due to lowering the potentiometric surface on local users of groundwater will no longer exist. This statement discounts the potential impacts due to: 1) the possibility of dewatered aquifer subsidence; 2) the potential chemical (e.g. oxidation-reduction potentials) and physical (e.g. permeability) alteration of aquifer materials caused by the dewatering operations (28 yrs.) and time required for groundwater potentiometric surface to return to normal (total of 64 years); 3) altered bedrock-overburden flow gradients due to the abandoned underground mine; and 4) the altered surface recharge because of the mine waste disposal facility. Exxon must consider these four factors in their groundwater analysis for the period after closure.

Response:

1) Aquifer subsidence -- The glacial soil materials that form the overburden including the aquifer have been preconsolidated by the pressure and movement associated with the glaciers' occurrence. Because of this preconsolidation the soil materials should not undergo further compression and consolidation. Therefore, removal of water from them should not result in any measurable subsidence of the land surface.

2) Physical and chemical reactions -- The exposure of the glacial aquifer soil materials to partially unsaturated conditions during mine operations will be relatively short. The dewatering during operations will expose the aquifer soil materials to partially unsaturated conditions for about 28 years; however, the water level in the aquifer is predicted to return to about 90 percent of its original level in approximately 3 years. Reduction and oxidation processes in geologic materials generally require hundreds or thousands of years to occur to the point of measurability.

3) Altered bedrock-overburden flow gradients -- After closure of the mine it is projected that the ground water flow regime will return to its premining condition. The premining bedrock-overburden flow regime does not exhibit strong gradients within the mine area and mining operations are not expected to alter the overburden-bedrock interface. Therefore, it is reasonable to assume that once the mine is closed and the mine has resaturated that the premining flow regime will be re-established.

4) Altered recharge distribution in the MWDF -- Placement of a relatively impermeable reclamation cover over the tailing ponds will have the effect of reducing surface water recharge to the ground water under the ponds. There will be some water recharge from pond seepage, but the amount will be far less than the average annual precipitation recharge. Precipitation falling on the reclamation cover will be subject to evapotranspiration, surface drainage, and drainage layer runoff. This surface drainage and runoff will be reintroduced into the hydrologic regime at the perimeter of the tailing ponds where it will evaporate, be transpired and/or infiltrate into the subsoil to recharge the ground water. This infiltration process will occur as the water spreads over the ground and will result in a higher than ambient ground water recharge in the area around the ponds. This higher recharge value has been calculated and included in the hydrologic impact modeling results presented in Appendix 4.1A of the EIR.

Section 4.4.1.7 Groundwater Discharge

Comment No. 60

Groundwater Discharge - The discussion of the three alternative locations for groundwater discharge of excess treated water must be expanded to include potential impacts to groundwater quality and hydrology.

Response:

As stated in EIR subsection 4.4.1.7, four sites were evaluated as potential locations for seepage lagoons (i.e., discharge of excess water to ground water). Of these four sites only two had subsoil materials with permeabilities high enough to be practical locations for seepage lagoon construction. During the operational period of these lagoons, the glacial soil material beneath them would become saturated and a ground water mound would form. In Area 3 (see EIR Figure 4.4-3) a ground water recharge mound would tend to mitigate the effect of mine dewatering on the hydrogeologic regime. A lagoon in Area 2 would alter the configuration of the ground water potentiometric surface below and immediately surrounding the pond, but would not have any detrimental effect on the hydrogeologic regime. In all cases the water in the lagoons for infiltration would be of the quality required to meet appropriate discharge permit standards and would also have to meet ground water quality standards at the compliance boundary.

Section 4.4.2.3 Tailings Disposal Methods

Comment No. 61

The EIR does not identify the major potential impacts associated with alternative subaerial and dry tailings disposal methods. Potential impacts could occur during construction, operations and reclamation. Please provide a discussion of the major potential impacts to air quality, groundwater quality, surface waters and wetlands that the alternatives could create.

Response:

Subaerial Disposal Method

Potential impacts which could occur during the construction, operation and reclamation phases of the Project as a result of tailings disposal by the subaerial method are generally similar but on a somewhat reduced scale to those associated with the proposed wet method. Although most of these reduced activities would indicate fewer environmental effects, application of the subaerial technology has been limited in a climatic region such as northeastern Wisconsin. Because of that, there is a much higher uncertainty associated with the performance of this system.

The major features of the subaerial method are primarily related to water removal from the tailings. Similar features will be incorporated in the proposed subaqueous (wet) method to the extent that they are possible. The underdrain is the main feature in this respect.

One of the most significant differences between the subaerial method and the proposed wet system is the method of deposition of the tailings. In the subaerial method, the tailings are deposited in thin layers (4 inches) and are allowed to partially dry before another layer is deposited. Partial drying causes the formation of a dense layer of tailings. In this manner, an overall higher density of tailings may be achieved.

The operation of this process requires that two deposition areas be available at any one time for the alternating flooding and drying process. This requires that the entire subaerial facility be constructed and operated for most of the mine life. The impacts of this method relative to the proposed wet method are expected to be as follows:

1) Wetlands

Overall, wetlands impacts are expected to be about the same. Although the proposed facility has a bigger size (202 ha [499 acres]), its development is phased, allowing material stockpiles and construction work areas to be located within the confines of the facility. While the subaerial facility is smaller (150 ha [276 acres]), it must be operated in a fully developed or completed configuration, meaning reclamation material stockpiles, borrow areas, work areas and other construction support areas must be located outside the confines of the subaerial facility. When these factors are taken into account, the total area impacted (either by the facility or to support its construction) is approximately the same (220 ha [543 acres]). However, the impacts at any one time for the subaerial facility will be slightly higher because the phased nature of the proposed system will require only approximately 40 ha (100 acres) to be in operation at any one time.

2) Surface Water

Potential surface water impacts from development of the subaerial disposal system should be similar to those associated with the proposed wet system. Erosion control measures, similar to those described in EIR subsection 1.3.1.7 for the proposed wet system, also would be applied for the subaerial method. These erosion control measures would control surface water runoff from the active construction and operation area and would ensure that surface water quality outside the confines of the facility would not be adversely affected.

When reclamation is complete, the subaerial disposal facility should have a reduced effect to surrounding surface waters because of its projected smaller overall size in contrast to the proposed wet facility. The reclamation system for the proposed facility, including the seal and the surface water management work in the 366-m (1200-foot) perimeter area, will minimize the potential for impacts to surface water bodies. However, because it does encompass a larger area than the subaerial facility, there would be a greater potential for impacts since the reclamation seal and work in the 366-m (1200-foot) zone would be comparable for either facility.

3) Ground Water

Overall, the impacts to ground water should be lower for the subaerial method due to the lesser area involved. However, during the operating life they may be equal or higher because of the greater active area involved with the subaerial system. (The unit seepage rate - gpm/ft^2 for the two systems should be the same because the liner/underdrain systems are the same).

4) Air Quality - Construction/Reclamation

Emissions will be generated from the excavation and deployment of soil materials and the associated construction equipment activity at the MWDF. Potential impacts associated with the subaerial method are expected to be less than the proposed wet system because of the lesser earthwork associated with MWDF construction and the shorter time and fewer pieces of equipment required to develop the facility. The proposed facility has an estimated total excavation of approximately 13 M m^3 (17 million cubic yards), while the subaerial facility is estimated at approximately 5 M m^3 (6.6 million cubic yards).

5) Air Quality - Operation

Because of the need to alternately flood and partially dry the subaerial deposit, wind blown air emissions may be higher with the subaerial system. The exact amount will depend upon the nature of the deposited tailings, the area exposed, the efficiency of dust control measures, and the wind velocity and direction. In any event, the area of exposed tailings will be greater for the subaerial system because of the phased reclamation of the proposed system.

Because of the similarities in design between the two systems (i.e., underdrain), the proposed system may achieve higher than projected densities. In that case, the ultimate facility size may be reduced. Conversely, if the subaerial facility did not fully achieve the tailings density increases and other expected benefits, then its final stage of development would be increased in size. As a result, the expected differences between the environmental impacts associated with the two systems could be much less than indicated above.

The greatest drawback to the subaerial system is uncertainty about its ability to perform in northern Wisconsin where precipitation exceeds evaporation and long periods of below-freezing temperatures are experienced. Additional operating experience is necessary to confirm the projected performance of this system which is now based on laboratory and engineering studies.

Dry Disposal Alternatives

The differences in concept between the dry disposal alternatives (cut and cover and landfill) and the proposed wet method are much greater. The technology to dewater the tailings is the most questionable element of the dry disposal concept. The cost and performance unknowns for such a critical element as the dewatering step preclude a commitment to the dry disposal method at this time. In addition, the physical properties of the dewatered tailings are not sufficiently well known to assure that either of the conceptual designs (cut and cover or the landfill system) will work.

Knowing this, it is possible to comment on the potential impacts as follows:

1) Cut and Cover Method

It is estimated that the cut and cover method would require a total excavation of approximately 16 M m^3 (21.0 million cubic yards). This is approximately 3 M m^3 (3.9 million cubic yards) greater than the proposed wet method. Earth moving equipment usage would be much less, consisting of a dragline and a dozer for grading the covered tailings. This equipment would, however, operate continuously throughout the life of the mine as compared with the periodic pond construction of the proposed wet method. Reclamation for the cut and cover system would be ongoing and would finally be completed in a much shorter time.

A comparison of the potential impacts is as follows:

a) Wetlands

Overall, the wetlands impacts are expected to be equivalent or somewhat greater due to the aerial extent of the cut and cover operation compared to the proposed wet method area requirement of approximately 202 ha (499 acres). However, if the angle of the repose of the filtered tailings is less than that predicted in the analysis, the cut and cover operation could require more land area.

b) Surface Water

If the cut and cover alternative worked as proposed, there would be little change in existing surface water quality. Infiltration and ground water recharge, which presently occur throughout the area, would continue during operation and reclamation of the facility through the windows between the disposal trenches. The relatively low surface runoff now occurring in the area could be accomplished with the final detailed reclamation grading plans. There would be flexibility in the layout and grading of the trench and tailings cover layer to achieve a desired balance of runoff versus infiltration.

c) Ground Water

In the cut and cover method, ground water protection depends upon the impermeability of the tailings mass and the angle of repose to prevent infiltration of precipitation through the tailings. The method of construction does not permit the installation of a liner or a top cover. Our most recent studies have indicated that the top cover is most important in the prevention of infiltration. Ground water impacts will probably be greater without the positive control afforded by the liner and top cover systems.

d) Air Quality

Emissions generated from the deployment of soil materials and the associated construction activities are expected to be greater, but less intense than the proposed wet method, due to the large amount of earth work performed continuously over the life of the mine. Windblown emissions from the tailings themselves are expected to be less due to the short time before reclamation.

2) Landfill Method

In the landfill method, a total excavation of approximately 8 M m^3 (10.5 million cubic yards) is required. This is substantially less than the 13 M m^3 (17.0 million cubic yards) required by the proposed system. As in the cut and cover method, equipment usage is continuous throughout the life of the mine but at a lower level of utilization than the proposed wet method. Reclamation would also be ongoing and would be completed sooner than the proposed method.

A major uncertainty associated with the landfill method, in addition to the dewatering process, is the physical characteristics of the dewatered tailings. For this method to be successful, the tailings must be workable by means of earth moving equipment. The filtered tailings should be able to withstand equipment bearing pressures, be not excessively plastic, nor sticky and difficult to move. It will be necessary to work the tailings during periods of heavy rain, snow and freezing temperatures. This lack of confidence in a knowledge of the workability of the dewatered tailings is a serious impediment to the application of this method.

As in the case of the cut and cover method, it is possible to discuss the potential impacts of this method as follows:

a) Wetlands

Overall, the wetlands impacts are expected to be equivalent or somewhat less than the proposed system due to the lesser amount of earth work estimated to be required. This, of course, depends greatly on the strength and flow properties of the filtered tailings. If the tailings are strong and non-plastic, then they can be stacked higher and thus occupy less area. The reverse is, of course, also true. If the tailings are weak and plastic, then the land requirements will be substantially greater.

b) Surface Water

A reclamation seal would be employed for the landfill method which would have the same "umbrella effect" as for the proposed wet facility or the subaerial facility. The ultimate size of the facility would depend upon the success of the tailings dewatering and handling steps. Assuming favorable results, the landfill dry disposal facility would be smaller than the proposed facility and the potential for surface water impacts would be reduced.

c) Ground Water

The landfill method lends itself to the installation of both a liner/underdrain system and a top cover/overdrain system. These systems, in combination with the reduced area requirements, theoretically provide the maximum ground water protection. Thus, ground water impacts with a successful landfill-type dry disposal system should be the least.

d) Air Quality

Total air emissions from the landfill method are also expected to be less than that from the proposed wet method. This conclusion results from the lesser amount of earth work estimated to be required and the rapid reclamation of exposed tailings.

The landfill-type dry disposal method has a number of conceptual advantages that make it appear to be environmentally highly desirable. When equipped with liner and top seal systems, it offers theoretically the maximum ground water protection. However, it has the most risk of all of the methods that we have studied. The costs and the effectiveness of the technology related to the filtering of the tailings are highly uncertain. Likewise, the strength and flow properties of the dewatered tailings remain largely unknown. When taking into consideration the climatic conditions under which the system must successfully operate, and the potential for liquefaction and flow of the tailings under load, the possibility of environmental impacts is many times greater than those that might be attributed to the proposed wet method. It is the potential severity of environmental impact and the uncertainty associated with the successful operation of the dry disposal system that rules out its application.

Section 4.4.2.6 Surface Water Discharge

Comment No. 62

The data from the pump test discharge to Duck Lake indicate more impacts (such as elevated alkalinity and pH, etc.) could occur than indicated. Exxon's own data on Duck Lake raises question on this analysis "...the only incremental impacts associated with lake discharge would be a possible increase in the lake water surface elevation or discharge flow out of the lake." Although Little Sand Lake's volume is greater than Duck Lake's, the temporary nature of the Duck Lake pump test discharge vs. long-term pumping in Little Sand Lake, and comparative dilution factors need more than a cursory analysis. Exxon should provide a more detailed analysis of this problem. It is possible that lake levels will be lowered by mine dewatering, and various alternative mitigating strategies, including discharge into lakes, would be required.

From the existing discussion, there is no basis for assessing why a lake discharge is not a preferred alternative.

Response:

Please refer to the full text from which this citation was excerpted; i.e., "The effluent standards and mixing zone requirements that would be imposed for a lake discharge will ensure protection of the lake ecosystem. If the water quality standards are met, the only incremental impacts associated with lake discharge would be a possible increase in lake water surface elevation or discharge flow out of the lake."

The water quality standards would be specific to the receiving lake, and WPDES permit limits would be compatible with existing lake conditions. This would preclude discharge of water to the lake with "elevated alkalinity and pH, etc.," unless these elevated conditions are compatible with existing lake water quality.

Although both lake and stream discharge alternatives are viable, there would be a larger change in surface flow from existing conditions with a lake discharge than the proposed discharge to Swamp Creek. As stated in the EIR subsection 4.4.2.6, the lake would have to be relatively large, or the discharge split and discharged to several lakes so not to drastically change the existing hydrologic conditions in the lake and down gradient streams.

The base flow immediately below Little Sand Lake, for example, is estimated to be less than 0.028 m^3/s (1 cubic feet per second) (EIR Table 2.4-19) while the estimated Project discharge is 0.11 m^3/s (4 cubic feet per second), resulting in a four-fold increase in base flow rate. However, the base flow at the proposed discharge is approximately 0.42 m^3/s (15 cubic feet per second) and the increase in flow caused by the Project discharge can easily be absorbed in the existing stream capacity.

Also, potential discharge lakes all have adjoining wetlands which may be impacted by the proposed discharge. Discharge to Swamp Creek in accordance with NR 1.95 would provide less potential for adverse impacts on wetlands, and this combined with the greater physical hydrologic effects on lakes and down gradient streams from a lake discharge make discharge to Swamp Creek the alternative with the least overall adverse environmental impact and, therefore, the proposed alternative.

Section 4.4.2.6 Surface Water Discharge

Comment No. 63

The alternative of a wetland discharge needs additional discussion. A brief discussion of the major impacts to wetlands hydrology, surface water and groundwater quality, vegetation must be provided.

Response:

Before a potential water discharge to wetlands could be proposed as the desired alternative, a considerable amount of information/data would be required. As part of the analytical process, potential wetlands would have to be selected to receive the proposed water discharge and seasonal environmental data obtained and evaluated. Concurrent with this analytical process, the DNR would have to develop water quality standards as a basis for the WPDES permit. The standards would probably vary depending on the type of wetland selected (i.e., shrub swamp, conifer swamp, marsh).

Although a wetlands discharge might theoretically have potential, particularly as it may relate to mitigation of Project operational effects, we perceive design and year-round operational problems which preclude us from seriously pursuing this alternative. Operational difficulties could be quite variable, depending on the type of discharge water distribution system selected, the hydrological regime of the wetland and the wetland vegetative type selected. During the winter period, frozen ground could prevent the discharge water from penetrating the wetland substrate and channels could form. Water passing through these channels would not have the benefit of the "living filter" function of the wetland ecosystem and could eventually reach a surface water body unattenuated. Without adequate attenuation of some chemical parameters, difficulties could arise in meeting the WPDES permit limits year-round. Overall it remains to be determined whether or not a particular wetland site in northern Wisconsin could be operated effectively throughout the year.

Generically, hydrologic impacts from a wetland discharge would result from an increase in the surface water flow. Initially, this could cause local scouring at the discharge site and possibly produce or increase channeling through the wetland. This may be particularly true during the winter.

Provided that the discharge water met DNR water quality standards, there should be no adverse impact to wetland plant and animal communities. Also, because most of the wetlands near the mine/mill site are perched overlying poorly drained low permeability soils, impacts to ground water quality should be negligible.

Realizing that water table wetlands in the site area are discharge points for ground water, it should follow that the discharge of mine intercept water (uncontaminated ambient ground water) at a flow rate commensurate with the size of the wetland should not have adverse impacts to the overall functions of the wetland. However, based on our monitoring of stream flow rates in wetlands, there are no wetland systems in the site area for which a discharge of 0.126 m^3/s (2000 gallons per minute) would not be a major increase in the estimated base flow rate. Consequently, such an increase would probably result in some impacts on the watershed functions of the wetland.

Section 4.4.2.7 Groundwater Discharge

Comment No. 64

Groundwater Discharge - For the three described alternatives (injection wells, infiltration basin, and drain field), please provide additional brief discussions of the potential impacts to groundwater hydrology and quality.

Response:

The impact to the ground water hydrologic regime from any of the three alternatives would be similar. In each case a ground water mound could be expected to form after saturation of the glacial soil material under the ponds or drain fields and around each injection well. Formation of the ground water mounds would not be a permanent feature of the hydrogeologic regime. After mining operations ceased, the ground water mounds would dissipate and the potentiometric surface would return to premining conditions.

The required quality of the water to be discharged in all three alternatives would meet appropriate discharge permit standards and would also have to meet ground water quality standards at the compliance boundary. There would not be any detrimental effects to the ground water quality.

Comment No. 65

In the EIR there is no discussion of the potential threats to the integrity of the MWDF reclamation cap. Eventual penetration by deep-rooted trees, soil creep, settling, erosion, animal burrows and frost heaving will act to slowly degrade the reclamation cap. Please provide an analysis on the integrity of the reclamation cap based on these factors.

Response:

The reclamation cap for the MWDF is a key element in the design and performance of the facility in controlling long-term seepage. The integrity of the cap is important in assuring that it continues to perform as planned.

Engineering design of the reclamation cap emphasized minimization of seepage through the cap. The bentonite/soil seal and the coarse drainage layer over the seal are important seepage control elements. The thickness of the protective soil cover has some minimal effect on seepage and water balance because of its water holding capacity; however, the soil cover primarily provides a vegetative growth media and protects the underlying cap components.

The 0.91-m (3-feet) thickness for the soil cover was determined by Exxon Minerals Company and its consultants, and judged satisfactory for the type of vegetative cover (black spruce and hybrid popular) originally proposed for the reclamation cap. During that study the black spruce rooting depth was the primary criterion in determining the cover thickness.

Long-term settlement of the tailings was studied and judged not to be a problem in reclaiming the tailing ponds. The tailings will consolidate somewhat, and settling occurs rapidly. Also, the reclamation work would be planned so that the grades could be checked over a season and readjusted if necessary before final planting of the vegetative cover.

The 2 percent grade planned for the cover will prevent ponding but is minimal enough to reduce erosion, especially when used in conjunction with a suitable vegetative ground cover. Also, the coarse grained nature of all soil materials in the cap, coupled with the final surface grades, eliminates stability or creep concerns for the cap.

Some revisions to the reclamation cap design are under consideration at the present time. Among the potential revisions or improvements being considered are design for invasion of site area vegetation types, increased thickness of the soil cover, incorporation of a root barrier layer, and handling and management of runoff waters in the area surrounding the MWDF.

Exxon Minerals Company will perform additional study in these areas as well as for the more general aspect of long-term future use for the MWDF area. This work will be performed with DNR and local community input and will be completed within the next few months.

Section 4.4.2.6 Surface Water Discharge

Comment No. 66

The proposed mine-mill complex will utilize a number of process reagents, some of them toxic, others potentially hazardous, in large quantities. The reagents will require a substantial amount of transport handling and storage, before they are utilized and eventually disposed. The potential impacts of an accidental spill, railroad car or truck accident, or other release of chemicals to the environment need to be discussed. Potential impacts to air quality, groundwater, surface water, and wetlands should be addressed.

Response:

During the life of the Project, the mill operation will use many different types of reagents in the ore processing. The anticipated quantities of reagents which will be stored on-site, the mode of transportation to the site from the supplier, reagent form (liquid or solid), and unit size (bulk or small quantities) are presented in EIR Table 1.4-4. The reagents will be unloaded and generally stored prior to use. Reagent storage and delivery systems will be designed based on reagent characteristics to prevent leaks or spills.

All equipment and operating procedures will be designed to meet applicable fire protection regulations. Emergency showers, eyewashes, and other first aid equipment will be conveniently located in the reagent handling areas.

The major concern with the use of reagents is spills. Spills could occur during transportation, unloading, storage, mixing, and/or use in the process. Certain chemicals, if mixed, could react to produce gaseous by-products. These gases could be toxic. However, when proper action is taken, these spills will not result in hazardous conditions.

The Project procedures will provide for curbing on-site and will ensure that spills are contained and handled properly; thereby avoiding accumulation in the soil and ultimately any possible effects to ground water, and preventing surface drainage of water and/or liquid reagents into nearby wetlands, lakes or streams. This will eliminate any long-term consequence which could adversely affect the environment and, ultimately, the public health and safety.

The likelihood of transportation related spills occurring within the Project boundary is considered negligible. The access road will be maintained and the posted speed will ensure safe operation. The railroad spur will be inspected and maintained regularly. In addition, the grade will be less than 1 percent and the operating speed will be slow. All equipment will be maintained in a condition which complies with all the Department of Transportation requirements. Therefore, equipment failure becomes a negligible factor.[1]

Documentation of off-site reagent spills in the mining industry is not available. However, the reagent transport, handling and storage facilities were selected to reduce the potential for spills. The greatest volume (approximately 80 percent) of reagents would be shipped by rail. Although specific probabilities of rail transport accidents involving reagents are not available, probabilities of various industrial accidents are provided in Reliability and Risk Analysis by N. J. McCormick, Academic Press, 1981. The probability of a train crash is listed as 1×10^{-1} to 1×10^{-2}

[1]Transport Canada, "Tank Truck Accidents Involving Dangerous Goods - Standards Assessment," December 1980.

events per year. Based on the previous experience of mill workers in Exxon Minerals Company, the probability of a major spill resulting from transportation of reagents to the Crandon Project is very low and we would not anticipate a major reagent spill over the life of the Project.

However, should such a low probability off-site transportation accident occur and result in a spill of a reagent cargo, most of which will be in solid form, appropriate steps should be taken to contain and clean up the spill area as soon as possible. Most reagents will be shipped in solid form and any resulting negative impacts to the environment should be localized and reversible.

Reagent spills in the mill during operation are also an important consideration in plant design. Spills may present hazardous working conditions for the worker. Spills pose a potential threat to the environment, are costly and adversely affect plant operating efficiency. Generally, the engineering design is required to ensure that reagent spill events have a low probability of occurrence. Reagent storage areas and handling facilities in the mill will have concrete floors and be designed to contain spills and keep spills of dissimilar materials separated. Solid spills will be thoroughly reclaimed. Liquid spills will be contained in blind sumps and the contents will be used as originally intended. Liquid spills will be recycled to original bulk containers or to mixing tanks as appropriate.

The following assessment of select reagents was made with the assumption that spills were unattended and no effort was made to contain or clean up the spill. In actual operation, this would not occur.

Sulfur dioxide, sodium cyanide, sodium dichromate, and sulfuric acid are the only reagents listed in EIR Table 1.4-4 which were considered to present a potential risk. A spill of liquid sulfur dioxide in large quantities could pose a short-term, environmental consequence. Liquid sulfur dioxide, if spilled, would vaporize rapidly at temperatures above -10°C (14 degrees Fahrenheit). This effect would result in gaseous sulfur dioxide being transported mainly through air movements because of its chemical properties. Therefore, contamination of surface water should not occur. Sulfur dioxide spills which occur during warmer months would vaporize and be transported by air movement. The effect would be directly dependent on the size of the spill, and the wind direction and velocity. In general, the immediate effects would be short-term and reversible. Public health and safety impairment from airborne SO_2 would be very small, depending on location.

During winter months, spilled liquid sulfur dioxide might remain in a liquid form and, if contact were made with surface water, a low pH would result. This condition would be short-term and reversible.

The construction materials required for storage, and the equipment required for safe handling of liquid sulfur dioxide are well defined. Sulfur dioxide is used in many industries and is handled, stored, and used daily in a safe, acceptable manner. Some other major industrial users include paper mills, food and grain processing, malting, and wastewater treatment facilities.

The sulfur dioxide storage area at the Crandon Project will be within an enclosed building adjacent to the mill, with a concrete floor and washdown facilities which drain to the water treatment system. Personnel will be trained for standard operating and emergency procedures. Safety equipment will also be available. In addition, the facility will be designed to comply with appropriate Mine Safety and Health Administration (MSHA) regulations. When facilities are properly engineered and operated, sulfur dioxide spills will have an extremely low probablity of occurrence.

Sodium cyanide will be received as briquettes which will minimize dusting during operation. The briquettes will be received in Flow-Bins™ which contain 1,364 kg (3,000 pounds). The empty bins will be returned to the supplier. The bins will be stored inside the mill. A briquette spill would have no public health and safety consequence resulting from transport of airborne particles.

If a spill of sodium cyanide occurs to surface water, it has potential to temporarily affect surface water quality. Sodium cyanide solution could be transported beyond the Project boundaries. However, sodium cyanide solutions require high alkalinity to maintain a free cyanide form. As pH decreases below 9.3, sodium cyanide will hydrolyze to form sodium hydroxide and hydrogen cyanide (HCN). The hydrogen cyanide has a high vapor pressure and, therefore, reacts further, establishing an equilibrium between HCN (liquid) and HCN (vapor). In addition to decreasing pH, increased temperature and turbulence (such as mixing) will accelerate volatilization of HCN. Any HCN remaining in liquid form will tend to oxidize to the cyanate (CNO) form, which can be complexed with metal ions or can further decompose to ammonia (NH_3) and carbonate (CO_3).

Because of the unstable nature of free cyanide, it is unlikely that sodium cyanide will remain in its original form, if it reaches surface water. Volatilization and oxidation will occur as well as complexing and decomposition with the result that minimal environmental effects will be realized beyond the Project boundary. Therefore, any effect realized off-site would be short-term and reversible.

Reagent mixing and solution storage will be designed in compliance with MSHA regulations. The floor in the reagent area will be concrete and designed to contain reagent spills separately. Solid spills will be swept into containers and the area washed. Liquid spills will be washed into the sump and pumped to the tailing thickener for treatment.

Materials of construction and other associated equipment required for sodium cyanide storage and handling will reduce the probability of a major cyanide spill. Containment and control of minor, accidental spills will further reduce the risk of potential environmental impact to a low probability. With a properly engineered and operated system the risks to the environment are negligible.

As with sodium cyanide, spills of sodium dichromate solution could pose potential environmental consequences through transport by surface water. Effects on the environment could occur in two ways: (1) hexavalent chromium (Cr^{+6}) concentrations higher than allowable water quality standards could result and (2) aquatic and terrestrial plant uptake of chromium. The environmental effects of hexavalent chromium are documented in the literature[2]. Should sodium dichromate solution infiltrate the soil on-site, studies performed have shown that chromium ions will be attenuated by the soil[3]. The effects of sodium dichromate would be short-term and reversible.

Sodium dichromate handling and storage systems will be designed with the proper construction materials and equipment to prevent accidental spills. Proper design indicates low probability of a spill. Within the concentrator building and the storage area, all spills will be contained and kept separate from other materials. This will afford the operator an opportunity to control and clean up spills in a safe manner.

Sulfuric acid will be received in bulk by truck or rail and will be stored in an above ground tank. The tank will be bermed and the berm will be lined to contain all spills. Materials of construction for vessels containing concentrated sulfuric acid are well defined.

With a proper design which complies with the MSHA regulations, the possibility of a spill is very low. Containment of spills in the storage area and the areas of use (water treatment) mitigate the potential effects to the environment. Should accidental sulfuric acid spills reach surface water, the pH of the water would be reduced in proportion to the amount of dilution. This effect would be short-term and reversible.

The effect outside the Project boundary would be small in that major consequences would require a continual spill of sizable quantity over a long period of time.

<u>Conclusions</u>

The risk of accidental reagent spills during routine Project operation will be a low probability event with properly designed reagent handling and storage systems. Consequences of small spills during reagent use will be mitigated by the containment and proper handling of each spill. Because these spills would be minor, discrete, short-term events, the consequences would not be severe. Since accidental spills would be localized, no threat to public health and safety will arise.

Contingency plans will be developed for the use of each reagent prior to operation. These plans will be used as training guides for the operators in the reagent area.

Comment No. 67

The EIR assumes that once the mine is operating, it will continue operating until the ore body has been completely mined. Exxon has addressed (comment 167) temporary shut down conditions, when the mine and facilities would be

[2]U.S. Environmental Protection Agency (EPA), "Water Quality Criteria Documents," 45 FR 79318, November 28, 1980.

[3]D'Appolonia, "Ground Water/Soil Attenuation Study, Crandon Project," July 1982.

maintained in a state of readiness. Under that situation, pumping the MWDF underdrain would continue, the mine dewatering would continue, and the tailings ponds would remain ready for use, and mining/milling could begin at short notice. In addition to short-term shutdowns, there is a possibility that mining would cease for longer periods of time. If that happened, would the mine ever be allowed to flood? Would the MWDF underdrain continue to be pumped? Would the tailings and reclaim ponds be allowed to dry? What would the closing duration have to be for these events to occur? For example, please discuss the potential impacts which would result from a closure of 2-5 years. Include in the discussion potential impacts to ground water quality, surface water quality, and implications of restarting the mine.

Response:

Cessation of mining, not set forth in the Mining Plan, will be conducted in a lawful manner under Wisconsin Statute 144.875, which requires that the operator notify the department and commence stabilization of the mining site. As presented in Statute 144.875, "If the department determines after hearing that stabilization of the mining site is inadequate to protect the environment, the department shall order the operator to commence additional measures to protect the environment, including, if the cessation is reasonably anticipated to extend for a protracted period of time, reclamation according to the reclamation plan or part of the reclamation plan." The following discussion briefly considers the points raised in the questions.

Evaluations of shutdown/startup questions during the operating life of the property consider many of the same parameters as the initial decision to start construction of a new mine. These considerations are similar whether the shutdown period is several months or several years. Some of these factors include:

1) The cost of maintaining facilities during shutdown, including environmental costs;

2) The cost of restarting the facilities;

3) The anticipated future metal prices and operating expenses;

4) The anticipated availability of personnel if the facility is restarted;

5) The remaining ore reserves; and

6) The cost of reclamation.

In general, the potential to restart the operation is more likely early in the property life when future ore reserves are still relatively high. As the remaining tonnage to be mined decreases, the restart of the operation becomes more difficult.

If the Project stopped operations for 2 to 5 years and the understanding was that it would be restarted at the end of this period, then the following might be expected:

1) The mine dewatering pumps would continue to operate;

2) The tailings underdrain pumps would continue to operate;

3) Chemical stabilization would occur of the tailings surface; and

4) The water treatment facilities would continue in operation.

The ramification of the above events would be the extension of the mine/mill operation and reclamation time periods.

If the shutdown decision included allowing the mine to flood, then there would be little hope that the mine would be restarted. In this instance the property would be closed and final reclamation work begun. The ramification of these events would be the premature termination of the operations. Environmental impacts would be as projected for the closure period and the reclamation plan would be completed.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

April 10, 1984

IN REPLY REFER TO: 4400

Mr. Barry J. Hansen
Permitting Manager
Exxon Minerals Company
P.O. Box 813
Rhinelander, WI 54501

Re: Completeness Check and Preliminary Review; Feasibility Report for the Crandon Project Mine Waste Disposal Facility; Forest County

Dear Mr. Hansen:

The Bureau of Solid Waste Management, Department of Natural Resources, has reviewed the various items submitted to document and justify the feasibility study for the Mine Waste Disposal Facility (hereafter referred to as the MWDF) for the Exxon Crandon Mine. These include:

1. Feasibility Study received on December 27, 1982.
2. Package of materials received July 20, 1983 responding to the Department's feasibility study incompleteness letter dated March 11, 1983.
3. The Siting Report Response letter dated July 11, 1983 in response to the Department's letter dated November 23, 1982.
4. The EIR Chapter 1 Response Comments dated October 3, 1983 in response to the Department's letter dated May 11, 1983.
5. The Mine Plan response comments received November 14, 1983 in response to the Department letter dated October 10, 1983.
6. The EIR Response Comments dated February 24, 1984 in response to the Department's letter dated December 29, 1983.
7. Contractor documents submitted to support EIR, Feasibility Study, and Mine Plan proposals.

Review of all these submittals was necessary due to the numerous individual details of site construction, operation, and closure which were discussed in each submittal. No one document addressed to the Bureau of Solid Waste Management can be considered representative of the entire MWDF proposal. Based on this review, the Department has determined that the feasibility report, including relevant information from other documents, does not contain the minimum information required by NR 182, Wisconsin Administrative Code. Therefore, the submittal is not complete. In addition, items listed below also present preliminary review concerns which affect site design and construction.

The subtitled sections below address the following major categories:

Documentation
MWDF Siting Alternatives
Hydrogeology and Monitoring
Site Design
Contingency Plan

The detailed incompleteness items and review concerns within each category must be addressed before the Department can consider the submittal to be an approvable proposal for the MWDF as well as providing adequate documentation for development of a comprehensive EIS.

Documentation

1. Certain documents or portions of documents previously requested by the Department have not been received and must be made available in order for the Department to conduct a complete review of the proposal.

    a. Those elements of the Lakefield Research data that describe waste characteristics of the materials which will be deposited in the tailings impoundments are not available to Department staff and should be provided. It is not apparent that the tailings liquors tested by Colorado School of Mines Research Institute and Golder Associates are representative of the range of concentrations of parameters likely to be present in the tailings slurry water or reclaim pond water. The intent should be to use the available data to best advantage to illustrate the means and ranges of total dissolved solids, pH, and concentrations of metals, common ions, and anions of liquids that will contact the liners of the MWDF and reclaim ponds and the drainage layer of the MWDF. This information is needed to evaluate liner stability.

    b. The soil attenuation study prepared by D'Appolonia is missing several pages of data contained in Appendix H. It appears that the last 9 pages of data were left out when the original documents were reproduced.

MWDF Siting Alternatives

2. The MWDF siting process and history were addressed in the Department's November 11, 1982 letter and Exxon's response dated July 11, 1983. With respect to the hydrogeology and preliminary engineering aspects of Exxon's preferred site (site 41), it is the opinion of Department staff that site 41 is a viable site which can potentially be developed into an environmentally acceptable disposal facility if adequate engineering design and construction of the site is accomplished. Furthermore, from a

hydrogeologic and preliminary engineering standpoint,the data provided to us to date does not indicate that there would be significant hydrogeologic advantages to emplacing the facility at another location within the Exxon-defined study area.

With respect to the broader environmental factors affecting site selection, the Department will be completing its analysis in the near future. This analysis will include comparisons between specific sites. Additional information may be required to develop in proper detail our judgments on your choice of site under NR 182.08(2)(k) and to develop a comprehensive environmental impact statement (EIS). It is only after this analysis is completed that we feel that Exxon can eliminate consideration of all but one site. The Department will be developing a letter in the near future which will specify any additional information required.

3. The materials submitted to demonstrate the feasibility of the preferred MWDF location illustrate the following important hydrogeological and locational features of this site:

   a. The MWDF is proposed to be located in and overlying relatively high permeability glacial deposits. Groundwater and potential disposal facility leakage can occur at a rapid rate through these materials as compared to disposal operations conducted in other areas of the state.

   b. Groundwater flow is nearly radial in the MWDF area. This flow geometry and the site location in a groundwater recharge area exposes a large area to potential groundwater impacts from the MWDF.

   c. The large separation distance between the base of the MWDF liner and the groundwater table is advantageous due to the beneficial effects of unsaturated flow on contaminant transport. However, the depth to bedrock imposes severe difficulties on construction of physical remedial actions such as cutoff walls or trenches should contamination below the groundwater table originate from the MWDF.

   d. The proposed groundwater contamination contingency plan utilizes pumping wells that may need to be operated for a considerable period of time, may involve long term costs for system operation and maintenance, and may necessitate a water treatment plant and associated sludge disposal.

   e. The wastes to be deposited in the MWDF contain sulfide minerals which will decompose upon exposure to oxygen and water and lead to generation of leachate. After disposal, their potential for producing leachate will exist for perpetuity.

The feasibility considerations listed above are the basis for Department staff opinion that this site has few natural advantages for waste disposal. Thus, successful site development will depend greatly on engineering modifications. It is the opinion of the Department staff that the MWDF design must incorporate conservative design concepts both in details and as a total system which includes proven technology, system redundancy, and safety margins which reduce the risks of MWDF failure. Specific issues are addressed in the section below entitled Site Design.

Hydrogeology and Monitoring

Numerous items of information dealing with hydrogeology and groundwater effects of the MWDF were dealt with in the Department's letter dated November 14, 1983. That letter was not intended to be a completeness check for the MWDF proposal specifically but dealt separately with groundwater issues due to the general need for similar information by other Department regulatory functions (Mine Dewatering Permit, effects of mine dewatering on adjacent surface water bodies, etc.). The issues raised in that letter are currently being resolved but additional hydrogeological issues raised in continuing review are also addressed below:

4. Previous discussions between the Department and Exxon staff over the last year and a half concerning Department need for the computer tape of the groundwater model programming have not been resolved. At this time Department staff wish to reaffirm why it is necessary for the Department to acquire the computer tape. The Department is concerned with both exercising the model through D'Appolonia's facilities and obtaining a copy of the model documentation in compatible machine format. Variations in scenarios and data can be successfully exercised under the present contractual arrangements between Exxon and D'Appolonia. However, real world verification of the model can only be performed with data generated after several years of MWDF construction and operation. The Department has no assurance that the present contractual arrangement will continue as long as needed. The Department's responsibility to periodically review site performance through time requires that the Department also possess the means to do so (i.e., the computer model). Therefore, Department staff request that Exxon submit this tape and any such program modifications as were made during the modeling work.

5. The proposed saturated and unsaturated zone monitoring systems for the MWDF and reclaim pond complex are inadequate both in density of sampling devices and in details of their installation. As noted above, the Department's November 14, 1983 letter also recommended additional well installations at specific locations, some of which may be useful for groundwater monitoring around the MWDF.

    a. The saturated zone groundwater monitoring plan should insure that all vectors of groundwater contamination are monitored. This means that water table wells and piezometers should be placed in a ring totally surrounding the facility. Instrumentation should also be developed to monitor groundwater quality and gradients below the tailings impoundments.

    b. The large separation distance between the base of the impoundments and the groundwater table and the long contaminant transport times predicted by Exxon necessitate a comprehensive unsaturated zone monitoring system below the tailings impoundments. Details on the types of devices utilized and sampling extraction methods are needed. Redundancy is needed due to the impossibility of replacing or repairing these devices after impoundment construction. It may be necessary to use a range of sampling devices including collection basin lysimeters, suction lysimeters, tensiometers, conductivity probes, or other devices in order to ensure a reliable monitoring system. Exxon should explicitly evaluate use of a range of unsaturated zone instrumentation.

The use and design of the collection basin lysimeters placed below the base of the impoundments must be detailed. The locations appear to be approximately 15 meters below existing ground surface of impoundment T-1. No details of construction are included in the Feasibility Study. The Department is concerned about the practical aspects of recovering a usable sample. Additional detail must be submitted on access to drain lines coming from the lysimeters, withdrawal of samples, length of drain lines and corresponding effects on the leachate captured, lysimeter location with regard to cell bases and side slopes, materials of construction, and installation.

c. Details are needed on abandonment of monitoring wells located within the MWDF area as well as methods of sealing any wells to be retained in the MWDF area for monitoring. Details must be supplied on the protection of wells which will be extended and utilized after facility construction and closure.

d. All existing groundwater quality and elevation data must be made available to the Department in a format which can be readily integrated with Department computer records. While Department and Exxon technical staff have begun to address details of electronic transfer of data, this process has yet to be completed. In addition, the Department requires that the individual elevation readings used to construct the groundwater hydrographs in the EIR be converted to mean sea level elevations and submitted.

e. Department staff consider all details of the monitoring plan for the MWDF to be part of the feasibility study. The monitoring plan is tied to site construction, operation, reclamation, and long-term care and will be reviewed with the rest of the proposal.

Site Design

As indicated above, the hydrogeologic environment in the Exxon siting area requires that the preferred site incorporate extensive engineering modifications in order to successfully protect the environment. The engineering concepts and details presented in the various documents and plans have been reviewed and Department staff have several reservations concerning the proposed design.

6. A major portion of the amended soil liner materials preparation and liner construction process needs to be detailed. The level of detail provided in the feasibility study, EIR, Mine Plan, and responses to Department comments on these subjects does not meet the Department's regulatory needs. Only very limited literature information is available on this design concept. There has been little experience with bentonite amended

soil liners in Wisconsin. Where there has been experience, such as in wastewater treatment plant lagoons, the track record has not been good. For these reasons, Exxon must demonstrate the constructability, quality control, and minimum design methods and tolerances at the feasibility study stage. It is not sufficient to assert (as stated in the Feasibility Study) that these issues will be dealt with in the plan of operation stage. In brief, the Department is questioning the basic feasibility of constructing the amended soil liner reliably and with the equivalent degree of redundancy available in clay liner technology. More specific information needs are:

a. The soil crushing, screening, and mixing plant has been demonstrated to date only through manufacturer's brochures and generalized calculations. Exxon must document in detail that the soil, bentonite, and water can be mixed reliably and can meet consistent quality control. Such documentation should include reports of construction and quality control of actual projects which utilized this method, detailed descriptions of procedures to be used on this project, groundwater monitoring data and leachate characterization for operating facilities which utilized this method, and, if possible, a pilot demonstration of the process.

   It must also be demonstrated that it is possible to vary bentonite content due to the estimated permeability of the soil used for mixing. Department staff do not believe this approach is practical given the inherent variability of soil materials and the difficulty of testing them on a continual basis. Department staff recommend that a minimum bentonite percentage be chosen which can be shown to be more than adequate based on a worst case soil gradation to be encountered.

   Department staff recommend that a basic decision be made on the mixing method. The Department doubts that sufficient quality control can be exercised through any method except the central mixing plant concept.

b. Quality control of compaction of the amended soil material must be defined to include suitable compactive effort by available machinery, design moisture content, amended soil curing time and effect of storage prior to use.

c. Exxon must define the actual quality control tests and parameters to be used for construction control during amended soil liner installation. It is the opinion of Department staff that the field permeability test submitted with the EIR Chapter 1 responses is not a practical method of maintaining adequate field control due to the unreliable and time consuming nature of the test. Department staff recommend this test be replaced and supplemented with the use of soil tests such as density, Atterberg limits, and gradation for liner quality control. In addition to these, Exxon must demonstrate a reliable method to certify bentonite content rapidly both at the mixing plant and in samples taken during actual liner construction.

While field and laboratory permeability tests are useful and necessary, their use must be explicitly defined as to whether they serve as field controls or as post-construction documentation.

d. The proposed liner thickness appears to be inadequate. Placement of a six inch liner in a single lift lacks redundancy which is inherent in more conventional liner technology used with landfills. The use of multiple lifts to construct a four or five foot liner compensates for construction, material, and testing irregularities which should be expected to occur when constructing earth structures. Liner construction for this facility must be demonstrated to meet the field control and redundancy inherent in usual liner construction. The Department suggests use of multiple lift placements, a greater overall thickness, and a better method of field control of thickness that does not involve continual refilling of grade stake holes.

e. An essential element of phased tailings impoundment construction is the necessity to seam adjacent lined sections. The amended soil liner is proposed to be constructed sequentially up the interior sidewalls of each impoundment cell as filling progresses. There are no details provided assuring continuity across seams between areas of side slope liner constructed during different periods of time. There are conventional designs which have been implemented successfully with thicker clay liners. A liner seaming method must be defined for this amended soil proposal which meets or exceeds the effectiveness achieved by clay liner seaming.

f. The Department requests further reevaluation and documented comparison of, at a minimum, the following design variations for the MWDF liner:

i. Double liner system similar in concept to that proposed for the Reclaim Ponds.

ii. Flexible membrane liner, with use of thicker synthetic materials currently being used in landfill design. Several recent hazardous waste landfills, for instance, have been constructed using thick high density polyethylene (HDPE) liners.

iii. Natural clay liner, using natural soil deposits, either as a backup liner or as a thick liner in its own right. The use of natural clay liner thicknesses less than 5 feet may be viable.

iv. Amended soil liner with a substantially increased thickness, to incorporate the above expressed concerns for redundancy and overcoming construction variability.

Monitoring data from several clay lined landfill sites in the State of Wisconsin have resulted in several years of performance data which demonstrate that clay liner technology can be successfully implemented. Exxon Minerals Company must demonstrate with similar data that, by creating a manufactured material out of a natural soil material and an admixture, the inherent variability of those materials can be overcome to create a predictable and usable product that has the potential to meet the clay lined landfill performance. It is not sufficient to assert that this will be done at the plan of operation stage. It should be pointed out that the Department is not precluding use of an amended soil liner. However, greater justification is needed for its use in this situation.

7. The Department has reservations about both the level of detail provided for the MWDF final cover design and the conceptual intent behind the design.

   a. The design infiltration rate of less than 1 inch does not appear to be realistic in the long term. The final cover drain and seal layers must perform indefinitely regardless of the effects of tipovers, animal burrowing, freeze-thaw effects, and erosion. There is also concern that the amended soil seal layer may develop fractures due to dessication or settlement which will lead to an increase in permeability.

      No details have been provided on the method of routing water diverted in the drainage layer to the exterior of the site. The level of detail provided on percolation control in the final cover design does not justify the assertion that the final cover will maintain the free-draining function of the drainage layer for an extended period of time.

   b. The Department disagrees with the conceptual model of the final cover proposed in the Feasibility Study. As presented, water that percolates through the seal layer is allowed to pass through the waste mass and to exit through the base of the site. Although variations in percolation volumes would be expected to occur from year to year, an assumed average volume of water is conceived to continually penetrate into the site. It is necessary to prevent water and oxygen from reaching the tailings, as these are essential reactants in the sulfide mineral oxidation process. The Department strongly suggests that a final cover redesign be developed which allows essentially no entrance of air (more importantly, O_2) or water to penetrate through the final cover into the waste mass. The Department also strongly suggests that a simpler final cover construction method be used which incorporates a thicker cover layer which both limits desiccation effects on final cover vegetation and provides additional protection to the seal layer from erosion and exposure effects.

      Department staff recommend a reevaluation of the use of flexible membrane materials (described in the Golder studies 3.1 and 3.2) for a final cover seal material in light of the recent use of thick synthetic materials such as HDPE in hazardous waste disposal sites. Using the elements suggested above would result in an alternative final cover system which consists of a thick membrane (for instance, HDPE) covered with a large thickness of soil cover suitable for establishment of a long term vegetative and erosion-resistant cover. This simpler system may more readily ensure a final cover which will prevent infiltration for the longest period of time possible.

In summary, the theory of operation of the final cover, the details of construction, and quality control of its installation are key to the successful long term operation of the entire waste containment structure. The intent should be to achieve a containment design that eliminates entry of air and water to the waste mass and allows for continued desaturation of the tailings to the maximum extent possible.

8. All details of the reclamation plan for the MWDF will be considered by Department staff to be part of the feasibility study document. The Reclamation Plan is tied to site closure, monitoring, and long term care and should not be viewed as segregated from the rest of the proposal. While it is acceptable to the Department to reference the Reclamation Plan submitted to comply with NR 132, you should be aware that Department staff will review the MWDF reclamation plan under NR 182.

   Certain details of the reclamation plan involve the routing of runoff from the MWDF and the balancing of long-term runoff effects on adjacent wetlands, surface water bodies, and groundwater. The Department is concerned about the proposal to utilize runoff from the surface of the closed tailings impoundments as enhanced infiltration in the soils within the proposed compliance boundary to compensate for decreased infiltration below the impoundments themselves. The Department must have detailed information to evaluate the inflow scenario and the possible clogging effects of the infiltration structures. The design and maintenance of infiltration structures must be shown to be feasible.

   Although erosion control for the entire Exxon Mine project has been proposed in a general manner, additional detail must be provided for treatment of the control of erosion and establishment of vegetation on the 3:1 exterior side slopes of the tailing impoundments. The Department requests that greater detail be provided, to include reduction of uninterrupted slope lengths and the directing of runoff to existing drainage channels.

9. Exxon has utilized estimates for the residual volumetric water content (field capacity) of the tailings to be disposed of in the tailings impoundments. Exxon should determine the actual value for this parameter. In addition, estimates of unsaturated tailings permeability were also made which should be verified through field or laboratory study and/or complete and detailed literature references. This information is needed in order to more precisely calculate the dewatering rate of the tailings and the length of time in which leachate collection should be practiced. (If you choose to rely extensively upon literature references, Department staff request that you provide reproductions of references which are not readily available in the northern United States or Canada. While extensive work has been done on mining projects in South Africa, Australia, and the Third World, much of this information is not readily available to the Department on short order.)

Settlement effects must be more explicitly addressed in order to evaluate constructability and long-term integrity of the final cover. It is not altogether clear from the Golder work and other literature sources that the consolidation behavior of the fine fraction of the tailings has been thoroughly evaluated. It should be made explicit whether long-term density changes are likely to occur in the fine tailings fraction.

The waste water sludges produced during the pilot plant studies should be subjected to a detailed waste characterization, including bulk analysis, moisture content, and leachability. This information is needed both by the Bureau of Solid Waste Management and Bureau of Waste Water Management.

In summary, the subjects addressed in this section indicate that Department staff not only have reservations about detailed design of segments of the MWDF but have a differing opinion from Exxon's designers as to the fundamental conceptual design of the disposal system as a whole. The MWDF as proposed postulates a limited but continuous flow of water into the top of the site and out of the base. This design does not provide sufficient assurance that the actual leakage qualities predicted or designed for can actually be met. More fundamentally, Department staff disagree with the concept of allowing long-term and continuous leakage.

Department staff suggest that there is considerable latitude for site redesign, based both on the range of technologies available and on the possible balance between emphasis on the liner, waste characteristics, and final cover. The Department strongly suggests that it would be in Exxon's best interests to redesign the site taking into account the concerns raised above.

Contingency Plan

10. The contingency plan proposed in the Feasibility Study and the Exxon document dated December 1982 and entitled "Contingency Plan" are not of an acceptable level of detail. Department staff also have concerns with the more basic concepts behind those details.

While groundwater pumping can control gradients below the impoundments (based on information presented to date), it does not constitute a realistic contamination control measure for the Exxon MWDF. Exxon's contention is that groundwater contamination is a remote possibility (as documented by the contaminant transport modeling). Thus, utilizing groundwater pumping for contingency purposes is also expected to be an extremely remote possibility. This does not meet the intent of a contingency plan which is that the plan must involve practical and realistic measures to correct a situation which, by intent and by regulatory code, must be postulated to actually occur at some time. A facet of the contingency plan which is completely lacking is the treatment and disposition of contaminated groundwater. This is a particularly troublesome point in that other documents, such as the EIR Mine Plan, indicate that the treatment plant at the mill will be dismantled at the end of mine and mill useful life. If groundwater pumping is to be proposed then additional details will need to be provided to demonstrate that this is a realistic alternative.

Other measures used to correct site defects have been alluded to in various responses to Department review letters, such as the proposal to inject grout beneath a leaky impoundment liner section. Additional details must be provided to demonstrate that this could be practically done.

The Department suggests that more emphasis be placed on design, initial site construction, operation, and closure to ensure containment of waste materials in the impoundments. A conservative site design is needed to reduce reliance on what must be viewed as extreme measures for site remedial action.

This letter is intended to indicate additional information which the Department needs to review the Feasibility Study for the MWDF. In addition, the results of review staff evaluation of the project conceptual design and engineering details are also included insofar as they may result in significant site reevaluation and redesign. Department staff believe that now is the appropriate time to address these conceptual issues and engineering details before proceeding with the review process. Because of the complexity and breadth of this project, Department staff believe it is essential to meet with Exxon's technical staff and consultants to address issues raised in this letter. The Department suggests that Exxon resolve conceptual difficulties with Department staff, perform redesign, and submit an amended design to the Bureau of Solid Waste Management. The submittal of the required information does not ensure approval of Exxon's Feasibility Study nor does it preclude the Department from requiring additional information if the need is demonstrated through continued review.

The completeness and review issues raised in the Department letter dated November 14, 1983 will continue to be evaluated as part of the combined review of the effects on the groundwater system of the MWDF, mine dewatering, and discharge of treated water. Common features of MWDF and reclaim pond designs should be coordinated and reconciled in order to facilitate both regulatory review and site construction. In addition, there are several other aspects of this project which are reviewed by the Department's Solid Waste program but which have not been explicitly addressed in detailed proposals to the Department. In brief, these are:

1. Pre-production ore storage site design.

2. Disposition of solid waste (not to be confused with mining waste from mine and milling circuits, such as tailings, waste rock, and sludges).

3. Hazardous waste materials identification and disposition. It is not likely that all spilled reagents, for instance, can simply be collected and returned to use.

4. Septic system sludge disposal.

5. Spill plan details and adequacy.

6. One time and demolition waste disposal permits.

The last five items in the list above should be evaluated by consultation with Department District and Area Solid Waste staff in the near future in order to establish the level of detail and information requirements which Exxon must meet. Please contact Jim Anklam at the Antigo area office at (715) 627-4317 in order to establish a schedule to address and review these issues.

If you have any questions regarding this letter, please call Gordon Reinke at (608) 266-2050, Ken Wade at (608) 267-9387, Robert Grefe at (608) 266-2178, or Archie Wilson at (715) 362-7616.

Sincerely,
Bureau of Solid Waste Management

Richard G. Schuff

Richard G. Schuff, P.E., Chief
Residuals Management & Land Disposal Section

Approved: Paul P. Didier
Paul P. Didier, Director
Bureau of Solid Waste Management

RPG:mk/4954S

cc: Robert Ramharter - EI/3
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Kevin Lyons - Milwaukee
Ray Huber - Wausau
Don Zuidmulder - Green Bay
Kathleen Falk - DOJ
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State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

July 19, 1984

File Ref: 1630 - Exxon

Dear Librarian:

Please put the enclosed document, a "Status Report of Department of Natural Resources Activities on the Proposed Exxon Mine near Crandon, Wisconsin, June 30" along with the other Exxon Environmental Impact Report (EIR) material.

Thank you for your assistance.

Sincerely,
Bureau of Environmental Analysis & Review

Carol Nelson

Carol Nelson
Environmental Specialist

Enclosure

CN:mm

Status Report of

Department of Natural Resources Activities on the

Proposed Exxon Mine near Crandon, Wisconsin

June 30, 1984

Introduction and Statement of Purpose

In 1976, Exxon Minerals Company announced the discovery of an ore body near Crandon, Wisconsin containing significant amounts of zinc, copper, and lead ores. Following their announcement, Exxon conducted additional planning and technical investigations into the feasibility of mining the deposit and potential consequences to the local and regional environments. In December 1982 Exxon submitted to the Department of Natural Resources a mining permit application and other key permit applications, along with its environmental impact report, as required by law. In doing so, Exxon confirmed its intentions to pursue a permit to mine the mineral deposit and triggered the formal state agency review and environmental impact processes.

Exxon's proposal to mine the ore body is relatively complex. It involves construction, operations, and eventual reclamation and closure periods covering nearly 30 years. An estimated $550 million would be spent by Exxon for construction of the underground mine, mill complex, and ancillary facilities before ore could be removed commercially; the project would involve an estimated 700 permanent operations workers for the duration of the mine.

Although the environmental impacts of the proposed project have not been fully determined, project development would result in impacts to the natural resources from groundwater drawdown, operations of a waste disposal site for mine tailings, emissions to the air, discharge of treated process water, and access and utility corridors. Socioeconomic impacts would include changes in regional employment, job competition, personal income, local property taxes, housing, and public services. These potentially significant impacts require a thorough analysis of the proposed project. The environmental impact statement on the proposed project will contain these analyses.

Substantial progress has been achieved in evaluating Exxon's environmental impact report and permit applications. The primary objective of this report is to briefly explain the status of these evaluations, identifying both the accomplishments and the areas where additional work is required. This includes a discussion of all significant issues and the approximate timetable for their resolutions.

In this report estimated dates for the completion and/or acceptance of the various permit reviews, Exxon's environmental impact report, and the environmental impact statement are provided. Completion dates are based on estimates of the time required to obtain additional information from the applicant, resolve new issues which arise, review submitted information as well as write the environmental impact statement. The schedule dates, therefore, are tentative. The Department is making every effort to complete its review and writing responsibilities in as timely a fashion as possible.

Major Permit Requirements

The status report is organized according to the major permits which are required for the development of the Crandon mine. Exxon has applied for five major permits from the Department: solid waste operating license, high capacity well permit, Wisconsin Pollution Discharge Elimination System (WPDES) permit, air quality permit and mining permit. While numerous permits are required from the Department as well as federal, other state agencies, and local units of government, these are the most important permits on the basis of potential impacts to the environment.

1. Solid Waste Plan Approval and Operating License

A solid waste operating license is required for this project, and in addition, a feasibility study and final engineering plans for the proposed disposal facility are required to be reviewed in detail. The solid waste site, known as the mine waste disposal facility (MWDF), would provide permanent storage for waste materials that cannot be returned to the mine. It would encompass about 500 acres and is designed to contain 31 million cubic yards of wastes, chiefly rock in the form of finely ground tailings. The tailings contain significant amounts of sulfide minerals, mainly iron pyrite, which produce, when exposed to air, water, and specialized bacteria, a leachate contaminated with acid, heavy metals and other pollutants. For effective environmental protection, it is imperative to isolate the wastes from the surrounding environment. A low permeability liner with a leachate recovery system is proposed for the base of the MWDF. A similar low permeability final cover is proposed to isolate the MWDF contents from precipitation and the atmosphere. In the long-term, the effectiveness of MWDF final cover is very important, for to the extent that it limits water reaching the tailings, it will also limit leachate generation and contaminant movement. Exxon has indicated they may submit revised proposals for the design of the MWDF liner and final cover. Following receipt of that proposal, the Department will evaluate the capability of the proposed liner and final cover to control leachate generation and examine the potential chemical interactions between the tailings and leachate and the liner materials.

A major concern is the gradual seepage of leachate and associated contaminants through the base and sides of the MWDF. Contaminant movement depends on several factors including the effectiveness of the liner and final cover, whether or not the glacial sediments beneath the MWDF are saturated, porosity and mineralogy of the soil particles, the nature of the contaminant, and the speed and direction of groundwater movement. The Department recognizes that no containment facility is completely water tight. Therefore, the Department is verifying, through reviews and computer modeling, Exxon's predictions of how contaminants will move away from the MWDF and disperse. In order to verify Exxon's predictions on contaminant movement, the Department has required Exxon to provide additional information on the nature of the glacial deposits and groundwater beneath the MWDF and conduct additional computer analyses of contaminant transport.

An integral function of the MWDF is to isolate the wastes from atmospheric precipitation. Exxon predicts that most rainfall and snow melt will move laterally as runoff to the surrounding landscape rather than penetrate the final cover. The details of how runoff from the MWDF will be handled and where it will flow have not yet been completed by Exxon. Completion of these plans will be required before a construction and operation approval letter can be issued.

DNR review letters on the MWDF Feasibility Report were sent to Exxon on March 11 and November 14, 1983 and April 10, 1984 following Exxon's submittal of the MWDF feasibility report and additional requested information. In its most recent letter, the Department requested greater detail on the construction of the liner and final cover, evaluation of alternative designs, additional provisions for monitoring water quality around the MWDF, and more detail on contingency planning. The timetable for receiving additional requested information and eventual approvability determination is not known, however Exxon has indicated they will expedite the submittal of additional information.

2. High Capacity Well Permit

The ore body near Crandon lies below a thick mantle of glacial deposits including silts, sands and gravels. Portions of the deposits are saturated with groundwater and provide water for local wells and discharge to the surface in the form of springs or as base flow contributions to streams. In order to access the ore body, Exxon must penetrate this glacial aquifer and develop the mine far beneath the glacial deposits in the underlying bedrock. A permit for mine dewatering is required. An additional approval for potable water supply also is required, and Exxon submitted both applications in October 1983.

Pumping for mine dewatering will result in a large cone of depression in the groundwater. The cone of depression will reach its maximum extent several years after underground shaft development begins. Preliminary estimates of the size of the cone of depression indicate that it would extend up to several miles in diameter from the mine. To the extent that surface water features such as lakes, wetlands, and streams are connected to the groundwater table, the resultant cone of depression would cause reduced stream flows, lowered lake levels, and reduced water availability to wetlands and springs. Those surface water features perched above the groundwater table may not be impacted by the drawdown. The Department has requested additional information on the groundwater modeling effort, including a worst-case analysis of the cone of depression and model runs with varying assumptions.

The greater the amount of pumping for mine dewatering, the greater the potential impacts on surface water. Thus, an accurate estimate of the cone of depression is critical when evaluating the impacts of the project. The Department is carefully evaluating the mine inflow estimates developed by Exxon and has required additional computer modeling of these estimates.

In their environmental impact report, Exxon developed an analysis of impacts to the surface water features in the vicinity of the mine. Factors such as soil permeability, soil water storage, groundwater levels, and depth to bedrock, were important inputs to these analyses. In order to verify Exxon's calculations the Department has requested additional information on these critical factors. Exxon is now obtaining data through a series of hydrogeological investigations. These investigations involve drilling and sampling bottom sediments from Duck, Deep Hole, Skunk and Oak Lakes to test the permeability of bottom sediments. Analysis of these sediments will yield estimates of how mine dewatering may impact the water levels of those lakes. Exxon has estimated they will have gathered the required hydrogeological information by the middle of 1984; however, the completeness of their data can only be determined after analysis by Department hydrogeologists.

Drawdown of the groundwater level may impact drinking water wells in the vicinity of the mine. Depending on location, depth, type and other characteristics, certain wells may become dry or require modifications for continued service. In some instances water quality may be adversely affected, although not necessarily initially. For these reasons, the Department has instructed Exxon to conduct a thorough well inventory and a well water sampling program to determine the existing conditions of those wells likely to be impacted.

This inventory of water wells will provide a basis for determining if or when mine dewatering has impacted a given well. This will facilitate replacement of water service, of equal or better quality, by Exxon for those wells impacted by mine dewatering.

3. Wisconsin Pollutant Discharge Elimination System Permit

An integral part of the proposed project is the discharge of excess wastewater from the mine/mill complex and the associated wastewater treatment facility. Most of the wastewater from the tailings ponds and the reclaim ponds is recycled directly back into the mill. A small portion of this water as well as a portion of the contaminated mine water will be treated in the reverse osmosis treatment facility to enhance water quality in the mill circuit. The rest of the contaminated mine water will be treated in the lime precipitation process and then mixed with the uncontaminated mine water before discharge to Swamp Creek. An estimate 2000 gpm (3000 gpm max. flow) of treated contaminated mine water combined with untreated, uncontaminated mine water (intercepted groundwater) is proposed to be discharged through an underground pipeline into Swamp Creek, southwest of Rice Lake. State law (Ch. 147, Stats.) requires a Wisconsin Pollutant Discharge Elimination System (WPDES) Permit be obtained for the proposed discharge. State law (Ch. 144, Stats.)

also requires approval of engineering plans for the proposed wastewater treatment plant.

In December 1982, Exxon submitted the CH_2M Hill Phase III Water Management Study to the Department. This study provides part of the preliminary engineering for the wastewater treatment facility. After a thorough review, the Department requested that Exxon conduct pilot plant testing of certain treatment processes. This work will help verify whether the proposed lime precipitation treatment could achieve the desired effluent quality required prior to discharge. The information would also be useful in writing those sections of draft EIS pertaining to the wastewater treatment system, and would aid the Department in its review of engineering plans and specification under sec. 144.04, Stats. Exxon has initiated some pilot plant testing studies but additional work may be necessary. Formal comprehensive preliminary engineering plans have not yet been submitted.

In September 1983, Exxon submitted their WPDES permit application to the Department. The Department reviewed the application for completeness and is currently drafting portions of the permit. Effluent limitations will come from two sources. The U.S. Environmental Protection Agency has promulgated categorical effluent limits for cadmium, mercury, zinc, copper, total suspended solids (TSS) and pH for mine/mill complexes such as that proposed at Crandon. The second source will be water quality criteria proposed by DNR's Bureau of Water Resources Management in April, 1984 for the effluent as per ch. 144, Stats. These criteria are specific to Swamp Creek and ensure the protection of fish and aquatic life as well as the continued recreational use of Swamp Creek. As a result of the Department's stream classification for Swamp Creek, the criteria and resultant effluent limits will protect all aquatic organisms in the creek (the entire aquatic food chain). Criteria and water quality based effluent limits for arsenic, barium, cadmium, fluoride, lead, mercury, selenium, silver, copper, iron, zinc, chromium, cyanide, pH, total dissolved solids and biochemical oxygen demand (BOD) were developed by the DNR.

4. Air Quality Permit

Operation of the proposed Exxon Crandon Mine requires a permit for air emissions from the Department. A number of pollutants (e.g., particulates, sulfur dioxide, carbon monoxide, etc.) will be released during mining operations. The estimated air emissions for each pollutant are less than 250 tons per year, thus the project is exempt from federal prevention of significant deterioration regulations. This also means that the project would be classified as a minor source under Wisconsin regulations.

Exxon and Department personnel have recently completed discussions on needed changes in the air quality permit application and air impact analyses to be prepared by Exxon. A number of changes were made to air pollutant emissions and impact calculations based on Exxon's air pollution control changes and the Department's review comments on impact assumptions and air pollution calculations. As per the discussions Exxon is revising their air modeling computer analyses and will submit revised model runs of projected maximum daily and average annual air quality impacts for particulates and other key air pollutants. Following review and approval by the Department of the air modeling results, Exxon will revise their air permit application for resubmittal to the Department.

An additional subject to be addressed by Exxon involves further testing of the tailings for asbestiform mineralization. Asbestos fibers are a known health hazard, and while they have not been detected in the ore body waste rock, the Department has requested additional testing by Exxon for confirmation.

It is anticipated that following asbestiform mineralization testing and revision of their air permit application, Exxon will have submitted all the required information to the Department for the air permit. If the information received is acceptable, the Department should be able to make a preliminary determination of the approvability of the application by late 1984. Actual approval can only occur after the Master Hearing.

5. Mining Permit

One requirement of the state mining law is that a mining permit be issued by the Department of Natural Resources prior to the operation of a mine. Before granting the permit, the Department must examine all pertinent aspects of the mining proposal, including review of mining plans and processes, construction and operations aspects, economic impacts to the region, and reclamation and closure plans. In addition, to determine compliance with the detailed requirements of the statutes and Wisconsin Administrative Code, the Department must: develop quality assurance requirements and data verification procedures; assure that wetlands disturbance would be minimal; review the site selection process for tailings disposal; and approve an environmental monitoring plan. The Department's Mine Reclamation Section in the Bureau of Solid Waste Management is responsible for administering the provisions of the state mining law. Comment letters were sent to Exxon on their mining permit application September 19 and October 20, 1983, and May 25, 1984, and review continues.

<u>Master Hearing</u>

The mine permit process culminates with a contested case hearing referred to as the Master Hearing. At the Master Hearing, testimony is presented on aspects of all DNR-required permits, licenses and approvals and on the contents of the environmental impact statement prepared by the Department of Natural Resources. Any person or agency (e.g., township, city, tribe, individual, or group) whose interest may be adversely affected by the action may become a participant in the Master Hearing. Based on the Master Hearing record, decisions on the permits and possible permit conditions are rendered in addition to a determination of whether the Department has complied with the Wisconsin Environmental Policy Act in preparing the environmental impact statement. Based on the information yet to be submitted by Exxon and the time needed to prepare the environmental impact statement, the Department estimates the Master Hearing could begin in late 1986 or early in 1987. It is possible this schedule could be advanced with timely resolution of all issues and early submission of all required information.

Review of Exxon's Environmental Impact Report (EIR) and Preparation of DNR's Environmental Impact Statement (EIS)

Exxon submitted the initial portions of their environmental impact report (EIR) in December 1982. The purpose of the environmental impact report was to provide a description of the project, to provide baseline information on the affected environment, to discuss some of the alternatives considered by the applicant in designing the project, and to provide some numerical analyses of impacts. The Department is in the process of reviewing the EIR for adequacy and has solicited and received public comments. When the Department determines that sufficient information is available for its preparation of the environmental impact statement on the project, the EIR is declared to be "adequate."

The Department submitted detailed EIR comment letters to Exxon in May 1983 and December 1983. Exxon has provided detailed responses to both of those EIR comment letters and adequately addressed many of the comments and questions. Additional letters to Exxon commenting on the EIR will be sent as additional information is received and evaluated by the Department. While it is uncertain when the EIR will be finally determined to be "adequate," the current estimate is that this is likely to occur by May 1985.

The Environmental Impact Statement (EIS) is prepared in cooperation with other state agencies but coordinated by the Department of Natural Resources. The EIS includes much of the information in the EIR such as the description of the proposed action and a description of the affected environment. However, the EIS contains independent analyses of the potential positive and negative impacts resulting from the project and an analysis of alternatives and their impacts also. Before the final EIS is prepared, a draft EIS is circulated for public and agency review. The Department is currently preparing the initial portions of the draft EIS on those portions of the project for which adequate information is available. While the exact date of completion of the draft and final EIS are not known, the Department currently anticipates completing the draft EIS in late 1985 or early in 1986 and the final EIS by approximately the middle of 1986. These dates are tentative, and the draft and final EIS will be written in a timely manner as soon as the required information is available from Exxon.

Consultants Retained by The Department of Natural Resources

The proposed Exxon Crandon mine would have potential impacts on a variety of local and regional human and natural environments. Analysis of these potential impacts is especially challenging because of the magnitude and complexity of the project. Therefore, the Department of Natural Resources has retained a number of consultants to help in the analysis of impacts of the project as well as to verify the baseline data and analyses that Exxon has gathered and performed.

The Department has developed contracts with the United States Geological Survey, the Wisconsin Geological and Natural History Survey and a private consultant to aid in reviewing the hydrogeological analyses and impacts of the project. The Department has also asked the United States Geological Survey to review work conducted by Exxon on wetlands. This review includes examining the wetland hydrology model used to calculate wetland impacts, reviewing stream flow characterization including low flow and annual flow calculations, and aiding the Department in the analysis of the impacts of the wastewater discharge to Swamp Creek.

A consultant was hired for soil chemistry analyses, which includes a review of waste characterization studies, the contaminant attenuation capabilities of the glacial material beneath the mine waste disposal facility, and to review leachate testing. The purpose of the leachate testing is to determine the nature of the contaminants likely to be picked up by groundwater as it moves beneath the tailings disposal area.

The Department hired a consultant to review and verify Exxon's work on mine waste by-product marketing, especially sulfur, a component of pyrites in the tailings. In addition, because the project would have noise and vibration impacts on the local area, the Department also contracted with a consultant to review Exxon's environmental impact report and other submittals by Exxon and verify analyses of noise predictions. A socioeconomic consultant has been retained to review the socioeconomic portions of the EIR and to help develop the draft EIS and the final EIS.

These consultants will provide their expertise to the Department on specific subjects and will aid the Department in preparing certain sections of the environmental impact statement. They also will be available to provide testimony on their particular area of expertise at the Master Hearing.

All costs incurred by the Department for preparing the environmental impact statement, including the costs of environmental consultants for the Exxon project, are reimbursed to the general fund (Section 23.40, Stats.) by Exxon.

Socioeconomics

Exxon has conducted socioeconomic studies in the region of the proposed mine. The results of those studies are contained in two major documents, the "Report on Current Conditions" (August 1981) and the "Forecast of Future Conditions" (November 1983), as well as numerous supporting documents and appendices. The report on the current condition in the region provides background information on population, housing, personal income, employment and government and services (e.g., schools, police and fire protection, roads, water supply and wastewater treatment). The "Forecast of Future Conditions" is Exxon's estimate of what changes may occur in the region with the development of the mine and, in contrast, without the mine. The difference between these two sets of estimates are Exxon's predicted socioeconomic impact of mine development.

The Department must arrive at its own estimate of what the potential socioeconomic impacts would be. In doing so, the Department will use portions of the Exxon "Future Conditions Report," as appropriate, but has retained a socioeconomic consultant (Denver Research Institute) to carry the major responsibility for developing the forecasts. This consultant will also review the adequacy of the "Report on Current Conditions."

The socioeconomic portion of the EIS will address the following major areas of significant impacts: economics and business conditions; population, including current residents and newcomers likely to be attracted by the mine; housing and land use; government services; taxes; transportation; and sociocultural concerns, including a discussion of the special impacts likely to be felt by the Native Americans near the mine site.

Verification Activities of the Department

Verification is one of the important functions of the Department in evaluating the adequacy of an Environmental Impact Report (EIR). The Department is required by law to insure that the information included in the EIR is thorough and provides adequate data for assessing the potential impacts of the proposed action on the environment. The need for verification is particularly crucial for a project of the size and complexity of the proposed Exxon mine because of the types of impacts expected and the need to project long-term impacts in some instances.

Information supplied by Exxon in the EIR and permit applications is being verified in two ways. The first relies upon the professional judgement of Department technical staff to determine adequacy. Most of the information has been verified in this fashion. The second requires independent sampling and quality control checks to assure the validity of the data. Various techniques such as independent field surveys, split samples, laboratory and field procedure inspections and the use of independent laboratories have been used. Fisheries, surface water and groundwater quality and quantity, and soil chemistry concerns have required extensive verification work by the Department. In some of these areas, verification activities continue because additional data are being gathered by Exxon.

Although the amount of verification depends on the subject, the overall goal is to assure the accuracy of the data by a representative sample. When the data from Exxon or their consultants have been independently verified, they are then considered to be acceptable for use in the environmental impact statement and for review of permit applications.

Public Input to Department Review of Exxon's Project

Throughout the Exxon project review, it has been the Department's objective to involve the public to the maximum extent practical. By necessity, the information exchange between the Department and the general public must be a two-way exchange. It is the Department's responsibility to explain the permit review and the environmental impact processes in the context of the project proposed. The permit review and environmental impact process are designed so that members of the general public who may be impacted by the project and who chose to become involved may do so in an effective manner and at the best time. On the other hand, the input of municipalities, Native American tribes, and the potential newcomers is essential in "scoping" the issues, that is, identifying the important as well as unimportant concerns.

To encourage public input into the review process, the Department established a network of 14 public libraries across the state where Exxon's environmental impact report and associated consultant reports are located. In addition, all significant correspondence and publications are routinely sent to the libraries and will continue to be sent throughout the project duration. The public libraries maintained as repositories are the public libraries located in Antigo, Ashland, Crandon, Eau Claire, Green Bay, Hayward, Ladysmith, Madison, Milwaukee, Platteville, Rhinelander (including Nicolet College), Stevens Point, and Wausau. Complete Exxon file information is also available for public use at both the Madison and Rhinelander Department offices. All information in the Department's Exxon files is public information and accessible to anyone during normal working hours.

Within the past year the Department conducted two public meetings in the Crandon area where Department technical staff were present to answer questions on the mining proposal. Periodically, North Central District staff and Madison personnel have met with municipal leaders, local mining impact committees, tribal leaders and individuals to discuss mining issues and their concerns about the project. The Department will continue to hold both official and informal meetings on a periodic basis or as requested in order to maintain an effective project dialogue. Comments from the general public on Exxon's consultant reports were requested, and when the draft environmental impact statement is completed, comments will be requested again.

For further information from the Department contact:

Rhinelander District Office
(715) 362-7616

Citizen participation:

Gen Bancroft
(608) 267-7758

For technical questions:

Robert Ramharter
Project Coordinator
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(608) 266-3524

4818Y

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

September 10, 1984

File Ref 1630
(Exxon)

Dear Librarian:

Exxon has provided the Department with the following documents pertaining to the firm's proposed Crandon Mine Project. They are enclosed for the public's information. Please place them with the rest of the Exxon Crandon Mine Project Environmental Impact Report (EIR) material.

1. RESPONSES TO DNR COMMENT LETTER DATED MAY 25 ON THE MINING PERMIT APPLICATION, by Exxon, July 31, 1984.

2. ERRATA FOR AUGUST 1983 SUPPLEMENTAL WETLANDS ASSESSMENT REPORT CRANDON PROJECT, by Interdisciplinary Environmental Planning, Inc., August, 1984.

Thank you for your assistance.

Sincerely,
Bureau of Environmental Analysis and Review

Carol Nelson

Carol Nelson
Environmental Specialist

enclosure

RESPONSES TO DNR COMMENT LETTER DATED MAY 25, 1984
ON THE MINING PERMIT APPLICATION

Comment No. 1 (Comment 5):

The table of reclamation costs should be revised to use consistent units. The first three pages (18-20) use english units while the following three pages present the costs in metric units.

Why do the contingency amounts included in the reclamation costs vary from 5% to 39% of the total cost of reclamation for the various facilities?

There appears to be some lack of uniformity in the estimated reclamation costs. Following are examples of apparent inconsistencies which should be addressed.

1. Removal of the bituminous concrete pavement for the access road is estimated to cost $2/yard, while pavement (asphalt and concrete) removal for the mine/mill site is $5/yard.

2. The unit cost for turf establishment at the mine/mill site is estimated at $2000/acre, while turf establishment at the MWDF is $2900/hectare ($1174/acre).

3. The estimated unit costs for the various activities, with the exception of turf establishment, included in the reclamation costs of the MWDF vary from pond to pond.

Do the costs for the reclamation of the reclaim ponds include the costs of removing and disposing of the liners, slope protection materials and sludge?

Do the regrading costs for the access road and railroad include removal of fill material from the wetland areas located within these corridors?

Response:

The attached tables of reclamation costs have been revised to include both English and metric units.

For these cost estimates the contingency amounts were varied according to the nature of the reclamation work. Generally, a cost contingency range of 5 to 15 percent was used, depending upon the reclamation work. A cost contingency greater than 15 percent was used for reclamation work with larger uncertainties. For example, the mine/mill site area reclamation work was assumed to have a higher degree of uncertainty and therefore a higher cost contingency was used. For reclaim ponds R1 and R2, a higher cost contingency was used because the cost of sludge removal was not included in the original estimate.

The apparent inconsistencies in the various unit rates, are a result of reclamation work of different nature. For example, bituminous concrete pavement removal for the access road represents only bituminous pavement for a continuous stretch of highway approximately 4.0 km (2.5 miles) in length.

(TABLE FOR RESPONSE TO COMMENT NO. 1 [COMMENT 5])

TOTAL ESTIMATED RECLAMATION COSTS FOR THE CRANDON PROJECT IN 1982 DOLLARS

Facility or Facility Group	Reclamation Year(s)*	Cost (K$)
Access Road	29	$350
Railroad Spur	29	500
Haul Road and Tailings Transport Corridor	29	100
Mine/Mill Site Area	27-29	8,000
Mine Waste Disposal Facility		
Tailings Pond T1	9	4,000
Tailings Pond T2 (Partial)	16	2,000
Tailings Pond T3	23	5,000
Tailings Pond T4 and T2	27-29	10,000
Reclaim Ponds R1 and R2	27-29	1,000
Excess Water Discharge System	29	10
Mine	27	300
TOTAL PROJECT RECLAMATION COST		$31,260

*Start Project Construction in Year 1.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 1 [COMMENT 5])

Access Road	Cost (K$)
Remove bituminous concrete pavement 37,625 m^2 @ \$2.39/m^2 (45,000 yd^2 @ \$2/yd^2)	\$90
Remove crushed aggregate base course 26,759 m^3 @ \$2.62/m^3 (35,000 yd^3 @ \$2/yd^3)	70
Regrading 83,612 m^2 @ \$0.60/m^2 (100,000 yd^2 @ \$0.5/yd^2)	50
Vegetation (seed and fertilizer) 83,612 m^2 @ \$0.60/m^2 (100,000 yd^2 @ \$0.5/yd^2)	50
Remove Swamp Creek Crossing Structure	50
Contingency (11%)	40
TOTAL ESTIMATED RECLAMATION COST	\$350

RECLAMATION COSTS

Railroad Spur

(Salvage value not included)

Remove track and ties 8,534 m @ \$32.81/m (28,000 ft @ \$10/ft)	\$280
Remove ballast and subballast 38,228 m^3 @ \$2.62/m^3 (50,000 yd^3 @ \$2/yd^3)	100
Regrading 66,890 m^2 @ \$0.60/m^2 (80,000 yd^2 @ \$0.5/yd^2)	40
Vegetation (seed and fertilizer) 66,890 m^2 @ \$0.60/m^2 (80,000 yd^2 @ \$0.5/yd^2)	40
Remove Swamp Creek Crossing Structure	10
Contingency (6%)	30
TOTAL ESTIMATED RECLAMATION COST (with no salvage value included)	\$500

RECLAMATION COSTS	Cost(k$)
Rock Haul Road and Tailings Transport Corridor	
Buried Pipe Removal	
Excavation - 3,823 m^3 @ \$2.62/m^3 (5,000 yd^3 @ \$2/yd^3)	10
Pipe Removal - 3,048 m @ \$6.56/m (10,000 ft @ \$2/ft)	20
Backfill and Cover with 0.15 m (0.5) Foot Soil	
7,646 m^3 @ \$3.92/m^3 (10,000 yd^3 @ \$3/yd^3)	30
Regrading	
25,084 m^2 @ \$0.60/m^2 (30,000 yd^2 @ \$0.5/yd^2)	15
Vegetation (seed and fertilizer)	
25,084 m^2 @ \$0.60/m^2 (30,000 yd^2 @ \$0.5/yd^2)	15
Contingency (10%)	10
TOTAL ESTIMATED RECLAMATION COST	$100

RECLAMATION COSTS	Cost (K$)
Mine/Mill Site Area	
Building Demolition	
707,921 m^3 @ \$3.53/m^3 (25,000,000 ft^3 @ \$0.10/ft^3)	\$2,500.0
Pavement Removal (asphalt and concrete)	
83,612 m^2 @ \$5.98/m^2 (100,000 yd^2 @ \$5.00/yd^2)	500.0
Foundations/Slabs Removal	
19,114 m^3 @ \$78.48/m^3 (25,000 yd^3 @ \$60/yd^3)	1,500.0
Pipe Removal	
12,192 m @ \$16.40/m (40,000 ft @ \$5.00/ft)	200.0
Railroad Track and Tie Removal	
3,048 m @ \$32.81/m (10,000 ft @ \$10.00/ft)	100.0
Site Regrading and Topsoil Replacement	
214,075 m^3 @ \$3.92/m^3 (280,000 yd^3 @ \$3.00/yd^3)	840.0
Turf Establishment	
40.47 ha @ 4942/ha (100 acres @ \$2000/acre)	200.0
Contingency (27%)	2,160.0
TOTAL ESTIMATED RECLAMATION COST	\$ 8,000.0

RECLAMATION COSTS

Mine Waste Disposal Facility

Tailings Pond T1 (Construction Phase 3)	Cost (K$)
Grading Cover	
714,000 m^3 @ $1.38/$m^3$ (933,877 yd^3 @ $1.06/$yd^3$)	$ 984.3
Bentonite Seal	
50,000 m^3 @ $20.69/$m^3$ (65,397 yd^3 @ $15.82/$yd^3$)	1034.4
Overdrain	
66,000 m^3 @ $10.29/$m^3$ (86,325 yd^3 @ $7.87/$yd^3$)	679.4
Cover Layer	
304,000 m^3 @ $1.76/$m^3$ (397,617 yd^3 @ $1.35/$yd^3$)	534.0
Turf Establishment	
53 ha @ $2900/ha (131 acres @ $1174/acre)	153.7
Contingency (15%)	614.2
Subtotal	$4000.0

Tailings Pond T2 (Partial Reclamation) (Construction Phase 4)	
Grading Cover	
1,132,000 m^3 @ $1.42/$m^3$ (1,480,600 yd^3 @ $1.09/$yd^3$)	$1601.9
Turf Establishment (Partial)	
15 ha @ $2900/ha (37 acres @ $1174/acre)	43.5
Contingency (18%)	354.6
Subtotal	$2000.0

Tailings Pond T3 (Construction Phase 5)	Cost (K$)
Grading Cover	
928,000 m^3 @ $1.53/$m^3$ (1,213,778 yd^3 @ $1.17/$yd^3$)	$1424.1
Bentonite Seal	
59,000 m^3 @ $21.43/$m^3$ (77,169 yd^3 @ $16.38/$yd^3$)	1264.4
Overdrain	
79,000 m^3 @ $10.20/$m^3$ (103,328 yd^3 @ $7.80/$yd^3$)	805.6
Cover Layer	
360,000 m^3 @ $1.84/$m^3$ (470,862 yd^3 @ $1.41/$yd^3$)	662.0
Turf Establishment	
55.5 ha @ $2900/ha (137 acres @ $1174/acre)	161.9
Contingency (14%)	682.0
Subtotal	$5000.0

Tailings Pond T4 and remaining T2 reclamation (Construction Phase 6)	
Grading Cover	
1,071,000 m^3 @ $1.55/$m^3$ (1,400,815 yd^3 @ $1.19/$yd^3$)	$1655.3
Bentonite Seal	
173,000 m^3 @ $20.09/$m^3$ (226,275 yd^3 @ $15.36/$yd^3$)	3475.8
Overdrain	
230,000 m^3 @ $10.24/$m^3$ (300,829 yd^3 @ $7.83/$yd^3$)	2354.2
Cover Layer	
1,053,000 m^3 @ $1.50/$m^3$ (1,377,272 yd^3 @ $1.15/$yd^3$)	1584.0
Turf Establishment (Partial)	
141.5 ha @ $2900/ha (350 acres @ $1174/acre)	410.4
Contingency (5%)	520.3
Subtotal	$10,000.0

Reclaim Ponds R1 and R2	Cost (K$)
Regrading	
402,000 m^3 @ $1.29/$m^3$ (525,796 yd^3 @ $0.99/$yd^3$)	518.2
Turf Establishment	
30.0 ha @ $2900/ha (74 acres @ $1174/acre)	87.0
Contingency (39%)	394.8
Sub Total	$ 1,000.0
TOTAL ESTIMATED MWDF AND RECLAIM POND RECLAMATION COST	$22,000.0

Reclamation Costs

Excess Water Discharge System

Concrete plugs at pipe ends, remove discharge structure and riprap, regrade disturbed areas Turf establishment as necessary	
TOTAL ESTIMATED RECLAMATION COST	$ 10.0

Reclamation Costs

Mine

Concrete plugs for the four shafts at overburden/bedrock interface, backfill to surface	
TOTAL ESTIMATED RECLAMATION COST	$ 300.0
GRAND TOTAL ESTIMATED RECLAMATION COST (OVERALL CONTINGENCY 15%)	$31,260.0

The unit cost for the mine/mill site area pavement removal included asphalt and concrete pavement removal at a higher estimated cost. The turf establishment unit cost differences between the MWDF and the mine/mill site are the result of a contractor estimate for the MWDF based on a much larger job with assumed economies of scale for similar type operations throughout the various stages of reclamation. Because the mine/mill area reclamation work is for a more dispersed physical area it was assumed to have a higher unit cost.

For the various earthwork related reclamation activities at the MWDF, the cost differences are a result of the different haul distances from the construction support area and stockpile area to the particular pond being reclaimed. The reclamation costs are directly related to the hauling distances.

For the reclamation cost estimate of the reclaim ponds, the contractors estimate included costs for removing and disposing of the liners and all slope protection materials. However, sludge removal was not included in the initial contractor estimate; therefore, a higher contingency was used in the estimated reclamation cost of the reclaim ponds.

The reclamation plan for the access road and the railroad did not include removal of fill materials and restoration of wetland areas. The roadbeds and embankments were left intact along both corridors.

Comment No. 2 (Comment 7):

The maps provided with this response should show the ponds or wetlands that will serve as infiltration areas for water draining off the reclaimed tailings ponds. These infiltration areas could affect existing wetlands and/or create new wetlands.

Response:

Work is currently underway by Ayres Associates to determine a complete water balance for the reclamation cap and the perimeter area of the MWDF within the compliance boundary. This work will include maps that will show the surface water movement through the 1200 foot perimeter zone and also depict the water balances on a watershed-by-watershed basis. The maps prepared with this work will be included with the revised Mining Permit Application.

Comment No. 3 (Comments 9 - 31):

(General) Exxon seems to dismiss many of the Department's comments regarding monitoring. The comments were not merely suggestions on the Deprtment's part. Rather, Exxon should meet with the various Department programs to finalize the monitoring requirements. The final monitoring plan, specifying all monitoring to be conducted by Exxon, must be made part of the revised mining permit application. Following are some specific comments related to the monitoring plan.

The surface water monitoring program (listed in Table 3, Section A, Volume I of the Mining Permit Application) should be initiated at least one year prior to construction to provide an adequate premining data base. Exxon should specify when the surface water program would begin relative to the construction phase. Also, chromium, barium and fluoride should be added to the list of parameters to be sampled for in Footnote #1, Table 3 of Section A.

Response:

Exxon did not dismiss any of the DNR's comments regarding monitoring. As was discussed with the DNR staff at a meeting on June 27, 1984, the Monitoring and Quality Assurance Plan (Monitoring Plan) was developed considering the most appropriate and cost-effective methodology which could be used to determine Crandon Project related impacts. As was also discussed with the DNR on June 27, all of the Department's comments were considered; however, as was noted at the meeting, the basic programs of the Monitoring Plan provide data to evaluate Project effects.

As was also discussed at the June 27 meeting, we will continue to meet with the appropriate DNR staff to finalize the monitoring requirements. A revised Monitoring Plan incorporating all agreed changes will then be submitted to the DNR as part of the revised Mining Permit Application.

The surface water monitoring program will be discussed with appropriate DNR staff as soon as possible. The revised Monitoring Plan will include the changes for parameter analysis as well as program initiation.

Comment No. 4 (Comment 10):

The Bureau of Water Supply is currently developing a plan for a water well survey, well water quality sampling and quality control/quality assurance provisions. Any provisions of the plan for pre-mining sampling and sampling during operation must be included as part of the revised monitoring plan.

Response:

Exxon is currently conducting a sampling program with the advice of the Bureau of Water Supply. We will continue to work with this Bureau's staff to develop the necessary monitoring program for the construction and operation phases. The appropriate changes will be included in the revised Monitoring Plan.

Comment No. 5 (Comment 12):

Some monitoring will likely be required for the preproduction ore storage area. These requirements will be determined after the plans for this facility have been submitted to the Department.

Response:

Comment acknowledged.

Comment No. 6 (Comment 13)

Department staff feel quite strongly that Oak Lake should be included in the surface water monitoring program. Oak Lake is a valuable resource with excellent water quality and deserves protection. Due to its proximity to the orebody, Oak Lake could be impacted. During the construction phase, the existing soil structure around the mine-mill complex will be disturbed. Since the natural drainage to this area is to Oak Lake, the Project could affect the lake. In addition, since Oak Lake is very near the orebody, potential impacts from airborne contaminants may also exist.

Further, the potential impacts to Oak Lake due to mine dewatering have not been determined. The expanded hydrogeological program currently being conducted by Exxon includes sediment sampling, water budget preparation and piezometer installation beneath Oak Lake. Until these data have been received and reviewed, this response is considered to be incomplete.

Response:

As was discussed at the June 27, 1984 meeting, we also consider Oak Lake as being a resource with excellent water quality. However, our review of the surface water drainage patterns indicated only a small portion of the watershed would be affected by development of the mine/mill complex with no direct impact to Oak Lake. Similarly, air quality modeling predictions indicated no effect from airborne contaminants to Oak Lake.

However, we will continue to work with the DNR staff to develop an appropriate monitoring program for Oak Lake if it is deemed necessary from evaluations of the recent sampling and ground water modeling predictions.

Comment No. 7 (Comment 17):

The predicted limit of the ground water drawdown zone of influence may change in light of additional ground water modeling efforts and field data from the hydrogeological program. For example, the use of a zero recharge area northeast of Rolling Stone Lake in the model and the use of Rolling Stone and Pickerel Lakes as "no-flow" boundaries in the model, all affect apparent drawdowns in this area. Additional model simulations and additional field data are necessary to determine water level effects in this area of the Project. Therefore, this response is not adequate and flow monitoring of these surface water bodies may still be necessary.

Response:

Comment acknowledged. However, the ground water program in the Monitoring Plan will have sampling locations to detect ground water changes which might affect Rolling Stone Lake and its tributaries long before they would be determined from sampling stations at these water bodies.

Comment No. 8 (Comment 23a):

This response is inadequate. There is no discussion of the sampling rationale presented for the sites on Swamp Creek associated with the wastewater discharge (sites U, A, DS). Additional surface water monitoring below the proposed discharge location in Swamp Creek and in the Wolf River may be required at the time of start-up of mine operations. The parameters to be monitored would reflect the list of pollutants identified in the WPDES permit.

Response:

As agreed at the June 27, 1984 meeting, we will continue discussions with the DNR staff on the surface water monitoring program. A detailed rationale for the appropriate program will be included in the revised Monitoring Plan.

Comment No. 9 (Comment 23b):

This response indicates that copper will be one of the measured parameters for the lake sampling program, but copper is not included on Table 3 of the monitoring plan. The department feels that copper should be included in addition to several other parameters such as dissolved oxygen, phosphorus, and additional heavy metals.

The Department does not agree with Exxon's response regarding biological monitoring. Biological monitoring is an important tool in detecting changes that may occur in the aquatic environment as a result of the mining activity. Biological parameters should not be secondary to physical-chemical parameters for detecting environmental changes as Exxon has indicated. Monitoring of the biota can frequently reveal sensitive changes occurring in the environment that chemical monitoring may miss.

Exxon should attempt to conduct spring and fall lake sampling during isothermal lake conditions ("turnover") to provide meaningful data.

As discussed under Comment 13, Oak Lake should be included in the lake monitoring program.

Response:

All of these comments will be discussed further with DNR staff to develop an appropriate surface water monitoring program. The rationale for the agreed program will then be detailed in the revised Monitoring Plan.

Comment No. 10 (Comment 23c):

This response indicates that several metals will be included in the sampling schedule, but these metals don't appear on Table 3. What parameters are actually included in the lake monitoring program?

Also, for shallow basins such as Skunk Lake, the criteria for deciding whether to sample at mid-depth or at several depths should be based on measurable data like temperature and dissolved oxygen profiles. If a lake is thermally stratified, then samples at the different depths are necessary. If no stratification is indicated, then single depth samples would suffice.

Response:

As mentioned previously, we will continue discussions with DNR staff to develop an appropriate surface water monitoring program. The rationale and any changes will be detailed in the revised Monitoring Plan.

Comment No. 11 (Comment 23d):

As discussed under Comment 23b the Department disagrees with Exxon's position on biological monitoring. The Department still feels that secchi depth and total-P should be included in the sampling schedule. Phosphorus is one of the most important parameters for lake quality assessment, especially during spring and fall turnover periods and secchi depth measurements would provide a comparative measure of water clarity throughout the monitoring period with a very minimal amount of effort required by field personnel.

Response:

As discussed at the June 27, 1984 meeting, we do not contemplate nor have we proposed having any discharges with phosphorus concentrations. Therefore, secchi depth and total-P measurements are not proposed for the surface water monitoring program since there is no rationale for what Project activity would effect these parameters. However, as mentioned previously, we will continue discussions with DNR staff to develop an appropriate surface water monitoring program. The rationale and any changes will be detailed in the revised Monitoring Plan.

Comment No. 12 (Comment 23g):

Any outlets for sedimentation ponds serving the mine/mill site should be located on Figure 4 of the monitoring plan.

Response:

The outlets for the sedimentation ponds serving the mine/mill site will be shown on the appropriate figures of the revised Monitoring Plan.

Comment No. 13 (Comment 26):

Exxon responded to this comment under Comment 23, and as stated above, the Department does not agree that biological parameters are secondary in importance to physical-chemical parameters for detecting environmental changes. Chemical monitoring indicates instantaneous conditions compared to biological indicators which will reflect short-term fluctuation which could be missed by a monthly monitoring program. There is also the possibility that the monthly monitoring parameter list may not include something that could affect the biota, and the only way to detect this change is through monitoring the biological parameters. This would especially be true of streams.

Response:

We did not respond that biological parameters were secondary in importance to the physical-chemical parameters for detecting environmental changes. However, as your comment indicates, chemical monitoring does indicate instantaneous conditions and changes which may or may not have some effect on the biological components of the ecosystem. It is doubtful that Project effects could be related to any biological population differences unless some physical-chemical parameter indicated a change from current conditions.

Therefore, the submitted Monitoring Plan and our earlier responses to your comments indicated our concern to detect these changes first and immediately, before undertaking a general or wide-ranging biological monitoring program.

However, as mentioned previously, we will continue discussions with DNR staff to develop an appropriate surface water monitoring program. The rationale and any changes will be detailed in the revised Monitoring Plan.

Comment No. 14 (Comment 27c):

It is stated in this response that three macroinvertebrate taxa may be selected for tissue analysis. What is the rationale behind the selection of these particular species? Consideration should be given to factors like the proximity of test species to the sediment, and the known ability of certain species to bioaccumulate metals.

Response:

The macroinvertebrate taxa identified for tissue analysis included crayfish (Orconectes spp.), clams (Fusconaia sp. or Lampsilis spp.) and snails (Campeloma sp.). These taxa were selected because they occur in Swamp Creek in the vicinity of the proposed discharge site and are present in sufficient numbers to allow collection of an adequate sample for tissue analysis.

Selection of representative taxa for tissue analysis, other than those identified above, will be done in conjunction with DNR staff. In the final selection of taxa, consideration will be given to habitat affinity of each taxon and the known ability of the species to bioaccumulate metals as reported in the literature.

Comment No. 15 (Comments 28, 29 and 30):

Exxon must prepare and submit complete, detailed construction and operation phase air monitoring plans as outlined by the Air Monitoring Section. These plans will be part of the overall monitoring plan contained in the mining permit application. The air permit application should contain a summary of the air monitoring plans and reference the detailed monitoring plans which will be part of the mining permit application. A determination of the need for asbestiform fiber monitoring will be made following review of the results of the recent testing program.

Response:

We have discussed construction and operation phase air monitoring programs with the Bureau of Air Management, including the Air Monitoring Section. The agreed air monitoring program will be included in the revised Monitoring Plan as part of the Mining Permit Application. The Air Permit Application will include the appropriate sections from the Monitoring Plan. We will discuss the need for asbestiform fiber monitoring with DNR staff after completion and evaluation of the current testing program.

Comment No. 16 (Comment 31):

The results of DNR wildlife monitoring programs will probably not show any significant impacts as a result of the project since these studies are regional in nature, and the impacts should be relatively local. Additional evaluation by the Department, of the need and procedures for wildlife monitoring is necessary and these findings will be provided to Exxon at a later date.

Response:

Comment acknowledged.

Comment No. 17 (Comment 32):

The net worth test method of providing proof of owner financial responsibility can only be used to satisfy the long-term care requirements for the MWDF. The costs associated with closing the MWDF must be made part of the reclamation bond as specified in section NR 182.16, Wis. Adm. Code.

Response:

Comment acknowledged.

Comment No. 18 (Comment 45):

In general, the response to this comment is adequate. Obviously, more detail regarding mine drainage and dewatering will have to be included in the high capacity well and mine dewatering approval. The interceptor system ground water monitoring plan should be specified. Plans should also be included for alternate discharge in the event this "clean" water source is found to be contaminated. The additional data collection and modeling efforts may also change some of the assumptions incorporated into this response.

Response:

Comments acknowledged.

Comment No. 19 (Comment 49):

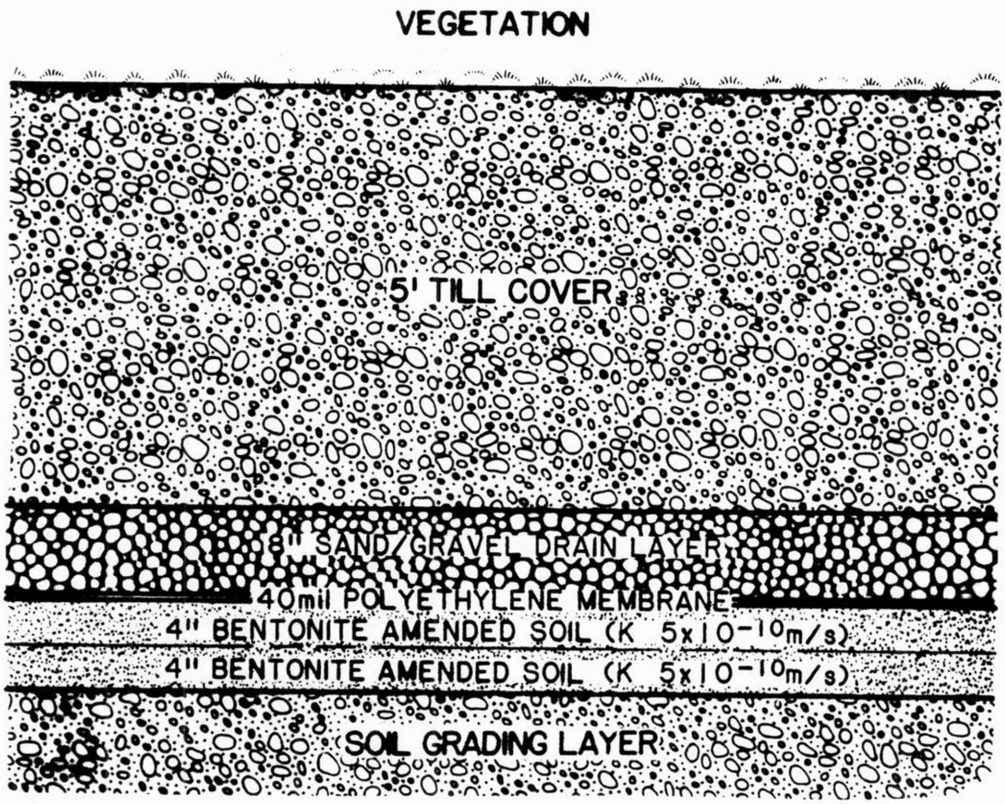
A. Up to this point, essentially no detail concerning the preproduction ore storage area has been provided. Details of the design, construction, operation, and reclamation of this facility must be discussed.

B. Any use of this facility for purposes other than preproduction ore storage (e.g., ore surge area or concentrate storage) must also be thoroughly described.

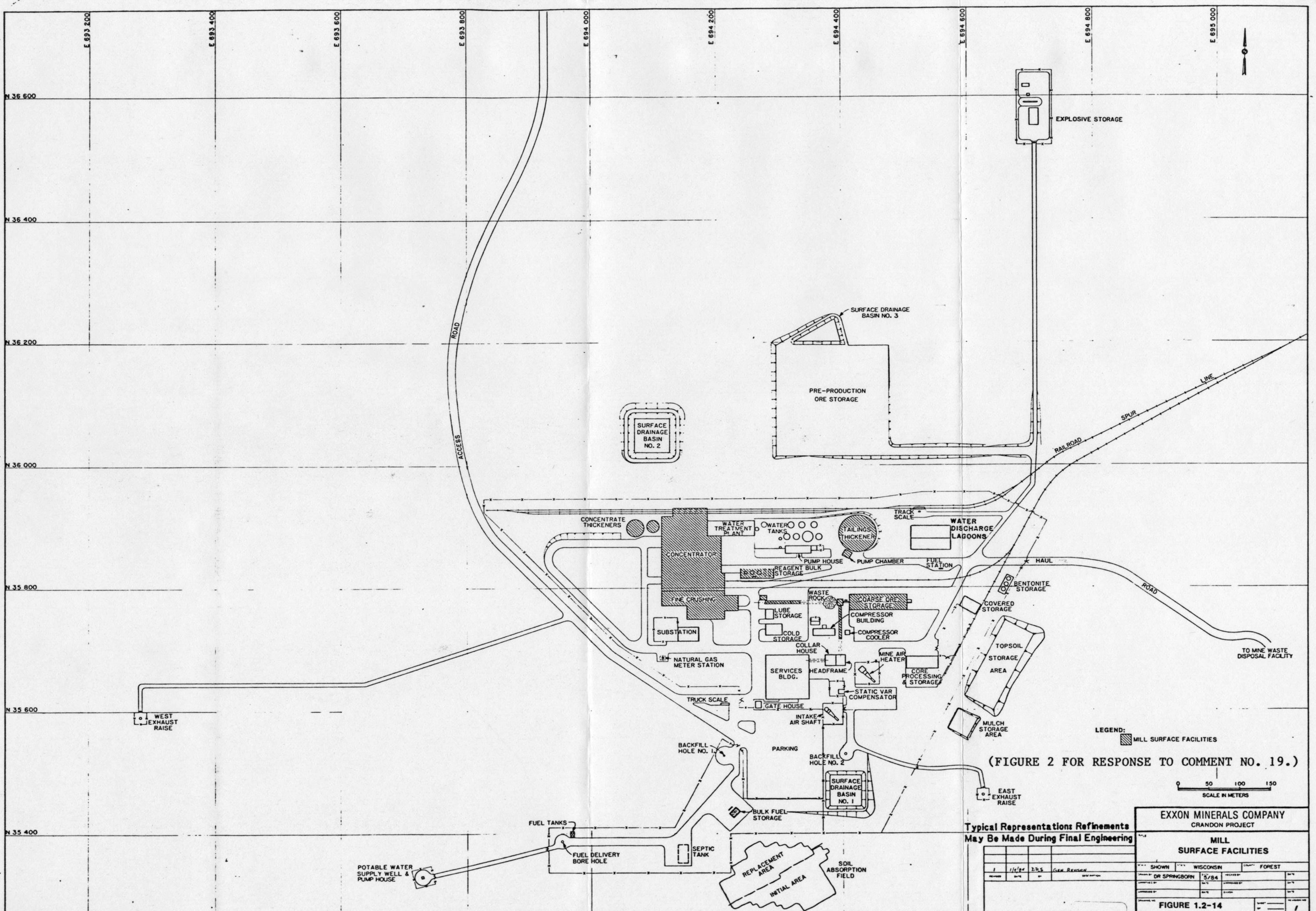
Response:

A. The preproduction ore storage area is designed and constructed with a liner system similar to the tailings ponds (Figure 1) and a peripheral drainage ditch with a permanent collection basin and a sump (Figures 2

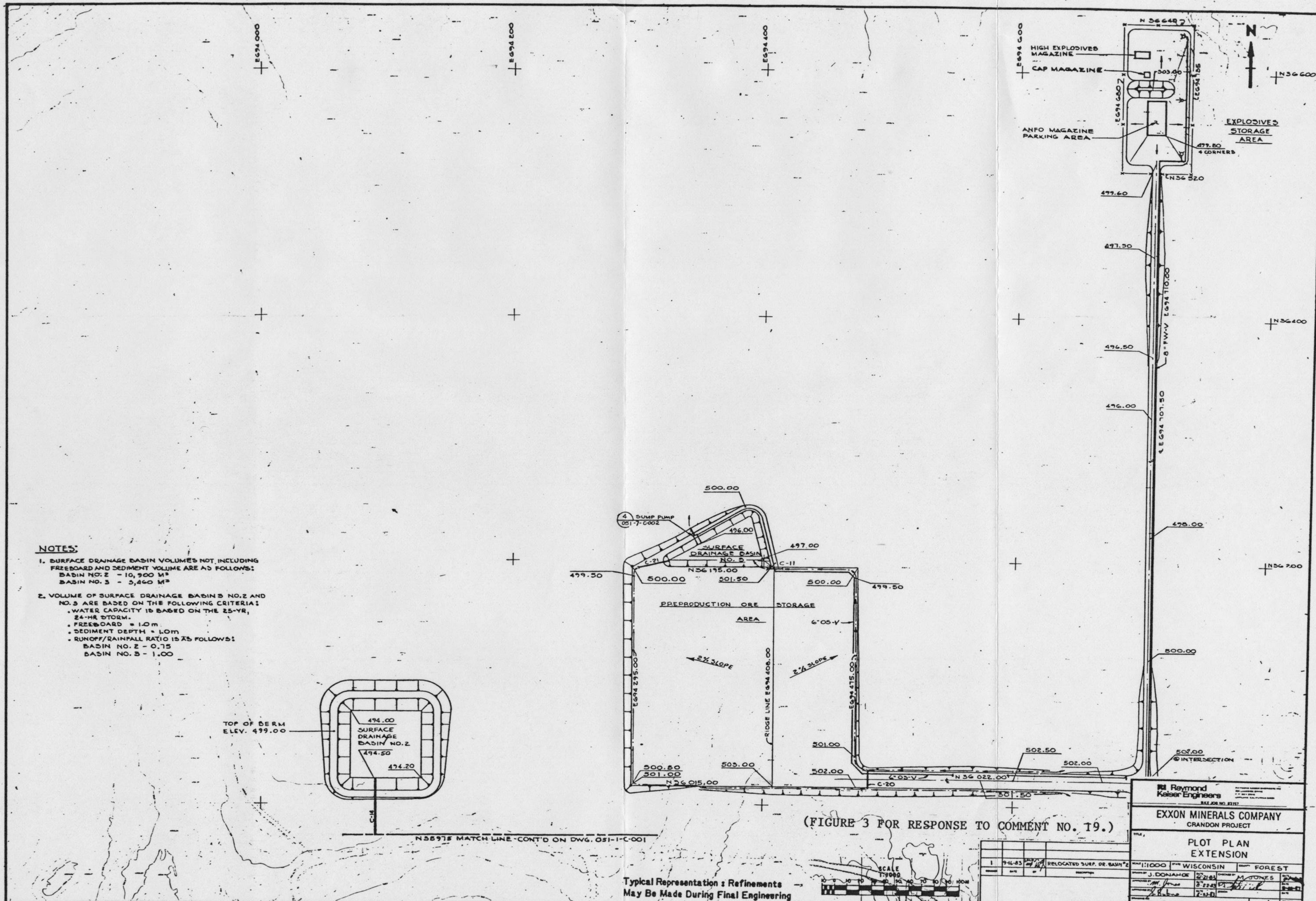
MWDF
CRANDON PROJECT
TAILINGS POND RECLAMATION SEAL



(FIGURE 1 FOR RESPONSE TO COMMENT NO. 19.)



(FIGURE 2 FOR RESPONSE TO COMMENT NO. 19.)



(FIGURE 3 FOR RESPONSE TO COMMENT NO. 19.)

051-1-G-002

and 3). This drainage basin volume is based on the following criteria:

- Water capacity is based on 25-year, 24-hour storm
- Freeboard - 1.0 m
- Sediment depth = 1.0 m
- Runoff/rainfall ratio of 1.00

With the above criteria, the basin volume not including freeboard and sediment volume equals 3,460 m^3. This arrangement will ensure that any precipitation will be captured and treated.

Operation of the preproduction ore pad is expected to commence in month 22 of the construction phase. Uncrushed (run-of-mine) ore will be hoisted from underground and hauled to the pad.

The haul and storage schedule is planned as follows:

Construction Month	Ore Stockpiled (metric tons)
22-32	62,000
33	27,000
34	58,000
35	79,000
36	85,000
37	86,000
38	87,000
39	88,000
40	95,000
41	74,000
42	-31,000 (withdrawn and processed)

The maximum amount of ore stockpiled at any time is expected to be 741,000 t (815,100 short tons) at month 41.

Ore will be withdrawn from the stockpile using front-end loaders and loaded into trucks for haulage to the mill.

These trucks will discharge the ore to a temporary primary crusher, which will crush the ore prior to its being conveyed into the coarse ore storage building.

Withdrawal of ore from the preproduction ore stockpile will begin in month 41 of the construction phase. The preproduction ore stockpile is expected to be depleted by month 18 of the operation phase. Monthly rates of ore withdrawal will depend on mine production rates and will range from 7,000 to 60,000 t (7,700 to 66,000 short tons) per month.

Reclamation of the facility will include the removal and disposal of the liner system in the tailing ponds. The remaining surface will then be graded, topsoiled, and revegetated.

B. See Comment No. 34 (Comment 121).

Comment No. 20 (Comment 59):

The response indicates that there is no longer a need to provide large volume surge storage capacity for backfill sands. Exxon should more clearly describe how the mine plan was revised so that the backfill sands storage area is no longer needed.

As discussed in relation to Comment 49, greater detail is needed for the description of the preproduction ore storage area.

Response:

The need for storage of backfill sands was based on a preliminary mine and mill plan. This plan envisioned the start of the underground stoping operation after the completion of the primary underground crusher. This, in turn, meant that when the mill started (at the same time underground stoping started), there was no space underground to receive the backfill material. Storage area was, therefore, provided for this early backfill product along with receiving the intermittent quantities that could not be immediately utilized underground at other times during mine operations.

A revised mine/mill plan has been developed to allow the mill to begin concentrate production earlier and provides for an empty stope underground to receive backfill when the mill starts operation. This will be accomplished by mining the first two underground stopes during the last six months of underground construction. This preproduction ore, along with the mine development ore (i.e. drifts), will be stockpiled on the preproduction ore storage pad. In addition, an allowance for a small amount of backfill surge capacity in the concentrator building eliminates the need for a large storage area for backfill sands. The revised plan has the added advantages of shortening the haul distance between the main mine shaft and the preproduction ore storage pad (i.e. rather than storage at the MWDF as originally proposed) and reducing the traffic in the MWDF area.

Comment No. 21 (Comment 62):

What will be done to control dust emissions from the soil processing plant?

Response:

The soil processing plant will have an associated air pollution control system which will include either a baghouse or insertable collector for particle retention. The revised air permit application will include this information as discussed with the Bureau of Air Management. For further information, see Appendix B of the submitted air permit application and response to comment E4 of the January 24, 1984, letter to Mr. Steve Klafka of the Bureau of Air Management.

Comment No. 22 (Comment 66):

A. Will the entire length of each pipeline be constructed and leak tested under pressure, with clear water, prior to backfilling or will they be constructed, tested and backfilled in segments?

B. The last paragraph on page 79 indicates that the tailing pipeline will be subjected to periodic scheduled shutdowns. What is the expected frequency and duration of these shutdowns? Will they necessitate total mill shutdown?

C. Exxon states in the sixth paragraph on page 80 that a pipeline break could be cause for complete plant shutdown. If the mill remains in operation, what is done with the tailings?

D. More information is needed concerning leak detection for the tailings pipeline. Where, along the line, will flow rate monitoring devices and pressure gauges be located? Approximately what magnitude leaks are actually detectable using the proposed system? How is it determined where a failure (total and partial) has occurred and hence where to initiate clean-up measures?

Response:

A. The opportunity exists to test the pipelines before or after backfilling and to test them as a complete system or in segments. Further details of the construction and testing procedures will be developed during detailed engineering.

B. The tailings pipeline is part of a continuous system which includes the grinding mills, flotation plant, tailings thickener, tailings disposal pipeline and its associated pumps.

When a mill shutdown is scheduled for major repairs or because of a shortage of ore, the entire system including the pipeline is shutdown. The tailings pipeline would be flushed with water before it is shutdown. We do not know what the frequency of any shutdowns will be. During the early days of mine and mill operation the frequency may be greater than in later years since increased operating experience should reduce shutdowns.

For preliminary design purposes, it was assumed that overall availability of the grinding, flotation and dewatering operation was 95 percent. The annual shutdown duration, based on experience, is 18 days per year, or an average of 1.2 hours per day (i.e., 360 days of mill operation). However, we do not know how this shutdown time might be distributed over an operating year.

Under certain circumstances it is possible that the milling plant could be shutdown and tailings continue to be pumped from the tailings thickener. However, the tailings thickener has limited storage capacity. It is also possible for the tailings pumping system to be shutdown while the plant continues operations. Tailings could be stored in the thickener for a short time. It is unlikely that more than an hour's capacity is available in the thickener under normal operating circumstances.

C. A pipeline break would be cause for a plant shutdown. The tailings thickner has insufficient capacity to sustain operations for more than one hour at full mill production rate.

D. Flow rate measuring devices will be located near the thickener underflow pumps in the plant area and on or near the point of discharge. Volumetric flow rate at the beginning and end of the pipeline could then be monitored continuously. A difference in entering and exiting flow rates would indicate that a leak had occurred.

This will be augmented by installation of additional pressure sensing or other instrumentation located at appropriate points along the pipeline. Specifics of these will be developed during final engineering. They would be expected to identify significant leaks (i.e., 10 to 20 percent of flow rate).

Comment No. 23 (Comment 71):

Which of the four specified disposal options for the sodium sulfate by-product from the water treatment plant is preferred by Exxon? Whichever it is, they should make it part of the proposal and discussion. Any proposal which involves disposal at the mining site must be described in considerable detail and could require a separate approval.

Response:

The preferred option which is discussed in some detail in response to comment No. 71 is to market the sodium sulfate by-product to Kraft paper mills either directly or through a broker. There is sufficient time during mine development, prior to production, to evaluate the marketability of sodium sulfate and develop the details for on-site disposal, if necessary. A separate area within each tailings pond would be provided to segregate and isolate the sodium sulfate from the tailings, if this by-product cannot be marketed.

Comment No. 24 (Comment 72):

Exxon states that details for the disposal of the reclaim ponds sludge have not been determined and then they proceed to describe how the sludge could be applied to the final tailings surface of Pond T4. If this is the preferred disposal method, it should be made a definite proposal and should be discussed in greater detail in this response and in any discussions concerning closure and reclamation of Pond T4.

Response:

As part of the reclamation plan, the synthetic liners for the reclaim water ponds will be removed. Prior to doing this, however, settled matter that will have accumulated in the ponds will be recovered by a suction dredge and pumped to the tailing pond. If necessary, this could also be done during operations without interfering with the operation of the reclaim ponds or tailing pond.

There are a number of lagoon pumpers available on the market and there are also reliable pond pumping services available under contract. Since the need to remove settled material from the reclaim ponds will be infrequent and most likely performed only once, this will likely be done as a contract service. If the sludge is dense and compact, suction pumps with cutter heads may have to be used. If the material is soft settling, a simple suction pump would be used.

Comment No. 25 (Comment 76):

There is concern for the type of liner used to contain fuel spills. Not all synthetic materials are compatible with diesel or gasoline fuels. More detail should be provided on the 60 mil spray-on elastomeric liner detailed on the referenced plan sheet.

Response:

We are continuing to evaluate liners for this application. The spray-on elastomeric liner initially envisioned, such as Chevron's CIM system, is not recommended for permanent storage of fuels or other hydrocarbons; however, they are used for installations similar to this where they would only have temporary short-term contact with fuels. We are also evaluating different coatings that could be added to the system to be fully compatible with the fuel and we are evaluating alternate material membranes that are installed and seamed in the field as opposed to being sprayed on. Additional information will be provided when all of this material has been evaluated.

Comment No. 26 (Comment 78):

A more detailed summary of the potable water facilities should be included in the mining permit application with reference to the high capacity well approval.

Response:

A more detailed summary of the potable water facilities will be included in the revised Mining Permit Application and reference will also be made to the High Capacity Well Permit Application.

Comment No. 27 (Comments 92 and 93):

This response indicates that monitoring boreholes will be provided during shaft construction. Exxon should discuss the construction, general spacing, and abandonment procedures for the monitoring boreholes and additional detail on how the monitoring will be conducted. This monitoring program should be included in the monitoring plan of the mining permit application.

Response:

Temperature monitoring boreholes will be provided at each shaft collar freezing site for the purpose of recording temperatures at 6 m vertical increments. The temperature data, recorded at least daily, will be used to estimate the thickness of the freeze wall at any time. The monitoring holes will be drilled at least 5 m (16 feet) into bedrock. Each site will have a minimum of two temperature monitor boreholes located on the designed outer perimeter of the freeze wall. They will be separated at least a quarter circle. If the freeze hole survey has shown that two adjacent holes have deviated up to the limit, the monitor hole would be placed midway between them but still on the outer ice wall perimeter. The monitor hole could then be used as a freeze hole itself if the area between those two holes did not freeze properly.

The typical temperature monitor borehole system will be constructed as follows:

1. After the monitor holes are drilled and surveyed, a nominal 10-15 cm (4-6 inches) steel pipe with the lower end capped will be placed in the hole. It will be pressure tested and must show no loss in pressure over a 6-hour test period when subjected to a gauge pressure of 2000 k Pa (290 psi).

2. The hole annulus will be filled with high viscosity fresh water drilling mud.

3. The inside of the pipe will be filled with salt gel drilling mud with a freezing point within the range -10 C (14 F) to -15 C (5 F).

4. Thermocouple or thermistor temperature elements will also be inserted at 6 m (20 feet) vertical intervals inside the pipe.

An internal pressure relief hole located at the center of the shaft will also be installed and similarly instrumented for temperature measurements until the shaft collar excavation is started. It differs in construction from the other temperature monitor holes in that it contains a casing perforated above the bedrock level which enables it to be used to check ground water level until it freezes, as well as temperature. Once excavation starts, it is no longer of any use.

Abandonment of the freeze monitor holes is similar to abandonment of freeze holes and is accomplished in the following manner, after thawing has occurred:

1. The salt gel drilling mud will be pumped and collected from the pipes and removed from the site for disposal or reuse. The pipes will be flushed with clean water.

2. The pipes will be perforated in the lowermost 3 m (10 feet) of their length. Measurements of the rate of decline of the water level inside each perforated pipe will be kept until the level approximates the ground water table level. Each pipe will then be filled with a 1:1 cement grout by placing an inner feed pipe to the bottom and introducing a volume of grout equal to the pipe volume. Top of grout level will be recorded and each pipe will finally be filled to surface after the initial volume has set.

3. These monitoring boreholes are a part of the construction process rather than for the purpose of environmental monitoring. Therefore, we do not believe it would be appropriate to include these boreholes in the Monitoring Plan.

Comment No. 28 (Comment 101):

The figure submitted in support of the response adequately delineates the route from the Woodlawn Siding to the MWDF to be used by trucks hauling bentonite for liner construction. Is the route along existing town roads or does Exxon have to obtain easements? If the latter, the route will be considered part of the mining site and as such, a final use for the road must be discussed. If the route is along unpaved roads, the potential for dust generation should be discussed along with any preventive measures to be implemented.

Response:

Bentonite for liner construction will be transported from the Woodlawn Siding on the Soo Line to the MWDF by cement tanker trucks. The route consists of approximately 3 km (2 miles) of unimproved private gravel road, approximately 6 km (3.5 miles) of unpaved town roads, and about 0.8 km (0.5 mile) of paved County Trunk highway. Exxon will obtain an easement for the use of the gravel road from near Jungle Lake to the Woodlawn Siding from the surface property owner. The use of this existing road will require only grading and compaction. Upon completion of the need for hauling from Woodlawn Siding, (i.e., when the railroad spur line is completed) the road will be left in its improved condition for use by, or at the discretion of, the surface owner.

As most of the proposed haul route is along unpaved roads, water will be used as a suppressant to prevent the potential for dust generation by truck traffic. Water will be applied by a truck similar to that used on typical highway construction projects for dust suppression.

Comment No. 29 (Comment 96):

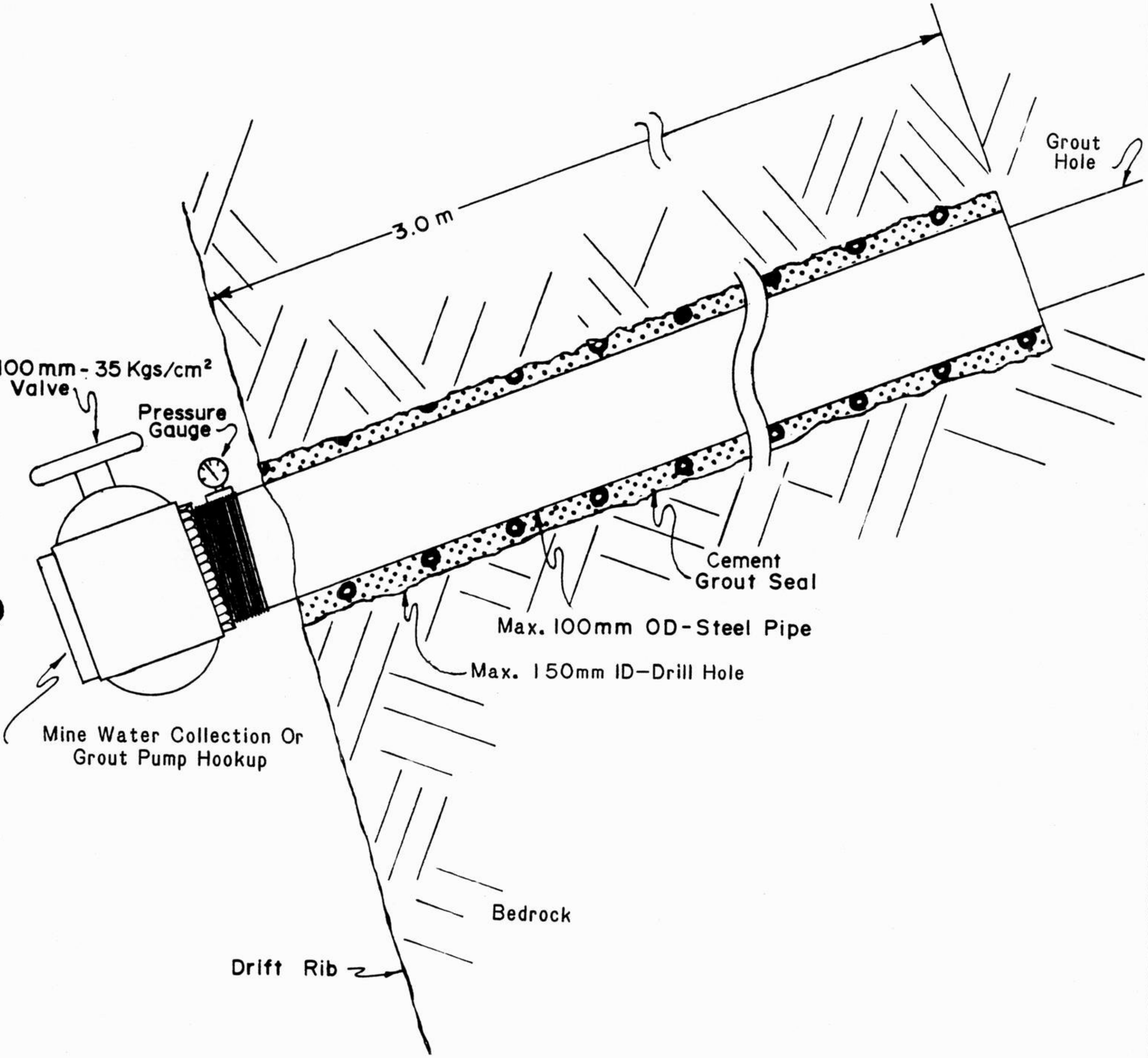
Will the ground water interceptor drill holes be plugged once mining ceases? A diagram of a typical grout well, showing diameter, method of construction, grouting, etc. should be provided. When and how will these holes be abandoned?

Response:

Drill holes located in the uppermost active mining levels to intercept and contain inflowing ground water prior to potential contamination by contact with the mining processes will typically be outfitted as indicated on Figure 1. Such drill hole collar manifolds will facilitate ground water collection, provide for ground water inflow monitoring, and ultimately serve as the preparation for drainage hole abandonment.

Actual ambient quality ground water collection will be from exploration or specific interception drill holes developed from normal mine access or designated mine water control drifts. These holes will be typically arranged in a conical fan above the drifts (Figure 2), increasing the effective radius of the adit as a line sink drain. As is common mine practice, each water producing hole will be collar sealed and equipped with a pipe manifold.

Initial ground water interceptor holes from the 230 m (755 feet) mine entry level will likely be cement grouted as they are abandoned when mining proceeds upward toward the crown pillar. Interceptor holes on the final uppermost mining levels beneath the permanent ore body crown pillar will be systematically abandoned and grouted during mine depletion and reclamation. Long-term site environmental security will be best served by closure of the

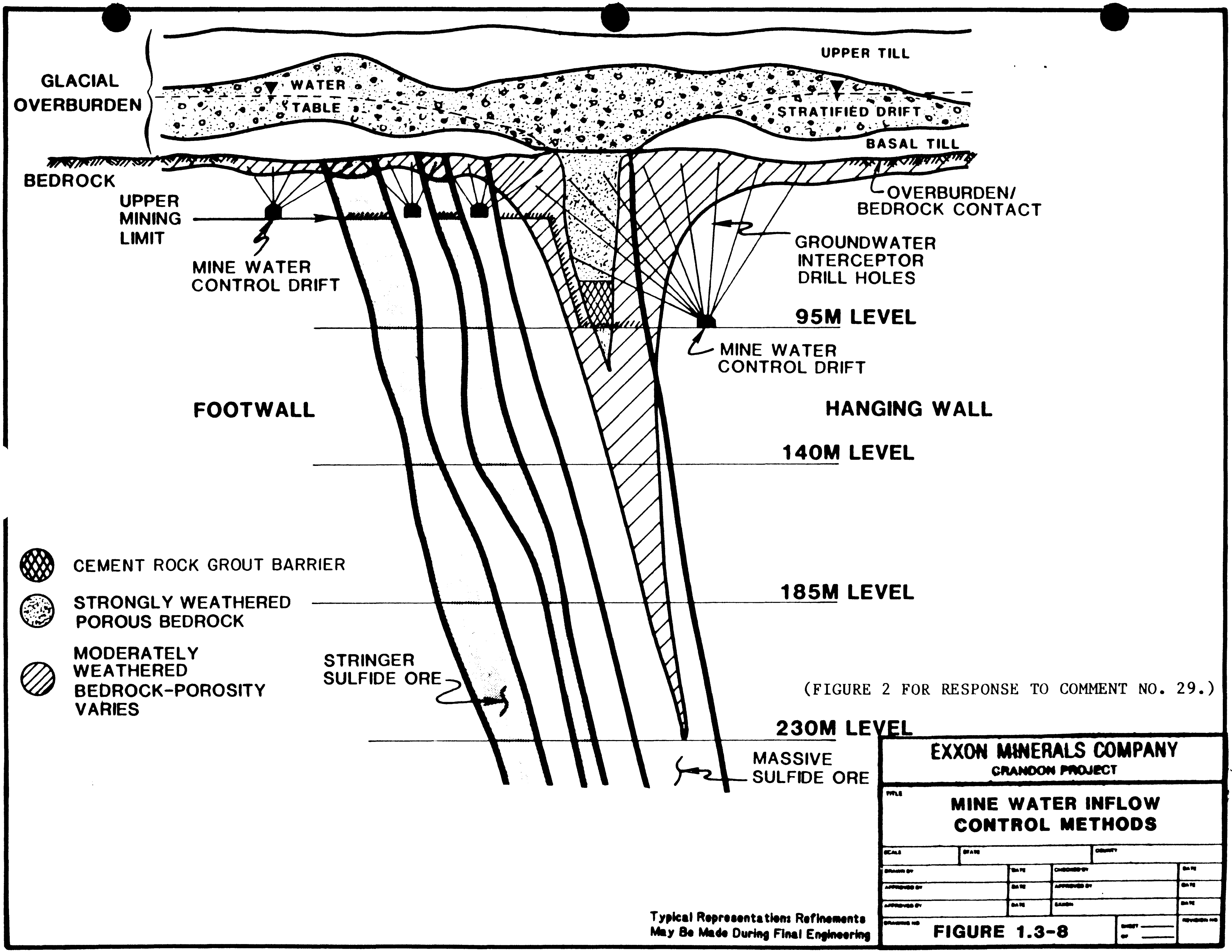


(FIGURE 1 FOR RESPONSE TO COMMENT NO. 29.)

SCALE

KLOHN LEONOFF INC. CONSULTING ENGINEERS	PROJECT: Crandon Mine Water Control			
	TITLE: TYPICAL WATER COLLECTION OR GROUT HOLE COLLAR DRILLED FROM INTERCEPTOR DRIFT			
CLIENT: Exxon Minerals Company A-MM-0206	DATE OF ISSUE: 4-16-82 APPROVED	PROJECT No.: CC0030	DWG. No.: Figure 14	REV.

NCI-457



(FIGURE 2 FOR RESPONSE TO COMMENT NO. 29.)

interceptor drains even though the bedrock is not considered a functional part of the local ground water regime.

Comment No. 30 (Comment 108):

More detail concerning the temporary reclaim pond to be used during the operation of the pilot plant is needed. Information on the pond's capacity, liner specifications, and construction, operation and reclamation procedures should be provided. Is retention in the reclaim pond the only water treatment that will be available at the time of the pilot plant operation?

Response:

Present plans do not include a separate water reclaim pond for the pilot plant. Tailings produced in the pilot plant will be collected in a concrete trough to be located just south of the pilot plant facility (i.e, core storage building). The trough will be approximatley 42.7 m (140 feet) long, 3 m (10 feet) wide, and 3 m (10 feet) deep at one end. The trough will be constructed such that water will drain from the tailings into a reclaim sump at the east end of the trough and be pumped into a 7 m^3 (247 cubic foot) water tank inside the pilot plant building. The location of the concrete trough to serve as a tailing launder and water decant facility is shown on the attached Figure 1.2-21. The trough is capable of holding 184 m^3 (6500 cubic feet) of settled tailings. The drained tailings will be removed from the concrete trough with a small loader and placed in a dump truck for haulage to the lined waste rock disposal area at the MWDF. When the trough is no longer needed, it will be removed and the area will be regraded.

Any excess water will be transported to reclaim pond R1 which will be in use at the time the pilot plant is operated. The water treatment plant will be in operation to treat mine water before the pilot plant is operated.

Comment No. 31 (Comment 110):

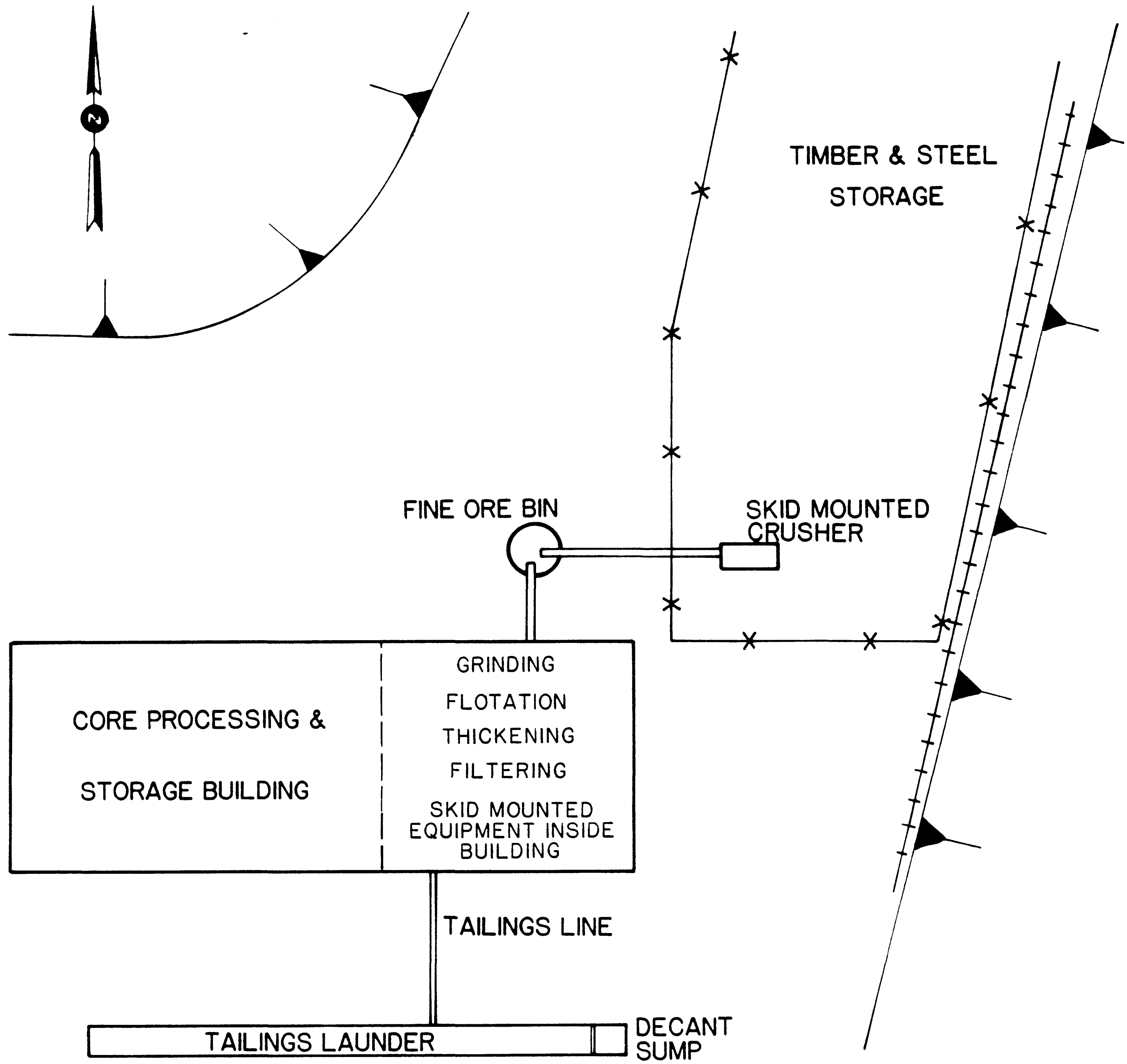
The plans and specifications for dust collection and ventilation for the testing and training facility will be reviewed when they are submitted.

Response:

The preliminary engineering for the Pilot Plant (i.e., testing and training facility) is complete and a schematic drawing of the facility arrangement is attached (Figure 1). Process rates and resultant TSP emission rates for various steps in the process were determined and indicate that ventiliation ducting and collecting are not warranted. Adequate control will be realized from enclosure or water spraying at dust emitting points in the process. The TSP emission estimates are also attached (Table 1).

Comment No. 32 (Comment 117):

The response indicates that in the case of a backfill shortage, sand or crushed rock would be used to supplement the normal backfill material. Where will the sand or crushed rock be obtained? Did Exxon consider using other environmentally suitable material to supplement the backfill?



(FIGURE 1 FOR RESPONSE TO COMMENT NO. 30.)

EXXON MINERALS COMPANY
CRANDON PROJECT

LOCATION OF PILOT PLANT

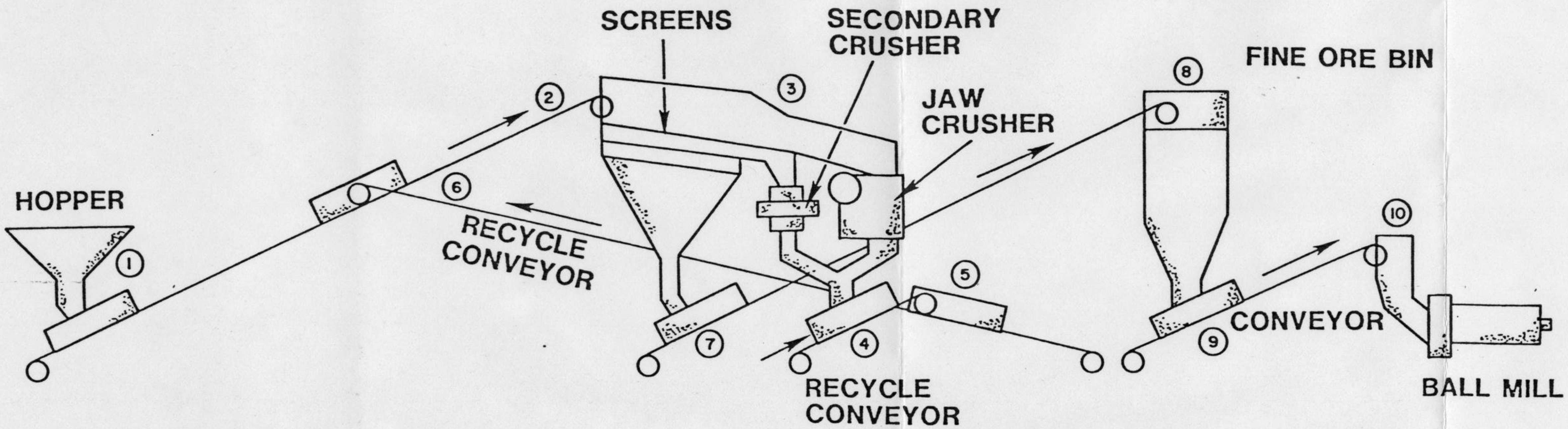
SCALE NONE | STATE WISCONSIN | COUNTY FOREST

DR SPRINGBORN 4/84

Typical Representation: Refinements May Be Made During Final Engineering

FIGURE 1.2-21

SYSTEM DIAGRAM



LOCATION/SYSTEM	PILOT PLANT CRUSHING AND SCREENING
1 TRANSFER POINT	ENCLOSURE
2 TRANSFER POINT	WATER SPRAY
3 TRANSFER POINT	ENCLOSURE
4 TRANSFER POINT	ENCLOSURE
5 TRANSFER POINT	ENCLOSURE W/ WATER SPRAY
6 TRANSFER POINT	ENCLOSURE W/ WATER SPRAY
7 TRANSFER POINT	ENCLOSURE
8 TRANSFER POINT	ENCLOSURE W/ WATER SPRAY
9 TRANSFER POINT	ENCLOSURE
10 TRANSFER POINT	ENCLOSURE W/ WATER SPRAY

(FIGURE 1 FOR RESPONSE TO COMMENT NO. 31.)

EXXON MINERALS COMPANY
CRANDON PROJECT

PILOT PLANT
DUST CONTROL SCHEMATIC

B.W.M. 06/84
W.S. 06/84

284-1-116M

(TABLE 1 FOR COMMENT NO. 31)

Mine and Mill Surface Facilities Construction Emission Estimates

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Pilot Plant - Crushing and Handling of High Moisture Ore for Metallurgical Testing

Emission Factor and Source: AP-42, Table 8.23-1

TSP - Primary Crushing - 0.01 kg/t

- Secondary Crushing - 0.03 kg/t

- Handling and Transfer - 0.0005 kg/t

Process Rate: 43.2 t/day, 3,000 t/yr

Control Method and Efficiency: Skirting Enclosure and Water Sprays

Example Calculation:

Daily - 43.2 t/day x 0.01 kg/t = .43 kg/day
43.2 t/day x 0.03 kg/t x = 1.30
43.2 t/day x 0.005 kg/t x 8 = 1.73
3.45 kg/day

Yearly - 3,000 t/yr x 0.01 kg/t ÷ 1,000 kg/t = 0.03 t/yr
3,000 t/yr x 0.03 kg/t ÷ 1,000 kg/t = 0.09 t/yr
3,000 t/yr x 0.005 kg/t ÷ 1,000 kg/t = 0.02 t/yr
0.14 t/yr

Total Yearly Emissions = 0.15 st/yr

Activity to start by the end of month 25.

Response:

The Crandon mine stopes are to be backfilled with classified (deslimed) mill tailings. Approximately 50 percent of the mill feed tonnage can be prepared as backfill with suitable drainage characteristics. Average backfill production combined with underground retention and use of mine development waste rock will satisfy the normal mine backfill demands. However, shortfalls of backfill tailings material could result from unanticipated operational events. These might include:

1. Periods of lower recovery of backfill sized materials compared to fine tailings resulting from changes in ore composition; and

2. Interruption of mine backfill operations, followed by a demand period in excess of the backfill plant capacity.

In these cases or others, it may be necessary to supplement normal classified tailings backfill production with glacial sand or crushed waste rock. The surface mine backfill preparation facilities will be designed with provisions for the future addition of equipment to supply additional materials. This equipment could include crushing, screening, and washing gear for recycling hoisted mine waste rock, or simply bins and conveyors to facilitate the addition of commercial sand trucked to the site from local sources.

At one time, power plant fly ash was also considered for use as a potential backfill material. Although this waste product had some attractive technical characteristics, there was no source within economical transportation distance of the mine site. No other materials have been seriously evaluated as potential sources of mine backfill.

Comment No 33 (Comment 119):

A. Exxon should outline what measures will be taken to assure adequate drainage of backfill, including a discussion of the bulkhead design, placement of coarse material above the bulkhead, and the installation of any drainage pipes.

B. Discuss the estimated permeability of uncemented backfill and cemented backfill.

C. Exxon should also discuss what the effects of failure of a backfilled stope would be in terms of safety and the overall impact on the mine operation. Discuss the potential failure of a backfilled stope as a result of blasting in an adjacent stope and the impact of such a failure.

D. Further, at some point, Exxon is going to have to address how the backfilled mine behaves hydrologically and allay concerns that the mine itself could act as a source of pollutants to the ground water contained in the overlying glacial aquifers.

E. Please provide the following documents prepared by J. D. Smith Engineering Associates Limited:

   1. Rock Mechanics Testing and Engineering of Large Diameter Core

   2. Testing of Conventional, Pyrite Concentrate, and Pyrite Slimes Backfill Materials.

Response:

A. Backfill bulkhead specifications will depend on stope block geometry and fill placement plans. Generally, the preparation for backfilling a depleted conventional sublevel blasthole stope will consist of constructing fill retaining bulkheads in all stope entries. Bulkhead design will vary with stope position and backfill type. Although some hydrostatically competent concrete bulkheads will be used early in the mine life until full scale fill performance can be measured, wooden controlled drainage structures (Figure 1) will be more typical during normal mine operations.

   Bulkheads will be equipped with backfill water drainage devices - cloth wrapped slotted pipes commonly known as "mousetraps." Water percolating to the stope bottom through uncemented backfill will exit through these bulkhead pipes or the wooden structure itself. The area immediately behind the bulkhead may be dry filled with clean sand to prevent mousetrap blockage by migrating backfill fines. All backfill seepage water will ultimately drain to the main mine sumps for discharge to the surface.

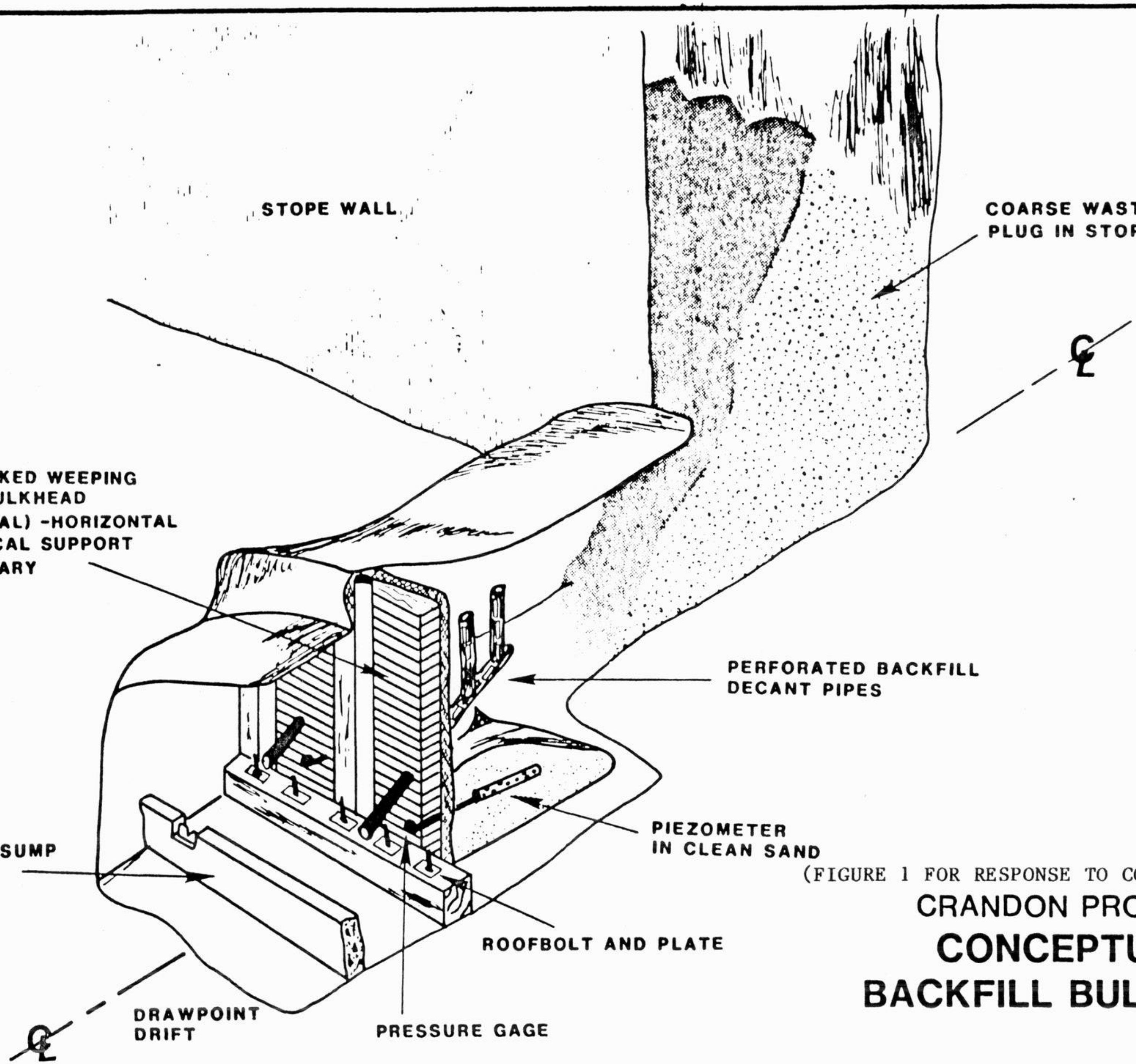
   In the case of stopes receiving cemented backfill (roughly one-third of the mine total) additional drainage devices will be required. Typically, cloth covered slotted pipes will be suspended between the stope sublevels and connected to the bulkhead discharge lines at the stope bottom. As the cemented fill is placed, the excess transport water will pool on top of the sands and be decanted through the vertical drains. Care must be taken to avoid blinding of the drainage pipe filter cloths by splashing cemented fill lines.

   Backfill bulkheads will also be equipped with water pressure gages and a drainage sump with integral flow rate measurement weir. Hydrostatic fill pressures will be monitored throughout placement and drainage. Filling will cease if bulkhead pressure exceeds the design safety limit, e.g., 20% of the structure failure strength. Drainage will be measured to assure that full saturation of the backfill mass, and potential fill liquefaction, is avoided. Backfill pressure and drainage records will be maintained until the fill is determined to be decanted and consolidated, usually a period of several months duration after completion of hydraulic placement.

   Special stope backfill practices will include:

   1. The placement of coarse development waste rock in the stope undercut as a barrier to fill movement into drawpoints and also to reduce classified mill tailings backfill demand.

   2. Exclusive use of coarse development waste rock as dry fill in isolated or peripheral ore body stopes of limited dimensions.



(FIGURE 1 FOR RESPONSE TO COMMENT NO. 33.)

CRANDON PROJECT

CONCEPTUAL BACKFILL BULKHEAD

Uncemented and cemented backfill will be introduced into open stopes at a high pulp density (60-70%) in order to minimize the amount of water to be removed.

B. Permeability is an extremely important uncemented fill property, and is usually expressed in terms of percolation rate. Tests on various size fractions of Crandon ore materials have been done on a large number of samples by John D. Smith Engineering Associates (Testing of Conventional, Pyrite Concentrate, and Pyrite Slimes Backfill Materials - Crandon Project, September 1981).

Repeatable results have been obtained by two different measurement techniques in the laboratory. These have indicated that coarser fractions of Crandon tailings will yield uncemented backfill material exceeding the universally accepted percolation rate of 10 cm/hr (0.32 feet per hour).

Permeability of hydraulic fill is greatly reduced by the introduction of portland cement. For instance, a backfill with four percent cement content by weight will exhibit only 25 percent of the permeability of the same material without cement (E. G. Thomas - Fill Technology in Underground Metalliferous Mines, 1979). Drainage of excess water from cemented backfill requires additional vertical drainage devices as described above, which remove the water primarily from the top of the fill rather than relying entirely on percolation through the fill to the horizontal drainage system at the bottom of the stope. Some decant water will migrate through the fill depending upon the cement content, as well as along vertical rock/backfill interfaces. Other residual water in the backfill will be incorporated in the hydration of the cement.

C. Properly mixed and placed cemented hydraulic backfill will stand vertically and support itself to full stope height while the adjacent pillar is extracted. A partial failure of a cemented backfilled stope could be caused by a weakened portion of the structure failing because of possible segregation of tailings material from the cement. This condition should be localized and not cause a major fill failure. Because of the self-supporting strength of the backfill mass, blasting should only cause localized failure of the backfill wall in the event of a misaligned blasthole.

Primary stopes in some locations may only be filled with uncemented backfill. The adjacent pillar block would be recovered but a "skin" of pillar ore would be left as a barrier to the uncemented backfill. The thickness of the skin would vary with pillar block geometry. It is possible that a misaligned pillar blasthole might cause a window in the "skin" and allow some fill to mix with the pillar ore. However, as stated above, pillar blasting will not occur until it is assured that adequate drainage has occurred in the adjacent stope and that fill liquifaction will be avoided.

In the event of either a cemented or uncemented fill failure during the mining phase, the primary result is the introduction of waste (backfill) into the adjacent stope block. This results in ore dilution and reduced ore grade in the active mining area. A fill failure into an adjacent stope from blasting is not a major safety or environmental problem but rather an ore grade and ore recovery problem.

D. The concerns about how the backfilled mine behaves hydrologically and whether the mine itself could act as a source of pollutants to the ground water in the overlying aquifers are currently being studied. The results of final mine inflow/site impact modelling now underway will be appended to the mine permit application when available.

E. The two reports by J. D. Smith Engineering Associates Limited will be sent to DNR under separate cover in August 1984.

Comment No. 34 (Comment 121):

Exxon staff have recently indicated that the preproduction ore storage area may be retained through the project life to serve as an emergency concentrate storage area. If this is the case, Exxon should elaborate on how concentrate would be deposited, stored and recovered from the facility, and how the facility would be maintained in an acceptable manner until it is needed.

Response:

The preproduction ore storage pad is designed to allow for minimum impact to the surrounding environment by the installation of a relatively impermeable liner, a compacted pad, a drainage collection ditch around the site, and a drainage pond with installed pump. The pad will be maintained by grading and compacting the top layer as required. The 0.5 m (18 inch) pad over the liner system will carry the equipment tire loads and prevent damage to the liner system.

This controlled site is now planned to remain in place for the life of the mine and mill operation. One identified potential use for this site is to provide an area for emergency storage of concentrate. If this plan were exercised, concentrate would be hauled from the mill to this site with trucks. Because of the value of the concentrates, they would be protected by covering either with commercially available spray binders or other effective material covers. The actual cover would be dependent upon the size of the concentrate pile and the expected duration of storage.

The quantity of material stored and the duration of storage will be kept to a minimum. The concentrate will be reclaimed from the storage piles with a front-end loader and possibly trucks and placed in rail cars for shipment.

Alternative uses for this area may also include temporary storage for ore or equipment.

Comment No. 35 (Comment 137):

Part one of this response says that Exxon will replace any public or private groundwater supplies which may be affected by the project. Do these provisions apply solely to water quantity impacts or are water quality impacts also covered? What will be the procedure by which a well owner obtains remedial action? How long will Exxon's offer for remedial action remain in effect.

Response:

Since 1979, Exxon has provided assurances to the Towns of Lincoln and Nashville with respect to protection of ground water quantity and quality. Exxon has stated that if its Crandon mining operations cause significant adverse effects on the quantity or quality of public or private ground water supplies, Exxon will expeditiously provide water of substantially the same quality and quantity at no cost to those individuals who may be affected for the duration of any significant impairment of supply caused by Exxon's operations.

Wis. Stat. 144.855(4) establishes a process by which persons who claim damage to the quality or quantity of their private water supply may file complaints with the Department of Natural Resources and receive alternate sources of water. Exxon has agreed to relieve (i.e., by being the supplier) the Towns of Lincoln and Nashville of the requirement under Wis. Stat. 144.855(4)(c) to supply the "immediate alternate source of water" for the complaining party and will cooperate with the department in investigating the complaint.

If the department concludes that there is reason to believe that the damage is mining-related a hearing must be scheduled [Wis. Stat. 144.855(4)(b)]. If after the hearing, the department concludes that mining is the cause of the damage, it must issue an order to the operator requiring the provision of water to the person found to be damaged [Wis. Stat. 144.855(4)(d)].

However, if as a result of studies prior to the start of operations, Exxon determines that the quantity of an individuals private water supply will be significantly adversely affected by mining operations, Exxon will develop appropriate remedies to alleviate potential impairment of supply. Implementation of such remedies, including replacement of or deepening of supply wells, will be at no cost to the affected individuals.

Comment No. 36 (Comments 138-142):

The discussion in these responses and in the Risk Assessment fail to address two (2) potential hazards: (a) Drought and (b) Failure of the Tailings Pond watering system. Both of these are related since the effect will be drying up of the tailings and the potential for "dust episodes" resulting from high winds in combination with dry conditions. Since 50% of the particles are 10 micron or less in size, this poses a potential for a hazard to human health since that size particle can lodge in the thoracic region of the respiratory system. The new proposed inhalable particulate standard is expected to be based on a 10 micron upper size cutoff for the mean particle diameter. Furthermore, while the risk assessment addresses airborne concentrate "spills", it fails to address the impact and control of "spills" (i.e., blowing dust episodes) resulting from the drying out of tailings.

The discussion on the risks associated with airborne particulate matter does not appear to be based upon experimental, pilot plant, or actual ambient data or experience. Our experience with a large tailings pond at an iron ore mine indicates severe particulate problems can occur when production is stopped or reduced, i.e., when the amount of water being utilized and added to the pond is reduced. Exxon should provide a discussion addressing these issues in this section and in the Risk Assessment.

Response:

Exxon believes the risk and potential hazard from "dust episodes" at the MWDF is very minimal. The paper prepared by Exxon dated February 1983 and entitled "Tailings Surface Dusting From Wind Erosion" (previously provided to DNR) describes the conditions for the MWDF that could lead to tailings dusting. In addition, the various methods of control of dusting available to Exxon are discussed in the paper. We intend to primarily rely on proper water management within the tailing ponds to achieve dust control. If this were not possible, the other means noted in the paper would be applied. Additional summarized detail of the paper will be presented in the revised Mining Permit Application, Risk Assessment Section of the Mine Plan.

Comment No. 37 (Comment 148):

The Department is continuing its review of Exxon's Risk Assessment. As a result of this review, the Department may require Exxon to provide additional information and quantification concerning portions of or the entire Risk Assessment. Some preliminary comments regarding specific aspects of the Risk Assessment are presented in the following 6 paragraphs, ending with Comment 174.

Response:

Comment acknowledged.

Comment No. 38 (Comment 151):

Contrary to Exxon's response, a concentrate spill <u>does</u> have the potential to be harmful to people with chronic respiratory conditions. Because of this, Exxon should outline a plan whereby any spilled concentrate would be recovered prior to undergoing significant drying.

Response:

The probability for a train crash is low at 1×10^{-1} to 1×10^{-2} events per year. The probability of a crash near a residential area would be less than the probability of a crash over water and would be less than 1×10^{-3} to 1×10^{-4} events per year because of the trains reduced speed while traveling through most towns. (Source: N. J. McCormick, <u>Reliability and Risk Analysis</u>, Academic Press, New York, NY, 1981.)

It is agreed that a concentrate spill <u>does</u> have the potential to be harmful to people with chronic respiratory ailments under certain conditions. However, the probability of this event happening is extremely low when considering the other factors that must also be present at the time of a train crash that would allow the concentrates to dry and become airborne, i.e.,:

- Hot, dry weather with windy conditions lasting several days.

- The rail carrier and EMC not taking remedial action.

Concentrates are valuable materials. Rapid and complete removal of spilled concentrates would be to Exxon's economic advantage. Dust-borne losses of the materials would cause financial loss. To Exxon there is an economic incentive to have the spillage recovered before dust losses occur.

Concentrates, as shipped, contain moisture; moisture contents are typically 8 to 10 percent. In order for concentrate particles to escape into the atmosphere they have to be dry and carried by wind. Even under hot, dry, windy, conditions it takes several days for spillage to dry to the extent particles can become wind-borne.

The recovery of concentrate spillage will depend on the extent of the material released. Minor spillage would be reclaimed by manual means using shovels and wheelbarrows. Major spillage would be removed by front-end loaders and trucks. Final recovery would be done manually using brushes and shovels to remove all the valuable material.

If a derailment should occur, Exxon would work closely with the rail carrier to begin immediate corrective action. This action will be highly dependent on the location, nature, and magnitude of a particular derailment and spillage.

Comment No. 39 (Comment 152):

The Department agrees that the probability of a major reagent spill is very low. However, it is not zero and therefore Exxon must prepare contingency plans for such an event.

Response:

Although a remote possibility, if a major reagent spill occurs on-site, the following actions will be initiated as part of the Contingency Plan. The spill will be reported to the environmental compliance staff and to the security personnel. In the event such a spill occurs when the environmental staff is not on duty, security personnel will be contacted initially and then environmental staff at home, if necessary. The following information will be provided:

<u>Observer Reporting</u>

- Identity of reagent spilled.

- Location of spill.

- Estimated amount of material spilled.

- Time spill occurred.

- Is anyone injured or in immediate danger as a result of the spill.

All responsible personnel will receive training to assure the following actions:

Action Following Notification

- Stay clear of the area (i.e., if the spilled reagent is identified on the master list of toxic agents).
- Assist in preventing entry to the area by unauthorized personnel.
- Do not leave the vicinity (i.e., in an assured safety zone) until someone arrives to assume the duty of isolating the area and commencing mitigative procedures.
- Notify the proper authorities (i.e., DNR), environmental staff if not previously notified, and any safety or medical personnel required, indicating the information obtained from the observer.

The responsible staff will initiate recovery and isolation of the spill consistent with the concerns for public safety and environmental protection. Actions will include the following:

Spill Recovery and Isolation

- Secure the spill site to prevent entry to the area by unauthorized personnel.
- Use only those personnel specifically trained and protected for handling such an emergency.
- Contain the spilled material to prevent further spread.
- Begin immediate recovery steps to assure maximum retention and isolation of the spilled material so that public exposure and environmental impact is kept to a minimum.
- Assure the storage or treatment of the recovered material.
- Begin disposal of the unusable material and aids (i.e., rags, containers) at a predesignated site approved for receipt of this material.
- Notify responsible state, federal, and company authorities of the occurrence and remedial actions initiated and implement all mitigation procedures consistent with the Contingency Plan.
- Begin investigation to determine cause of spill and to the maximum extent possible prevent future occurrences.

Comment No. 40 (Comment 153):

This response concerning the hazard presented by certain reagents is not adequate. Methyl isobutyl carbinol is listed as a toxic substance in industrial toxicology references while ethers are considered to be acutely toxic. Thus methyl isobutyl carbinol and propylene glycol methyl ether could present significant health hazards. Exxon must discuss the toxicology of all the typical reagents that will be used.

Response:

All substances possessing toxic properties will be handled in accordance with state and federal regulations. Also, employee exposure to these substances will be monitored and controlled through our industrial hygiene program. The attached data sheets for the following list of reagents should address your concerns regarding toxicology. If further information is required, we recommend Patty's Industrial Hygiene and Toxicology, Volumes I, II, and III as a source that may aid in answering a specific question.

Activated Carbon
CMC-7LT
Copper Sulfate
Dowfroth 250
Flocculant
Lime
MIBC*
Potassium Amyl Xanthate
Soda Ash
Sodium Cyanide
Sodium Dichromate
Sodium Ethyl Xanthate
Sodium Hexametaphosphate
Sodium Isopropyl Xanthate
Sodium Silicate
Sodium Sulfide
Sulfur Dioxide
Sulfuric Acid
Zinc Sulfate

*A data sheet has been requested but has not been received, information will be forwarded upon receipt.

Comment No. 41 (Comment 156):

Is there any inspection/monitoring data available for the two operating facilities cited in this response as examples of facilities with leachate control systems similar to Exxon's proposed MWDF design? If such information is available, Exxon should present a discussion which demonstrates the successful performance history of facilities which use a design similar to that proposed by Exxon.

Response:

EMC has developed additional information regarding facility designs similar to those proposed for the Crandon Project. This information has been discussed with the DNR at a meeting on June 14, 1984 and will be documented in reports to be submitted in August 1984.

Comment No. 42 (Comment 163):

Exxon should present information regarding the anticipated thickness distribution of the crown pillar. Are there any plans to recover the crown pillar as contemplated in section 4.1 of the report, Evaluation of Surface Effects, prepared by John D. Smith Engineering Assocites Limited?

ICI Americas Inc.

Product Data

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

DARCO® GFP

DARCO GFP powdered activated carbon is a high adsorptive capacity lignite based activated carbon designed for mineral process applications. Most of DARCO GFP's surface area is in the range suitable for adsorption of flotation reagents and metallic ions. To insure good dispersion in ore pulps and concentrates, DARCO GFP is ground to a minimum of 95% -325 mesh.

General Characteristics

pH (water extract)	Alkaline
Bulk density, tamped (Lbs./FT^3)	Approx. 30
Water solubles, %	Approx. 4.0
Total surface area, dry basis (M^2/g)	Approx. 500
Total pore volume, dry basis (ML/g)	Approx. 0.95
Storage space (FT^3/Ton)	Approx. 80

Specifications

Moisture, % as packed	8.0 max.
Mesh size, % thru 325	95.0 min.

Safety

CAUTION

AVOID INHALATION OF EXCESSIVE CARBON DUST

Use adequate ventilation or dust masks when necessary. For protection against airborne nuisance dust (carbon) exposures, see Code of Federal Regulations -- Title 29, Subpart G, Par. 1910.93.

CAUTION: IMPORTANT USE INFORMATION

OXYGEN IS REMOVED FROM AIR BY WET ACTIVATED CARBON. Oxygen may be rapidly reduced to a hazardous level in closed or partially closed tanks, receptacles or other enclosed spaces containing carbon.

When entering any enclosed space regardless of its contents, follow recommended safety procedures (See MCA Safety Guide SG-10, "Recommended Safe Practices and Procedures, Entering Tanks and Other Enclosed Spaces", Mfrg. Chem. Assoc., 1825 Connecticut Ave., N.W., Washington, D.C., 20009).

11/77 400

MATERIAL SAFETY DATA SHEET

HERCULES

(Approved by U.S. Department of Labor as "Essentially Similar" to Form OSHA-20)

MSDS WS 002E
DATE 2/16/82

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

I. PRODUCT IDENTIFICATION

CHEMICAL NAME AND SYNONYMS: Sodium carboxymethyl cellulose, technical	REGULAR TELEPHONE NO. 302—575-5000 EMERGENCY TELEPHONE NO. 302—995-3000*
CHEMICAL FAMILY: Cellulose ether	CAS NO. 9004-32-4; Cellulose, carboxymethyl ether, sodium salt
FORMULA: —	MOLECULAR WEIGHT: —

TRADE NAME AND SYNONYMS: HERCULES® CMC-TECHNICAL GRADE, minimum purity 88%-dry basis, various particle sizes, substitutions, and viscosities**.

II. HAZARDOUS INGREDIENTS

MATERIAL	%	TLV-TWA VALUES ADOPTED BY ACGIH
Note: As Hercules interprets the U. S. Occupational Safety and Health Act of 1970, this product should not be considered a hazardous material.		

III. PHYSICAL DATA

BOILING POINT, 760 mm Hg	NA	FREEZING POINT	NA
VAPOR PRESSURE @	NA	BULK DENSITY (AS SHIPPED)	600 kg/m^3 - Granular ($38\ lb/ft^3$) Typical
VAPOR DENSITY (AIR=1)	NA	MOISTURE CONTENT % BY WEIGHT	8% maximum (as packed)
SOLUBILITY IN WATER, % BY WEIGHT @ 25°C	Complete	EVAPORATION RATE (BUTYL ACETATE=1)	NA
APPEARANCE AND ODOR: White to tan granular powder or pellet; odorless.		pH	—

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (TEST METHOD): NA	AUTOIGNITION TEMPERATURE: Ca 370°C (698°F) Dust

FLAMMABLE LIMITS IN AIR PERCENT BY VOLUME	LOWER NA	UPPER NA

EXTINGUISHING MEDIA: Foam, dry chemical, CO_2, water spray or fog.

SPECIAL FIRE-FIGHTING PROCEDURES: None

UNUSUAL FIRE AND EXPLOSION HAZARDS: Flammable dust when finely divided and suspended in air.

NOTES: NA = NOT APPLICABLE

**Most types of technical grades of CMC are designated with a "T", e.g., CMC-7MT. CMC-1A and CMC-6-DG-L are also technical grades although a "T", does not appear in their designations.

*Use this emergency number only after normal business hours and only for emergencies involving safety and health.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

V. HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: Not established[1]

EFFECTS OF OVEREXPOSURE: None known

EMERGENCY AND FIRST AID PROCEDURES: None required

NOTE 1. This material is not expected to cause physiologic impairment at low concentration. Until a specific TLV is adopted by the American Conference of Governmental Industrial Hygienists (ACGIH), Hercules Incorporated suggests that this material be treated as a nuisance dust or particulate in accordance with the recommendations of ACGIH.

VI. REACTIVITY DATA

STABILITY		CONDITIONS TO AVOID: None
UNSTABLE		
STABLE	X	

INCOMPATIBILITY (MATERIALS TO AVOID): None

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION			CONDITIONS TO AVOID: None
	MAY OCCUR		
	WILL NOT OCCUR	X	

VII. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Mechanical clean-up for use or disposal.

WASTE DISPOSAL METHOD: Incineration or landfill. Dispose of in accordance with local, state, and Federal regulations.

VIII. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE): Nuisance dust respirator approved by NIOSH/MSHA in excessive air concentrations.

VENTILATION				
LOCAL EXHAUST	—	SPECIAL	—	
MECHANICAL (GENERAL)	—	OTHER	Adequate to control nuisance particulate	

PROTECTIVE GLOVES: —

EYE PROTECTION: Safety glasses

OTHER PROTECTIVE EQUIPMENT: —

IX. SPECIAL PRECAUTIONS

PRECAUTIONARY LABELING:

CAUTION! FLAMMABLE DUST WHEN FINELY DIVIDED AND SUSPENDED IN AIR.
SURFACES SUBJECT TO SPILLS OR DUSTING WITH THIS PRODUCT CAN BECOME SLIPPERY WHEN WET.
Keep away from heat, sparks, and open flame.
Use with adequate ventilation.
Keep floors clean.

OTHER HANDLING AND STORAGE CONDITIONS: Surfaces subject to spills or dusting with this product can become slippery when wet. To protect product quality, store in sealed containers in a dry place away from heat and sunlight.

Form Approved
Budget Bureau No. 44-R1387
Approval Expires April 30, 1971

U.S. DEPARTMENT OF LABOR

WAGE AND LABOR STANDARDS ADMINISTRATION
Bureau of Labor Standards

May 1969
(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME: PHELPS DODGE REFINING CORPORATION	EMERGENCY TELEPHONE NO.: 212 - 751-3200
ADDRESS (Number, Street, City, State, and ZIP Code): 300 Park Avenue, New York, New York 10022	
CHEMICAL NAME AND SYNONYMS: Copper Sulfate	TRADE NAME AND SYNONYMS: Blue Vitriol
CHEMICAL FAMILY: Inorganic Salt	FORMULA: $CuSO_4 \cdot 5H_2O$

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS None			BASE METAL None		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
None		

SECTION III PHYSICAL DATA

BOILING POINT (°F.) Dehydrates / Decomposes	150°C / 653°C	SPECIFIC GRAVITY (H_2O=1)	2.28
VAPOR PRESSURE (mm Hg.) None		PERCENT VOLATILE BY VOLUME (%)	None
VAPOR DENSITY (AIR=1) None		EVAPORATION RATE (______=1)	None
SOLUBILITY IN WATER 26.6 g./100 g Sat. Soln.			
APPEARANCE AND ODOR Blue crystalline powder or crystals.			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) None	FLAMMABLE LIMITS	Lel	Uel
EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES None			
UNUSUAL FIRE AND EXPLOSION HAZARDS None			

Copper Sulfate p. 2 of 2

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	1 mg/m^3
EFFECTS OF OVEREXPOSURE	Possibility of irritation. Wash area of contact
EMERGENCY AND FIRST AID PROCEDURES	

SECTION VI REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	
INCOMPATABILITY *(Materials to avoid)*	No		
HAZARDOUS DECOMPOSITION PRODUCTS	Sulfur trioxide above 653 °C		
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Repackage

WASTE DISPOSAL METHOD Return to producer.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)*	Approved respirator		
VENTILATION	LOCAL EXHAUST: Yes	SPECIAL	
	MECHANICAL *(General)*: Yes	OTHER	
PROTECTIVE GLOVES	Yes	EYE PROTECTION	Yes
OTHER PROTECTIVE EQUIPMENT			

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Store in dry place.

OTHER PRECAUTIONS

[redacted]

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

6-1554
(Apr. 1972)

Chemical Safety Data Sheet

DOWFROTH 200, 250,1012

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20240

METAL AND NONMETAL MINE HEALTH AND SAFETY

MATERIAL

CHEMICAL NAME	FORMULA NA	CHEMICAL FAMILY Polypropylene Glycol Methyl Ethers
TRADE NAME Dow froth 200,250, and 1012		

PHYSICAL DATA

MELTING POINT (°F)	below - 50	THRESHOLD LIMIT VALUE	-
BOILING POINT (°F.)	243 -293°C	VAPOR DENSITY (AIR=1)	-
SPECIFIC GRAVITY (H_2O=1)	0.980	VAPOR PRESSURE (mm Hg.)	-
SOLUBILITY IN WATER	Soluable	MOLECULAR WEIGHT	pH = 7.2
APPEARANCE AND ODOR	Clear liquid with odor of ether.		

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) 250, 285, 375	FLAMMABLE LIMITS	Lel -	Uel -

EXTINGUISHING MEDIA foam, CO_2, dry chemical

SPECIAL FIRE FIGHTING PROCEDURES None

UNUSUAL FIRE AND EXPLOSION HAZARDS None

HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE No unusual health problems.

EMERGENCY AND FIRST AID PROCEDURES Eyes or skin: Flush with plenty of water and call a doctor.

Dow250 p.2 of 2

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATABILITY (*Materials to avoid*) None

HAZARDOUS DECOMPOSITION PRODUCTS None

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED Use an absorbant to pick up flush to ground, not to sewer.

WASTE DISPOSAL METHOD To ground in a restricted area.

SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION None

VENTILATION	LOCAL EXHAUST Normal	SPECIAL
	MECHANICAL (*General*)	OTHER

PROTECTIVE GLOVES Yes	EYE PROTECTION Goggles

OTHER PROTECTIVE EQUIPMENT None

SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Store in a cool well ventilated area.

OTHER PRECAUTIONS None

☆ U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 462-263

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

CYANAMID

MATERIAL SAFETY DATA

MSDS NO. 0850-03
CAS NO. ----------
DATE: 01/15/83

PRODUCT IDENTIFICATION

TRADEMARK:	**SUPERFLOC® 1202 Flocculant**
SYNONYMS:	Anionic polyacrylamide in water-in-oil emulsion
CHEMICAL FAMILY:	Anionic polyacrylamide copolymer
MOLECULAR FORMULA:	Mixture
MOLECULAR WGT.:	Mixture

WARNING

HARMFUL IF INHALED
CAUSES SKIN BURNS
MAY CAUSE EYE IRRITATION
SPILLS OF THIS MATERIAL ARE VERY SLIPPERY

HAZARDOUS INGREDIENTS

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
Petroleum distillate	008002-05-9	24	500 ppm	OSHA

NFPA HAZARD RATING

Not Established

HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE:

Acute oral (rat) and acute dermal (rabbit) LD50 values are $>$10 ml/kg. Minimal eye irritation was produced in rabbit testing. When this product was tested in rabbits for skin irritation under occlusive conditions, as would be produced if the product was spilled into boots, irreversible skin damage was produced. When the product was tested under nonocclusive conditions with 24 hours of skin contact, as would occur when product was spilled on clothing, some eschar formation was observed but the overall skin irritation score was lower (2.2 moderately irritating). Aspiration of the solvent, petroleum distillate, may cause chemical pneumonitis. Overexposure to vapor may cause dizziness, drowsiness, headached and nausea.

FIRST AID:

If SUPERFLOC 1202 is swallowed do not induce vomiting. Give several glasses of milk or water. Administer a saline cathartic. In case of skin contact, remove contaminated clothing with out delay. Cleanse skin thoroughly with soap and water. Do not omit cleaning hair or under fingernails if contaminated. Do not reuse clothing without laundering. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. Refer to a physician if irritation persists. If vapors of SUPERFLOC 1202 are inhaled, remove from exposure. Administer oxygen if there is difficulty in breathing. If patient is not breathing, give artificial respiration until normal breathing is restored.

EMERGENCY PHONE: 201/835-3100

AMERICAN CYANAMID COMPANY, WAYNE, NEW JERSEY 07470

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

EXPOSURE CONTROL METHODS

Where a closed system is not used, good enclosure and local exhaust ventilation should be provided to minimize exposure. Where concentrations are below the PEL, no respiratory protection is required. For spills or leaks, such protection may be necessary. Where exposures exceed PEL, use respirator approved by NIOSH for the material and level of exposure. See "GUIDE TO INDUSTRIAL RESPIRATORY PROTECTION" (NIOSH). Material causes eye and skin irritation on contact. A full facepiece respirator will provide eye and face protection. Wear the following as necessary to prevent skin contact; work pants, long sleeve work shirt, impervious gloves and impervious apron. For operations where eye or face contact can occur wear respiratory protection outlined above, (full facepiece) or chemical splash proof goggles. Provide eyewash fountain and safety shower in close proximity to points of potential exposure.

FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT: METHOD:	> 200 F (> 93.3 C) Pensky-Martens
FLAMMABLE LIMITS (% BY VOL):	Not Available
AUTOIGNITION TEMP:	Not Available
DECOMPOSITION TEMP:	Not Available
FIRE FIGHTING:	Use alcohol foam, carbon dioxide or dry chemical to extinguish fires. Water may be ineffective. Wear self-contained, positive pressure breathing apparatus and full firefighting protective clothing. See Exposure Control Methods for special protective clothing. Use water to keep containers cool.

REACTIVITY DATA

STABILITY: CONDITIONS TO AVOID:	Stable None known
POLYMERIZATION: CONDITIONS TO AVOID:	Will Not Occur None known
INCOMPATIBLE MATERIALS:	Strong oxidizing agents. This material reacts slowly with iron, copper and aluminum, resulting in corrosion and product degradation.
HAZARDOUS DECOMPOSITION PRODUCTS:	Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, ammonia and/or oxides of nitrogen.

PHYSICAL PROPERTIES

APPEARANCE AND ODOR:	White, viscous, opaque liquid; slight hydrocarbon odor
BOILING POINT:	Water phase boils at ≈212 F (≈100 C). Initial boiling point for oil phase is ≈347 F (≈175 C).
MELTING POINT:	0 F (−18 C)
VAPOR PRESSURE:	Not Available
SPECIFIC GRAVITY:	1.0
VAPOR DENSITY:	Not Available
% VOLATILE (BY VOL):	≈70
OCTANOL/H_2O PARTITION COEF.:	Not Available
pH:	Not Available
SATURATION IN AIR (BY VOL):	Not Available
EVAPORATION RATE:	< 1 (Butyl Acetate = 1)
SOLUBILITY IN WATER:	Appreciable

SPILL OR LEAK PROCEDURES	STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:	Where exposure level is not known, wear NIOSH approved positive pressure self-contained respirator. Where exposure level is known, wear NIOSH approved respirator suitable for level of exposure. In addition to the protective clothing/equipment in Exposure Control Methods, wear impervious boots. Spills of this material are very slippery. Spilled material should be absorbed onto an inert material and scooped up. The area should be thoroughly flushed with water and scrubbed to remove residue. If slipperiness remains apply more dry-sweeping compound.
WASTE DISPOSAL	Disposal must be made in accordance with applicable governmental regulations.	
SPECIAL PRECAUTIONS	HANDLING AND STORAGE/OTHER:	OSHA regulations (29 CFR 106.a.14), require that the flashpoint of materials of this type be determined by the Pensky-Martens Closed Tester method. The test for this product indicates it has a flashpoint greater than 200 F (93.3 C). Another method indicates a potential for flash at approximately 154 F (67.8 C); therefore, caution should be exercised in storage and handling. Avoid storage vessels and piping constructed of iron and aluminum. Store SUPERFLOC 1202 at temperatures between 40 F (5 C) and 90 F (30 C) to maintain stability of the emulsion.

Marvin A. Friedman

Marvin A. Friedman, Ph.D., Director of Toxicology and Product Safety

CHAPTER VI

Economic and safety considerations

Selection of lime

For many uses all or many of the forms and types of lime, as described in Chapter I, can be used. For certain applications, however, only one or two types can be utilized. Where the consumer has an option, he naturally wants to select the type that is best for his purpose and/or is least costly.

For some uses there is either a firm requirement or a decided preference for either high calcium or dolomitic lime, usually because of the presence or absence of the magnesium constituent. In other uses both types can be employed. Each has particular advantages over the other which should be weighed for a given application. Eg., with limes of equal purity the dolomitic limes have slightly greater neutralizing power per pound and will produce less sludge by weight, but the high calcium types have much greater reactivity and tend to produce a denser sludge. Yet, where both types can be used, the determining factor may be a source of supply in close proximity that offers significant savings in transportation. By the same token, savings in delivered cost can often justify the use of less pure or reactive limes. Actually, the only sure basis for determination of the relative applicability of a given lime is to test it under actual or simulated process conditions. Empirical tests, such as for basicity, are generally of value only when the application is analogous to the test.

MP-53

Relative cost

Material cost of lime is dependent on whether bagged or bulk lime, hydrated or quicklime is used. The cost of packaging in multiwall paper bags adds about 20% to the bulk cost; the cost of hydrate is about 30% greater than quicklime on an equivalent basis, owing to its slightly higher ton price and allowing for its water of hydration. The cost disparity, however, with pulverized quicklime is slightly less generally than the above with lump, pebble, or granular forms. These rule of thumb percentages do not include transportation cost.

However, balanced against such savings in material costs are additional capital equipment costs and in one case (slaking) the cost of an extra processing step that must be evaluated in making this determination.

The most important consideration, at least on an average, is the tonnage requirement or rate of use. However, other factors in diverse individual plant situations may be as important, i.e., plant layout, the extent of storage space available and convenience of its location, and storage characteristics of different limes.

As simple generalizations on the tonnage range for these determinations, the following is offered:

1. Where lime consumption is small, such as 50 to 1,000 lb./day, i.e., 1 to 20 50-lb. bags, bagged hydrated lime is clearly indicated. Probably this limit could be extended to 1,500 lb./day, but at this point, if lime is being consumed seven days a week, consumption will reach 22½ tons/month. Then, the economy of truck load bulk shipments of 15 to 20 tons starts to become attractive. But then bulk silo storage and unloading facilities may have to be purchased and installed. If headroom is unavailable for a silo and there is ample ground-floor space for storing bags, then the use of bagged hydrate may be justified up to 2,000 lb./day or even more.
2. With respect to bulk lime, hydrate is generally indicated up to 3 to 4 ton/day (100-125 ton/month) over quicklime. At this point the inherent economy of quicklime, in spite of slaking expense, should be considered. Again, due to peculiar plant conditions the use of hydrate up to 200 tons/month may be warranted; however, above this figure it is quicklime's province. Many of those plants that use quicklime in the lower ranges suggested for hydrate may be saving little or nothing due to greater losses of lime through air slaking and recarbonation. This is particularly true if the quicklime is highly reactive, of small particle size, and is used under humid conditions. Hydrate is more stable and stores better.

Safety considerations

The subject of safety in connection with lime's use in chemical treatment processes is actually two-fold. First, because lime, particularly quicklime, is caustic, the worker handling lime must be adequately protected to avoid burns. Should burns occur or lime get in eyes, immediate first aid is necessary. Secondly, due to the heat of hydration of quicklime, care should be taken to avoid accidental contact with moisture or with chemicals possessing water of crystallization in order to avoid excessive heat generation which might lead to fire.

Although both problems do exist, they are not so prevalent to be alarming – any more so than with many other chemicals used in treatment processes. Thus, lime is not a dangerous chemical, and problems will not develop if a few simple safety precautions are followed.

Worker Safety Dust from hydrated lime can be irritating if inhaled, but it is not injurious to the respiratory system. This is evidenced by studies of workers in lime plants where dust concentration and continuity of exposure exceed by many times that at any consumer's plant. In plant areas where lime dust may be prevalent, e.g., in handling lime bags, unloading rail cars or trucks, around open feeders, etc., workers should wear a lightweight filter mask and tight fitting safety glasses with side shields.

The problem of protection from quicklime burns is more serious, particularly in hot weather when workers are perspiring freely. Besides using eye protection and respirators workers exposed to quicklime dust should also wear proper clothing, including long-sleeved shirt with sleeves and collar buttoned, trousers with legs down over tops of shoes or boots, head protection, and gloves. Clothing should not bind too tightly around neck, wrists, or ankles. It is also advisable to apply a protective cream to exposed parts of body, particularly neck, face, and wrists.

Freshly slaked lime in stiff putty or milk form can produce burns when hot. Workers inspecting or cleaning slakers should wear safety goggles. After slurry is cool, contact with skin is virtually harmless, the principal effect being removal of natural skin oils. Therefore, workers who frequently handle lime slurry should oil their skin where exposed daily, using vaseline, etc. This will help prevent chapping and thus reduce danger from burns or infection.

After handling lime, operators should shower. If clothes are permeated with dust, or splattered with lime slurry, remove and launder. If possible, wear clean clothes every shift.

First Aid If lime gets in eyes, flush with copious amount of cold water immediately, followed by boric acid solution. Report to First Aid. Don't rub eyes if irritated by lime dust; doing this will only add to the discomfort.

Lime burns should be treated similarly to caustic burns. Wash thoroughly with soap and warm water, then with vinegar to remove all lime. Apply burn ointment like boric acid salve and cover with sterile bandage. Keep bandaged during healing to prevent infection.

Plant Safety An efficient dust collecting system is recommended at lime handling points. For removing fugitive dust around and on feeders, slakers, etc., a dry pickup vacuum is practical. The cleaner should be emptied after each use.

As pointed out in Chapter II, quicklime bags should be stored in a clean, dry place to avoid moisture pickup. Otherwise the intense heat generated from accidental contact with water may be enough to start a fire in nearby flammable materials.

A vital slaker safety measure is the installation of a thermostatic valve to prevent overheating and possible explosion. This could occur if the controlled water supply fails while the lime feed continues, allowing the lime to overheat and produce excessive steam. The safety valve delivers a supply of cold water as soon as maximum safe temperature is exceeded. An alternate, provided in the W & T paste slaker, is a low pressure switch installed in the water supply line to stop the lime feeder; this *prevents* excess heat buildup rather than *correcting* it.

Another important safety precaution is to avoid using the same conveyor or bin for alternately handling both quicklime and one of the coagulants containing water of crystallization, e.g., copperas, alum, ferric sulfate, etc. The water of crystallization may be withdrawn by the quicklime, perhaps generating enough heat to cause a fire, e.g., in dust collector bags. Explosions have also been reported from lime-alum mixtures in enclosed bins, where the intense heat (+1100°F) generated from the reaction liberated sufficient hydrogen from the water to cause the explosion. Therefore, if the facilities are to be used alternately, they should be cleaned thoroughly before switching over. Of course, this hazard would not apply to hydrated lime.

MP-54

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

About the publisher of this book

National Lime Association is the trade association for manufacturers of commercial quicklime and hydrated lime. Among its most important functions are the education of the consuming public as to the most efficient application of lime, as well as publishing general technical information in those fields where lime is used.

In addition to this book, National Lime Association has published the following literature that is applicable to the water and sanitation field.:

1. "Chemical Treatment of Sewage and Industrial Wastes," by Dr. Wm. A. Parsons, 1965 (under revision).
2. "Water Supply & Treatment" (11th edition), 1976, by Merrill L. Riehl, $5.00 plus 20¢ postage.
3. "A Study of the Reaction Between Calcium Oxide and Water," by T. C. Miller, Azbe Award No. 1, 1960, $1.00 plus 15¢ postage.
4. "Lime Industry Safety Manual," 1970, $1.25 plus 10¢ postage.
5. "Chemical Lime Facts," $1.00 plus 15¢ postage.
6. "Lime Stabilization Construction Manual," 25¢ plus 10¢ postage.

MP-55

Other pertinent references:

1. ASTM, 1975, Book of Standards, Pt. 13, particularly C 25-72 on Chemical Analysis of Lime and Limestone and C 110-71 on Physical Tests for Lime.
2. A.W.W.A., "Water Treatment Plant Design," 1969.
3. A.W.W.A., "Standard for Quicklime and Hydrated Lime," Std B 202-65.
4. BIF, "Lime for Water and Wastewater Treatment," Ref. No. 1.22-24 (1969).
5. Boynton, R. S., "Chemistry and Technology of Lime & Limestone, John Wiley & Sons, Inc., N.Y. (1966).
6. Hirsch, A. A., "Dry Feed of Ground Quicklime Without a Slaker," AWWA Journal, Dec., 1962.
7. Hoak, R. D., "How to Buy and Use Lime as a Neutralizing Agent," Water & Sewage Works, Dec., 1953.
8. Infilco, Bulletin on Slaker, No. 255-C.
9. Wallace & Tiernan, Bulletin on Lime, T 60.350-1 (1970).

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

CYANAMID

MSDS NO. 0632-01
CAS NO.
DATE: 04/28/82

MATERIAL SAFETY DATA

PRODUCT IDENTIFICATION

TRADEMARK:	**AERO® Xanthates 317, 325 and 355**
SYNONYMS:	Potassium or sodium alkyl xanthates
CHEMICAL FAMILY:	Xanthates
MOLECULAR FORMULA:	ROCS(S) Na or ROCS (S)K
MOLECULAR WGT.:	Mixture

WARNING

CAUSES EYE AND SKIN IRRITATION

HAZARDOUS INGREDIENTS

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
No Permissible Exposure Limits (PEL), have been established by OSHA				

NFPA HAZARD RATING

Not Established

HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE:	The acute oral (rat) LD50 value for Aero Xanthate 317 is between 0.5 and 2.0 g/kg. Skin or eye contact with solutions of any of these products may cause primary irritation. Airborne dust may cause significant eye and skin irritation or irritation of the respiratory airways.
FIRST AID:	In case of eye contact, immediately irrigate with plenty of water for 15 minutes. Refer to a physician if irritation persists. In case of skin contact, wash affected areas of skin with soap and water. Do not reuse contaminated clothing without laundering.

EMERGENCY PHONE: 201/835-3100

AMERICAN CYANAMID COMPANY, WAYNE, NEW JERSEY 07470

EXPOSURE CONTROL METHODS

Where a closed system is not used, good enclosure and local exhaust ventilation should be provided to minimize exposure. Food, beverages, tobacco products should not be carried, stored or consumed where this chemical is in use. Before eating, drinking or smoking wash face and hands with soap and water. Where engineering controls are effective, respiratory protection is generally not required. If certain operations require respiratory protection, use a NIOSH approved respirator recommended by an industrial hygienist. Material causes eye or skin irritation on contact. A full facepiece respirator will provide eye and face protection. Wear the following as necessary to prevent skin contact; work pants and long sleeve work shirt. For operations where eye or face contact can occur wear respiratory protection outlined above and dust proof goggles.

FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT:	Not Applicable
FLAMMABLE LIMITS (% BY VOL):	Lower - 1.25 Upper - 50.0
AUTOIGNITION TEMP:	248 F(120 C) Residual Carbon Disulfide
DECOMPOSITION TEMP:	Not Available
FIRE FIGHTING:	Use carbon dioxide, dry chemical or water to extinguish fires. Heat causes decomposition to vapor of carbon disulfide. Wear self-contained, positive pressure breathing apparatus and full firefighting protective clothing. Solid xanthates are stable when kept cool and dry. However, exposure to heat and moisture can cause decomposition to flammable and explosive vapor of carbon disulfide. Since xanthates decompose in solution, even at room temperature, fire and explosion hazards can develop with aging.

REACTIVITY DATA

STABILITY:	Unstable
CONDITIONS TO AVOID:	Heating of solid xanthates or heating or aging of xanthates solutions.
POLYMERIZATION:	Will Not Occur
CONDITIONS TO AVOID:	None known
INCOMPATIBLE MATERIALS:	No specific incompatibility.
HAZARDOUS DECOMPOSITION PRODUCTS:	Thermal decomposition or combustion may produce carbon monoxide, carbon dioxide, carbon disulfide and/or sulfur dioxide.

PHYSICAL PROPERTIES

APPEARANCE AND ODOR:	Yellow pellets or powder; odor of carbon disulfide
BOILING POINT:	Not Applicable
MELTING POINT:	360-493 F; 182-256 C
VAPOR PRESSURE:	Not Available
SPECIFIC GRAVITY:	Not Applicable
VAPOR DENSITY:	Not Available
% VOLATILE (BY VOL):	Negligible
OCTANOL/H_2O PARTITION COEF.:	Not Available
pH:	Not Applicable
SATURATION IN AIR (BY VOL):	Not Available
EVAPORATION RATE:	Not Available
SOLUBILITY IN WATER:	Appreciable

SPILL OR LEAK PROCEDURES	STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:	Wear NIOSH approved air purifying cartridge or canister respirator. In addition to the protective clothing/equipment in Exposure Control Methods, wear coveralls. Vacuum spills instead of sweeping.
WASTE DISPOSAL	Disposal must be made in accordance with applicable governmental regulations.	
SPECIAL PRECAUTIONS	HANDLING AND STORAGE/OTHER:	Heating of solid xanthates or heating or aging of xanthate solutions causes some decomposition to poisonous and flammable carbon disulfide. Maintain good housekeeping to control dust accumulations. Special precautions against fire and explosion must be observed in (1) pumping xanthate solutions, (2) draining mobile tanks, (3) cleaning mobile tanks, and (4) performing maintenance work on storage tanks and pipelines leading to and from tanks. Storage tanks should have certain design features for maximum safety, and the vapor space should be free of sources of ignition. Use nonsparking tools and do not smoke when opening drums of xanthate. Do not use xanthate products until you have read the "Safety Discussion" in the AERO Xanthate Handbook from this Company.

Marvin A. Friedman

Marvin A. Friedman, Ph.D., Director of Toxicology and Product Safety

[redacted]

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

[redacted]

6-1554
(Apr. 1972)

Chemical Safety Data Sheet

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20240

SODIUM CARBONATE

METAL AND NONMETAL MINE HEALTH AND SAFETY

MATERIAL

CHEMICAL NAME	FORMULA	CHEMICAL FAMILY
Sodium Carbonate	Na_2CO_3	Inorganic Chemical
TRADE NAME: Sodium Ash		

PHYSICAL DATA

MELTING POINT (°F)	1564	THRESHOLD LIMIT VALUE	Not established
BOILING POINT (°F.)	Decomposes	VAPOR DENSITY (AIR = 1)	---
SPECIFIC GRAVITY ($H_2O = 1$)	2.532	VAPOR PRESSURE (mm Hg.)	---
SOLUBILITY IN WATER 96°F	49.7%	MOLECULAR WEIGHT	106.00
APPEARANCE AND ODOR: White - no odor.			

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) ---	FLAMMABLE LIMITS	Lel ---	Uel ---

EXTINGUISHING MEDIA: Standard

SPECIAL FIRE FIGHTING PROCEDURES: None

At temperatures above 1000°C, it will decompose and form CO_2.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None

HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE: Will cause severe irritation of the eyes and irritate skin. Chronic skin ulcers can develop.

EMERGENCY AND FIRST AID PROCEDURES

Ingestion: Wash mouth and lips with water. Do not induce vomiting. Call a doctor.

Eyes: Flush for a minimum of 15 minutes with water.

Skin: Flush with an excess of water.

Inhalation: Remove to fresh air; give artificial respiration if required.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID Excessive heat.
	STABLE	X	
INCOMPATABILITY *(Materials to avoid)* Acids			
HAZARDOUS DECOMPOSITION PRODUCTS Reacts with hydrated lime to form caustic soda.			
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

Reacts violently during neutralization of acids.

SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED Sweep or vaccum up-may be washed to sewer.

WASTE DISPOSAL METHOD To sanitary landfill.

SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION Dust type respirator.		
VENTILATION	LOCAL EXHAUST X	SPECIAL
	MECHANICAL *(General)*	OTHER
PROTECTIVE GLOVES Yes	EYE PROTECTION Safety goggles	
OTHER PROTECTIVE EQUIPMENT None		

SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Store in a cool dry place.

OTHER PRECAUTIONS Avoid acids in same area.

★ U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 462-363

DU PONT

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Name Sodium Cyanide

Tradename: Cyanobrik®/Cyanogran®

Synonyms Cyanide of Sodium

Chemical Family Metal Cyanide

CAS Name Sodium Cyanide

CAS Registry No. 143-33-9

I.D. Nos./Codes NIOSH Registry No. VZ 75250
Wiswesser Code NC-NA-

Formula = NaCN

Manufacturer/Distributor
E. I. du Pont de Nemours & Co., (Inc.)

Product Information and Emergency Phone (901) 357-1546

Address
Wilmington, DE 19898

Transportation Emergency Phone (800) 424-9300

HAZARDOUS COMPONENTS

Material(s)	Approximate %
Sodium Cyanide	100%

PHYSICAL DATA

Boiling Point, 760 mm Hg 1496°C/2725°F

Specific Gravity 1.6

Vapor Density (Air = 1) 1.7

% Volatiles by Vol. 0

Form Solid

Appearance Granular

pH Information Not available

Melting Point 564°C/1047°F

Vapor Pressure Not applicable

Solubility in H_2O 37% (at 20°C)

Evaporation Rate (Butyl Acetate = 1) Not applicable

Color White

Odor Pungent

Octanol/Water Partition Coefficient Not applicable

FIRE AND EXPLOSION DATA

Flash Point None Method

Flammable Limits in Air, % by Vol. Not applicable

Lower

Upper

Fire and Explosion Hazards Will not burn

Autoignition Temperature Not applicable

Extinguishing Media Not applicable

Special Fire Fighting Instructions Do not use water if involved in fire. Toxic water solutions may escape to surrounding areas. Contact with acids or acid salts will release highly toxic and flammable hydrogen cyanide gas.

HAZARDOUS REACTIVITY

Instability Will react with acids to liberate highly toxic and flammable hydrogen cyanide gas.

Incompatibility

Decomposition

Polymerization Will not occur.

NaCN p 2 of 3

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

HEALTH HAZARD INFORMATION

Exposure Limits OSHA time weighted average (as CN) = 5 mg/m^3

Routes of Exposure and Effects Highly toxic; may be rapidly fatal if swallowed or inhaled. Causes eye burns. May irritate skin.

First Aid Study and plan First Aid action <u>before</u> beginning work with cyanide --- SEE ATTACHMENT.

PROTECTION INFORMATION

Ventilation Use only with adequate ventilation.

Personal Protective Equipment Use respirator if there is danger of breathing dust; air or oxygen mask in emergencies.

Other Wear coverall chemical safety goggles and/or face shield. Rubber gloves for solutions. Dry cotton gloves for dry material.

DISPOSAL PROCEDURES

Aquatic Toxicity Not available.

Spill, Leak or Release Do not breathe dust or gas. Do not get in eyes. Avoid skin contact. Sweep up spillage and store in covered container pending transfer to disposal facility.

Waste Disposal Comply with Federal, State & Local Regulations. Do not flush sodium cyanide into sewers which may contain an acid. If approved, neutralize with sodium or calcium hypochlorite and flush to waste water treatment system or call disposal contractor.

SHIPPING PRECAUTIONS

Transportation DOT shipping Name = Sodium Cyanide, solid (or solution). DOT class. = Poison B

Shipping Containers 49 STCC Code = 4923228. UN No. 1689. IMCO Class 6.1. Railroad tank cars. Flo-bins®. Drums.

Storage Conditions Store in dry place. Keep container closed and away from acids, weak alkaline salts & oxidizing agents. Do not store near foodstuffs.

REFERENCES AND ADDITIONAL INFORMATION

Do not breathe dust or gas. Do not get in eyes. Avoid contact with skin. Do not carry foodstuffs, beverages or tobacco where contamination with cyanide is possible. Wash thoroughly after handling. Wash contaminated clothing before re-use.

SEE: Du Pont Bulletin on Sodium Cyanide
National Fire Protection Association Manual 49, 491M.

DU PONT

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

ATTACHMENT TO SODIUM CYANIDE MSDS

FIRST AID FOR EXPOSURE TO CYANIDE

Always have on hand a Cyanide First Aid Kit and a Medical Supplies Kit (see Du Pont Product Data Sheet). Carry patient to fresh air, have him lie down. Remove contaminated clothing, but keep patient warm. Start treatment immediately. Call a physician.

ANTIDOTE

IF GAS IS INHALED: Break an Amyl Nitrite Pearl in a cloth and hold lightly under nose for 15 seconds. Repeat 5 times at about 15 second intervals. Repeat as necessary using a fresh Amyl Nitrite Pearl every three minutes until 3 or 4 pearls have been given. Use artificial respiration if breathing has stopped.

IF SWALLOWED: Break an Amyl Nitrite Pearl in a cloth and hold lightly under nose for 15 seconds. If patient is conscious, or when consciousness returns, give patient one pint of 1% sodium thiosulfate solution (or soapy or mustard water) by mouth and induce vomiting. Repeat until vomit is clear. Call a physician. Repeat inhalation of Amyl Nitrite 5 times at about 15 second intervals. Repeat as necessary using a fresh Amyl Nitrite Pearl every three minutes until 3 or 4 pearls have been given. Use artificial respiration if breathing has stopped.

Never give anything by mouth to an unconscious person.

IN CASE OF EYE OR SKIN CONTACT: Immediately flush skin or eyes with plenty of water for at least 15 minutes. Call a physician.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Chemical Safety Data Sheet

(1972)

SODIUM CYANIDE

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20240

METAL AND NONMETAL MINE HEALTH AND SAFETY

MATERIAL

CHEMICAL NAME	FORMULA	CHEMICAL FAMILY
Sodium cyanide	NaCN	Inorganic chemical
TRADE NAME Sodium Cyanide		

PHYSICAL DATA

MELTING POINT (°F)	1040	THRESHOLD LIMIT VALUE	Not established
BOILING POINT (°F.)	2723	VAPOR DENSITY (AIR=1)	---
SPECIFIC GRAVITY ($H_2O=1$)		VAPOR PRESSURE (mm Hg.)	---
SOLUBILITY IN WATER	Complete	MOLECULAR WEIGHT	49.01
APPEARANCE AND ODOR	White solid - odorless when dry		

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	N.A.	FLAMMABLE LIMITS	Lel ---	Uel ---

EXTINGUISHING MEDIA Water

SPECIAL FIRE FIGHTING PROCEDURES Do not use CO_2 as it is possible to form hydrocyanic acid gas. Approach the fire from the upwind side and wear self contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS Avoid water contact with molten sodium cyanide as a severe steam explosion will result.

HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE See attached information

EMERGENCY AND FIRST AID PROCEDURES

See attached information

SAFETY IS EVERYONE'S BUSINESS

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

REACTIVITY DATA

STABILITY			
STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATABILITY *(Materials to avoid)* All acids and salts of heavy metals.

HAZARDOUS DECOMPOSITION PRODUCTS HCN

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED Vacuum and sweep up all material. In case of liquid, dilute with a deluge of water, and wash to sewer.

WASTE DISPOSAL METHOD Consult a chemical manufacturing Co.

SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION Dust mask

VENTILATION	LOCAL EXHAUST X	SPECIAL
	MECHANICAL *(General)*	OTHER

PROTECTIVE GLOVES Yes	EYE PROTECTION Safety goggles

OTHER PROTECTIVE EQUIPMENT Self breathing apparatus, if fire is present or a chemical reaction has started.

SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Never store near acids, salts of heavy metals or oxidizers.

OTHER PRECAUTIONS

★ U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 462-263

HAZARD

NaCN

EMPLOYEE SAFETY

EMPLOYEE EDUCATION AND TRAINING

Safety in handling sodium cyanide depends, to a great extent, upon the effectiveness of employee education, proper safety instructions, intelligent supervision and the use of safe equipment.

The education and training of employees to work safely and to use the personal protective equipment or other safeguards provided for them is the responsibility of supervision. Training classes for both new and old employees should be conducted periodically to maintain a high degree of safety in handling procedures.

Employee education and training should emphasize the need to handle sodium cyanide according to the methods outlined in this Data Sheet and the necessity to avoid spills, leaks, burns, inhalation of the dust, and ingestion.

New employees should be instructed thoroughly in the proper handling of sodium cyanide before they are allowed to work in an area where the material is made, handled, or used. Older employees should be reinstructed and quizzed periodically.

Each employee should know the location, purpose, and methods of maintenance of personal protective equipment. They should also be trained thoroughly as to when and how to use this equipment.

Each employee should know the location of safety showers, bubbler fountains for flushing the eyes, hose lines, and other washing facilities.

Each employee should know what to do in an emergency arising from the handling of sodium cyanide. He should realize the necessity for the prompt application of first aid in case of ingestion, inhalation, or skin contact.

All employees should be trained to wash out their mouths with water if the sense of taste indicates the presence of sodium cyanide. The water must not be swallowed.

All employees should be instructed to report to the proper authority all equipment failures and/or signs of illness.

Job instructions, including safety precautions, should be posted in the work area.

PERSONAL PROTECTIVE EQUIPMENT

Eye Protection

Chemical Safety Goggles. Cup type or rubber framed goggles equipped with approved impact resistant glass or plastic lenses, should be worn whenever there is danger of sodium cyanide in water solution coming in contact with the eyes. Goggles should be carefully fitted by adjusting the nose piece and head band to insure maximum protection and comfort.

Spectacle Type Safety Goggles. Metal or nonflammable plastic rim safety spectacles with side shields which can be obtained with prescription safety lenses, or suitable all plastic safety goggles may be used where continuous eye protection is desirable, for example, in working with fused salts containing sodium cyanide. These types, however, should not be used where complete eye protection against chemicals is needed.

Face Shields. Nonflammable plastic shields (full length, 8 in. minimum) with forehead protection may be worn in lieu of, or in addition to, chemical safety goggles where complete face protection is desirable. Chemical safety goggles should always be worn as added protection where there is danger of material striking the eyes from underneath or around the sides of the face shield.

Respiratory Protection

Two distinct respiratory hazards are possible where sodium cyanide is manufactured, stored, or used: (1) The hazard of inhaling hydrocyanic acid gas in the event of acids or acid salts coming in contact with sodium cyanide, and (2) the hazard of inhaling sodium cyanide dust.

Respiratory protective equipment intended for use in connection with the hazards of hydrocyanic acid gas or sodium cyanide dust must be carefully maintained, inspected, cleaned and sterilized at regular intervals, and always before use by another person. Personnel wearing such equipment must be carefully instructed as to its operation and limitation.

Air or oxygen supplied masks must be worn for protection where an oxygen deficiency, less than 16 percent by volume, or a concentration of a harmful gas above 2 percent by volume may be encountered for a few minutes in connection with rescue work or a similar emergency such as:

(a) In fumigating with sodium cyanide and an acid, the liberated hydrocyanic acid gas being the fumigant.

(b) In emergencies when the vapor concentration of sodium cyanide is not definitely known.

[redacted] [redacted]

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Only masks approved for this purpose by the U.S. Bureau of Mines should be used and the manufacturer's instructions must be carefully followed. Types generally available include:

(a) Self-contained Breathing Apparatus permitting the wearer to carry a supply of oxygen or air compressed in the cylinder, the self-generating type which produces oxygen chemically, and the re-breathing type.--These allow considerable mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air, oxygen or regenerating material carried. Compressed oxygen should not be used in confined spaces such as tanks or pits.

(b) Positive Pressure Hose Masks supplied by blowers requiring no internal lubrication.--The wearer must be able to use the same route for exit as for entrance and must take precautions to keep the hose line free of entanglement. The air blower must be placed in an area free of contaminants.

(c) Air-line Masks supplied with clean compressed air.--These are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied with air piped to the area from a compressor. It is extremely important that the air supply is taken from a safe source and that it is not contaminated by oil decomposition from inadequate cooling at the compressor. The safer method is to use a separate compressor of the type not requiring internal lubrication. Pressure reducing and relief valves, as well as suitable traps and filters, must be installed at all mask stations. An alternative arrangement frequently used is high pressure breathing air from standard (200 cu. ft.) cylinders, with a demand-type valve and face piece. This arrangement may also be used with 50-100 lb. clean piped plant air, and, as an additional precaution with the demand mask, a small cylinder of compressed air may be worn for use as an emergency escape from the area. Consult a reliable safety equipment dealer for details on the proper use of Bureau of Mines approved equipment.

(d) Industrial Canister Type Gas Masks approved by the U.S. Bureau of Mines, fitted with the proper canister for absorbing hydrogen cyanide vapor.--These will afford protection against concentrations not exceeding 2 percent by volume when used in accordance with manufacturer's instructions. The oxygen content of the air must not be less than 16 percent by volume. The masks should be used for relatively short exposure periods only. They may not be suitable for use in an emergency since, at that time, the actual vapor concentration is unknown and an oxygen deficiency may exist. The wearer must be warned to leave the contaminated area immediately on detecting the odor of a harmful vapor. This may indicate that the mask is not functioning properly, that the vapor concentration is too high, that the canister is exhausted or that the mask is not properly fitted.

Because hydrocyanic acid may by absorbed through the skin, persons entering a gas-filled area for emergency purposes must wear gas-tight garments, such as those designed for gas decontamination squads during the war, in addition to the prescribed respiratory protection.Gas-tight suits are available commercially.

Dust respirators approved by the Bureau of Mines, will afford protection against sodium cyanide dust. The respirators should be cleaned at frequent and regular intervals, and the filters should be changed when breathing resistance increases. If the odor or taste of hydrocyanic acid becomes noticeable, a full face mask approved for the material should be used.

Body, Skin, and Hand Protection

Aprons made of rubber or other suitable protective material should be used for protection against accidental contact.

Dry cotton gloves should be worn to protect the hands from solid sodium cyanide.

Gloves made of rubber or other suitable protective material should be worn to protect the hands from sodium cyanide solution.

Sleeves made of suitable protective material should be worn when the need for complete arm protection is indicated.

Suits made of rubber or suitable protective material and properly designed should be used to provide complete body protection where sodium cyanide or its solutions are handled and when such protection is indicated.

Clothing wet by sodium cyanide solutions must be removed immediately, and the body must be washed thoroughly before clean clothing is put on. Splashed clothing must be washed thoroughly and dried before it is worn again.

EMERGENCY KITS

Emergency kits should always be quickly available and readily accessible to every operating area. However, they should not be located in the operating area lest they not be accessible in case of a spill.

SAFETY SHOWERS AND EYE BATHS

A readily accessible, well marked, rapid action deluge type safety shower should be available in any area where sodium cyanide either as a solid (dust or granular) or in solution is handled. Special eye washing [redacted] [redacted]

fountains, or a ready source of running tap water such as a bubbler fountain, or a hose with a soft, gentle flow of water, should be available for eye irrigation. All of this equipment should be inspected at frequent and regular intervals to insure that it is in working condition at all times.

WASHING FACILITIES

Adequate washing facilities should be conveniently located for the use of employees before eating, smoking or leaving the plant. A shower is recommended for the latter time. Locker facilities also should be provided for a complete change of clothing.

EATING FOOD AND CHEWING TOBACCO

Food, gum and tobacco should not be carried in work areas where contamination with sodium cyanide is possible.

FIRST AID

GENERAL PRINCIPLES

Prompt treatment of cases of sodium cyanide poisoning is of the utmost importance. If the patient has breathed sodium cyanide dust, he should be immediately removed to an area free from dust. If solutions of cyanide or molten cyanide have contaminated the skin or clothing, the clothing should be immediately removed and contaminated skin areas copiously flushed with water until all cyanide has been removed. The clothing should be thoroughly cleansed before being reworn.

Someone should be sent immediately to call for a physician, and in the meantime first aid should be started. The physician should be told the exact location of the patient and the nature of the accident.

Maintenance of respiration is the most important initial first aid measure. If breathing has ceased, an effective method of artificial respiration should be started at once. Anyone properly trained may use a resuscitator or give mouth-to-mouth resuscitation.

CONTACT WITH SKIN OR MUCOUS MEMBRANES

If the patient has inhaled sodium cyanide dust or swallowed sodium cyanide, first aid for inhalation and/or ingestion should be given first.

The emergency shower should be used immediately to remove the sodium cyanide with large quantities of water. Contaminated clothing should be removed under the shower. Skin areas should be washed with large quantities of soap and water. Contaminated clothing and shoes should not be worn until they have been thoroughly washed and decontaminated. No ointments or salves should be applied for 24 hours. A physician should see all cases other than minor exposures.

Sodium cyanide may be absorbed through the skin, especially if the skin is broken by small wounds, and fatal poisining can follow. Therefore, additional first aid procedures may be necessary.

CONTACT WITH THE EYES

If sodium cyanide has entered the eyes, they should be irrigated immediately with large quantities of water for a minimum of 15 minutes The eyelids should be held apart during the irrigation to insure contact of water with all tissues of the surface of the eyes and lids. A physician, preferably an eye specialist, should be called into attendance. If a physician is not available, the eye irrigation should be continued for a second period of 15 minutes. No medicaments should be instilled in the eyes unless ordered by a physician.

TAKEN INTERNALLY

The patient should be removed to fresh air; and if he is conscious, he should be made to vomit by giving him an emetic of warm salt water (1 tablespoon of salt to each cup of water). This should be repeated until the vomit fluid is clear. To induce vomiting, the patent should be encouraged to stick his finger down his throat. He should then be given orally one pint of a 1 percent solution of sodium thiosulfate, to be repeated in 15 minutes.

Nothing should ever be given by mouth to an unconscious patient.

If breathing has stopped, an effective means of artificial respiration or resuscitation should be started as soon as it is certain that the patient has a clear airway. This is done by examining the mouth to see if the tongue has dropped back. If it has, it should be pulled forward. False teeth, loose bridges, chewing gum, tobacco, etc., should be removed to prevent the patient from choking. Oxygen is recommended and may be administered by anhone properly trained.

If the victim is breathing unassisted, amyl nitrite may be administered 15 to 30 seconds each minute. This may be alternated with the administration of oxygen which should be carried out the remaining part of each minute.

INHALATION

A worker with symptoms or signs of cyanide poisoning should be moved promptly to an uncontaminated area.

[redacted]

An effective method of artificial respiration or resuscitation must be started at once if breathing has ceased, and it must be continued uninterruptedly until breathing has been resumed. If available, oxygen administration is advisable.

A physician should be called immediately, and the first aid kit made ready. The physician should be told the exact location of the patient and the nature of the injury.

A first aid kit containing the following items should be readily available. (A Cyanide Antidote Package is available only from Eli Lilly and Company, Indianapolis, Indiana.)

2 boxes (2 dozen) of amyl nitrite* pearls
2 sterile ampules of sodium nitrite solution
(10 cc of a 3% solution in each)
2 sterile ampules of sodium thiosulfate solution
(50 cc of a 25% solution in each)
One 10 cc and one 50 cc sterile syringe with sterile
intravenous needles
1 tourniquet
1 stomach tube
1 dozen gauze pads and 1 small bottle of 70% alcohol
2 one-pint bottles of 1% sodium thiosulfate solution
*Amyl nitrite is unstable and should be replaced annually.

The kit should be conveniently located and checked at regular intervals by a responsible person.

WARNING: Amyl nitrite should not be used near any source of ignition such as an open flame or cigarette.

If able, the patient should breathe the contents of amyl nitrite pearls 15 to 30 seconds each minute until, if necessary, five pearls have been used. The pearls are to be wrapped lightly in a handkerchief or gauze pad, then broken in the wrapping and the latter held about one inch from the patient's mouth and nose.

WARNING: Those giving first aid should be careful to keep the broken pearls away from their own mouths and noses; otherwise, they may inhale the amyl nitrate, become dizzy, and be rendered incompetent to give proper assistance to the poisoned worker.

...ond Shamrock Chemical Company

DIAMOND SHAMROCK CORPORATION

300 Union Commerce Building / Cleveland, Ohio 44115 / Telephone (216) 621-6100

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

...RIAL SAFETY DATA SHEET

Similar To: *United States Department of Labor, Wage and Labor Standards Administration, Bureau of Labor Standards (Form LSB 0054)*

D 270

CHEMICAL NAME (In Full) Sodium Bichromate Dihydrate

PRODUCT NAME Technical Sodium Bichromate Granular

FORMULA

$Na_2Cr_2O_7 \cdot 2H_2O$

GENERAL INFORMATION

Sodium bichromate is commercially available as a concentrated liquid and as a granular product. Sodium bichromate is widely used in chemical and allied industries. Sodium bichromate is unregulated by the Interstate Commerce Commission. It is mildly oxidizing in character but becomes a strong oxidizer in concentrated solutions in presence of strong acids. Sodium bichromate is noncorrosive to metal, is noncombustible but may react slowly with certain organic material such as paper and clothing fibers.

HAZARD CLASSIFICATION

I. IMPORTANT PHYSICAL and CHEMICAL PROPERTIES

PHYSICAL STATE	Liquid or Solid Crystals	FLAMMABLE LIMITS	----	VAPOR PRESSURE	----
	Liquid - dark red; Crystals - orange-red	LIGHT SENSITIVITY	----	TEMP. MMHg.	----
ODOR	None	SOLUBILITY (20°C)	70% by weight		
FLASH POINT (Closed Cup)	----	SPECIFIC GRAVITY (H_2O = 1.0)	1.706 for 70% solution		
BOILING POINT	400°C decomposes	THRESHOLD LIMIT VALUE (AIR BORNE)	0.1 mg/cubic meter as CrO_3	% VOLATILE (Volume)	----
AUTOIGNITION TEMPERATURE	----	VAPOR DENSITY AIR = 1.0	----	EVAPORATION RATE (Ether = 1.0)	----
CRITICAL TEMP.	----	VISCOSITY 20°C	10 centipoises for 70% solution	REACTIVITY	Mildly oxidizing in solution but becomes strongly oxidizing in strong acid solution.
DENSITY AT 20°C	2.35 for solid	MINIMAL LETHAL DOSE	Poisonous - see section on health hazards p. 2.		
HEAT OF COMBUSTION	Noncombustible	LD50 TEST	----		

II. CHEMICAL REACTIVITY DATA

STABLE [X] Yes [ ] No   SELFPOLYMERIZE [ ] Yes [X] No

HAZARDOUS DECOMPOSITION PRODUCTS

None

AVOID CONTACTS WITH THESE MATERIALS

S...ng acids and oxidizable materials if in presence of acids.

...TIONS TO AVOID

Avoid contact with eyes or skin. Avoid breathing vapors or dust. Do not take internally. Avoid storage in humid air.

SPILLS and LEAKS

Solids may be shoveled up, followed by flushing with water. Remaining traces should be neutralized with soda ash.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

WASTE DISPOSAL

The hexavalent chromium in sodium bichromate solutions may be reduced to trivalent chromium by a variety of reducing agents such as sodium bisulfite, sodium sulfite, sulfur dioxide or ferrous sulfate or chloride. The reduced chromium may then be precipitated as the hydrous chromic oxide by neutralizing to a pH of 7.0 with soda ash, caustic soda, or lime.

DISPOSAL and RETURN PROCEDURES (Returnable Containers)

Most sodium bichromate containers are nonreturnable. Returnable containers should be tightly closed after emptying to avoid contamination.

NON-RETURNABLE CONTAINERS

Empty containers should be rinsed with water before disposal. Methods of disposal depend upon local laws and ordinances.

SPECIAL HANDLING and STORAGE PROCEDURES

Store in a dry location to avoid caking of bagged material and the rusting of steel drums.

Avoid contact with skin or eyes.

Do not swallow or inhale mists or dusts.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

III. HEALTH HAZARDS

General

Sodium bichromate is not dangerous to transport and use if handled properly. It may cause irritation to mucous membranes and skin. It can cause irritation and conjunctivitis if in contact with the eyes. It can cause ulceration of skin wounds. If inhaled, it can cause irritation of the respiratory system. May cause harmful effects if swallowed and death can result if ingested in excessive amounts.

A. FIRST AID PROCEDURES

Ingestation

Antidote: Give magnesia, chalk, or whiting suspended in water. Follow with an emetic (a tablespoon of mustard in a glass of warm water). Then give olive oil or mucilaginous drinks. Call a physician.

Inhalation

Irrigate nasal passages and mouth with salt water.

Skin Contact

Flush skin with copious quantities of water without delay. Clothing penetrated with solutions or dusts should be removed promptly.

Contact With Eyes

Flush eyes with water for at least 15 minutes without delay. Eyelids should be held apart during irrigation to insure contact of water with entire surface of eyes and lids. Call a physician without delay.

B. PERSONAL PROTECTIVE EQUIPMENT

Gloves, chemical safety goggles, and dust respirator (U.S. Bureau of Mines 2175 model 7100 or American Optical R2090 Red Devil with mist filter or equivalent.)

IV. FIRE and EXPLOSION

General

Sodium Bichromate will not burn or support combustion.

Fire Fighting (Procedure, Equipment)

Flush with water.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Product Safety Information

SODIUM HEXAMETAPHOSPHATE

(Glassy Sodium Phosphate)

This Product Safety Information Sheet is principally directed to managerial, safety, hygiene and medical personnel. The description of physical, chemical and toxicological properties and handling advice is based on experimental results and past experience. It is intended as a starting point for the development of safety and health procedures.

I. PHYSICAL AND CHEMICAL PROPERTIES

Formula: $(NaPO_3)_n \cdot Na_2O$
Formula Weight: Polymeric
Physical State: White granular or powdered solid
Bulk Density: 70-81 lbs/ft^3
Water Solubility: Very soluble
pH: 7 (1% aqueous solution)
Odor: None
Flash Point: None

II. CHEMICAL REACTIVITY

This material will react as a typical neutral salt.

III. STABILITY

This material is thermally stable.

IV. FIRE HAZARD

This material is not considered combustible, nor will it support combustion.

V. FIREFIGHTING TECHNIQUE

As in any fire, prevent human exposure to fire, smoke, fumes or products of combustion. Evacuate nonessential personnel from the fire area.

When there is a potential for exposure to fire, smoke, fumes, products of combustion, etc., firefighters should wear full-face, self-contained breathing apparatus and impervious clothing such as gloves, hoods, suits and rubber boots.

Use standard firefighting techniques in extinguishing fires involving this product. Use water, dry chemicals, foam, carbon dioxide or other suitable extinguishing agents.

VI. TOXICOLOGY

CAUTION: May cause irritation. Prolonged contact with skin and eyes may cause irritation.

Ingestion
The acute oral LD50 is greater than 1000 mg/kg in male rats. A single oral dose of 1000 mg/kg did not produce signs of toxicity in male rats.

Skin Contact
Mild irritant to rabbit skin following a 24-hour exposure.

Threshold Limit Value (TLV)
The American Conference of Governmental Industrial Hygienists has not established a TLV.

For Stauffer Reference Only: T-1861, T-4054.

VII. FIRST AID

CALL A PHYSICIAN IMMEDIATELY

If a known exposure occurs or if poisoning is suspected, do not wait for symptoms to develop. Immediately initiate the recommended procedures below. Simultaneously contact a physician, or the nearest hospital, or the nearest Poison Control Center. Inform the person contacted of the type and extent of exposure, describe the victim's symptoms, and follow the advice given. For additional information, call collect, day or night, Stauffer Chemical Company (203) 226-6602 or Chemtrec (800) 424-9300.

Ingestion
If swallowed—Immediately dilute the swallowed material by giving large quantities of water. Induce vomiting by gagging the victim with a blunt object placed on the back of the victim's tongue. Continue fluid administration until vomitus is clear. Never give anything by mouth to an unconscious person. Call a physician or the nearest Poison Control Center immediately.

Skin Contact
Remove any contaminated clothing and wash all affected areas with plenty of soap and water. Seek medical attention if irritation occurs.

Eye Contact
Immediately flush the eyes with large quantities of running water for a minimum of 15 minutes. Hold the eyelids apart during the flushing to ensure rinsing of the entire surface of the eye and lids with water. Do not attempt to

In case of suspected exposure, refer to the procedure and emergency contacts in Section VII—FIRST AID.

In case of spillage, refer to the procedure and emergency contacts in Section IX—SPILL HANDLING.

In case of animal poisoning, call a veterinarian or call collect, day or night (203) 226-6602 (Stauffer Chemical Company) or (800) 424-9300 (Chemtrec).

In case of contamination of other materials with this product, call (800) 424-9300 (Chemtrec).

B-11424 (4/80) Printed in U.S.A.

Stauffer CHEMICALS

STAUFFER CHEMICAL COMPANY
INDUSTRIAL CHEMICAL DIVISION
Westport, Connecticut 06880

neutralize with chemical agents. Obtain medical attention as soon as possible. Oils or ointments should not be used. Continue the flushing for an additional 15 minutes if the physician is not immediately available.

Inhalation
Remove from contaminated atmosphere. Seek medical attention if respiratory irritation occurs. If the victim is having difficulty breathing, oxygen may be administered, preferably with a physician's advice.

VIII. INDUSTRIAL HYGIENE

Ingestion
All food should be kept in a separate area away from the working location. Eating, drinking, and smoking should be prohibited in areas where there is a potential for significant exposure to this material. Before eating, hands and face should be thoroughly washed.

Skin Contact
Skin contact should be minimized through the use of gloves and suitable long-sleeved clothing.

Eye Contact
Eye contact should be prevented through the use of chemical safety glasses, goggles or a face shield.

Inhalation
This material should be handled in open or well-ventilated areas. If dust is generated it should be controlled by local exhaust ventilation. When this is not feasible, inhalation can be prevented through the use of a NIOSH-approved, particulate filter respirator.

IX. SPILL HANDLING

Make sure all personnel involved in the spill cleanup follow good industrial hygiene practices (refer to Section VIII).

Spills can be handled routinely. Use adequate ventilation and wear a dust mask to prevent inhalation. Wear suitable protective clothing and eye protection to prevent skin and eye contact. Use the following procedures:

Sweep up the material being careful not to create dust and transfer to an appropriate chemical waste container. Seal container and dispose of in an approved landfill or in such a manner that will not adversely affect the environment. The residue may be flushed with water.

IN CASE OF EMERGENCY, CALL, DAY OR NIGHT
(800) 424-9300 (CHEMTREC)

X. CORROSIVITY TO MATERIALS OF CONSTRUCTION

The material is not corrosive to materials commonly used in the construction of process equipment, storage and shipping containers.

XI. STORAGE REQUIREMENTS

The containers should be stored in a cool, dry, well-ventilated area. The material is hygroscopic, and therefore the containers should be kept closed when not in use. Exercise due caution to prevent damage to or leakage from the container.

XII. DISPOSAL OF UNUSED MATERIAL

Material that cannot be used or chemically reprocessed should be disposed of in an approved landfill or in such a way that will not adversely affect the environment.

XIII. DISPOSAL OF CONTAINER

Empty containers may be incinerated by means equipped with appropriate environmental pollution controls or discarded with the general trash.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

CYANAMID

MSDS NO. 0293-01
CAS NO.
DATE: 07/29/82

MATERIAL SAFETY DATA

PRODUCT IDENTIFICATION

TRADEMARK:	**AERO® 343 Xanthate**
SYNONYMS:	Sodium isopropyl xanthate
CHEMICAL FAMILY:	Alkyl xanthate
MOLECULAR FORMULA:	(CH3)2CHOC(S)SNa
MOLECULAR WGT.:	176

WARNING

CAUSES EYE AND SKIN IRRITATION

HAZARDOUS INGREDIENTS

COMPONENT	CAS. NO.	%	TWA/CEILING	REFERENCE
No Permissible Exposure Limits (PEL), have been established by OSHA				

NFPA HAZARD RATING

Not Established

HEALTH HAZARD INFORMATION

EFFECTS OF OVEREXPOSURE:	Acute oral (rat) LD50 value is between 0.25 and 2.0 g/kg. Skin or eye contact with solutions of the product may cause primary irritation. Airborne dust may cause eye and skin irritation or irritation of the respiratory tract.
FIRST AID:	In case of skin contact, remove contaminated clothing without delay. Flush skin thoroughly with water. Do not reuse clothing without laundering. In case of eye contact, immediately irrigate with plenty of water for 15 minutes. Refer to a physician if irritation persists. If vapor of AERO 343 Xanthate is inhaled, remove from exposure. Administer oxygen if there is difficulty in breathing.

EMERGENCY PHONE: 201/835-3100

AMERICAN CYANAMID COMPANY, WAYNE, NEW JERSEY 07470

EXPOSURE CONTROL METHODS

Utilize a closed system process where feasible. Where a closed system is not used, good enclosure and local exhaust ventilation should be provided to minimize exposure. Food, beverages, tobacco products should not be carried, stored or consumed where this chemcial is in use. Before eating, drinking or smoking wash face and hands with soap and water. Shower after completion of workshift. Launder work clothing at end of workshift prior to reuse. Store street clothing separately from work clothing and protective equipment. Work clothing and shoes must not be taken home. Where engineering controls are effective, respiratory protection is generally not required. If certain operations require respiratory protection, use a NIOSH approved respirator recommended by an industrial hygienist. Material causes eye or skin irritation on contact. A full facepiece respirator will provide eye and face protection. Wear the following as necessary to prevent skin contact; work pants, long sleeve work shirt and impervious gloves. For operations where eye or face contact can occur wear respiratory protection outlined above, (full facepiece) or dust proof goggles.

FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT:	This product has no flash point or explosive limits. Carbon disulfide may be evolved; however, (see Reactivity Data) with a flash point of -22 F.
FLAMMABLE LIMITS (% BY VOL):	1.25 lower; 50.0 upper (residual carbon disulfide)
AUTOIGNITION TEMP:	248 F; 120 C (residual carbon disulfide)
DECOMPOSITION TEMP:	428-464 F; 220-240 C (residual carbon disulfide)
FIRE FIGHTING:	Use carbon dioxide or dry chemical to extinguish fires. Do not use water. Do not flush to sewers. Wear self-contained, positive pressure breathing apparatus and full firefighting protective clothing. See Exposure Control Methods for special protective clothing. Dust may be explosive if mixed with air in critical proportions and in the presence of a source of ignition. Liberates carbon disulfide slowly in aqueous solution, or when heated, or in presence of moisture. Due to its high vapor density (2.2 @ 100 F) carbon disulfide may accumulate in the bottom of tanks or drums containing this product or solutions of it and create a fire or explosion hazard.

REACTIVITY DATA

STABILITY:	Unstable
CONDITIONS TO AVOID:	Heat or moisture will liberate carbon disulfide which is toxic and explosive.
POLYMERIZATION:	Will Not Occur
CONDITIONS TO AVOID:	None known
INCOMPATIBLE MATERIALS:	Acids and strong oxidizing agents.
HAZARDOUS DECOMPOSITION PRODUCTS:	Heat or moisture will liberate carbon disulfide. Thermal decomposition may produce carbon monoxide, carbon dioxide, sulfur oxides and/or carbon disulfide.

PHYSICAL PROPERTIES

APPEARANCE AND ODOR:	Yellow pellets or powder; slight, disagreeable odor
BOILING POINT:	Not Applicable
MELTING POINT:	451-462 F; 233-239 C
VAPOR PRESSURE:	Not Applicable
SPECIFIC GRAVITY:	Not Available
VAPOR DENSITY:	Not Applicable
% VOLATILE (BY VOL):	<15.0
OCTANOL/H_2O PARTITION COEF.:	Not Applicable
pH:	Not Applicable
SATURATION IN AIR (BY VOL):	Not Applicable
EVAPORATION RATE:	Not Applicable
SOLUBILITY IN WATER:	Appreciable

SPILL OR LEAK PROCEDURES	STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:	Where exposure level is not known, wear NIOSH approved positive pressure self-contained respirator. Where exposure level is known, wear NIOSH approved respirator suitable for level of exposure. Same protective clothing/equipment as in Exposure Control Methods. Vaccum spill instead of sweeping.

WASTE DISPOSAL Disposal must be made in accordance with applicable governmental regulations.

SPECIAL PRECAUTIONS	HANDLING AND STORAGE/OTHER:	Store in a cool, dry, well-ventilated area. Maintain good housekeeping to comtrol dust accumulations. Areas where handling or use may result in the evolution of carbon disulfide should have fire safe practices and electrical equipment in accordance with Electrical and Fire Protection Codes (NFPA-30) governing Class I Flammable Liquids.

Marvin A. Friedman

Marvin A. Friedman, Ph.D., Director of Toxicology and Product Safety

DU PONT

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

Name Sodium Silicate Solution

Synonyms Water glass

Chemical Family Silicate

CAS Name Silicic Acid, Sodium Salt

CAS Registry No. 1344-09-8

I.D. Nos./Codes NIOSH Registry #WE-06600 (2/1 ratio); WE-06800 (3/1 ratio)

Manufacturer/Distributor
E. I. du Pont de Nemours & Co., (Inc.)

Address
Wilmington, DE 19898

Product Information and Emergency Phone
302-774-2421

Transportation Emergency Phone
800-424-9300

HAZARDOUS COMPONENTS

Material(s)	Approximate %
Sodium Oxide (Na_2O)	
#6, 22, 26	18.4-13.3
#16, 14, 30, 2.50, 2.58	13.9-10.6
#9, JM, F, 20WW	9.1- 8.7

PHYSICAL DATA

Boiling Point, 760 mm Hg ~100°C, 212°F.

Melting Point 0°C, 32°F.

Specific Gravity 1.39-1.72 depending on grade

Vapor Pressure @ 25°C = 24mm Hg, @ 37.7°C = 49mm Hg

Vapor Density Vapor is water

Solubility in H_2O Complete

% Volatiles by Vol. 70-80

Evaporation Rate (Butyl Acetate = 1) < 1

Form Liquid

Appearance Viscous, clear to hazy

Color Colorless

Odor Odorless

pH Information 11-13 depending on grade

Octanol/Water Partition Coefficient

FIRE AND EXPLOSION DATA

Flash Point Will not burn Method

Autoignition Temperature

Flammable Limits in Air, % by Vol.

Lower

Upper

Fire and Explosion Hazards

Extinguishing Media

Special Fire Fighting Instructions

HAZARDOUS REACTIVITY

Instability Stable

Incompatibility No known hazardous incompatibility.

Decomposition Will not occur

Polymerization Will not occur

HEALTH HAZARD INFORMATION

Sodium Silicate p. 2 of 2

Exposure Limits Not established

Routes of Exposure and Effects

Grades #22, 6, 26 cause eye burns, skin irritation
Grades #16, 30WW, 14, 2.50, 2.58 cause severe eye irritation, skin irritation
Grades #F, JM, 9, 20WW may irritate eyes and skin

First Aid

In case of eye contact, immediately flush with plenty of water for at least 20 minutes. Call a physician.

In case of skin contact, flush skin with water. Remove contaminated clothing; wash before re-use.

PROTECTION INFORMATION

Ventilation Maintain adequate ventilation.

Personal Protective Equipment Coverall chemical safety goggles. Rubber gloves.

Other Not required.

DISPOSAL PROCEDURES

Aquatic Toxicity

Spill, Leak or Release Flush spill area with plenty of water.

Waste Disposal Comply with Federal, State, Local regulations. If approved, flush to sewer to waste treatment plant.

SHIPPING PRECAUTIONS

Transportation Not regulated by Department of Transportation.

Shipping Containers Railroad tank cars, tank trucks.

Storage Conditions Keep container tightly closed, Store in warm area as needed to facilate transfer from container.

REFERENCES AND ADDITIONAL INFORMATION

Wash thoroughly after handling. Wash contaminated clothing before reuse. For more information, refer to Du Pont's Sodium Silicate Data Sheet, Product Information Bulletin.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

SODIUM SILICATE N,RU,O,K,BW

Chemical Safety Data Sheet

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20240

METAL AND NONMETAL MINE HEALTH AND SAFETY

MATERIAL

CHEMICAL NAME	FORMULA	CHEMICAL FAMILY
Sodium Silicate	$Na_2O.1.6SiO_2$	Alkali Silicates

TRADE NAME B - W, N, RU,O,K

PHYSICAL DATA

MELTING POINT (°F)	---	THRESHOLD LIMIT VALUE	Not established
BOILING POINT (°F.)	212°F	VAPOR DENSITY (AIR=1)	N.A.
SPECIFIC GRAVITY (H_2O=1)	1.676	VAPOR PRESSURE (mm Hg.)	N.A.
SOLUBILITY IN WATER	Soluable	MOLECULAR WEIGHT	---

APPEARANCE AND ODOR Colorless and odorless

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	Lel	Uel
None			

EXTINGUISHING MEDIA None required.

SPECIAL FIRE FIGHTING PROCEDURES None

UNUSUAL FIRE AND EXPLOSION HAZARDS Contains 19.70% Na_2O, 31% SiO_2 plus H_2O

HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE Irritates skin and eyes.

EMERGENCY AND FIRST AID PROCEDURES Flush skin and eyes immediately for 15 minutes with plenty of water; for eyes, call a physician.

EVERYONE'S BUSINESS

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Sodium Silicate

p.2 of 2

REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID N.A.
	STABLE	X	

INCOMPATABILITY *(Materials to avoid)* N.A.

HAZARDOUS DECOMPOSITION PRODUCTS None

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	N.A.	

SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Flush to sewer with large amount of water.

WASTE DISPOSAL METHOD Flush to sewer with large amount of water.

SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION

VENTILATION	LOCAL EXHAUST None required	SPECIAL
	MECHANICAL *(General)*	OTHER

PROTECTIVE GLOVES

EYE PROTECTION Safety glasses

OTHER PROTECTIVE EQUIPMENT

SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS Prevent from freezing.

* U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 463-283

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

DU PONT

INDUSTRIAL CHEMICALS department

SODIUM SILICATES

and

POTASSIUM SILICATES

Storage and handling

MP-87

MP-88

NOTICE: MAY CAUSE EYE INJURY AND SKIN IRRITATION.
See Personal Safety and First Aid on page 8.

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(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

MP-89

INTRODUCTION

This bulletin is a guide for the storage and handling of sodium silicate and potassium silicate solutions. Du Pont manufactures aqueous sodium and potassium silicates in various silica/alkali oxide ratios and concentrations. These silicates are highly stable, viscous, opalescent or clear solutions.

Sodium and potassium silicates are nonflammable and nonexplosive. Their physical properties vary with solids content and with the ratio of silica to sodium or potassium oxide, expressed as a weight ratio of percent silica divided by percent sodium or potassium oxide (SiO_2 : Na_2O or SiO_2 : K_2O). Some important properties of Du Pont silicate solutions are listed in Table I and Table II. The freezing point of these solutions is approximately 32 F and specific heat is approximately 0.60 to 0.70 g cal/g-C.

Du Pont manufactures solid sodium and potassium silicates, including sodium metasilicate. Consult the nearest sales office of Du Pont's Industrial Chemicals Department for further information.

TABLE I

SPECIFICATIONS SODIUM SILICATE SOLUTIONS

Grade	Wt.* Ratio SiO_2/Na_2O	% SiO_2**	% Na_2O†	Specific Gravity Be at 60 F (15.6 C)††	Viscosity cP at 68 F (20 C)	Approx. Density lb/gal at 60 F (15.6 C)
Regular Solutions						
F	3.25	28.40	8.70	40.60	160 ± 40	11.6
JM®	3.25	29.60	9.10	42.60	775 ± 95	11.8
No. 6	1.95	36.00	18.40	60.25	–	14.3
No. 9	3.25	29.00	8.90	41.60	345 ± 85	11.7
No. 14	2.87 ± 0.06	32.04 ± 0.71	11.14 ± 0.31	47.59 ± 0.45	1255 ± 165	12.4
No. 16	2.38	33.10	13.90	52.25	–	13.0
No. 22	1.90	28.50	15.00	50.25	–	12.7
No. 28	2.20	29.20	13.30	48.25	–	12.5
Filtered Solutions						
No. 20	3.25	28.40	8.70	40.60	160 ± 40	11.6
No. 30	2.55	27.00	10.60	42.50	–	11.8

*Ratio ± 0.05
**Silica (SiO_2) ± 0.15%
†Sodium oxide (Na_2O) ± 0.2%
††Gravity ± 0.25 Be
} except as otherwise indicated

PRECAUTIONS IN USE

Storage tanks and drums must be maintained below 90 F and above 32 F to avoid thermal decomposition at high temperatures and separation of solutions at freezing temperatures. Direct sunlight and heat should be avoided. These factors must also be considered in pipe line placement. If separation of liquid silicate occurs, a thorough mixing is required.

At loading stations, storage areas, and other locations where silicate solutions are handled, the following should be easily accessible:

1. A water hydrant and hose to flush away accidental spills which may cause slipperiness.

2. An eye-wash fountain or other means for washing the eyes with a gentle flow of water.

Silicate spills should be immediately washed with a large quantity of water to avoid slippery footing. Unless there is quick action, spills may build up and become difficult to remove later.

PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment should protect the wearer during accidents and is not a substitute for safe working conditions. Protection suggested for operating and maintenance personnel includes:

1. Chemical safety goggles or face shields.
2. Rubber gloves.

TABLE II

SPECIFICATIONS POTASSIUM SILICATE SOLUTIONS

Grade	Wt. Ratio SiO_2/K_2O	% SiO_2	% K_2O	Specific Gravity Be at 60 F (15.6 C)	Viscosity cP at 77 F (25 C)	Approx. Density lb/gal at 60 F (15.6 C)
No. 30	2.50 ± 0.05	20.8 ± 0.50	8.3 ± 0.20	30.0 ± 0.20	–	10.5
Electronics No. 200	2.07 ± 0.03	19.50 ± 0.30	9.42 ± 0.14	30.45 ± 0.20	–	10.6
No. 865*	2.10 ± 0.05	26.35 ± 0.50	12.45 ± 0.20	40.5 ± 0.25	375 ± 75	11.6

*0.35% max Na_2O

UNLOADING AND TRANSFER

TANK CARS

Du Pont ships silicate solutions in 8,000 and 10,000 gallon tank cars. The cars may be unloaded through a bottom outlet by gravity flow or pump; air pressure connections can be supplied on request.

Figure 2, page 5 illustrates the tank car dome, outlet, and coil arrangement. The bottom outlet is equipped with a 2- or 2½-inch gate valve that is sealed by a pipe plug in shipment. Inside the tank, a carrot-type plug valve on a rod fits tightly into the outlet valve seat. The pipe plug in the outlet gate valve is 12 to 16 inches above the top of the rails. In addition to the bottom outlet, some newer tank cars are equipped with a dip pipe for top unloading.

The dome cover is held in place either by a bar through two yokes (tightened by a threaded rod through the bar) or hinges from bolts through slots in the cover. The domes also have connections for air unloading.

All cars are equipped with a safety valve or vent set at 30 pounds. They have internal steam coils with 1½- to 2-inch pipe, the ends of the coils generally protrude from the car bottom. Insulated cars are available to meet special shipping situations.

Unloading requires the following steps:

Placement of Cars

Be sure the car is properly spotted. Securely block the wheels, set the hand brake, and follow other safe practices as outlined in DOT regulations. Place derails where appropriate.

Unloading

a. Remove dome cover and be sure that plug valve handle is in "down" position. Either leave the dome cover open or insert a stick under it so air may enter the car during unloading. Test gate valve on bottom outlet to be sure that it is closed.

b. Carefully remove pipe plug in discharge side of the gate valve. If appreciable and prolonged drainage occurs, replace pipe plug and get plug valve and gate valve closed properly.

c. Connect unloading line of a size suitable to fit the 2- or 2½-inch outlet. A section of reinforced rubber hose at the outlet connection will provide desirable flexibility; connecting is easier and line breakage less likely.

d. Open the gate valve.

e. Open the plug valve by turning the handle inside the dome.

f. By gravity or pump, transfer the car contents to storage. Occasionally tank cars are unloaded by applying compressed air to the cars. If this method is used, the car dome must be pulled down tightly before applying the air. Not over 30 pounds of air pressure should be used on the car.

g. When the car is empty, close plug valve and gate valve. Disconnect the unloading line and replace the pipe plug in the outlet connection. Fasten the dome cover securely.

Precautions

After the car is empty, precautions should be taken to insure that the unloading line is drained or flushed thoroughly, otherwise the silicate may harden or freeze in the line. If gravity unloaded, the unloading line may be cleared by blowing air or steam from the tank car end of the line. If pump unloaded, the line should be pumped as dry as possible and a valve closed on the inlet side of the pump, then by air (or preferably steam), connected to the tank car side and adjacent to this valve, blow the line thoroughly.

It is recommended that the flexible connection on the unloading line be removable so that it may be disconnected and soaked in water or flushed out thoroughly after use; hardening of silicate in the threaded joint should thereby be prevented. Cap the tank car end of the line after clearing to minimize drying of any remaining silicate.

Winter Unloading

Further precautions are necessary in cold weather, for cold silicate solutions are very viscous and flow or pump very slowly. Lines should be heat-traced and insulated.

The relation of viscosity to temperature is shown in Figure 2, page 6. Since liquid silicates freeze at 32 F and become too viscous to handle near that temperature, measures should be taken to prevent such occurrences. Tank cars should be heated to 60 F or above before unloading. 70 F is the minimum unloading temperature for potassium silicate solution No. 865 and sodium silicate solutions JM®, No. 6.

®Reg. U.S. Pat. & Tm. Off. E. I. du Pont de Nemours & Co. (Inc.)

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

No. 14, and No. 16. If frozen, thoroughly agitate the thawed solution with an airstick. Under these conditions the product is unchanged chemically or physically.

The procedure for heating cars follows (CAUTION: use a maximum of 50 psig steam pressure – high pressure may rupture the coils if they are blocked):

1. Be sure the steam coil outlet is open.

2. Blow all water from the steam line; then connect steam line to coil.

3. Open steam valve and maintain full flow of steam until it flows freely from the coil outlet. Then reduce steam flow until only a small amount of steam escapes from the outlet.

4. When the car contents are warm, turn off the steam and unload as previously described.

5. After steaming, clear water from the coils with compressed air. If air is unavailable, use steam. To assure drainage **do not** replace the caps on the steam connections.

TANK TRUCKS

Tank trucks have various maximum loads. They are driver-unloaded by gravity, pump, or compressed air to the customer's 2-, 2½-, or 3-inch line.

To receive such a truck, the consignee needs:

1. An all-weather, serviceable roadway to the unloading station. Railroad sidings with open ties and full-height rails are not suitable for tank truck movements.

2. Vertical clearances of at least 13 feet.

3. An open area at the loading station that permits normal maneuverability to the tractor and trailer.

4. A tractor-trailer spotting area having a good level surface capable of supporting 20,000 pounds per axle.

5. Securely anchored intake lines with receiving connections within 3 to 4 feet off the ground and no further than 8 feet from the rear end of the trailer tank spotted in normal unloading position.

Spotting Tank Truck for Unloading

The driver will properly spot the trailer and will see that both tractor and trailer are securely blocked and protected with warning signs.

Connecting Plant Line to Product Discharge Valve

The driver will connect the product discharge valve to the plant unloading line. Potassium silicate solution Electronics No. 200 should be unloaded through a line filter. Some trucks are equipped with such a filter, otherwise plant personnel should install such a filter in the unloading line.

Plant personnel should see that connection is made to the **proper** plant unloading line. They should also be sure that all valves in the line to the storage tank are open, that the storage tank will hold the entire load, and that the storage tank vent is operating.

Unloading

Transferring the contents of the trailer tank to an underground storage system can easily be done by gravity flow. Transfer to a tank at or above ground level can be made by pump. If compressed air is used to unload a tank truck, the maximum pressure should be 30 psig.

Disconnecting Plant Line from Product Discharge Valve

The driver will disconnect the product discharge valve from the plant unloading line at the unloading station. He will assist plant personnel in washing down any spillage at the unloading station before requesting the plant receiving department personnel for release of the tank truck.

Winter Unloading

The preceding precautions for winter unloading (page 5) should be observed. Since tank trucks are not equipped with coils, every effort should be made to prevent freezing.

FIGURE 1. VARIATION OF VISCOSITY WITH TEMPERATURE

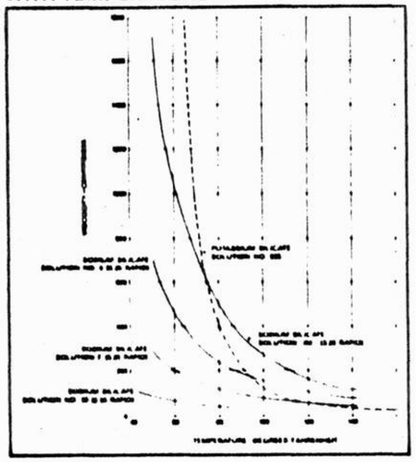
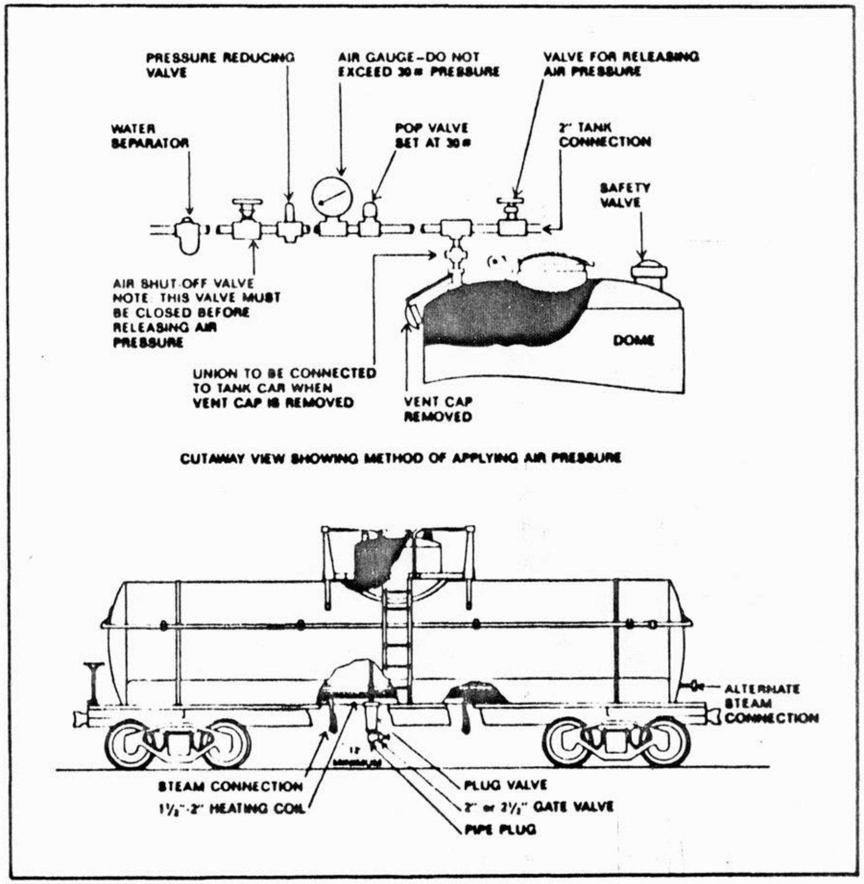


FIGURE 2. TYPICAL SILICATE SOLUTION TANK CAR



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(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

EQUIPMENT

Silicate solutions may be stored and handled in containers made of non-reactive metals, such as cast iron, nickel, stainless steel, and carbon steel. Concrete is also satisfactory. Metals such as aluminum, galvanized iron, and zinc should not be used because hydrogen gas may form. Silicate solutions should not be stored in glass or under conditions where water can be lost or carbon dioxide absorbed. Among the plastic materials suitable for handling silicate solutions are polyvinyl chloride and polyethylene.

STORAGE TANKS

Silicate solutions may be stored in either steel or concrete tanks, with capacities dependent on consumption and size of shipments. Steel tanks are preferred because of more economical installation, less leakage around connections, and ability to be moved.

Steel tanks are usually made of welded ⅜-inch steel. This thickness depends on whether the tank is vertical or horizontal, on wind loading, weight of superstructure to be supported, etc.

Tanks for storing potassium silicate solution Electronics No. 200 should be stainless steel or lined steel. Two linings which have been found suitable are "Lithcote"[c] LC-34 and "Amercoat"[d] 55.

Reinforced concrete tanks are satisfactory (except for potassium silicate solution Electronics No. 200), but the following precautions must be taken in construction and use:

1. The designer must consider density, freezing point, and need for occasional clean-out of tank.

2. The initial charge of silicate may react with free lime in the concrete to form an insoluble calcium silicate. Because it is semi-porous, the concrete will tend to absorb the solution. Any fine cracks will fill up with silicate deposits. For these reasons, the initial charge of silicate solution should be checked carefully for several days — water and silicate losses may change properties such as viscosity. To prevent this problem, fill the new tank with water, neutralize the lime alkalinity with acetic or sulfamic acid, empty and rinse the tank, and then fill with silicate.

3. Heating concrete tanks is difficult except for indoor locations or in warm climates — steam coils inside the tank become coated with silicate and the low thermal conductivity of concrete makes indirect heating from the outside inefficient.

4. Silicate solutions stored in concrete show an increased turbidity due to magnesium seeding crystal formation.

All silicate tanks should be covered and equipped with a manhole and bottom outlet for inspection, repairs, and cleaning (see Figures 3 and 4). They should be suitably supported either above or below ground level. They also should be provided with a vent and inlet and outlet valves. If valves are located on opposite sides or ends of the tank to allow circulation of solution, dead areas should not develop in the tank. With the arrangement shown in Figures 3 and 4, it is possible to use the unloading pump for transfer of solution to the point of use.

In addition to the conventional outside gate valve, it is desirable that storage tank outlets be equipped with plug valves similar to those on tank cars. Such an installation permits repairing the outlet gate valve and fittings without first draining the storage tank.

Since silicate solutions freeze near 32 F, storage tanks must be located or designed to prevent freezing in winter. The tanks may be located in a heated building, but outside tanks are satisfactory if heated and insulated to maintain 60 F. Because of viscosity considerations, sodium silicate solutions JM®, No. 6, No. 14 and No. 16 and potassium silicate solution No. 865 should be maintained at 70-90 F. Insulation such as 2-inch mineral wool blanket and asphaltic weather coating are recommended. External heating devices (low-pressure steam coils or electric heating elements) are preferred, since internal heating results in baking of the silicate on the heating unit as well as concentration of the solution with sludge formation, and ultimate solidification of the entire contents of the tank.

PIPING

Piping can be iron or steel with screwed or welded fittings.

VALVES

Rubber diaphragm or plug valves are satisfactory, although gate valves and ball valves are often used. Globe valves should be avoided.

[c] Reg. U.S. Pat. & Tm. Off., Lithcote Corporation, 5000 West Lake Street, Melrose Park, Ill. 60126

[d] Amercoat Corporation, 201 North Berry St., Brea, Calif. 92621

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FIGURE 3. UNLOADING AND STORAGE LAYOUT

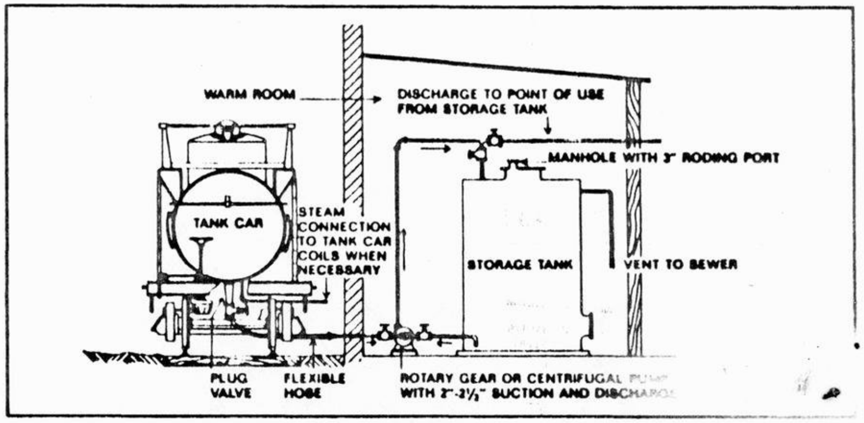
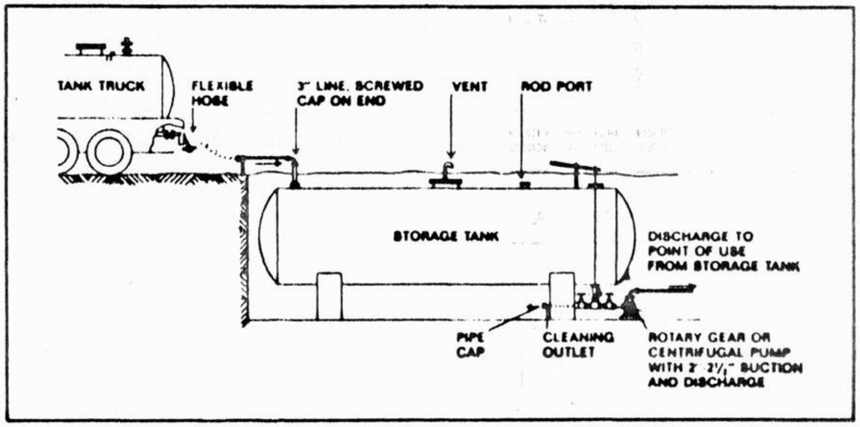


FIGURE 4. UNLOADING AND STORAGE LAYOUT



(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

PUMPS

Rotary gear or centrifugal pumps constructed of cast iron or steel are recommended. gear pumps require either internal or external relief of pressure

Generally, unloading requires a high capacity pump geared to an electric motor through a speed reducer. A 2-inch inlet and outlet connection is usually satisfactory. The pumping and handling system should be arranged so that the pump will remain full at all times.

Packings should be kept tight, or shaft scoring from dried silicate results, making it impossible to keep packings in. A water drip near the packing will help prevent silicate from drying and scoring the pump shaft until packing glands can be tightened or packing renewed. Packings should be Garlock #5203 or the equivalent

LEVEL GAUGE

Floats attached to an indicator by ropes and pulleys can be used to measure silicate solution level in tanks. Rods are still the most accurate

METERING PROCESS

Volumetric measuring tanks are most practical for usual silicate consuming operations. However, in high capacity or continuous operations, a magnetic flowmeter lined with TEFLON* fluorocarbon resin is recommended

EQUIPMENT CLEANING

NEW EQUIPMENT

New equipment should be cleaned before use to avoid possible contamination of the silicate solutions. This is especially important in chemical processes such as textile or pulp bleaching

Storage Tanks

1. To remove all rust, mill scale and organics, sandblast the tank

2. To remove loose scale and organics, scrub the surfaces with a good metal cleaning and degreasing detergent and water

3. To remove loose scale, use a high pressure water hose and/or a heavy wire brush

For all the above cases, flush the tank thoroughly with water after cleaning, and coat the surfaces with silicate solution as rapidly as possible to prevent further rusting

Pumps and Transfer Lines

1. To remove loose scale and organics, pump a detergent solution through the lines and flush the pump and lines with water

2. To remove loose scale, pump water through the lines. In both cases, pump some silicate solution through the lines after the water flush to protect against rusting.

EQUIPMENT IN USE

Storage Tanks

Drain and flush with a high pressure hot water hose. Periodic cleaning is recommended because normal deposits become difficult to remove if cleaning is delayed for several years. It may be necessary to remove residual sediment by air hammer and shovel.

*Reg. U.S. Pat. & Tm. Off. E. I. du Pont de Nemours & Co. (Inc.)

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PERSONAL SAFETY AND FIRST AID

SODIUM SILICATES

All spills of sodium silicate solutions should immediately be washed away with large volumes of water to avoid slippery footing. Quick action is necessary because spills can build up and become more difficult to remove later

Sodium silicate solutions and powders are alkaline and may irritate skin or cause eye injury. Laboratory tests with rabbits indicate that the principal hazard is to the eye. The most important step in first aid in case of eye contact is immediate flushing (within 20 seconds) with plenty of water for at least 15 minutes

Eyes

Eye tests conducted on rabbits demonstrated that the extent of injury varied with the pH of the product. The most alkaline silicates, for example sodium silicate No. 6 (pH 12.8), can cause eye burns which are not reversible even if promptly flushed with water. The least alkaline silicates, such as sodium silicate No. 9 (pH 11.3), can cause eye irritation which is reversible even without flushing with water

The precautions in handling are described below for product groups having similar hazards to the eye

Sodium Silicates Nos. 26, 22, 6-Glass, and 6-Solution – Solutions and powders can cause severe eye burns which result in permanent eye damage

Do not get these silicate solutions or powders in eyes. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician immediately

Wear chemical goggles whenever the possibility of eye contact with silicates exists

Sodium Silicates Nos. 16, 14, 30WW, and Mineral Adhesive – Solutions can cause severe eye irritation. Permanent eye damage can result from contact with sodium silicate No. 16 if it is not promptly flushed out of eyes with water. With prompt flushing, the effects are reversible. There is much less possibility of serious permanent complications in the case of contact with sodium silicate No. 14 or Mineral Adhesive

Avoid contact of these silicate solutions with eyes. In case of contact, immediately flush with plenty of water for at least 15 minutes. Call a physician promptly

Wear chemical goggles whenever possibility of eye contact with these silicates exists

Sodium Silicates Nos. 20WW, 9, F, F-Glass, and "JM" – Solutions and powders can cause eye irritation.

Avoid contact of these silicate solutions or powders with the eyes. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician promptly

Wearing of chemical goggles is suggested whenever possibility of eye contact with these silicates exists

Skin

Laboratory tests indicate that sodium silicates are not primary irritants. Literature references suggest that the effects on the skin would be typical of a mild alkali. Accordingly, the more alkaline silicates such as Nos. 22, 6, 26, and 16 may cause irritation

Contact of silicates with the skin should be avoided. In case of contact, flush skin thoroughly with water. Promptly remove contaminated clothing and wash before re-use

Prolonged contact of the skin with any silicate solution or powder should be avoided. Exposure of skin to silicates can be minimized by wearing rubber gloves

POTASSIUM SILICATES

Potassium silicate solutions and flake are alkaline and may irritate skin and cause eye injury. Laboratory tests with rabbits indicate that the principal hazard is to the eyes. The most important step in first aid in case of eye contact is immediate flushing (within 20 seconds) with plenty of water for at least 15 minutes

Eyes

Potassium Silicate Nos. 30, 865 and Electronics 200 Solutions – These solutions can cause moderate to severe eye irritation

Avoid contact of these potassium silicate solutions with the eyes. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician promptly

Wearing of chemical safety goggles is recommended whenever the possibility of eye contact with these silicates exists

Potassium Silicate Glass (Flake) – The glass solids are corrosive to the eye and can cause permanent eye damage if not promptly flushed out with water. With prompt flushing, the effects are reversible. Solutions or suspensions of the glass in water can cause eye irritation

Do not get the flakes in the eyes. In case of contact immediately flush eyes with plenty of water for at least 15 minutes. Call a physician promptly

Wear chemical goggles whenever the possibility of eye contact with the flake product exists

Skin

Laboratory tests indicate that alkali silicates are not primary irritants. Effects on the skin would be typical of a mild alkali, so that the more alkaline products may cause irritation

Contact of potassium silicates with the skin should be avoided. In case of contact, flush skin thoroughly with water. Promptly remove contaminated clothing and wash before reuse

Prolonged contact of the skin with any of the potassium silicate solutions or flakes should be avoided and rubber gloves should be worn to protect the hands

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

FMC

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Technical data

Sodium Sulfide

60% flake

CAS No 1313-82-2

Formula	Na_2S, 60%	MW (mol) 78.06
Description	Yellow, odorless flakes	

Chemical properties

	Typical analysis*
Na_2S + NaHS as Na_2S, % by weight	60.3
Hydrosulfide as NaHS, %	2.5
Moisture, %	36
Thiosulfate as $Na_2S_2O_3$, %	1.0
Carbonate as Na_2CO_3, %	0.4
Polysulfide sulfur as S, %	0.6
Iron as Fe_2O_3, ppm (µg/g)	20

*Typical analyses are based on average production material and are not binding specifications. Customers should specify requirements on critical components and properties.

Physical properties

Solubility, g/kg water, at 10°C	280
at 80°C	1300
Flake thickness, inches (mm)	0.03
Bulk density, lb/ft³ (kg/m³)	56 (900)

Screen analysis*

	Cumulative, %
Retained on U. S. 10 (2.00 mm)	90
Retained on U. S. 100 (150µm)	100

*Metric-SI values from ASTM Standard E-11-70 based on ISO recommendation.

Hazardous properties

Contact with the material in solid or dissolved form can cause skin irritation or chemical burns. Contact with acid will liberate the poisonous gas H_2S; sodium sulfide can be poisonous if swallowed.

For details request a Material Safety Data Sheet.

Standard container

400 lb (181 kg) drums—approx 60 gal (227 liter) with either full open head or 14 inch (0.36 m) lug cover

FMC Corporation Industrial Chemical Group 2000 Market Street Philadelphia Pennsylvania 19103

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

U.S. DEPARTMENT OF LABOR

Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1387

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
The Ansul Company	715/735-7411
ADDRESS *(Number, Street, City, State, and ZIP Code)* One Stanton Street, Marinette, Wisconsin 54143	
CHEMICAL NAME AND SYNONYMS Sulfur Dioxide	TRADE NAME AND SYNONYMS Ansul Sulfur Dioxide
CHEMICAL FAMILY Oxide of Sulfur	FORMULA SO_2

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
Sulfur Dioxide	99.98	

SECTION III - PHYSICAL DATA

BOILING POINT (°F.) at 760 mm Hg	14	SPECIFIC GRAVITY (H_2O=1) at 14° F.	1.46
VAPOR PRESSURE (mm Hg.) at 70° F.	2538	PERCENT, VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1) at 32° F.	2.264	EVAPORATION RATE (________ =1)	
SOLUBILITY IN WATER % by satn. at 68° F.	10.64		

APPEARANCE AND ODOR Colorless gas and liquid. Sharp, pungent odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	Lel	Uel
Non-flammable			

EXTINGUISHING MEDIA

SPECIAL FIRE FIGHTING PROCEDURES

UNUSUAL FIRE AND EXPLOSION HAZARDS

MP-94

(Continued on reverse side)

SO_2 p. 2 of 2

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE
5 ppm or 13 mg/m^3

EFFECTS OF OVEREXPOSURE
Irritation of eye, nose and throat occurs at low levels. Asphyxia results from excessive exposure. Contact with liquid causes freezing.

EMERGENCY AND FIRST AID PROCEDURES
Remove from exposure. Remove clothes if contaminated. Administer oxygen if asphyxiated. Take patient to a physician or hospital.

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	x	
INCOMPATABILITY *(Materials to avoid)*			
HAZARDOUS DECOMPOSITION PRODUCTS			
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	x	

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Ventilate contaminated areas. Transfer contents of a leaking container to another container, if possible.

WASTE DISPOSAL METHOD
Neutralize with alkali.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)*
Air pack or gas mask (MSA or Wilson type n, red canister)

VENTILATION	LOCAL EXHAUST: Preferable	SPECIAL
	MECHANICAL *(General)*: Acceptable	OTHER

PROTECTIVE GLOVES: Rubber

EYE PROTECTION: Safety goggles or glasses

OTHER PROTECTIVE EQUIPMENT: Rubber clothing if liquid spills are possible.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Store in original container, preferably in cool, ventilated, fire resistant building.

OTHER PRECAUTIONS
Do not fill pressure containers beyond 87% on a volume basis.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Ansul Sulfodox™

Ansul Sulfodox, Liquid Sulfur Dioxide, is a high purity and versatile chemical which makes it useful in a wide variety of manufacturing processes. Sulfur Dioxide is currently being used by industry in many different ways: as an acidifying, neutralizing and bleaching agent; as an antioxidant, anti-chlor and polymerizing agent; as a bacteriostatic agent, a chemical intermediate and solvent. It finds application in a wide variety of industries such as paper, chemicals, food products, metalworking, and petroleum.

The Ansul Company is ready to help you at all times with any problems which arise in the application, handling or storage of Sulfur Dioxide.

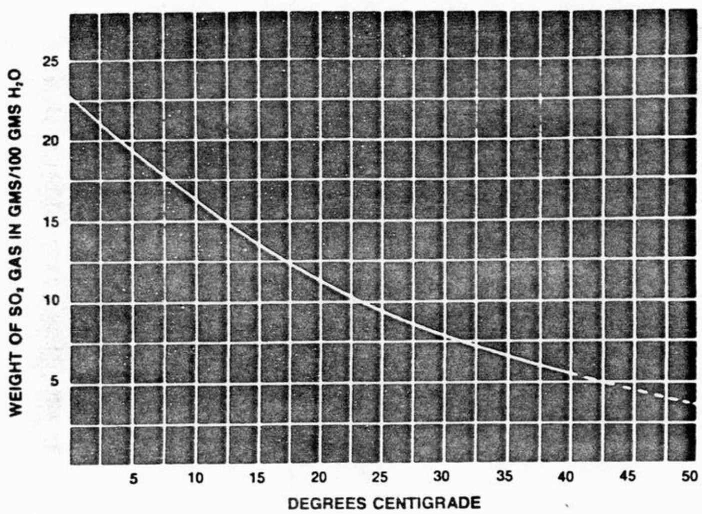
Contents

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

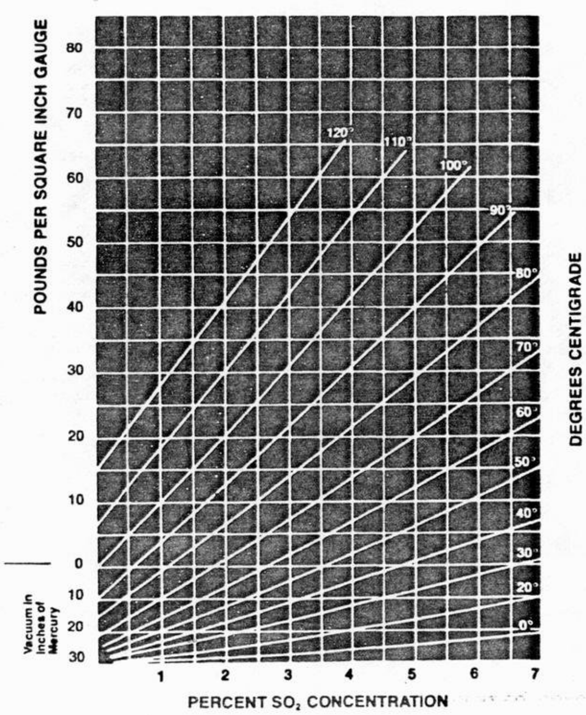
Physical properties

CAS Registry Number	7446-09-5
Chemical Formula	SO_2
Molecular Weight	64.06
Specific Gravity	
Liquid, 0°C	1.434
Gas, 0°C, 760mm Hg	2.2636
Boiling Point, °C, 760mm Hg	−10.0
°F, 760mm Hg	14.0
Melting Point, °C, 760mm Hg	−75.5
°F, 760mm Hg	−103.9
Surface Tension, −25°C, dynes/cm	32.00
−10°C, dynes/cm	25.59
15°C, dynes/cm	23.64
30°C, dynes/cm	20.73
50°C, dynes/cm	16.85
Refractive Index	
Liquid, n20°/D	1.410
Gas, n15°/D	1.000686
Dielectric Constant	
Liquid, 0°C	15.6
15°C	13.8
22°C	12.4
Gas, 0°C	1.0095
100°C	1.0053
175°C	1.0039
Diffusion in Hydrogen, 0°C, cm^2/sec.	0.48278
Specific Heat	
Liquid, 0°C	0.318
60°C	0.361
100°C	0.418
Gas, 15°C, 760mm	0.152
Viscosity	
Liquid, cp, 0°C	0.393
Gas, cp, 0°C	0.116
Latent Heat of Vaporization, B.T.U./lb., 760mm Hg	172.3
Heat of Formation, 25°C, Kcal/mole	70.94
Critical Pressure, p.s.i.a.	1141.5
Critical Temperature, °C	157.12
Static Head	
−17.8°C, (0°F), liquid head, lbs./sq.in./ft.	0.641
4.44°C, (40°F), liquid head, lbs./sq.in./ft.	0.617
26.7°C, (80°F), liquid head, lbs./sq.in./ft.	0.590
49.0°C, (120°F), liquid head, lbs./sq.in./ft.	0.562
Color, Gas & Liquid	Colorless
Odor	Sharp, Pungent
Flammability	Will not support combustion—Non Flammable

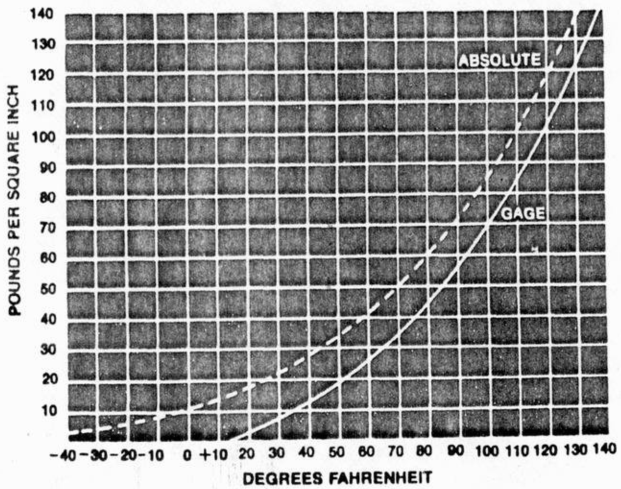
Solubility of Sulfur Dioxide in water



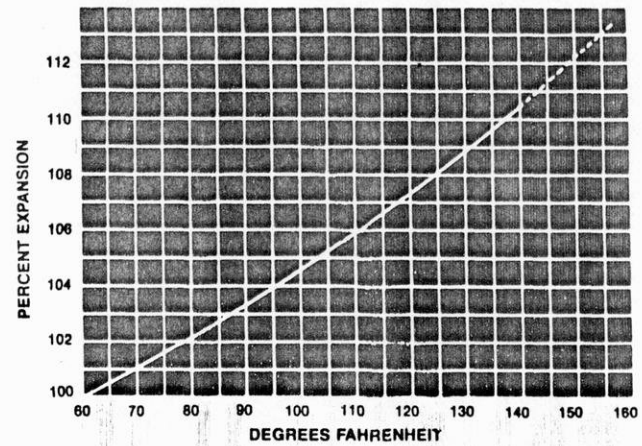
Total vapor pressure Sulfur Dioxide solutions



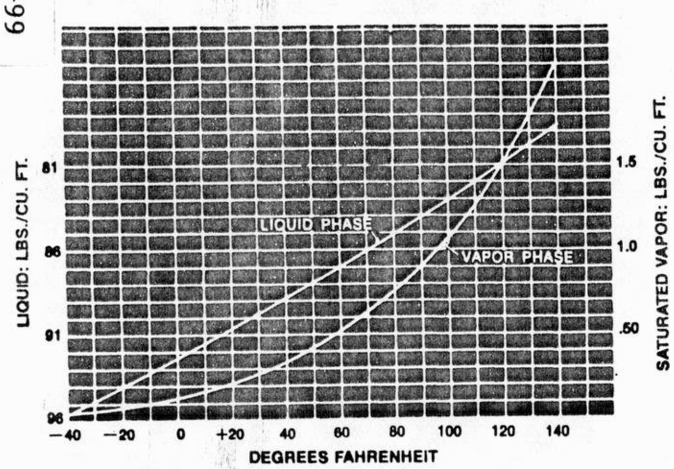
Sulfur Dioxide vapor pressure—temperature



Sulfur Dioxide liquid expansion (100% at 60°F)



Sulfur Dioxide density—liquid and saturated vapor



MP-99

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Specifications

	Specifications	Typical Analysis
Purity	99.98% min.	99.99%
Moisture	100 ppm max.	30 ppm
Residue (oil, iron, sulfur)	50 ppm max.	40 ppm

Analytical procedures

Moisture

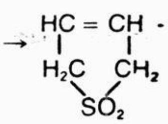
Water in Sulfur Dioxide is determined by a standard Karl Fischer titration utilizing a 50 ml sample.

Residue

The quantity of residue is measured on a 100 ml sample contained in a previously tared Erlenmeyer flask. The sample is evaporated to dryness in an appropriate hood at temperatures not to exceed 110°C and the flask reweighed.

Typical Reactions

The following reactions and processes suggest the broad application and versatility of Sulfur Dioxide in industry today.

Acid:	$SO_2 + H_2O \rightarrow H_2SO_3$
Hydrosulfites:	$2SO_2 + Zn \rightarrow ZnS_2O_4$
Sulfoxylates:	$2SO_2 + 2Zn + 2CH_2O + H_2O \rightarrow (CH_2O{\cdot}HSO_2)_2Zn + ZnO$
Sulfuryl Chloride:	$SO_2 + Cl_2 \rightarrow SO_2Cl_2$
Sulfites:	$SO_2 + H_2O + 2NH_3 \rightarrow (NH_4)_2SO_3$ $SO_2 + CaCO_3 + H_2O \rightarrow CaSO_3 + CO_2 + H_2O$ $SO_2 + Mg(OH)_2 \rightarrow MgSO_3 + H_2O$
Thiosulfates:	$SO_2 + S + 2NH_3 + H_2O \rightarrow (NH_4)_2S_2O_3$
Sulfones:	$SO_2 + CH_2 = CHCH = CH_2 \rightarrow$ 
Plastics:	$SO_2 + CH_3CH = CH_2 \rightarrow \left[\begin{array}{c} CH_3 \quad\quad\quad\quad CH_3 \\ \vert \quad\quad\quad\quad\quad \vert \\ CHCH_2SO_2CH_2CHSO_2 \end{array} \right]$
Methyl Bromide:	$Br_2 + SO_2 + 2H_2O \rightarrow 2HBr + H_2SO_4$ $HBr + CH_3OH \rightarrow CH_3Br + H_2O$
Anti-Chlor:	$SO_2 + 2H_2O + Cl_2 \rightarrow H_2SO_4 + 2HCl$
Antioxidant:	$SO_2 + Na_2O_2 \rightarrow Na_2SO_4$ $SO_2 + H_2O_2 \rightarrow H_2SO_4$
Neutralization:	$2SO_2 + 2NaOH \rightarrow 2NaHSO_3$
Chrome Tanning:	$3SO_2 + Na_2Cr_2O_7{\cdot}2H_2O \rightarrow 2Cr(OH)SO_4 + Na_2SO_4 + H_2O$

Typical Uses

Listed below in brief form are a few of the many uses for liquid Sulfur Dioxide. The wide variety of applications for Sulfur Dioxide is shown by the fact that it is used in such diverse manufacturing processes as leather tanning, metal working, chrome waste treatment, glass treating, photography, varnish, and food processing in addition to those listed below. Our technical staff can supply further information concerning your particular need.

Paper

Sulfur Dioxide is widely used in sulfite, Kraft, and semi-chemical mills for fortifications of sulfite liquors, acid flash bleaching and neutralization of peroxides. It also is used in the preparation of sodium sulfite, magnesium and ammonium bisulfites, chlorine dioxide, zinc and sodium hydrosulfite bleaches.

Food

Food industries such as wet process grain milling, beet sugar production, malting process, wine making, cherry brining, and the manufacture of soy protein utilize the bleaching, bacteriostatic, fungistatic, and germicidal properties of Sulfur Dioxide.

Metals & Mining

Sulfur Dioxide is used in the production of such metals as magnesium and cobalt. It is also used in the extraction, enrichment and recovery of copper and lead, as well as in ores containing such metals as uranium, selenium, and tellurium.

Chemicals

The chemicals and pharmaceutical industry uses Sulfur Dioxide as a general oxidizing, reducing and purifying agent. It is commonly used as a reagent, solvent or an extraction media in the plastic, detergent, petroleum, and petrochemical industries.

Shipping information

Tank Cars

Capacity: 60,000 and 100,000 lbs.

Tank Trucks

Capacity: 40,000 lbs., equipped with transfer compressor for unloading.

All shipping containers are fabricated, periodically tested, and filled in accordance with regulations of the DOT and the Bureau of Explosives. Sulfodox™ brand liquid Sulfur Dioxide is classed as a non-flammable gas under pressure.

Tank Cars

1. Description
Single unit tank cars of 60,000 and 100,000 pounds capacity are available for shipment of bulk quantities. The cars are horizontal pressure vessels designed for 300 psi operating pressure and are equipped with a safety relief valve set at 225 psi. The tanks are insulated, and equipped with an exterior steel shell. Insulation serves to control the temperature of the contents and prevent excessive pressure fluctuations during shipment or storage. The dome of the tank car is equipped with two liquid valves and usually two gas valves. A few 100,000 pound cars in Sulfur Dioxide service have only one gas valve. The liquid valves are located along the longitudinal centerline of the car, and are connected to liquid drop pipes which extend into a shallow well in the bottom of the car. The gas valves are located on either side of the dome and open directly into the top of the tank. The pressure relief valve is located in the center of the dome.

The valves are usually 1-inch ball or globe valves, however, a few 100,000 pound cars are equipped with 2-inch globe valves. All valves are equipped with female N.P.T. threaded ends of the size indicated.

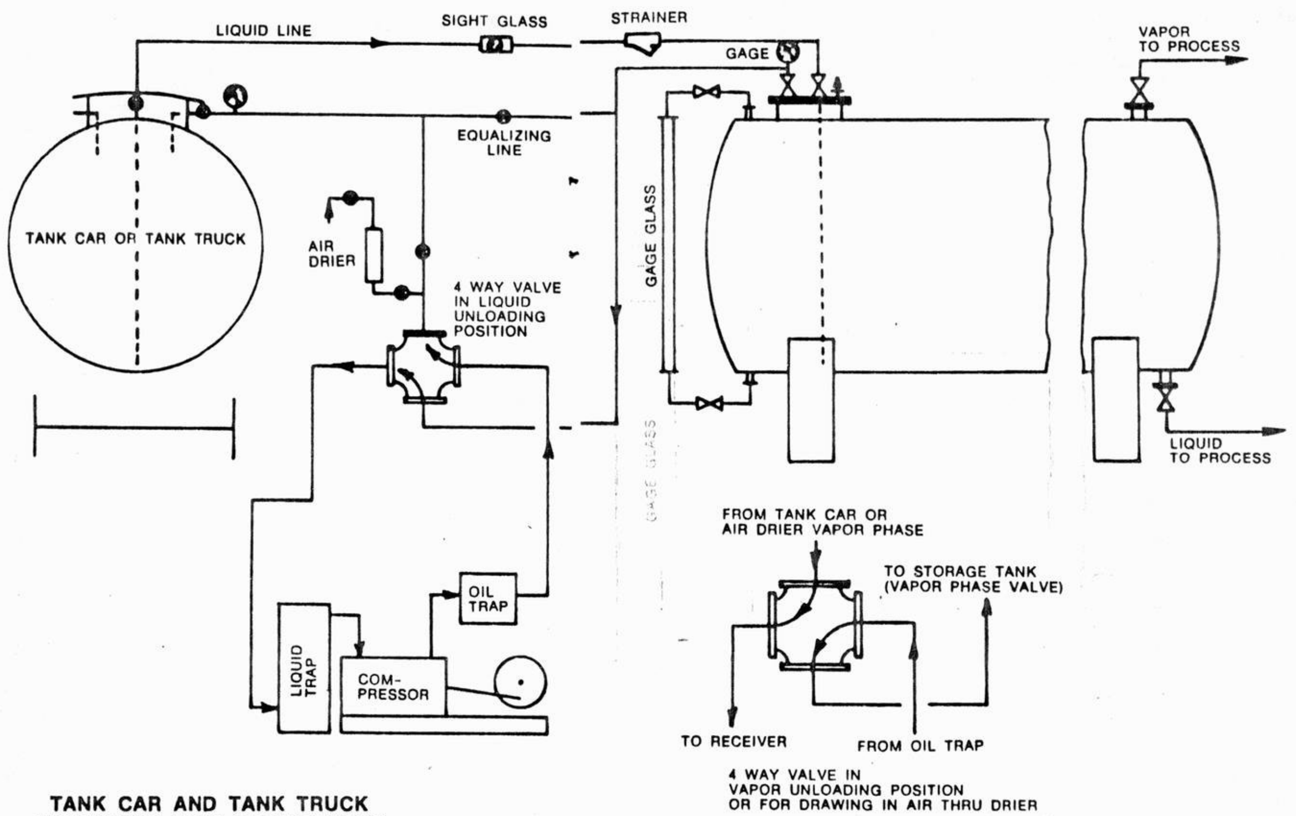
All valves are fitted with a plug in transit to prevent loss of Sulfur Dioxide in the event of valve leakage. Whenever the valves are not connected to unloading lines, these plugs should be inserted and tightened in place with proper thread lubricant. The dome cover should be closed at all times, except when piping connections are being made. Before an empty car is returned, the valves should be plugged, cover secured, and all D.O.T. regulations pertaining to empty cars complied with.

2. Unloading
Unloading of a Sulfur Dioxide car is usually accomplished by maintaining a pressure on the tank car greater than the operating pressure in the storage tank. This differential causes the liquid to flow from the car into the tank. A typical system with a 25-30 psi differential will unload tank cars at the rate of approximately 20,000 pounds per hour.

Unloading by compressor—The preferred method of unloading utilizes a gas compressor. A properly installed system will work simply and efficiently and has the added economy of vapor recovery. The liquid lines of the car and storage tank are connected together. The gas line of the car is connected to the compressor discharge, and the gas line of the storage tank is connected to the compressor suction. The compressor will maintain a differential between the vessels to accomplish the transfer. Once the car is empty of liquid, vapor is recovered by connecting the suction side of the compressor to the car and the discharge side to the tank. Figure 1 illustrates a typical arrangement for unloading tank cars by compressor.

Unloading by compressed air—In this method, clean dry air pressure is applied to the tank and the liquid is forced out. A 25-30 psi differential should be maintained. A pressure greater than 125 psi should never be applied to the car. If sufficient differential cannot be obtained, it may be required to occasionally vent down the storage tank. This usually becomes necessary because non-condensible gases are introduced into the tank.

Figure 1



TANK CAR AND TANK TRUCK UNLOADING WITH COMPRESSOR

MP-102

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Bulk handling and loading (continued)

Unloading by pump—The liquid can also be transferred from the car by use of a turbine pump equipped with a mechanical seal designed for Sulfur Dioxide service. A turbine pump is recommended because of its low NPSH requirements and fairly high head characteristics. When unloading, the liquid line on the car is opened first to prime the pump, and then the liquid valve on the tank is opened. The gas phase lines between the storage tank and the car are connected directly to equalize pressure. This unloading method is very satisfactory and rarely requires venting, although dry compressed air is usually used to flush out liquid lines. There is, of course, no provision for vapor recovery.

3. Determining When The Car Is Empty
During the unloading procedure, the quantity in the storage tank should be checked periodically to verify that the transfer is proceeding normally. Calculate the storage tank level at which the car is empty and check the car shortly before this point is reached. A sight glass placed in the liquid unloading line will indicate whether or not liquid is flowing.

Tank Trucks

1. Description
Bulk shipments by single unit tank trucks of 40,000 pounds capacity are also available to supply bulk users. These tanks are designed for a 150 psi working pressure and they are fitted with a safety relief valve set at 138 psi. Each trailer is equipped with a gasoline powered compressor and transfer hoses that are used during unloading the truck. The driver is trained and experienced in handling Sulfur Dioxide and will perform the unloading task independently. However, a qualified person from the customer's staff should be there to assist in making connections to the proper lines and locating valves and piping.

2. Unloading
The unloading procedure for tank trucks is basically the same as for tank cars, and the instructions outlined above should be followed. If it is desired to use the truck compressor, all that is required are gas and liquid lines from the storage tank to the truck unloading area. The liquid line should have a valve and a 1½ inch male N.P.T. end connection and the gas line should have a pressure gauge, valve, and one inch male N.P.T. end connection. The end connections should be rigidly supported and located about 36 inches from the ground, pointing downward. They should be close enough to where the truck will be parked to be reached by hoses that are 15 feet long. The liquid line from the unloading point to the storage tank should be 1½ inch in size and the vapor line should be 1-inch.

STORAGE AND HANDLING EQUIPMENT

The selection of equipment for the bulk storage and general handling of Sulfur Dioxide is quite straight forward. Relatively common materials of constructions are used, with the general precautions that all equipment have a working pressure of 150 psig, and have a minimum of potential leak sources. The following recommendations are offered as a general guide.

1. Storage Tanks
A storage tank should be constructed of A.S.M.E. SA 285 Grade C steel, electrically fusion welded throughout, and conforming to A.S.M.E. specifications for a working pressure of 150 psi. Inspection and hydrostatic testing are required. The capacity should be at least one and one-half times the maximum shipment size so that scheduling of shipments can be fairly flexible.

2. Piping
Schedule 80 carbon steel or wrought iron piping of welded construction is recommended. One inch piping is used throughout, except for liquid loading lines which are 1½ inch in size. Flanged connections are preferred, and gasket material should be either ⅛ inch blue asbestos, Teflon*, or chemical lead. Where threaded joints are required, a nonhardening, insoluble luting material such as John Crane Plastic Lead Seal No. 2 should be used and connections pulled tight as for steam service. After assembly, all piping should be hammered to loosen scale, and blown out with air to remove foreign matter.

Whenever there is the possibility of closing two valves in a liquid Sulfur Dioxide line, pressure relief must be provided in that section of line to avoid dangerous hydrostatic pressure which will be caused by temperature increases. Pressure buildup is prevented by installation of 150 psi pressure relief devices or by vertical expansion chambers located at the high point of each line. The capacity of each chamber should be approximately 20% of the isolated section of line.

3. Valves
Ball or plug valves with Teflon seats and seals are recommended for Sulfur Dioxide service. Carbon steel, ductile iron or brass construction are used. Valves equipped with type 316 stainless steel internals or of all stainless steel construction are used where service is critical and a safety factor is desired. Several manufacturers produce a ball valve with separable socket or butt weld ends which can be permanently installed, but yet allow complete access to the internals. Such valves give excellent service at low cost, and are easy to maintain. Where check valves are required, the spring loaded type with stainless steel internals are preferred.

4. Flexible Piping
Where flexible lines are required, such as the unloading facilities, either corrugated metal hose or a special rubber hose may be used. The metal hose should be of corrugated 316 stainless steel tubing with a braided metal overlay and end connections welded on. Rubber hose such as Gates Type 205 MB saturated steam hose may be used. This has a wire braided reinforcement, an ethylene-propylene rubber liner, and a Hypalon** exterior coating.

*Teflon is a registered trademark of E.I. duPont de Nemours & Co., Inc.
**Hypalon is a registered trademark of E.I. duPont de Nemours & Co., Inc.

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

Toxicity

. Miscellaneous

Compressors, vaporizers, pumps, air dryers, gauging devices, gas masks, and other specialized equipment should be specified for a particular application.

The preceding information applies to dry Sulfur Dioxide at normal temperatures. Where wet Sulfur Dioxide (greater than 1000 ppm water) or high temperatures are encountered, special materials of construction are required. Type 316 stainless steel is used most frequently, but Haveg, chemical lead, Alloy No. 20 stainless steel, or Alloy CD4M may also be used.

Information concerning materials of this nature is available by contacting the Ansul Specialty Chemical Technical Service Representative.

In many applications, the flow of Sulfur Dioxide is regulated by a control valve which acts upon the desired response of the Sulfur Dioxide input. Instruments that measure the control pH, oxidation-reduction potential, concentration, turbidity and other variables have proved successful in controlling the flow of Sulfur Dioxide to a process.

PRECAUTIONS IN HANDLING SULFUR DIOXIDE

Handling of Leaking Containers

Serious leaks in shipping containers seldom occur except through accident or careless handling. Leakage around a valve stem can usually be stopped by careful tightening of the packing compressor. Leakage through the valve caused by failure of the valve to seat properly may be stopped by capping or plugging the valve. Leaks from a broken or cracked valve or hole in the container itself are considered serious and should be treated with quick but cautious action.

In the event of a serious leak, gas masks approved by the U.S. Bureau of Mines for Sulfur Dioxide should be worn. This includes MSA or Willson Type N (red canister) gas masks. If possible, the leaking container should be connected to the storage tank, process, or another container and the material quickly transferred out. This will result in the minimum loss or disposal problem. If transfer is not possible, the container should be taken to as remote and downwind an area as is available. If possible, the container should be placed so that the leak is at the upper portion. This will release gas phase rather than liquid and will cool the vessel, thereby lowering pressure. If possible, the leaking stream should be released into a corrosion resistant water tank or barrel filled with lime, caustic soda or soda ash solution. This will minimize the quantity released to the air.

Contact The Ansul Company if any serious leaks are encountered, and attach a labeled tag to the particular item that has failed. This will simplify repairs and retesting of the container.

Filling Volume

Due to the danger of hydrostatic pressure created by liquid expansion, care should be taken never to overfill containers. The maximum amount of liquid Sulfur Dioxide allowable in a container is fixed by the Department of Transportation at 1.25 times the water capacity in pounds. This means that a container or storage tank should not be filled beyond about 87% of the volumetric capacity.

Sulfur Dioxide is an irritant gas and because of this property, minute leaks of Sulfur Dioxide are readily detectable. The gas acts as its own warning agent and is usually detected by taste rather than smell at levels of 0.3 to 1 ppm. The odor of Sulfur Dioxide is very apparent at 3 to 5 ppm. Irritation of the nose and throat is noticeable at 6 to 12 ppm with coughing and eye irritation occuring at 20 ppm. At 10,000 ppm (1.0%) Sulfur Dioxide is an irritant to moist areas of skin within a few minutes of exposure.[1,2]

At the time of this writing, the acceptable permissible limit for prolonged exposure is 5 ppm.[3] It has been announced that this level will be lowered to 2 ppm in the near future. As stated above, the irritating effects at either of these concentrations may not be sufficient to cause significant discomfort. A level of 50 to 100 ppm is considered the maximum permissible concentration tolerable for short periods of exposure, that is, 30 to 60 minutes. Levels exceeding 400-500 ppm are dangerous and within the asphyxiation zone for even short periods of time. Because of its irritating properties, however, personnel are not likely to voluntarily or unknowingly enter concentrations high enough to be of immediate harm.

Exposure to Sulfur Dioxide chiefly affects the upper respiratory and the bronchi, but it may cause edema of the lungs or glottis. In some cases it may produce respiratory paralysis.

Careful examinations of workers exposed daily to allowable concentrations of Sulfur Dioxide for prolonged periods of time showed no harmful chronic effects.[4,5] An exposure to variable concentrations of Sulfur Dioxide ranging from 30 ppm with occasional peaks up to 100 ppm is reported to have produced significantly higher than normal incidence of nasopharyngitis (an alteration of the senses of smell and taste), high urinary acidity and increased fatigue.[6]

Some individuals exhibit a sensitivity or allergy in the presence of sulfur or its compounds. This usually manifests itself as asthma, gastrointestinal upset or skin rash. Persons who demonstrate these characteristic symptoms should not be allowed in areas where SO_2 fumes are present.

[1] Frank A. Patty, Ed., "Industrial Hygiene and Toxicology," 2nd ed. Vol. II, Interscience Publishers, 1963, pp 892-5.
[2] N. Irving Sax, "Dangerous Properties of Industrial Materials," 5th ed., Van Nostrand Reinhold Co., 1979, pp 1001-2.
[3] NIOSH, "1978 Registry of Toxic Effects of Chemical Substances," 1979, p. 1187.
[4] T. H. Durrans, *British Medical Journal* **1948**, 1039.
[5] "Handbook of Labor Statistics," p. 351, 1936
[6] R. A. Kehoe, W. F. Machle, K. Kitzmiller, and T. J. LeBlanc, *J. Ind. Hyg.* **14**, 159 (1932)

First Aid[7]

Both the gas and the liquid phases of Sulfur Dioxide must be considered in the treatment of the possible harmful physiological effects of this chemical. As a gas, it diffuses through the air and can be inhaled into the lungs of persons in the area of its release. In the liquid phase, persons accidently sprayed may be subject to a freezing action due to the absorption of heat from the affected area when the liquid rapidly changes to a gas, its physical state under normal ambient conditions.

First aid should be initiated at once in case of contact with liquid Sulfur Dioxide or inhalation of excessive concentrations of the gas.

Contact of Liquid Sulfur Dioxide with Skin and Mucous Membranes

The exposed person should immediately use the emergency shower and remove all clothing and shoes wet with Sulfur Dioxide. Care should be taken not to tear the skin in the affected area. Skin areas are to be washed carefully with large quantities of soap and water. No salves or ointments should be applied to chemical burns for 24 hours. Clothing and shoes that have been wet with Sulfur Dioxide should not be worn until they have been thoroughly washed. A physician should be consulted in all cases.

Contact with Eyes

If liquid has entered the eyes, they should be washed promptly with copious quantities of water for at least 15 minutes. Chemical neutralizers are not recommended. It is advisable to irrigate the eyes gently with water at room temperature in order to minimize pain and discomfort. Refer the individual at once to a physician, preferably an eye specialist.

Taken Internally

A physician should be called immediately. Induce vomiting by giving large quantities of warm salt solution (2 tablespoonsfug of table salt to each pint of water)nor warm soap water. The patient should be kept comfortable and warm.

Inhalation

A worker who has been overcome with Sulfur Dioxide gas must be removed from the contaminated atmosphere at once and artificial respiration initiated immediately if breathing has ceased. A physician should be called at once. If oxygen apparatus is available, oxygen should be administered, but only by trained personnel. Oxygen inhalation must be continued as long as necessary to maintain the normal color of the skin and mucous membranes.

While pulmonary edema (severe lung congestion) is a rare occurrence following exposure to Sulfur Dioxide, in order to prevent its development, 100 per cent oxygen should be administered as soon as possible after a severe exposure. In such cases the patient should breathe 100 per cent oxygen under positive exhalation pressures for one-half hour periods every hour for at least three hours. If there are no signs of lung congestion at the end of this period, and if breathing is easy and the color is good, oxygen inhalation may be discontinued. Throughout this time, the patient should be kept comfortably warm, but not hot. Stimulants will rarely be necessary where adequate oxygenation is maintained. Any drugs for shock treatment should be given only by the attending physician.

[7] Chemical Manufacturers Association, Safety Data Sheet SD-52, p. 14

Product Safety Information

SULFUR DIOXIDE
(Sulfurous Acid Anhydride)

This Product Safety Information Sheet is principally directed to managerial, safety, hygiene and medical personnel. The description of physical, chemical and toxicological properties and handling advice is based on experimental results and past experience. It is intended as a starting point for the development of safety and health procedures.

I. PHYSICAL AND CHEMICAL PROPERTIES

Formula: SO_2
Formula Weight: 64.07
Physical State: Colorless, compressed liquefied gas (20° C/68° F-14.7 psia)
Odor: Suffocating, pungent
Specific Gravity: 1.36 at 25° C/77° F (water = 1.0)
Vapor Density: 2.26 (air = 1.0)
Boiling Point: −10° C/14° F
Melting Point: −75.5° C/−104° F
Vapor Pressure: 22.7 mmHg at 0° C/32° F
49.6 mmHg at 21.1° C/70° F
84.5 mmHg at 37.7° C/100° F
Water Solubility of Gas: 11g/100g H_2O @ 20° C/68° F

II. CHEMICAL REACTIVITY

Sulfur dioxide is an acidic gas and is reactive. In its liquid state it will react violently with alkalies and act as an acid. In the presence of chlorates it reacts to form unstable chlorine dioxide.

III. STABILITY

Sulfur dioxide is stable at ambient temperatures and atmospheric pressures.

IV. FIRE HAZARD

Sulfur dioxide is not considered flammable nor will it support combustion.

V. FIREFIGHTING TECHNIQUE

As in any fire, prevent human exposure to fire, smoke, fumes, or products of combustion. Evacuate nonessential personnel from the fire area.

Because of a possible release of sulfur dioxide gas in fires involving this material, firefighters should wear full-face, self-contained breathing apparatus and impervious clothing such as gloves, hoods, suits and rubber boots.

Use standard fire-fighting techniques in extinguishing fires involving this product — use water spray or fog, dry chemical, foam, carbon dioxide or other suitable suffocation agents. Keep containers cool with a water spray to prevent relief valves from popping, thereby releasing sulfur dioxide gas.

VI. TOXICOLOGY

WARNING: Extremely irritating. Gas and liquid under pressure. Liquid causes burns.

Ingestion
Ingestion of liquid sulfur dioxide will result in burns of the mouth and gastrointestinal tract due to the freezing effect of the liquid.

Skin Contact
Contact of sulfur dioxide with the skin will result in burns.

Eye Contact
Contact of sulfur dioxide with the eyes will result in burns. Sulfur dioxide gas is intensely irritating to the eyes.

Inhalation
Inhalation of sulfur dioxide gas will result in irritation of the eyes, throat and upper respiratory system. Inhalation exposures to concentrations of 8-12 ppm sulfur dioxide gas causes throat irritation, coughing, constriction of the chest, tearing and irritation of the eyes. Inhalation exposures to concentrations of 150 ppm sulfur dioxide gas is so irritating that it can be endured for only a few minutes. Inhalation exposures to concentrations of 500 ppm sulfur dioxide gas is so intensely irritating that it causes a sense of suffocation.

A single exposure of guinea pigs to 0.16-835 ppm for one-hour resulted in a dose-related increase in pulmonary flow-resistance.

Repeated exposures of guinea pigs to 0.1, 1.0 or 5.0 ppm for 7 days/week, 22 hours/day for 12 months did not produce signs of toxicity.

Repeated exposures of Cynamolagus monkeys to 0.1-5.0 ppm for 7 days/week, 24 hours/day for 18 months did not produce signs of toxicity.

Repeated exposures of rats to 500 ppm for 5 days/week, 5 minutes/day for 300 days did not produce an increased incidence of tumors.

In case of suspected exposure, refer to the procedure and emergency contacts in Section VII — FIRST AID.

In case of spillage, refer to the procedure and emergency contacts in Section IX — SPILL HANDLING.

In case of animal poisoning, call a veterinarian, or call collect, day or night, (203) 226-6602 (Stauffer Chemical Company) or (800) 424-9300 (Chemtrec).

In case of contamination of other materials with this product, call (800) 424-9300 (Chemtrec).

Stauffer Chemicals
STAUFFER CHEMICAL COMPANY
INDUSTRIAL CHEMICAL DIVISION
Westport, Connecticut 06880

B-11418 (4/80) Printed in USA

SO2 p 2 of 3

Threshold Limit Value (TLV)
The American Conference of Governmental Industrial Hygienists has assigned a TLV of 5 ppm (13 mg/m^3) by volume in air as the maximum allowable concentration of sulfur dioxide vapor for exposures not exceeding a total of 8 hours daily.

For Stauffer Reference Only:
Gig. Sanit. *24*: 22-26 (1959)
Arch. Env. Health *21*: 769-777 (1970)
Arch. Env. Health *24*. 115-128 (1972)
Brit. J. Cancer *21*: 608-618 (1967)

VII. FIRST AID

CALL A PHYSICIAN IMMEDIATELY

If a known exposure occurs or if poisoning is suspected, do not wait for symptoms to develop. Immediately initiate the recommended procedures below. Simultaneously contact a physician, or the nearest hospital, or the nearest Poison Control Center. Inform the person contacted of the type and extent of exposure, describe the victim's symptoms, and follow the advice given. For additional information, call collect, day or night, Stauffer Chemical Company (203) 226-6602 or Chemtrec (800) 424-9300.

Ingestion
Do *NOT* induce vomiting. Immediately give large quantities of water. If vomiting does occur, give fluids again. Never give anything by mouth to an unconscious person. Call a physician or the nearest Poison Control Center immediately.

Skin Contact
Immediately remove contaminated clothing wiping away excess material from the skin. Under a safety shower, flush all affected areas with large amounts of water for at least 15 minutes. Do not attempt to neutralize with chemical agents. Obtain medical advice immediately.

Eye Contact
Immediately flush the eyes with large quantities of running water for a minimum of 15 minutes. Hold the eyelids apart during the flushing to ensure rinsing of the entire surface of the eye and lids with water. Do not attempt to neutralize with chemical agents. Obtain medical attention as soon as possible. Oils or ointments should not be used. Continue the flushing for an additional 15 minutes if the physician is not immediately available.

Inhalation
Remove from contaminated atmosphere. If breathing has ceased, clear the victim's airway and start mouth-to-mouth artificial respiration, which may be supplemented by the use of a bag-mask respirator, or a manually-triggered, oxygen-supply capable of delivering one liter/second or more. If the victim is breathing, oxygen may be delivered from a demand-type or continuous-flow inhalator, preferably with a physician's advice.

VIII. INDUSTRIAL HYGIENE

Ingestion
All food should be kept in a separate area away from the working location. Eating, drinking and smoking should be prohibited in areas where there is a potential for significant exposure to this material. Before eating, hands and face should be thoroughly washed.

Skin Contact
Skin contact should be prevented through the use of impervious clothing, gloves and footwear. A face shield should be used where use conditions could result in exposure to this material.

Eye Contact
Eye contact should be prevented through the use of chemical safety goggles.

Inhalation
This material should only be handled in well-ventilated or open areas. Where adequate ventilation is not available and there is a possibility of gas or liquid release, control of low-level inhalation exposures can be achieved through the use of a NIOSH-approved, full-face-piece, acid-gas cartridge, air-purifying respirator.

IX. SPILL HANDLING

Make sure all personnel involved in the spill cleanup are aware of the hazards associated with sulfur dioxide and follow good industrial hygiene practices (refer to Section VIII). Only trained personnel equipped with gas masks and/or self-contained breathing apparatus should attempt repairs on leaking sulfur dioxide equipment. Protective clothing should be worn to prevent skin and eye contact.

Occasionally containers may develop leaks. In such cases, immediate steps should be taken to overcome the trouble as sulfur dioxide leaks become progressively worse if not corrected promptly.

Small leaks may be readily located by spraying the potential leak areas with ammonia hydroxide solution. A dense white fume will form if sulfur dioxide is present.

— *Never apply water to a sulfur dioxide leak.* The application of water makes sulfur dioxide much more corrosive.

— If a leak develops in a container within a congested area, every effort should be made to transfer the leaking container to a place where fewer people will be exposed.

— A leaking sulfur dioxide container should be so shifted that gaseous rather than liquid sulfur dioxide will escape.

— A small liquified sulfur dioxide spill or leak can be handled routinely by passing sulfur dioxide through an alkaline neutralizing solution. One pound of sulfur dioxide is equivalent to about two pounds of lime or one and one-half pounds of caustic soda.

— Flush small spills with copious amounts of water and neutralize with alkali.

Large spills should be handled according to a predetermined plan. For assistance in developing a plan, contact the Technical Service Department, Industrial Chemical Division, Stauffer Chemical Company, Westport, CT 06880.

IN CASE OF EMERGENCY, CALL, DAY OR NIGHT
(800) 424-9300 (CHEMTREC)

X. CORROSIVITY TO MATERIALS OF CONSTRUCTION

Dry sulfur dioxide is not corrosive to ordinary metals. It is

SO2 p. 3 of 3

usually shipped in steel containers. Valves and fittings of brass or stainless steel are employed. Safety valves are fitted with lead gaskets.

Sulfur dioxide, contaminated with water, will rapidly corrode steel.

XI. STORAGE REQUIREMENTS

The following safety facilities should be readily accessible in all areas where sulfur dioxide is handled or stored:

Safety Showers—with quick opening valves which stay open. Water should be supplied through insulated lines to prevent freeze-ups in cold weather.

Eye Wash Fountains—or other means of washing the eyes with a gentle flow of tap water.

Sulfur dioxide should be stored in properly designed pressure vessels. Bulk quantities may be stored in outdoor storage tanks equipped properly for this service. Contact the Technical Service Department, Industrial Chemical Division, Stauffer Chemical Company, Westport, CT 06880 for details.

XII. DISPOSAL OF UNUSED MATERIAL

For assistance in disposing of unused material, contact the Technical Service Department, Industrial Chemical Division, Stauffer Chemical Company, Westport, CT 06880.

XIII. REFERENCES

Sulfur Dioxide. Stauffer Chemical Company.

Sulfur Dioxide, a Novel Reaction Medium. Stauffer Chemical Company.

Sulfur Dioxide. Compressed Gas Association, Inc., Pamphlet G-3 (1972).

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

SULFURIC ACID

'54 (Apr. 1972)

Chemical Safety Data Sheet

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20240

METAL AND NONMETAL MINE HEALTH AND SAFETY

MATERIAL

CHEMICAL NAME SULFURIC ACID	FORMULA H_2SO_4	CHEMICAL FAMILY Inorganic chemical
TRADE NAME Oil of vitriol.		

PHYSICAL DATA

MELTING POINT (°F)	---	THRESHOLD LIMIT VALUE	1mg/m3
BOILING POINT (°F.)	---	VAPOR DENSITY (AIR=1)	---
SPECIFIC GRAVITY (H_2O=1) 60°F	100%=1.8392	VAPOR PRESSURE (mm Hg.)	---
SOLUBILITY IN WATER		MOLECULAR WEIGHT	
APPEARANCE AND ODOR Clear colorless liquid, with sharp odor.			

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) None	FLAMMABLE LIMITS	Lel ---	Uel ---

EXTINGUISHING MEDIA Dry chemical, CO_2, fog spray.

SPECIAL FIRE FIGHTING PROCEDURES Do not allow water to enter storage tanks, hydrogen gas can accumulate and care must be taken so as not to ignite.

UNUSUAL FIRE AND EXPLOSION HAZARDS Avoid dilution with water and contact with combustible liquids and solids. Hydrogen will be generated with potential explosion.

HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE Due to corrosive, oxidizing and sulfonating properties rapid destruction of tissue will occur.

EMERGENCY AND FIRST AID PROCEDURES Obtain medical help at once!

Ingestion: Induce vomiting until vomitus is clear.

Eye contact: Wash with water for at least 15 minutes.

Skin contact: Flush with water and remove clothing.

Inhalation: Remove from area and give artificial respiration.

SAFETY IS EVERYONE'S BUSINESS

H_2SO_4 cont.

REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID Can cause ignition on
	STABLE	X	contact with organic materials.
INCOMPATABILITY *(Materials to avoid)* Organic materials and nitrates, carbides, chlorates			
HAZARDOUS DECOMPOSITION PRODUCTS Hydrogen, SO_2 and heat			
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

Extremely corrosive and if water is added an exothermic reaction will result. Keep away from organic or oxidizing materials.

SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Zone off the area. Flush the area with copious amounts of water and soda ash or lime, spread around to neutralize any remaining acid.

WASTE DISPOSAL METHOD Neutralize with lime or soda ash. Must be done in an open area as CO_2 is released. Effulent holding basin may be required to settle out suspended calcium sulfate.

SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION Self contained breathing apparatus or fresh air masks.		
VENTILATION	LOCAL EXHAUST X	SPECIAL
	MECHANICAL *(General)*	OTHER
PROTECTIVE GLOVES Rubber gloves	EYE PROTECTION Chemical safety goggles	
OTHER PROTECTIVE EQUIPMENT Rubber safety shoes		

SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Store in an area where spills or leaks can be contained and correctly disposed of.

OTHER PRECAUTIONS Consult the manufacturer for safety procedures in handling the acid.

* U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 462-363

(SUPPORTING DATA FOR RESPONSE TO COMMENT NO. 40)

MATERIAL SAFETY DATA SHEET

"ESSENTIALLY SIMILAR" TO FORM OSHA-20

75-82

SECTION I

MANUFACTURER'S NAME Eagle-Picher Industries, Inc. | EMERGENCY TELEPHONE NO. 417 - 623-8000

ADDRESS P. O. Box 550 Joplin, Missouri 64802

CHEMICAL NAME & SYNONYMS zinc sulfate monohydrate | TRADE NAME & SYNONYMS industrial grade zinc sulfat

CHEMICAL FAMILY inorganic salt | FORMULA $ZnSO_4 \cdot H_2O$

SECTION II • HAZARDOUS INGREDIENTS OF MIXTURES

PRINCIPAL HAZARDOUS COMPONENT (S)	%	TLV (Units)
does not apply		

SECTION III • PHYSICAL DATA

BOILING POINT (°F)	decomposes	SPECIFIC GRAVITY (H_2O = 1)	3.28 at 15°C
VAPOR PRESSURE (mm Hg)	not pertinent	PERCENT VOLATILE BY VOLUME (%)	--
VAPOR DENSITY (AIR = 1)	N/A	EVAPORATION RATE	--
SOLUBILITY IN WATER (____ = 1)	59.1 gm/100 ml. 25°C	molecular weight	179.46

APPEARANCE & ODOR white free flowing powder, no distinctive odor

SECTION IV • FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) not flammable | FLAMMABLE LIMITS N/A | LEL UEL | IGNITION TEMPERATURE

EXTINGUISHING MEDIA use extinguishing agent appropriate for surrounding fire

SPECIAL FIRE FIGHTING PROCEDURES

not pertinent

UNUSUAL FIRE & EXPLOSION HAZARDS

none known to Eagle-Picher

SECTION V • HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV-TWA) not listed (ACGIH)

EFFECTS OF OVEREXPOSURE

skin and eye irritation may result from contact. Inhalation of dust may cause irritation of nasal mucous membranes.

EMERGENCY & FIRST AID PROCEDURES

MP-111

eye and skin contact: flush affected areas with copious quantities of plain water. Ingestion of large amounts of this product: induce vomiting, followed by prompt and complete gastric lavage, cathartics and demulcents.

SECTION VI • REACTIVITY DATA

STABILITY	Unstable		Conditions to Avoid
	Stable	X	store dry

INCOMPATIBILITY (Materials to avoid) oxidizing materials can cause a reaction

HAZARDOUS DECOMPOSITION PRODUCTS decomposes to oxides of zinc and sulfur

HAZARDOUS POLYMERIZATION	May Occur		Conditions to Avoid
	Will not Occur	X	not applicable

SECTION VII • SPILL OR LEAD PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
collect and contain for salvage or disposal, dry sweeping can be used

WASTE DISPOSAL METHOD
landfill: observe all federal, state and local laws concerning health and environment

SECTION VIII • SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify Type) NIOSH - approved respirator for dust should be worn if needed

VENTILATION	Local Exhaust recommended		Special none known
	Mechanical (General) recommended		Other

PROTECTIVE GLOVES
should be worn

EYE PROTECTION safety glasses or dust goggles recommended

OTHER PROTECTIVE EQUIPMENT
eye bath

SECTION IX • SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING & STORING ------keep dry----
Avoid contact with eyes, skin and clothing
Avoid breathing dust
Maintain good housekeeping practices

OTHER PRECAUTIONS product residue may remain in or on empty bag. All precautions for handling the product must be used in handling the empty bag.

Information contained herein is furnished without warranty of any kind. Employers should use this information only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use of these materials and the safety and health of employees.

Since 1977 Exxon has completed a number of studies concerning the proposed mining of the Crandon ore deposit. The results of these studies have indicated that the ore lying below the 140 m (459 feet) level can be mined using sublevel blasthole stoping with delayed fill. The ore above the 140 m (459 feet) level was recognized as non-typical and has not been included in previous studies for the following reasons:

1. The ore has been affected by supergene weathering which has resulted in zones of mineral leaching, mineral enrichment, and a reduction in rock mass strength.

2. The overlying overburden is water bearing and cannot be disturbed through mining.

3. The area was not considered to be suitable for mining by sublevel blasthole stoping with delayed fill.

In 1982, a study was conducted concerning the technical and economical feasibility of mining the crown pillar area ores (above the 140 m [459 feet] level).

For the purpose of this study, the crown pillar was defined as that ore above the 140 m (459 feet) level which requires mining by some method other than the normal sublevel blasthole stoping with delayed fill.

In this study, the following work was completed:

- Determined the shape and extent of the crown pillar area ore.
- Selected suitable mining methods.
- Designed a primary access development scheme.
- Calculated the cost of mining using the methods selected.
- Determined the ore reserves and economic limits of crown pillar mining.

The results of these studies will be summarized briefly.

An ore reserve estimate completed in this study indicated that the Crandon deposit contains approximately 14 Mt (15.3 million short tons) of "in-place" ore above the 140 m (459 feet) level. Of this, 10 Mt (11 million short tons) (72 percent) is considered potentially mineable using the methods examined. The total tonnage to be mined using specialized crown pillar area methods is 7.2 Mt (7.9 million short tons) (72 percent) with the remainder 2.8 Mt (3 million short tons) (28 percent) mined by normal sublevel blasthole open stoping with delayed fill. Approximately 4 MT (4.4 million short tons) (28 percent) of in-place ore are not considered mineable because of leaching, poor ground conditions, and requirements for a permanently stable remnant crown pillar.

The ore above the 140 m (459 feet) level will be mined from four main levels - 140 m (459 feet) level, 95 m (312 feet) level, and intermediate and top mining levels of varying elevation. Initial access will be from the main shaft and mobile equipment ramp on the 140 m (459 feet) level. This initial access is located on the hanging wall side of the ore body. Because of possible poor ground conditions caused by weathering, all of the development associated with crown pillar mining above the 140 m (459 feet) level will be located in the footwall.

The base of the remnant crown pillar has been designated the top mining or stability line. The position of this limit, in relation to the subcrop, varies from one stope block to another. On the average, the permanent crown pillar has a thickness of about 20 m (66 feet). It is considered that this thickness will be adequate to provide support and stability to the subcrop bedrock, and preclude the possibility of surface subsidence.

The crown pillar area mining methods proposed require the use of backfill in order to ensure long-term stability. The crown pillar area mining is expected to occur during the last one-half of the mine life.

Mining methods above the 140 m (459 feet) level include:

1. Post pillar cut and fill (PPCF) in the upper sections of the crown pillar just below the top mining level, where the rock is the least stable.

2. Vertical crater retreat (VCR) stoping in more stable rock, below PPCF areas.

3. Blasthole stoping with delayed fill in the most stable areas, generally below the 95 m (312 feet) level and in stringer ore zones.

These methods will be modified to meet the actual ground conditions encountered as more technical information on rock mass properties has been gathered through diamond drilling, in-situ stress determinations, and other rock mechanics investigations.

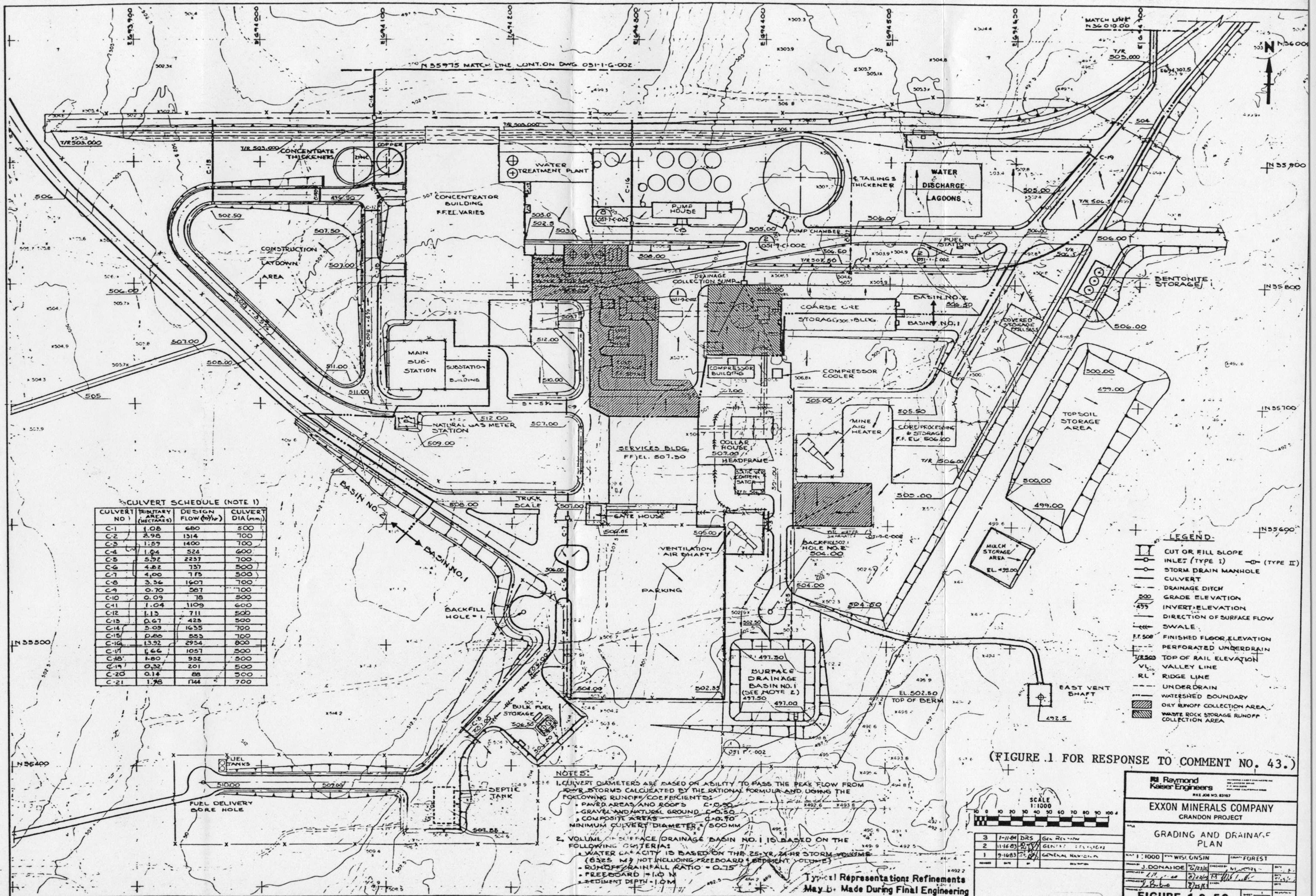
Comment No. 43 (Comment 174):

It is necessary to address the potential for surface water contamination resulting from the failure of mine/mill site erosion control structures and how such contamination would be prevented.

Response:

The permanent mine/mill site erosion control structures are shown on the attached Figures 1, 2 and 3. These structures consist of drainage ditches and swales, culverts, sedimentation basins, and attendant drainage basin inlet and outlet structures.

Figure 1 contains a table of estimated flow rates for all culverts based upon the peak estimated surface drainage from the 10 year storm. This table demonstrates the adequacy of the sizing of these structures, the maximum predicted flow rate being approximately 6.7 cfs (3,000 gallons per minute) through the 800 mm (31 inch) culvert which conducts the surface drainage water to drainage basin No. 2.



CULVERT SCHEDULE (NOTE 1)

CULVERT NO	TRIBUTARY AREA (HECTARES)	DESIGN FLOW (m^3/hr)	CULVERT DIA (mm)
C-1	1.08	680	500
C-2	2.98	1314	700
C-3	1.59	1400	700
C-4	1.04	524	600
C-5	5.92	2237	700
C-6	4.82	737	500
C-7	4.00	773	500
C-8	3.36	1607	700
C-9	0.70	587	700
C-10	0.09	78	500
C-11	1.04	1109	600
C-12	1.13	711	500
C-13	0.67	425	500
C-14	3.09	1635	700
C-15	0.88	553	700
C-16	13.92	2954	800
C-17	1.66	1057	500
C-18	1.80	952	500
C-19	0.32	201	500
C-20	0.14	88	500
C-21	1.98	1744	700

NOTES:

1. CULVERT DIAMETERS ARE BASED ON ABILITY TO PASS THE PEAK FLOW FROM 10-YR STORMS CALCULATED BY THE RATIONAL FORMULA AND USING THE FOLLOWING RUNOFF COEFFICIENTS:
   - PAVED AREAS AND ROOFS C=0.90
   - GRAVEL AND NATURAL GROUND C=0.50
   - COMPOSITE AREAS C=0.70

   MINIMUM CULVERT DIAMETER = 500MM
2. VOLUME OF SURFACE DRAINAGE BASIN NO. 1 IS BASED ON THE FOLLOWING CRITERIA:
   - WATER CAPACITY IS BASED ON THE 25-YR, 24-HR STORM VOLUME (6325 M^3 NOT INCLUDING FREEBOARD & SEDIMENT VOLUME)
   - RUNOFF/RAINFALL RATIO = 0.75
   - FREEBOARD = 1.0 M
   - SEDIMENT DEPTH = 1.0M

Typical Representations Refinements May be Made During Final Engineering

(FIGURE 1 FOR RESPONSE TO COMMENT NO. 43.)

REVISION	DATE	BY	DESCRIPTION
3	1-11-84	DRS	GEN. REVISION
2	11-16-83		GENERAL REVISIONS
1	9-16-83		GENERAL REVISION

Raymond Kaiser Engineers
RKE JOB NO. 83157

EXXON MINERALS COMPANY
CRANDON PROJECT

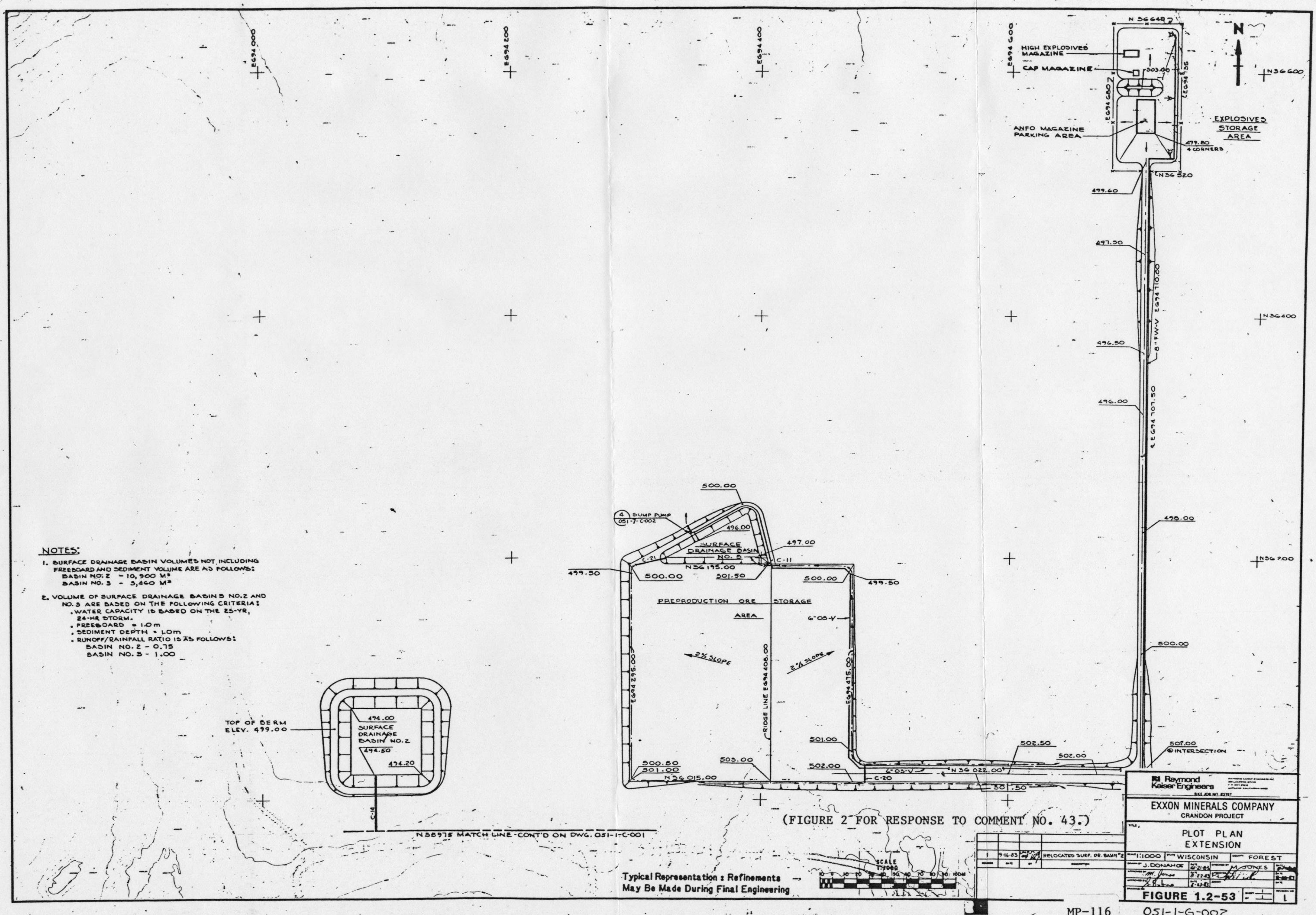
GRADING AND DRAINAGE PLAN

SCALE 1:1000 STATE WISCONSIN COUNTY FOREST
DRAWN BY J. DONAHOE

FIGURE 1.2-52

REVISION 3

051-1-C-001

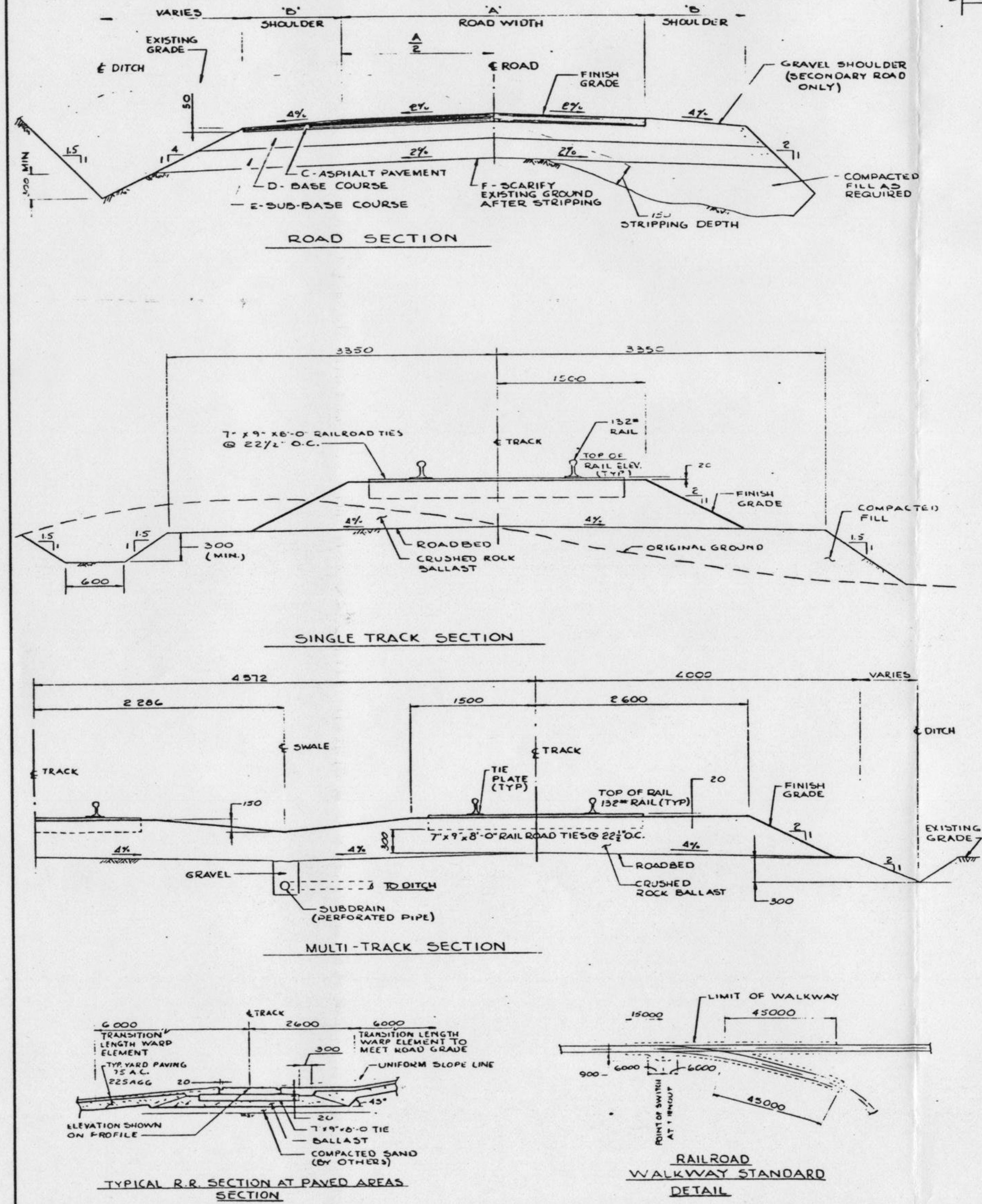


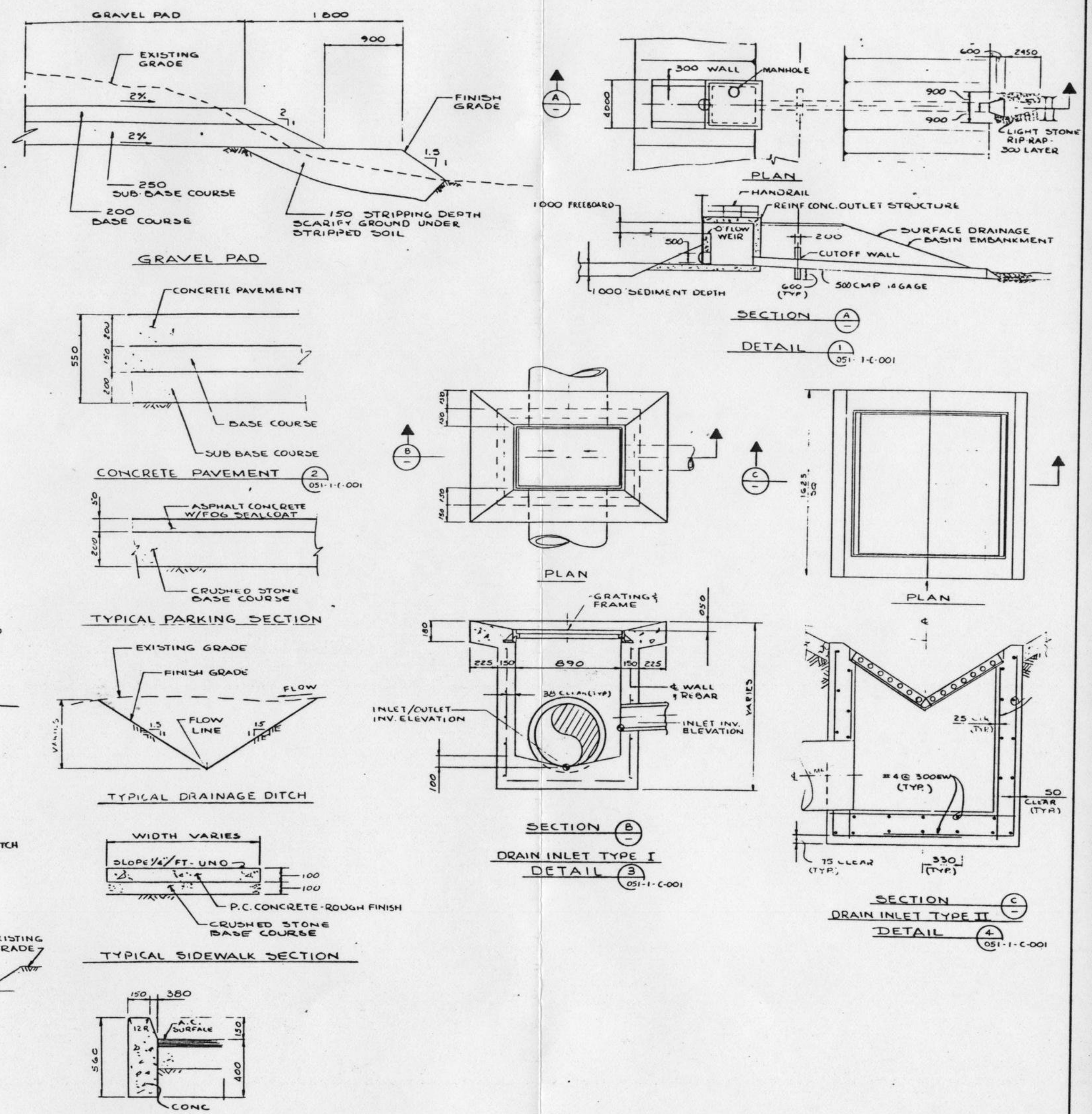
(FIGURE 2 FOR RESPONSE TO COMMENT NO. 43.)

MP-116

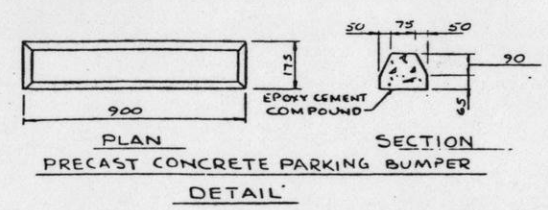
051-1-G-002

ROAD PAVEMENT SCHEDULE						
NAME	A	B	C	D	E	F.
CLASS A	7.500	2.500	0.100	0.200	0.250	0.150
CLASS B	7.500	1.800	0.100	0.200	0.250	0.150
CLASS C	6.00	–	0.050	0.200	–	0.150
CLASS D	VARIES	VARIES	–	0.200	–	0.150





(FIGURE 3 FOR RESPONSE TO COMMENT NO. 43.)



Typical Representation: Refinements May Be Made During Final Engineering

1	9.16.83		GENERAL REVISION

Raymond Kaiser Engineers

EXXON MINERALS COMPANY
CRANDON PROJECT

PAVING, GRADING & DRAINAGE DETAILS

NTS | WISCONSIN | FOREST

J. DONAHOE | M. JONES

FIGURE 1.2-54

051-1-C-002

The design of the surface drainage basins themselves will be finalized following more detailed site soil studies work to be conducted at the time of final engineering. The width of the containment berms and the side slopes of such berms will then be determined. These designs will be conservative in nature.

The capacity of the currently proposed drainage basins are based upon the 25 year, 24 hour storm. A freeboard of 1.0 m (3.3 feet) has also been included or approximately one-quarter the volume of the basin. With a maximum depth of only 5.5 m (18 feet) (drainage basin No. 1) the hydraulic heads which might be generated on these structures are extremely modest.

Failure of any of the surface drainage structures as presently contemplated could only be the result of extraordinary circumstances impossible to predict.

Comment No. 44 (Comment 177):

This response indicates that Exxon will report any incidents which are required to be reported to the Department under various regulatory requirements. In addition to what is required under the codes, the Department will require that a record of all incidents reported to the Environmental Control Engineer be maintained and periodically submitted to the Department and that any incident which requires corrective action also be reported to the Department.

Response:

Our position on reporting to the DNR remains that we will comply with duly established reporting requirements. Information to be reported should be that which meets certain well-defined criteria. Open-ended requirements such as submittal to the DNR of records on everything reported to the Environmental Compliance Engineer (ECE) should be avoided since the ECE duties may well include many activities which are of no interest to the DNR. The ECE's logs and records will be available for review by DNR personnel during their periodic onsite inspections and we would suggest that this is a more appropriate mechanism for review of these materials.

Similarly, we would consider that a requirement to report any incident with a corrective action to be an overly broad criteria. We do not believe that reporting of situations which do not involve reasonable potential for adverse environmental impact would be useful to the DNR in completing its responsibilities. Again, we believe the onsite inspections will be the best mechanism for reviewing these records.

We believe it is incumbent upon the DNR to establish clear and unambiguous criteria for establishment of reporting requirements as well as for all other permit conditions. Broad or open-ended requirements are subject to interpretation and could lead to continual uncertainty on both the part of the operator and the DNR over compliance status.

Comment No. 45 (Comment 182):

Exxon states that structures within a 1/2 mile radius of any of the shafts will be inspected as part of the pre-blasting survey. What justification was used for establishing the 1/2 mile radius? Any available data or analyses regarding Exxon's evaluation of seismic and/or air blast effects should be provided.

In a recent discussion with Exxon staff, it was indicated that Exxon is considering conducting monitoring of blasting effects during the early stages of development. Such plans should be discussed in the monitoring plan.

Response:

As detailed in the attached planning note (Attachment I) on blasting seismic effects, maximum expected peak particle velocities from blasting at 0.8 km (0.5 mile) are expected to be less than 0.6 cm/s (0.25 inches per second). Blasting vibrations at that level are detectable but do not indicate a need for extending the pre-blasting survey beyond the 0.8 km (0.5 mile) radius.

As also stated in the planning note, it will be necessary to measure peak particle velocities during shaft sinking and stope blasting, to verify or establish new parameters for the mathematical model. In addition to concern for residences, we need to measure and predict the magnitude of peak particle velocities at various surface plant facilities and underground installations in order to protect these facilities from damage which may result from blasting. The general plan for blast monitoring is described in Section 4.0 of the planning note.

Comment No. 46:

General - In reviewing the responses pertaining to the reclamation plan, it is apparent that there were two areas of greatest concern to the Department. These were: (1) Erosion control and surface water drainage on the mine site and (2) Final use (including vegetation) of the mine site, particularly the MWDF. These issues are still not clearly resolved.

Response:

Comment acknowledged.

Comment No. 47:

The erosion control/surface water drainage issue centers on two points. The first of these is that many of the practices to be employed by Exxon will be temporary in nature and cannot be determined until the final engineering phase or until construction is actually in progress. The second aspect of the problem is that discussions of erosion control are scattered throughout the mining plan and reclamation plan and are never adequately consolidated into one coherent section. Exxon should do this and include some quantification of the amount of runoff expected during different phases of the operation. This was requested in comment R5 but was not addressed by Exxon.

Response:

The revised Erosion Control Plan is presented in Attachment II.

Comment No. 48:

The question of final use, including vegetative cover, of the mining site is unresolved for a different reason. The Department is fairly well satisfied with Exxon's proposed reclamation of the mine/mill site and corridors. However, the reclamation and final use of the MWDF cannot sensibly be proposed until the final design aspects of the MWDF are put forth. This is reflected by Exxon's repeated response that the revised reclamation plan will contain a comprehensive final use plan which will address the various comments raised by the Department.

Response:

As stated in EMC's response to DNR comment No. R2 (DNR letter dated October 10, 1983), a final use plan will be included in the revised Reclamation Plan. The final use plan for the MWDF will focus on uses that are compatible with those in adjacent undisturbed areas not affected by mining-related activities. These uses include recreation and forestry.

The final proposed design for the reclamation cap for the MWDF includes 1.5 m (5 feet) of native soil over a 20.3 cm (8 inch) drain layer, a 40 mil polyethylene membrane and two 10.2 cm (4 inch) layers of bentonite modified soil. The 1.5 m (5 feet) of native soil will provide a growth medium for plant species. As indicated in the response to DNR comment No. R2 of the October 10, 1983 letter, EMC proposes to initially establish a herbaceous cover of grasses and legumes on the cap following final grading to ensure stabilization of the soil surface, and then allow invasion of native species from adjacent undisturbed plant communities. This will promote the development of plant communities on the reclaimed MWDF that are similar to those in adjacent areas.

Comment No. 49 (Comment R10):

The waste wood mulch storage area will require stabilization.

Response:

This material will be used throughout our landscaping efforts during Project construction, operations and closure. Since this is considered to be an active (live) storage area we do not think it is necessary to stabilize the wood chips.

Comment No. 50 (Comment R17):

This response implies that the perimeter fence is not going to be removed but on p. 3.9-3 of the original reclamation plan it says the fence will be removed. Which is correct?

Response:

The security fence around the mine/mill site will be removed during final grading and reclamation of this area following Project closure. The fence around the MWDF will be maintained during the long-term maintenance period for this facility. This will allow long-term monitoring and maintenance activities associated with the MWDF area to be performed and will ensure stabilization of the soil surface of the reclamation cap and the establishment of a vegetative cover. Following the long-term maintenance period, a decision on whether to remove the fence or not will be discussed jointly with the DNR.

Comment No. 51:

General Comment - The reclamation plan indicates that the route from the mine/mill site to the MWDF and the access/inspection road around the MWDF will be regraded and seeded. The Department feels that reasonable access to the MWDF and the various monitoring locations should be maintained through the period of long-term care to allow for inspections and monitoring. The reclamation plan should consider this need.

Response:

The Reclamation Plan will be revised to indicate that the access/inspection road around the MWDF will not be reclaimed following Project closure. These roads will be maintained to allow access to the MWDF and monitoring locations during the period of long-term care.

Comment No. 52 (Miscellaneous Comments):

The reclamation plan states that the four vertical shafts will be capped and sealed in accordance with designated health, safety and environmental standards. Exxon should expand the discussion to describe how they actually intend to abandon the shafts and how this proposal assures that if the shaft lining were to fail, that significant caving and slumping of unconsolidated material into the shaft would not subsequently occur.

Response:

All four circular Crandon mine shaft collars will be constructed with reinforced concrete linings from the surface, through the unconsolidated glacial overburden, and into competent bedrock. Factors of safety applied to the design of these linings, coupled with the stabilizing hydrostatic forces present following mine inundation, should preclude the possibilities of collar lining failure and related local overburden subsidence.

Shaft abandonment practices in fact vary with facility design and local regulatory requirements. Plans for shaft reclamation at Crandon include removal of salvageable equipment from the main production/service shaft. The other three shafts, used primarily for ventilation, will contain little installed equipment.

Final abandonment for each of the four shafts will include a concrete overburden ground water isolation plug installed at the bedrock subcrop elevation, to reduce any potential for vertical mixing of stagnant mine water and the aquifer above. This cement plug is connected with the shaft lining and bedrock with reinforcing steel. After the concrete plug is installed, the shaft will be stripped of all internal equipment from the plug depth to the soil surface. The shaft will then be filled with overburden to within 10 feet of the surface. The remaining 10 feet of concrete in the shaft collar will be broken and combined with the fill to the soil surface. It will be covered with soil and regraded to blend with the surrounding contours.

Comment No. 53:

Also, as has been recently discussed, Exxon should present some type of figure illustrating the distribution of underground area which will not be filled upon closure of the mine, and discuss why all underground voids cannot be filled.

Response:

In the simplest terms, classified mill tailings and mine development waste rock will be used as backfill in all areas of the mine from which ore is produced. The three mine plan and cross-section figures (Figures 1, 2 and 3) attached illustrate the orebody outline, the interior of which would be completely backfilled at ore depletion. Also depicted is the extent of horizontal and vertical mine access openings exterior to the orebody which would normally be left open as the mine floods. The unfilled shafts, drifts, raises, and facilities represent less than 10 percent of the rock volume removed during mining, and the openings are well separated.

Local post-mining drift or raise failure is very unlikely because of the original mine design parameters which will provide stable rock pillars among the vertical and horizontal openings.

Comment No. 54:

Responses which indicate that Exxon will submit additional information or that future planning is necessary include the following: Comments 9-31, Comment 71, Comment 105, Comment 109, Comment 110, Comment 113, Comment 129, Comment 134, Comment 136, Comments 139 and 141, Comment 155, Comment 173, Reclamation Plan, Comment R13 and Comment R33.

Response:

Comments acknowledged.

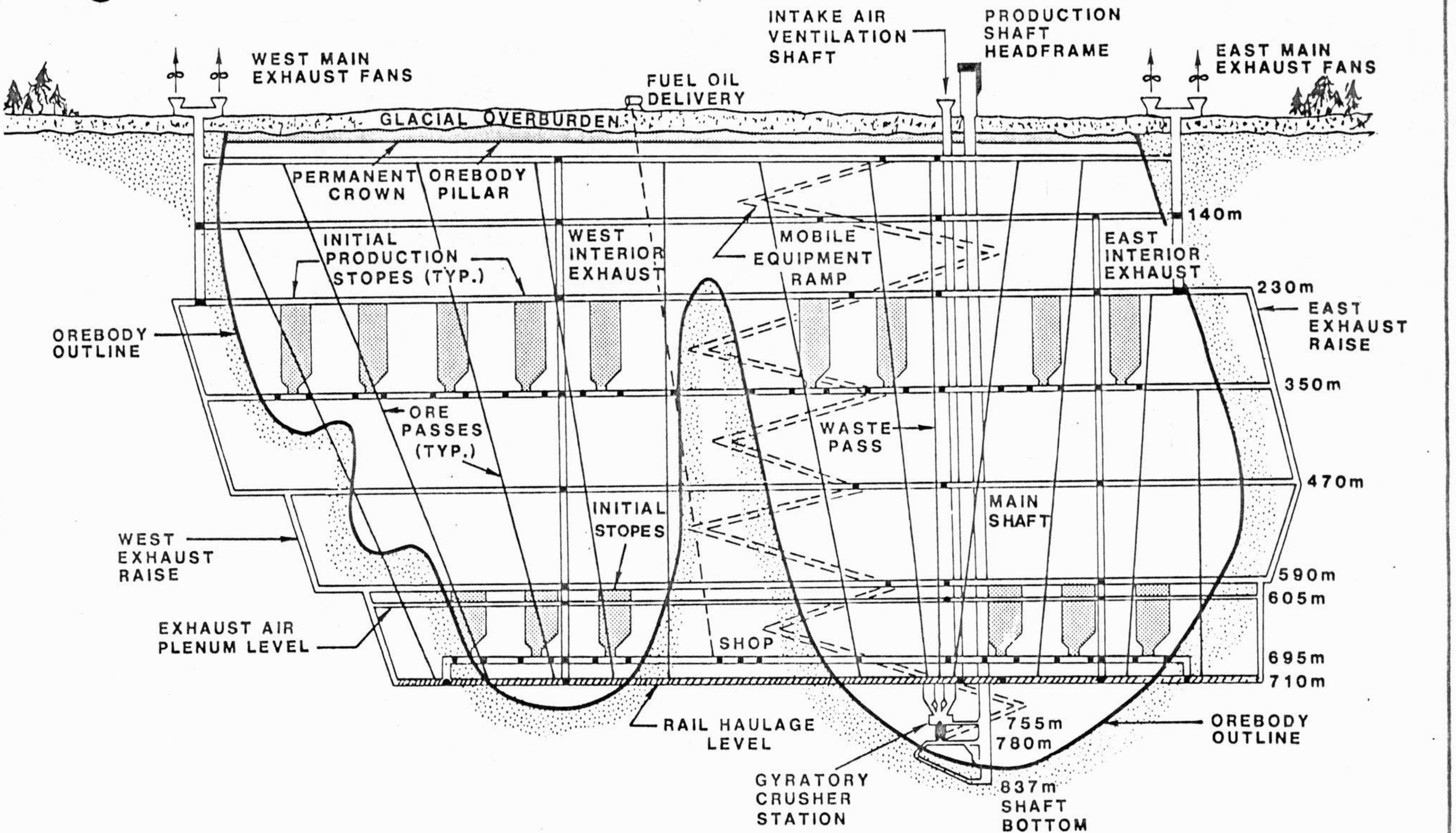
Comment No. 55:

Those responses which specify that additional detail cannot be provided until the final engineering phase of the project include the following: Comment 76, Comment 85, Comment 96, Comment 99, Comment 102, Comment 103, Comment 148, Comment R5, Comment R6, Comment R10, Comments R18 and R21 and Comment R27.

Response:

Comments acknowledged.

MP-123



EXXON MINERALS COMPANY
CRANDON PROJECT

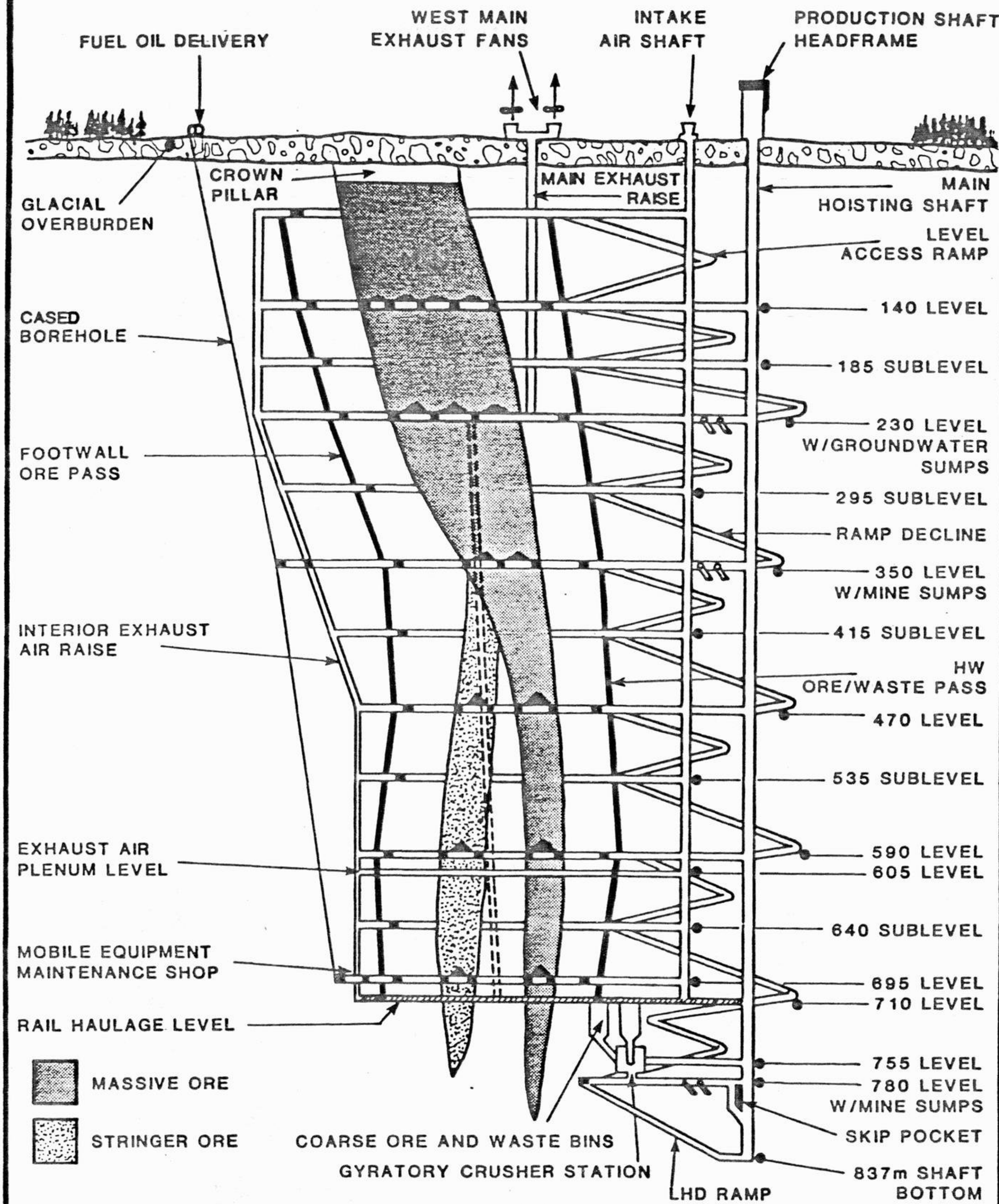
TITLE: **UNDERGROUND MINE LONGITUDINAL SECTION - SCHEMATIC (LOOKING NORTH)**

SCALE NONE	STATE WISCONSIN		COUNTY FOREST			
DRAWN BY RGH	DATE 1/84	CHECKED BY		DATE		
APPROVED BY	DATE	APPROVED BY		DATE		
APPROVED BY	DATE	EXXON		DATE		
DRAWING NO	FIGURE 1.3-7		SHEET OF		REVISION NO	

(FIGURE 1 FOR RESPONSE TO COMMENT NO. 53.)

Typical Representation; Refinements May Be Made During Final Engineering

184-1-11M-1



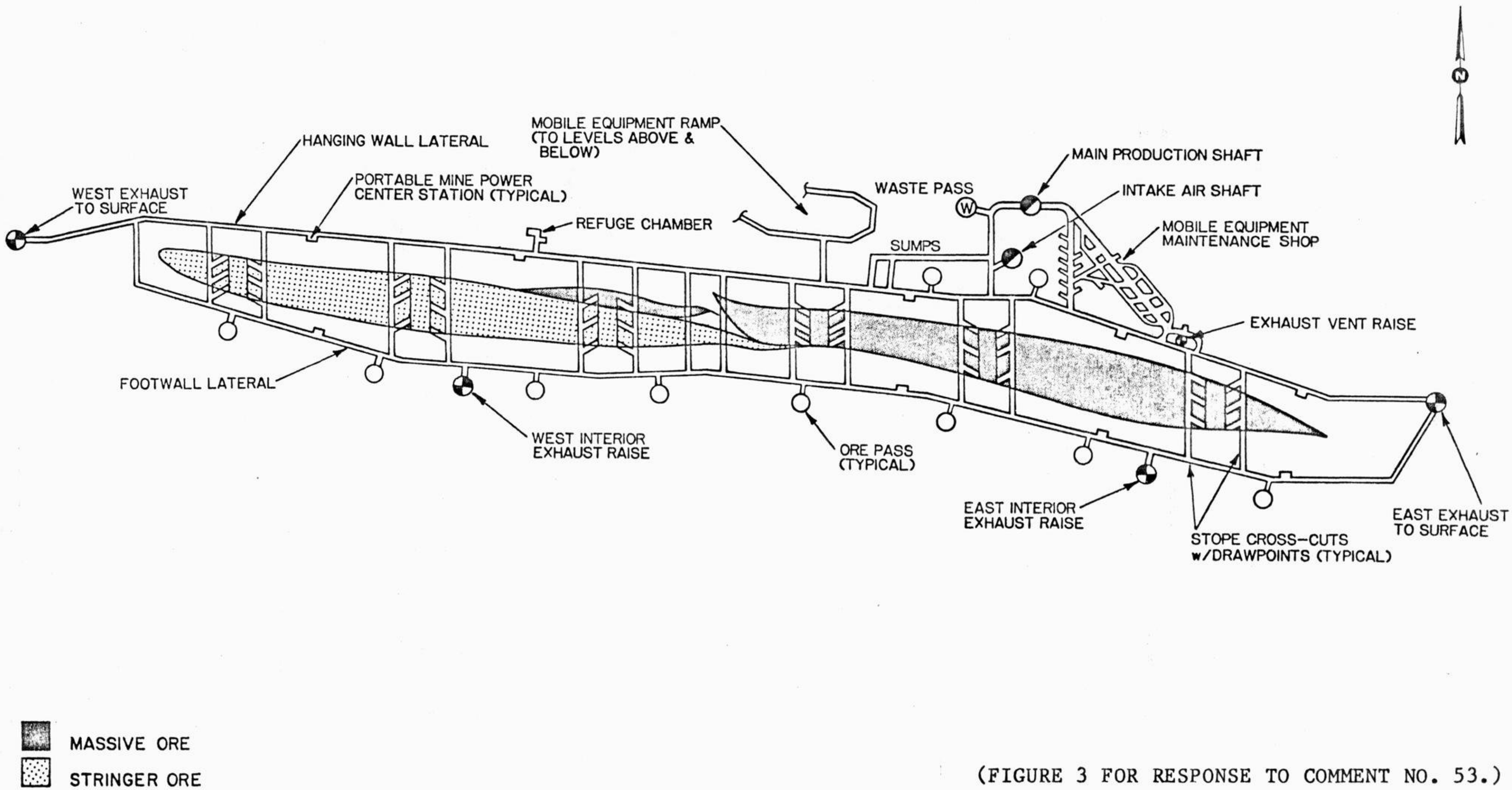
(FIGURE 2 FOR RESPONSE TO COMMENT NO. 53.)

CRANDON PROJECT

CONCEPTUAL CROSS-SECTION

(LOOKING WEST)

NOT TO SCALE



MP-125

(FIGURE 3 FOR RESPONSE TO COMMENT NO. 53.)

Typical Representation: Refinements May Be Made During Final Engineering

EXXON MINERALS COMPANY
CRANDON PROJECT

TITLE
MAIN MINE LEVEL (350m) CONCEPTUAL PLAN

SCALE NONE	STATE WISCONSIN	COUNTY FOREST

DRAWN BY	DATE	CHECKED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	EXXON	DATE
DRAWING NO FIGURE 1.2-5		SHEET OF	REVISION NO